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A BRIEF HISTORY OF EUROPEAN UNION RESEARCH POLICY

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A Brief History of European Union Research Policy

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PREFACE

This journey through the evolution of scientific and technological co-operation in the shaping of the European Union is above all a response to the need to preserve the memory of these events.

At a time of reflection on the ways and means of future developments, a knowledge of past successes and failures, of the different forces which can advance or hold back this sector, can make a contribution to our better understanding of the complex framework in which we must set out our new aims.

This was a difficult undertaking, both because of the quantity and variety of the documentation, and because the events in question are in the very recent past.

The result is an important first contribution for which we must thank the commitment and intelligence of Luca Guzzetti. He has produced a systematic account of the data and material relating to the development of European policies, and has presented this information within the political and economic context in which research decisions were considered. His work forms an excellent basis for further analysis and study.

One of the merits of this work is to uncover the presence of two fluctuating tendencies throughout the history of research policy.

The first can be seen in the choice of means of co-operation: a choice between intergovernmental mechanisms, through the creation of institutions (CERN, EMBL, ESA, ESO etc.) and programmes (EUREKA, COST etc.) which bring together the Member States, and Community mechanisms via the development of the Framework Programme and the activities of the Joint Research Centre.

The pendulum has swung between these two options, and today the fabric of European policy is complex and flexible. This is certainly a result of the differences of outlook which affect our cultural and political visions of the future of Europe. However, it is also a reflection of the complex nature of research in industrialised societies, in which many players pursue differing objectives. This could be a fruitful element in the growth of co-operation, and should of course be borne in mind in any systematic research policy at European level.

The second of these fluctuating trends can be seen in the differing aims of research. While some research is directed to industrial ends (for example the initial EURATOM programmes, or the space programmes), there are also programmes in support of basic research (such as research in nuclear physics, or the researcher mobility programmes).

Here too the pendulum has swung in response to differing views of the proper balance to be established between competition and co-operation in industrial policy. The development of research programmes has been correspondingly influenced by their relative distance from the market. Where to draw the line between co-operation and competition remains a central issue for research policies on a European scale.

However, within this fluctuating picture the pragmatic, functionalist model has proved effective. The geopolitical equilibrium in which the construction of Europe was begun and developed has also played an important part, especially during the initial phase. We have thus moved forwards, consolidating and widening the Community's involvement. The financial dimension, and the wide range of actions under the last Framework Programme are proof of this.

Today the situation has changed. With the altered geopolitical balance comes the problem of whether, in this new context, it is still possible to sustain a pragmatic approach, and how this may be achieved. A first analysis suggests that the need to increase the competitiveness of production might be a new spur to action. This conviction has inspired the proposal for an increase in joint actions, under a previously unapplied part of the Treaty. This is the question with which this volume closes.

Finally, I would like to thank Luca Guzzetti for his involvement and for his excellent and stimulating contribution. The issues raised in this book are at the heart of a meeting of the European Science and Technology Forum, entitled "The History of European Scientific and Technological Cooperation", which takes place in Florence, 9-11 November 1995, and at which many other collaborative scientific and technical ventures are discussed. I hope that these initiatives will stimulate a reflection on the importance of the history of national and European scientific institutions, and their place in the history of science and technology.

PROF. ANTONIO RUBERTI

Rome, October 1995

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My thanks go first of all to Professor Antonio Ruberti, European Commissioner responsible for research and education , who provided the idea for this book and who saw in it the nucleus of a memoir of what has been achieved and discussed in the area of scientific and technological research over more than 40 years of Community life.

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LUCA GUZZETTI

Brussels, October 1995

TABLE OF CONTENTS

CHAPTER ONE

EURATOM

1. The Prehistory of Community Research (1948-1958)

We are so accustomed to thinking of the post-war reconstruction of Europe in essentially economic and political terms that it is easy to forget or to undervalue those aspects of European reconstruction which are linked to science and technology. During the 1950s, interest in scientific and technological research sprang from the requirements of two different groups. On the one hand, governments saw the control of energy sources as the key to political stability and industrial development. Political attention was focused on two sources of energy: coal, the traditional source, and nuclear energy, which was regarded as the energy source of the future. In their different ways, the development of each required scientific and technological involvement. On the other hand, the European scientific community, with the support of some of those responsible for policy making in this area, asked national governments to provide new structures for research which would enable Western Europe to regain the ground which it had lost to the superpowers, and to the United States in particular. Given the costs and the complexity of research infrastructure and the limited economic resources available to set up and maintain them, it was soon proposed that national governments should come together to collaborate on joint projects.

The interests of scientists and politicians converged, and during the 1950s this led to the birth of several organisations with certain supra-national characteristics: the objectives of some, such as the European Coal and Steel Community (ECSC) and EURATOM, were primarily economic and political, and only secondarily technical or scientific; others, such as the European Organisation for Nuclear Research (CERN), were dedicated to pure research. Like all research bodies of the time, in Europe as in the United States, they were organised strictly by sector, which explains, among other things, why the Treaty setting up the Common Market made no provision for a research and development policy, but referred solely to agricultural research. The scientific and technological activities of the ECSC, the EEC and EURATOM, which were at first rigorously separated, form the nucleus of Community research, which is the subject of this book, whilst the importance of CERN, apart from its excellence in the field of high-energy physics, lies in its being the first example of a scientific organisation at a *European* level. CERN is an intergovernmental institution with no formal relations with the European Community[1], but the circumstances of its founding are to some extent linked with that of the Community, and CERN itself represents an important element in the general European integration process.

1948 was an important year in the political evolution of Europe. April saw the foundation of the Organisation for European Economic Co-operation (OEEC), the primary task of which was to manage the economic aid provided under the Marshall Plan. In May a Congress at the Hague brought together around seven hundred and fifty people, delegates and observers, from almost all the countries of Europe, to call for a united Europe. These two events are representative of the two principal forces which were urging greater unity upon Europe. On the one hand, the United States hoped that the political and military strengthening of Western Europe (NATO would be founded in 1949) would provide a guarantee against the possible expansionist ambitions of the Soviet Union; on the other, many Europeans, who had seen two wars break out on the Continent and rapidly spread to the rest of the world, saw the reconciliation of France and Germany and the suppression of nationalism as the best hope of a peaceful and prosperous future, a future of freedom and democracy in which totalitarianism would find no place.

In the immediate post-war period, in a Europe which was physically and morally in ruins, science and technology were not major government preoccupations[2]. However, in the eyes of some pro-Europeans and scientists - and in many cases these two categories coincided - scientific co-operation could make a contribution both to reconstruction and to uniting the continent. The primary objective of the Council of Europe, created in 1949 at the instigation of the Hague Congress, was to encourage the co-operation of Member States in legal, social, administrative and *scientific* affairs. This reference to science was due to the presence in the European Movement (EM)[3] of a number of influential science administrators, including Raoul Dautry, who had been the French arms minister before the war and general administrator of the Commission à l'Energie Atomique (CEA) since 1945. It also accorded with various initiatives which physicists such as Pierre Auger and Edoardo Amaldi were undertaking both at national level, in France and Italy, and at a European level through contacts with colleagues in many countries. The Council of Europe will play a very marginal role in the field of science and technology, but as a first debating chamber of Europe it will help to bring about other initiatives. One of these was CERN.

More concrete proposals for the setting up of European scientific laboratories were put forward at the European Conference on Culture which took place in Lausanne in December 1949 at the instigation of Denis de Rougemont and the European Movement. A subcommittee of the Conference dealt with scientific matters, and at the end of its deliberations suggested that stronger ties were needed between the research organisations of the various European countries, and proposed the creation of a European Institute for nuclear physics to study its applications in daily life. The project was still somewhat ill-defined, but Dautry proposed to link nuclear research to industrial development which would exploit the new source of energy: "One day, perhaps not twenty years hence, the material life of Europe will no longer be based on millions of tons of coal but on a few tons of uranium. By this time the physiognomy of the world economy will have changed, and if European industries are condemned to use today's sources of energy, they will have no choice but to close down."[4] As we shall see in the next section, very similar arguments can be found in the proposals which lay at the origins of the European Atomic Energy Community.

The choice of nuclear physics as the priority area in which to concentrate European scientific research reflected the spirit of the times, which was profoundly influenced by the myth of the atom, the new symbol of progress, power and prestige. For physicists, the atom represented a vast and largely unexplored territory at the frontiers of research, the study of which required finance beyond the means of any single European country. For governments, this was the branch of research which offered the greatest scope for important and radical developments in the military field and in energy; but for these very reasons, nuclear research touched areas considered to be of vital national interest and thus it seemed at first to be a very poor candidate for research at a supra-national level.

The turning point, which led some years later to the establishment of CERN, was the new American nuclear policy. After the Soviet nuclear tests in 1949, a policy based on absolute secrecy in all areas of atomic research had lost much of its meaning and the possibility arose that scientific collaboration with Western Europe could have valuable results both technologically and politically. The new American position was put forward in Europe by Isidior I. Rabi, the American representative at the UNESCO General Assembly in Florence in June 1950, when he declared that after economic aid and military co-operation, the time had now come for the United States to make its contribution the scientific renaissance of Europe.

Rabi's proposal was very vague both as to how this potential collaboration might come about and what areas it might cover, attesting only to the American willingness to support a future partnership with European countries in the field of science. However, he succeeded in stimulating European moves to lessen the existing gap in nuclear physics between the two sides of the Atlantic, following the United States on a path which during the course of the war had transformed physics from an academic study into a "big science" requiring huge investment. The initiative was taken by Pierre Auger, who together with other scientists and science administrators, drafted a proposal for an initial project to build the most powerful particle accelerator in the world, surpassing the energy levels which were expected to be reached by the Bevatron (6 GeV), which at that time was under construction at Berkeley. In 1951, the project grew still more ambitious, proposing the construction of two installations, a small

synchrocyclotron and a proton synchrotron more powerful still (10 GeV) than was originally proposed.

At the European level, meanwhile, the political situation was profoundly changed. On 9 May 1950, the French Foreign Minister, Robert Schuman, suggested placing both French and German production of coal and steel under a single authority, inviting other European countries to join the initiative. The plan, inspired by Jean Monnet, was to create a supra-national body which, unlike the Council of Europe, would have real powers, although in a limited economic field. According to what came to be called the functionalist method[5], the creation of common interests and practical solidarity between the countries of Europe would lead to increasingly close political links, and potentially to some kind of federal or confederal unity. Belgium, France, Italy, Luxembourg, the Netherlands and the German Federal Republic thus set up the European Coal and Steel Community (ECSC), under the Treaty which came into force in July 1952. Although the objectives which the new Community set itself were only to be attained in part, and in some instances not at all, the ECSC remained a useful example of what could be achieved by European co-operation in economic and political fields.[6]

The Community also had some limited research objectives. Article 55 of the ECSC Treaty gave the High Authority the task of encouraging research into technological and economic aspects of production and growth in the consumption of coal and steel; it was also to foster research into matters affecting safety at work in these industries. Although to a contemporary ear it may seems strange that research should be directed towards encouraging the "growth in consumption" of coal and steel, the drafters of the Treaty did not intend to promote market research in the sector. Their objective was rather to study the qualities of coal and steel, and new production methods, with a view to more economical production and to finding new applications for the materials. It must be remembered that, particularly by the end of the 1950s, European coal had to compete not only with imports from non-Member countries, which were often cheaper, but above all with oil and natural gas. The steel industry, too, saw a part of its market threatened by new products in light alloys and plastic materials. From 1955 onwards, the Community, through its specialised committees (mining technology, exploitation of coal, and steel technology research), offered its support to studies set up by the industry, co-ordinated research projects to avoid duplication, and directly financed a number of projects. This work was frequently carried out in collaboration with British public bodies. Examples of research undertaken in this first phase include the complete mechanisation of the excavation of galleries, the extraction of coal, the technical development of coking, testing different qualities of coke for use in blast furnaces, the technical processes of rolling and the irradiation of flames. In collaboration with the International Standards Organisation (ISO) the High Authority promoted the adoption of European standards (*Euronorm*) for the products of the iron and steel industry, and participated in the compilation of a Metallographic Atlas. In the fields of safety, hygiene and health at work, the Community set up studies into matters such as escapes of fire-damp in mines, which were at that time a cause of many serious accidents; industrial diseases such as silicosis; and the atmospheric pollution caused by steel works ("red smoke").[7]

In July 1953, the governments of nine European countries, immediately followed by a further three[8], signed the Convention which set up the European Organisation for Nuclear

Research (CERN). However, the ratification of the Convention by some parliaments was put at risk in part by a widespread lack of enthusiasm for the process of European integration, and in particular by the unpopularity of proposals for a European army, which were being debated by national parliaments at the time. The idea of a European Defence Community (EDC) arose immediately after the outbreak of the Korean War (June 1950), when the problem of German rearmament became urgent. The question was no longer whether or not Germany might rearm, but simply what form this rearmament should take. The French Prime Minister, René Pleven, suggested the creation of an army made up of national divisions from each of the Member States of the ECSC, including Germany; the new international army should be placed under the authority of a council of ministers, a committee, and a European parliament. [9]

Five out of the six countries approved of this project. However, the European Defence Community project arose from a French initiative, and its rejection by the French National Assembly on 30 August 1954 marked its definitive abandonment, together with that of the project for a political Community which had developed from it. When the following month the CERN Convention was due to be ratified by France, the tactics adopted by members of parliament who supported the construction of the new laboratory were to dissociate the project from its *European* elements, underlining instead its *scientific* merits. They emphasised that what was at issue was "neither a movement for Europe nor a political movement, not the Cold War, not the European Defence Community, not the European Coal and Steel Community, still less the production of atomic bombs, but simply the construction of an important laboratory which France would find hard put to build on her own[10] ". These tactics worked, and the CERN Convention was finally ratified.

However, the history of CERN is linked, for good and ill, with that of the various Communities which were developing at the same time in Europe: CERN, as well as being a laboratory, was also part of those movements and initiatives, any connection with which was so strenuously denied in the National Assembly. Firstly, the ambiguities which existed between pure research in high energy physics and nuclear research in a broader sense had not been completely resolved. On the one hand, scientists advocating the building of the European laboratory had always tried to play down the political, military and ideological aspects of the project. They tried to avoid the association, which at that time appeared obvious and inevitable to a large part of public opinion, between nuclear physics and the "Bomb". At the same time, however, these same scientists exploited the interest of European governments in the possible long-term military applications of such ground-breaking research in atomic physics. Besides, the Cold War encouraged the Americans to support European initiatives in science. Similarly, there was no proposal to build a reactor, since the governments would in all probability have never been able to reach an agreement to do so; but interest in the energy aspects of nuclear studies certainly encouraged the setting up of CERN. Finally, the project had its pro-European side from the very beginning. In many countries this contributed to its approval, while in others, for example Great Britain and Sweden, it was explicitly rejected. [11]

From 1954 up to the present day, CERN has achieved extraordinary scientific success. This was especially true during the 1980s when many European scientists were awarded Nobel prizes for work carried out in Geneva. CERN has for many years formed a constant

point of reference for all technical and scientific initiatives at a European level. Although the European Communities have intervened relatively little in the field of basic research, whenever this has happened the example of CERN and its international role have always been kept in mind: "CERN acts not as a magnet, attracting eminent physicists and never letting them go, but rather as a pump in the circulatory system of scientific research, drawing in individuals on a temporary basis in order to return them to the system with enhanced knowledge and skills."[12] Many different metaphors have been used (that of a "catalyst" is the most common), but the role which the Communities have tried to establish for their own encouragement of basic research in various fields is very similar to that attributed to CERN.

The European integration process resumed half way through 1955, when the foreign ministers of the six ECSC countries met in Messina. An intergovernmental committee was set up under the chairmanship of Belgian Minister Paul-Henri Spaak, charged with examining the prospects for a European common market and for co-operation in certain economic areas. A year later the Minister presented his report in Venice. It was on the basis of this report that both the European Economic Community (EEC) and the European Atomic Energy Community, or EURATOM, would be created. The two communities were primarily economic in character, but also had political objectives, as the first President of the Commission of the EEC, Walter Hallstein, asserted in a famous declaration: "We are not integrating our economies, we are integrating our policies. We are not just dividing up the furniture, together we are building a new and more spacious house". From the beginning, science and technology were essential to the work of the Atomic Energy Community, whilst their role in the EEC, if we exclude the agricultural research provided for by Article 41, did not develop until the 1970s. Our attention therefore now turns to nuclear research.[13]

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2. THE ORIGINS OF EURATOM

The European Atomic Energy Community (EAEC), better known as EURATOM, came into being in Rome on 25 March 1957, created by the six European countries (Belgium, France, Italy, Luxembourg, the Netherlands and West Germany) which had formed the European Coal and Steel Community (ECSC) in 1952. After the failures in military (EDC) and political (EPC) integration in the mid 1950s, this was an attempt to relaunch the European ideal along strictly functional lines: economic integration was seen as a means of furthering and eventually imposing political unity. The Action Committee for the United States of Europe, founded and led by Jean Monnet after he had relinquished the ECSC presidency, proposed the establishment of economic integration in what was known as little Europe or the Europe of the Six, along both horizontal and vertical lines. Horizontal integration was to be based on a common market, while the vertical was to take in certain sectors of primary economic importance or probable rapid development: suggestions included energy in general, atomic energy, air transport, and postal services and telecommunications, with the prospect of setting up some kind of European technological Community.

Although with hindsight it may seem strange given the differing destinies of the two Communities, at the time of their creation the greatest hopes were placed with EURATOM, while the Common Market seemed to be an exercise that would be more awkward to arrange and altogether of lesser importance. If Monnet's Committee and a part of the French governing classes supported the proposals for integration sector by sector with particular vigour, the other Community countries led by Germany did not hide their inclination towards generalised economic integration. Thus both the Common Market and EURATOM were created. Pierre Uri described the compromise that was reached by suggesting that "in a certain sense, EURATOM was following one of the approaches of the Schuman plan: producing a common basis for development. The other approach proposed a limited experiment in integration, which might by appropriate modifications be transformed into more general integration. It is a fact seldom noted that the idea of combining the two approaches and of extrapolating from the second possibility to form a Common Market for the whole economic spectrum was in a way a by-product of EURATOM. It was a condition for Germany's agreement to the nuclear project, as Germany might otherwise have been unable to find any specific interest in an association with its partners in the coal and steel grouping, had integration gone no further. Conversely, it was interest in EURATOM that made it easier for French political circles to come to terms with the idea of the Common Market."[14]

EURATOM therefore represented another step in the construction of Europe. It is rather less clear exactly in which direction the step was taken. In the brief period between the presentation of the Spaak report in April 1956 and 1 January 1958, when the Treaty of Rome came into force, there was a radical transformation of the ends and the functions of EURATOM. From an instrument of industrial policy, EURATOM was transformed via its projects into an instrument of energy policy, and eventually into a scientific and technical research organisation in the nuclear sector.[15]

a) industrial policy

"A new technological revolution is in sight."Thus the intergovernmental committee set up by the Messina Conference for the European relaunch, chaired by Paul-Henri Spaak, heralded the entry of the use of the atom for peaceful ends onto the European scene. Indeed, the expectations did not merely centre on a new energy source, however promising. It was anticipated that nuclear science would give rise to a new technological and industrial revolution, which was to transform the whole productive system and the applications of which would extend to all sectors. Projects were therefore not merely aimed at acquiring competence in nuclear techniques, but rather at developing a group of technologies which would today be called "generic", promising countless areas of application, in many cases unforeseeable. The role which the atom was expected to fulfil was in many ways comparable with that played earlier by steam and that which information technology has actually had in the second half of the 20th century.

This enthusiasm for the atom was in large part the fruit of President Eisenhower's "*Atoms for Peace*" speech in which he announced the USA's willingness to favour nuclear development for non-military ends. The American commitments were restated and made more concrete during the first International Conference on Peaceful Uses of Atomic Energy held in Geneva in August 1955. The prospects afforded by nuclear power seemed extraordinary to most contemporary observers, and certainly not to supporters of a new European Community alone. Even the most fervent opponents of EURATOM and any such move to delegate national sovereignty did not dispute the extraordinary potential of nuclear power. Indeed, for the most ardent nationalists it was precisely that potential, in both military and economic terms, that meant it was imperative for any development to take place under the strictest state control. [16]

In the Spaak report, the nuclear sector was presented as forming part of a grand future, and an area in which Europe at that time lagged well behind the great nuclear powers (the USA, the USSR and Great Britain), but could certainly catch up as soon as the Six decided to co-operate. One of the major advantages presented by the sector was that, in appearance at least, the Community was able to start from scratch, without having to risk divisions over existing interests: "The negotiators of the EURATOM Treaty saw the nuclear sector as a kind of "virgin territory", uncontaminated by the protectionist spirit of established industries, on which it was necessary to operate on a European scale right from the outset."[17] This belief was shown to be false quickly enough, but it cannot be denied that the situation was demonstrably different from that with which the European Coal and Steel Community was faced at the time, and that was the only experience of the "Europeanisation" of an economic sector that had so far been attempted. In the coal and steel industry, in fact, the established interests had survived the war more or less intact, particularly in the form of "cartels", and had proved to be a practically insurmountable obstacle to the liberalisation of the market at a continental level. [18]

Meanwhile, however, nuclear programmes both military and civil were developing rapidly at a national level. France was the largest power in the Europe of the Six, from both a military and political point of view, and her nuclear projects were ambitious: civil development within the Community, military research outside it, leading to the development of her own *force de frappe*. A

member of both NATO and the Western European Union, Germany had renounced the use of atomic energy for military ends; in 1955, she was allowed to resume nuclear research for non-military purposes, and entry into EURATOM both enabled German industry to pursue civil nuclear research, and provided safeguards, most importantly for France and the United States, together with the opportunity to inspect all such developments. As for Italy, Belgium, the Netherlands and Luxembourg, for these countries the value of EURATOM lay in the often repeated assumption that their size made it impossible for them to pursue nuclear research independently, so that they could only benefit from co-operation within the Community. It was a situation of which, some years later, a commentator observed: "The basic overheads of science have to be met separately by each state, with the result that there is much useless duplication and subthreshold effort. The situation is much the same as if, in the United States, each state of the Union were to attempt individually to provide the whole apparatus of the contemporary scientific effort."[19]

The interests of the United States, the chief ally of the six Community countries and the great supporter of the foundation of EURATOM, only partly coincided with those of Europe in general and of France in particular. The USA expected the birth of a European Community in the nuclear sector to encourage the political and economic strengthening of Western Europe as an anti-Soviet measure, to channel European research exclusively towards peaceful uses of the atom, and eventually to provide a new market for American industries. It must also be noted that, in economic terms, the European market was much more favourable to the relatively swift development of a nuclear-power industry because the costs of traditional fuels were much higher in Europe than in the United States.

In a wide-ranging nuclear industrialisation project, the first step must be to build plants suitable for the control of every stage of the nuclear fuel cycle, and indeed the Spaak report proposed the building of an installation for the isotopic separation of uranium, and another for the chemical processing of irradiated uranium. The commissioning of this first type of plant seemed necessary in order to ensure Europe's independence from the United States, which held a monopoly of enriched uranium and of the know-how necessary for its production. However, the question was not merely political and economic but also had military implications. Enriched uranium, as well as being the fuel for the most common types of reactor, was also one of the essential elements for the production of the atomic bomb. Under these circumstances, the American response, advocated in Europe by Louis Armand, was very prompt: why spend large sums of money on such development when Europe did not yet have its own nuclear power stations and the United States was willing to provide all the enriched uranium she might need?

When EURATOM was set up, the plan to build an isotopic-separation plant was abandoned. However, although it had initially excluded the possibility, the Treaty left it open to Member States to pursue individual nuclear programmes with military aims if they wished to do so. France was thus able to set up her own programme of research and development to build an isotopic separation plant, which eventually led, though not until 1967, to the entry into operation of the installation in Pierrelatte; this gaseous-diffusion plant, like the analogous English plant in Capenhurst, would be used almost exclusively for military applications. The project of building a plant for civilian use would not be seriously reconsidered until the beginning of the 1970s, when new ultracentrifuge techniques for the enrich-

ment of uranium became available as the result of work in Germany, Great Britain, and Holland, which set up the Urenco organisation. In 1973, Belgium, France, Italy and two non-member States, Spain and Sweden, set up Eurodif to build a diffusion plant, which came on line in 1979.

As to the other installation, for the reprocessing of fuel, this was established at a European level but by a different organisation, the European Nuclear Energy Agency (ENEA) set up by the seventeen member countries of the Organisation for European Economic Co-operation (OEEC). This project, set up in December 1957, consisted in the building of a small joint installation at the Centre for Nuclear Studies in Mol, Belgium. The plant was to reprocess natural uranium and lightly enriched uranium from the nuclear establishments of all the member countries. The European Company for the Chemical Processing of Irradiated Fuels (Eurochemic), of which all six EURATOM countries were members individually (although neither the Community as such nor other ENEA countries such as Britain were), completed the construction of this plant in 1966.

b) Energy Policy

When the representatives of the Six signed the Treaty of Rome, the report which they had commissioned from Louis Armand, Franz Etzel and Francesco Giordani on the goals which the new European Atomic Energy Community (EAEC) should set was for the most part ready. The three, known to history as the "three wise men", identified the production of electricity as the objective of EURATOM. Their analysis in *Un objectif pour EURATOM* takes as its starting point the supposition that, with the end of the coal era, Europe was becoming massively and increasingly dependent on external fuel sources. Importing hydrocarbons was not only expensive, creating balance of payment problems throughout Europe, but worse still it seemed likely to become an increasingly uncertain process. The recent Suez crisis had highlighted the risk that oil supply could be jeopardised by political factors. The proposed solution was that EURATOM should launch a major programme to build nuclear power stations which would enable Europe, within ten years, to produce about 15 million kW of electricity from nuclear sources.

The estimate, which proved to be entirely unrealistic, was endorsed by the American authorities, who promised technological and scientific assistance to the nascent Community. The analysis that showed the need to develop energy sources which could be produced directly in Europe was held to be fundamentally sound by the governments of the Six. Certainly even the "three wise men" realised that the economic cost of such a development would be very high, but they foresaw, on the basis of the data presented in their report, that with the construction of large nuclear power stations Europe would eventually be in a position to guarantee a supply of energy which would prove both secure and, in the long run, economical. Not all the estimates of the future energy requirements of Europe, and of the relative costs of the various sources, predicted such a rosy future for nuclear energy, even at the time; but it must be remembered that all these predictions were to a great extent "guesstimates", based on a very limited acquaintance with the existing situation, whilst faith in the new nuclear technologies was absolute.[20]

Paradoxically, the decision, which was essentially a political one, to set up a vast programme of nuclear energy production was taken as a result of the Suez crisis, whilst those

very events delayed the European governments' realisation that in years to come petroleum would be available in ever greater quantities at decreasing prices. This would radically affect the practicality of the nuclear projects. The Europe of the Six, however, was not alone in misjudging the future availability of energy; in Britain, the Western European country with the most advanced nuclear programme, the Suez crisis also encouraged activity in the new nuclear sector.

The Messina Conference anticipated that the European Economic Community would have a comprehensive energy policy, and the Spaak report suggested that the co-ordination of such a policy should be the responsibility of the High Authority of the ECSC[21]. However, neither the EEC nor the EURATOM Treaty makes any mention of energy policy, so that what little was achieved in the coming years in this sector was the responsibility of three separate Communities: the ECSC for coal, the EEC for oil, and EURATOM for nuclear energy. The first timid steps towards an energy policy which would take account of all the available sources were not taken until the 1970s.

In practice, by accepting the report of the "three wise men" the founding countries of EURATOM put aside the idea of furnishing the Community with a solid scientific and technological base for a European nuclear industry which could prepare for a future in which electricity from nuclear sources would be economically appropriate. They chose instead to build nuclear power stations immediately. In November 1958, EURATOM and the United States government signed a co-operation agreement in which the two parties undertook to "bring into operation within the European Atomic Energy Community (EURATOM) large-scale power plants using nuclear reactors of types on which research and development have been carried to an advanced stage in the United States, having a total installed capacity of approximately one million kilowatts of electricity by December 31, 1963 (except that two reactors may be selected to be in operation by December 31, 1965), and under conditions which would approach the competitive range of conventional energy costs in Europe."[22]

c) Research policy

The development of nuclear research had a central place in the EURATOM Treaty, and in time it became clear that this was the only task which the Community was able to carry out. Euratom's sectoral approach was in line with that of the other two Communities: research on coal and steel in the ECSC, and exclusively agricultural research in the EEC. Although limited to one sector, Euratom's research was much more wide-ranging, since, following the proposals of the Spaak report, the Community had to deal with the development of an industry which did not yet exist. This approach was, however, contrary to the view expressed in the report of the "three wise men": "nuclear energy has emerged from the scientist's laboratory and passed onto the engineer's drawing board ... it has now reached the industrial phase."[23] The nuclear industry was presented as a fully mature sector, the further development of which was a matter of quantity and which only required skills which, however specialised, lay fundamentally within the field of engineering.

Article 4 of the EURATOM Treaty gave the Commission, the executive arm of the Community, the task of promoting and facilitating the nuclear research of Member States, and integrating them through the implementation of the Community's research and training programme. In Euratom's first official documents[24] we find some of the aims of this re-

search and training programme listed: to avoid duplication, to co-ordinate national contributions, to cover gaps in national programmes, to standardise measures and equipment, to promote the exchange of ideas and methods, but also its own research at the Joint Research Centre (JRC)[25] and activities aimed at directing research. To achieve these objectives it was necessary "for the Community to be aware of these activities to enable it to assist in co-ordinating and directing such efforts to increase their efficiency".[26] Some of the essential tasks listed in Article 5 of the Treaty relate to the role of the Commission as a clearing-house: in order to avoid duplication and fill the gaps, the Commission invited all parties involved in nuclear research at a national level to forward details of the work they had undertaken and their future projects, so that it could organise their co-ordination.

The principal fields in which research should be concentrated are indicated in the first annexe to the EURATOM Treaty. There are eight vast areas: raw materials, the physics of nuclear energy, the physical chemistry of reactors, the processing of radioactive material, applications of radioelements, studies of the harmful effects of radiation on living things, equipment, and the economic aspects of energy production. This was a very broad programme, covering all aspects of nuclear research. A large number of specific projects were then identified for each subject area, and in the future, Member States were to complain that EURATOM tried to cover too many research fields, and dissipated its efforts. The validity of this criticism depended on what role was envisaged for the Community, and what its principal aims were thought to be; it was on precisely these points, however, that it was never possible to be clear. The Treaty stipulated that Euratom's programmes must complement national ones, but EURATOM also tried to provide direction and stimulus in a way which the governments of the Six rarely appreciated. "How in these circumstances can a common effort be conceived? As an extension of national projects, as a complement to the collective activities of participating countries, or as the co-ordination of national programmes?"[27] The endeavours of EURATOM, in accordance with the Treaty, went in all three directions (co-ordination, promotion and complementation of national projects), but internal restrictions and external obstacles limited its chances of success in each of them.

EURATOM was set up with all the characteristics of a state-controlled enterprise, with a centralised decision-making process. It had little contact with the industries which were to build the power stations or with the electricity companies which were to be the eventual clients, nor did it have any clear development policies. The impression is that when EURATOM was set up it was with only the haziest understanding of the fact that fundamental decisions with long-term consequences would have to be taken, and without sufficient appreciation of the economic and military interests which were developing in the sector. Rather it seems that the founders of EURATOM believed that the nuclear future had already arrived, and that the important task was to give it a European identity: EURATOM was an empty box which the presumed certainties of the nuclear age would quickly fill. Only thus can we explain the fact that within two short years the Community had completely changed its aims, from seeking to become the cornerstone of a new technological revolution, an instrument for an ambitious energy policy, to becoming a simple research agency, to which Member States entrusted, as we shall see, their most uncertain projects.

d) The Institutions and Aims of EURATOM

The institutions of EURATOM were very similar to those of the European Economic Community and the European Coal and Steel Community. Two of its structures, the Assembly and the Court of Justice, were common to the three Communities. The first was made up of members of the national parliaments "on loan" to Europe, and had very limited powers: it could express its opinion of the projects and decisions of the Council, approve the budget and possibly censure the Commission. The second functioned as a "constitutional court" in relation to the three Treaties establishing the Communities: "In its essentials, the rules of procedure which the Court applies in handling such disputes are analogous to those applying at the highest level in the judicial systems of Member States. The Court's judgements do not merely settle individual disputes but at the same time establish the interpretation of contentious clauses in the Treaties, on whose precise application it rules."[28] Common to the EEC and EURATOM only was the Economic and Social Committee, a consultative body composed of representatives of various aspects of economic and social life (workers, employers, and various organisations linked to the employment world).

The Council of EURATOM, the "legislative" body of the Community with decision-making powers, was made up of representatives from Member States, generally ministers. The Treaty established that, depending on the matter at issue, the Council could take decisions by simple majority, by qualified majority, or unanimously. However, the French insisted on the right of every government to a veto and that all decisions therefore should be unanimous. This approach was formalised in the so-called Luxembourg Compromise and prevailed throughout the 1960s. The Commission was the executive arm of the Community, charged with guaranteeing the correct application of the Treaty and with the power to make proposals to be forwarded to the Council for approval. The Commission was made up of five members from the Member States (excluding Luxembourg) chosen jointly by the government concerned. Nevertheless, according to article 126, the members of the Commission were to carry out their functions independently in the interests of the Communities as a whole. The Commission was assisted by a Scientific and Technological Committee, a consultative body which gave its views on various matters including the implementation of the research and training programmes presented by the Commission. Finally there was a Supply Agency, with the pre-emptive right to buy the nuclear materials for the Community, the exclusive right to enter into contracts for their supply, and the task of making both commercial and security inventories.

One of the general aims of the Community, in the nuclear field as elsewhere, was the creation of a real common market in which products, equipment, capital and labour could circulate freely. The chief specific aims of EURATOM, set out in article 2 of the Treaty, fell into four main categories: research and the dissemination of knowledge (an issue which will be more fully covered later); investment in the development of the nuclear industry within the Community; the laying down of regulations, particularly on health matters; and public administration at the international level, that is the supervision and management of nuclear fuels and the maintenance of relations with non-member states and internal organisations.

A nuclear industry did not yet exist in Europe, and EURATOM had to promote the nuclear investments of public and private bodies in Member States, co-ordinating and guid-

ing them; the aim was the establishment of the basic structures necessary for the development of nuclear energy in the Community (Article 2). Although EURATOM could not interfere in the investment decisions taken by States or businesses, these were obliged to inform EURATOM of their investment plans in the hope that investment could be influenced by a continuous flow of information throughout the continent, and by close contact with the other major Western nuclear powers. A more direct means of intervention was afforded by the Joint Undertaking. Whenever the Council of EURATOM recognised a project in the nuclear sector as being of central importance to the development of the European nuclear industry, it could help to finance the undertaking and could concede a number of advantages, from tax exemptions to easing exchange regulations. Nevertheless, after it was decided not to go ahead with the projected creation of two Community plants, for the enrichment of uranium and the processing of irradiated fuel, the term "Joint Undertaking" was for many years hardly used, except to cover a few Community participations in industrial initiatives at a national level. It was not until 1978, with the creation of the Joint European Torus (JET), that the instrument of the Joint Undertaking was used again (this time for R&D purposes) and its value demonstrated.

Like the operation of nuclear power stations, the production, transfer and stockpiling of radioactive materials can create public health problems both for the public at large and especially for the workers involved. The EURATOM Treaty anticipated that the Commission, working with experts in public health, would fix basic standards of health protection from the dangers of ionising radiation for the population and the workforce, and expected these standards to be implemented in the national legislation of the Member States, establishing uniform criteria for all European industries. These basic standards concerned maximum admissible levels, the maximum exposure and contamination admissible and the fundamental principles of health supervision for workers. The Treaty merely called for such standards to be established, but in practice their definition entailed much scientific research.

As has been said, under the Treaty the provision of essential materials for the nuclear industry (minerals, raw materials, and fissile material in particular) was entrusted to a special agency under the supervision of the Community, which was to oversee the fair distribution of such materials to all the bodies which requested them. The Community was to own all special fissile material whether produced or imported by a Member State, and was to guarantee, through security checks, that nuclear materials were not diverted from the peaceful ends for which they were intended. However, when speaking of the Supply Agency the conditional tense is always required: it was never put in a position to undertake its tasks fully, and in practice governments never recognised the monopoly control of nuclear materials that the Treaty conceded to it. Finally, EURATOM was empowered to make agreements and sign conventions with non-member states in order to favour the development of the Community nuclear industry; however, the Treaty gave the same prerogative to individual Member States, so that from the beginning EURATOM was not able to present itself to the rest of the world as the sole spokesman for the Six in nuclear matters.

If we compare the tasks of EURATOM with those of the Atomic Energy Authority (AEA), set up by the British government in 1954,[29] we can observe a number of significant dif-

ferences, bearing in mind that Great Britain was the principal European nuclear power at the time and had the most advanced programmes of nuclear research.The British body was made up of three principal groups concerned respectively with industry, military research and civil research. The Industrial Group, which would subsequently be subdivided into separate groups for production, development and engineering, and reactors, was in practice the customer, together with the Central Electricity Generating Board (CEGB), nationalised in 1947, of the nuclear power stations, the construction of which was entrusted to groups of national businesses. Similar policies were pursued by the French Commissariat à l'Energie Atomique (CEA), whereas EURATOM, which was greatly influenced by the German government's suspicion of all forms of state intervention, could play no part in the building of power stations and could only support their construction. As for military research, it was explicitly vetoed by the agreements which set up EURATOM, and among the Six only France had a nuclear programme with military aims. Furthermore, among the tasks of the AEA was the building of plants for the enrichment of uranium and the processing of irradiated fuel, two projects which, as we have seen, EURATOM had abandoned prematurely. The only roles common to both EURATOM and the AEA were their research and development programmes, their role in the training and education of nuclear personnel, and the responsibility for the supply of fissile material to their respective industries.

Another instructive comparison is with the European Nuclear Energy Authority (ENEA), which was set up within the OEEC at more or less the same time as EURATOM, but with a radically different organisational structure. Firstly, ENEA did not have its own research and development centres, but simply promoted the creation of joint projects between different countries, and was responsible for liaison between the various research institutes involved in such contracts. Secondly, membership of the organisation did not carry with it the obligation to take part in all its joint enterprises: each government could decide individually which projects were of interest, and which it wanted to support financially. This was what came to be known as an "*à la carte*" programme, to be used by EURATOM in its moments of gravest crisis. It would also serve as a model for other European programmes for scientific research and technological development.

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3. RESEARCH AND THE FIRST FIVE-YEAR PROGRAMME (1958-1962)

Article 215 of the EURATOM Treaty set out an initial programme of research and training for the next five years, with a budget of up to 215 million U. A. [30] The programme was divided into two parts: the first concerned the Joint Research Centre - research by direct means. The second involved the use of external contracts - research by indirect means. The Joint Centre was to consist of general laboratories - chemistry, physics, electronics and metallurgy; special laboratories, for work on nuclear fusion, the isotopic separation of different elements from uranium 235, prototypes of mining equipment, mineralogy and radiobiology; and a measuring bureau specialising in nuclear measurements. The Joint Centre was to provide documentation, information and training in the nuclear sector, to build prototype reactors and to initiate research into high flux reactors. External contracts were to cover areas which complemented the Centre's research into nuclear fusion, the isotopic separation of different elements from uranium 235, physics, chemistry, electronics, metallurgy and radiobiology, research at national high flux reactors and at joint undertakings where necessary. The 215 million U.A. were allocated as follows: 66 million for laboratories, equipment and infrastructure at the Joint Centre; 8 million for documentation, information and training; 60 million for prototype reactors; 34. 4 million for the high flux reactor; and 46. 6 million for external contracts.

a) The Joint Research Centre

One of the basic aims of EURATOM was to enable the Europe of the Six to fill the gaps in its nuclear knowledge and know-how. At least at first, Euratom's activities were concentrated on research and training in the nuclear sector, and the addition to the Treaty of an annexe detailing a research budget for the next five years demonstrates the urgency of the Community's need to pursue these ends. The sum made available for this research, although considerable, nevertheless represented less than a quarter of the total sum that the individual Member States were investing in the same research areas. These obvious financial restrictions meant that the directors of EURATOM had to take certain significant decisions. Generally speaking, the choice was to "Europeanise", or to adopt for "European" ends, installations and laboratories which already existed or were under construction in the Member States. This policy was adopted for both the laboratories of the Joint Research Centre and for the high flux reactor project: although initially it was intended to build one from scratch under the aegis of EURATOM, in 1960 it was decided to make use of the experimental areas in existing nationally-owned reactors, or rather, to Europeanise national projects, which is what happened with the Dutch HFR. On the other hand, spending money available under the budget proved difficult too. The greater part of Euratom's investments date from after mid-1960; and sums from the first programme still appear in the budget of the second five-year programme. This delay in expenditure primarily reflects the slow decision-making process of the Member States, particularly with regard to the setting up of the Joint Centre. Another considerable problem which EURATOM faced was the non-availability of specialised personnel: scientists, engineers, and nuclear technicians were necessarily in limited supply in Europe,

given the newness of the field, and the Community had to compete with national governments to acquire this scarce human capital.

Having abandoned the idea of building a new European research centre from scratch, and faced with delays in the "Europeanisation" of the Italian centre in Ispra, it was decided to create a number of research centres scattered throughout the Six. The cost of this would be shared by EURATOM and the host countries: "It must be emphasised that through the agreements already in place or which will be reached, the countries concerned are making a considerable contribution to the infrastructure costs of the establishments situated on their territories. Thus the Community's intervention has not slowed the pace of national endeavours in the nuclear sector.This is particularly important, since the Community's action, far from aiming to replace national programmes, is designed rather to stimulate and integrate them."[31] The decision to make use of already existing national research centres served to emphasise the fact that the interests of EURATOM and the Member States were identical; it also saved both time and money.

The most important and largest centre was in Ispra. In July 1959, with the consent of the Italian government, the National Committee for Nuclear Research and EURATOM signed an agreement for the Europeanisation of the Ispra research centre, near Varese, which was then at an advanced stage of construction. However, the ratification of the agreement met with obstacles in the Italian Parliament; opponents accused the government of making a present to the other European countries without any return.The position was remembered by Felice Ippolito, then Secretary General of the CNRN:"According to both the letter and the spirit of the agreement, the centre at Ispra was to become a *joint* centre, and, therefore, also Italian. It was not true that we had given it to foreigners, as was claimed. The centre was passed to the Community, which was composed of six members, of which Italy was, at that time, the third most important after France and Germany."[32] Ispra was a general-purpose establishment, intended for all kinds of nuclear research; it was a true stronghold of science and technology, not unlike the more famous CERN centre in Geneva, endowed with offices, laboratories, and major installations, including the research reactor Ispra I, built by the Italians, the management of which was transferred to EURATOM on 1 March 1963. Ispra was also the headquarters of the European Scientific Data Processing Centre (CETIS), which used powerful computers to provide various services to the Commission and other Community institutions, and also to undertake research into machine translation, documentation systems and mathematics. As for the other JRC establishments, the agreement with the German government to build the Transuranic Elements Institute in Karlsruhe came into force in December 1960; the agreement which established the Central Bureau for Nuclear Measurements (BCMN) in Geel was signed by the Belgian government in June 1961; and a month later a similar agreement was signed by the Dutch government, assigning the establishment in Petten to EURATOM. However, no agreement was reached with the French government and the planned transfer of the research centre in Grenoble to EURATOM was abandoned. The scientific and technological personnel of the JRC was 1466 strong in 1961, with more than half working in Ispra.

b) External contracts and basic research.

As well as undertaking in-house research through the JRC, EURATOM financed and participated in research through various types of contract: this was what was officially known as "research by indirect means". During the period from 1958 to 1967, such contracts absorbed in total around 350 million U.A., more than half the entire budget for EURATOM for this period.[55] EURATOM had recourse to three kinds of contract: research contracts, contracts of association and contracts of participation. Under the first type, the Community entrusted the research to an outside body - whether a university, a laboratory or a company. This was the most common type of contract, and 850 of them were signed during the period in question, 414 of which were part of the first five year programme. However, they absorbed only 30% of the entire cost of the contracts, since they included research contracts lasting only a few months and worth only a few thousand U. A. EURATOM spent the remaining 70% of its contracts budget on contracts of association (participation agreements concern industrial activities, and will be discussed in the next session), although these were not explicitly provided for under the terms of the Treaty. There were only 70 contracts of association, but they were considerably larger. Through such contracts, EURATOM was able to participate in the national projects of Member States, of non-member states, and of international organisations: administrators, scientists, engineers and technicians from EURATOM took part in the work, of which the Community financed on average 40% of the total costs.

EURATOM, it is important to note, did not entrust research to outside bodies solely because it lacked its own research structures. The strategy of EURATOM required that nuclear development in Europe should evolve in the public and private centres of the Member States: the prime task of the Community was to stimulate and co-ordinate their efforts. Research contracts, therefore, had an intrinsic value to the Community, and were not necessarily directed towards studies which were immediately relevant to the industrial development programme. At the beginning of the 1960s two aims seemed equally essential: the acquisition of basic knowledge, and in particular nuclear know-how, on the one hand, and the development of reactors on the other.

Areas of basic research conducted under research contracts included low-energy physics, solid-state physics, metallurgy, electronics, isotopic separation, isotopic geology, and the chemistry of atomic energy (organic coolants, fuel reprocessing, waste processing, and the applications of radioisotopes). However, in Euratom's first research and training programme, two areas of study organised under contracts of association were clearly independent of the nuclear research linked to industrialisation: radiobiology and plasma physics. The first five-year programme assigned 3. 1 million units of account to the biological programme, which was initially divided into plant and animal radiobiology. Euratom's involvement began in 1959 with an agreement with the Nederlandsche Centrale Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO) in the Netherlands, for the study of illnesses caused by radiation in animals. Similar research was undertaken within the Community radiation protection programme. In 1961, a contract of association was signed with the Istituut voor Toepassing van Atoomenergie in de Landbouw (ITAL), another Dutch body, to study the genetic and somatic effects of radiation on plants, the use of radiation in preserving foodstuffs, and the behaviour of radioactive elements in the soil,

in plants, and in animals. In these studies the radioactive elements were used as markers, in order to follow their movements and measure their concentrations in biological systems. They also analysed the effects of the radiation itself, with a view to applications in agricultural genetics and in the field of food preservation[34]. From 1963, research undertaken under the EURATOM-ITAL agreement was able to make use of a reactor, called BARN (Biological and Agricultural Reactor Netherlands), specifically built for the irradiation of plants with slow and fast neutrons. Other agreements for co-operation were signed with numerous universities and research centres throughout the Community countries.

Although not yet committed to the construction of a major installation, EURATOM allotted 7.5 million units of account to work on controlled nuclear fusion. In 1959, EURATOM and the French Commission for Nuclear Energy (CEA) were already collaborating on a research programme into phenomena of strition, magnetic spectrums and plasma tubes. The following year, co-operation was extended to Italy, by means of a sub-contract with the National Committee for Nuclear Energy (CNEN). In 1961, another contract of association was agreed with the Institut für Plasmaphysik in Munich-Garching (the Max Planck Institute) for experiments into strition, the study of the physical properties of stationary plasma, research on high- intensity arcs, the study of various technological problems and theoretical research into numerous areas of plasma physics. In 1962, as well as renewing its contracts with the CEA (in Fontenay-aux-Roses) and the CNEN (in Frascati), EURATOM concluded two new contracts of association, each lasting three years, with the Stichting Fondamenteel Onderzoek van de Materie of the Netherlands, and the Kernforschungsanstalt des Landes Nordrhein-Westfalen, the headquarters of which were in Jülich, Germany. By now the EURATOM Commission was in contact with the chief centres of research into controlled thermonuclear fusion within the Member States, and set up a liaison group charged with overseeing the intensification of links between these laboratories via a continual exchange of information and discussion of the directions which research was taking. The objective of all these studies was the development of a reactor which would produce energy by fusion. In the first annual reports of EURATOM, this type of reactor was presented as the fourth generation of nuclear reactors, which once achieved would guarantee a supply of cheap energy for all time; however, as the years passed, the prospect of commissioning such reactors retreated, and research into fusion was redefined as basic research into plasma physics, rather than research into reactors.

Historical assessments of the research activities of EURATOM usually point to biological applications and the work on thermonuclear fusion as the only areas which enjoyed undeniable success. Such a judgement is ungenerous, and is adversely influenced by an entirely negative assessment of Euratom's industrial activities. It was not in fact true that the work on nuclear chemistry or metallurgy, for example, was at a low level or without results; but such research was closely linked to the development of reactors so that, although it was in many cases certainly capable of further development, it suffered from the general discredit into which the main projects fell. We can in fact say that all the research undertaken by EURATOM produced useful results,[35] and if only nuclear fusion and the biological research programme are listed as successes, this is primarily on account of their greater scientific "purity" and because they are not associated with the technology of the reactors. As regards fusion in particular, we must remember that this was the only area in which

EURATOM, from the beginning, was in a position to co-ordinate effectively all the main Community research centres. In this field, research would continue uninterruptedly and with great success throughout the years to come, thanks above all to the Joint European Torus (JET), which will be discussed in the next chapter.

c) Research into Reactors

In the 1950's and 1960s work was undertaken on three generations of reactors, which were known respectively as experimented reactors, intermediate or advanced reactors, and fast-breeder reactors. At the first Geneva Conference on the Peaceful Uses of Atomic Energy, in 1955, it was acknowledged that around a hundred different kinds of reactors were theoretically possible. In the following years, research in the field eliminated some possibilities, but opened up new prospects as well. The main choice, for EURATOM as for all the countries involved in nuclear research, was between the immediate commitment to the development of one specific type of reactor and wider-ranging research which would enable a more considered approach. Such choices must always be made when dealing with "big science" and technological projects which involve huge investment. However, the criteria for such decisions are not always easily defined. Of course, there were some technological constraints, but during this period of widespread enthusiasm for the nuclear industries, nothing seemed impossible, and hypothetical solutions to problems both old and new were constantly put forward. Even the economic constraints were only relative; as we have seen, the sector was developing in a medium to long-term perspective, in anticipation of a future in which nuclear energy would be able to compete with traditional energy sources. As well as technological and economic criteria, political and military considerations arose. The most obvious case is that of France, where the decision to pursue research into reactors using natural uranium was taken almost entirely from a wish to remain politically and economically independent of the United States. The one constant among so many variables, at least in Europe, was the conviction that the future of nuclear power laid with fast-breeder reactors, which produced more fissile material than they consumed.

Around 1965, the nuclear "market" consisted of two main families of experimented reactors, or power reactors of which examples had already been built and tested. The first type consisted of reactors of American design which used enriched uranium as fuel and light water both as a moderator and in the cooling circuit. In this type the water could be either boiling - BWR - or pressurised - PWR. The second type consisted of reactors of the French or British type, which used natural uranium as fuel, graphite as a moderator and gas as a coolant. Research and development in these experimented reactors concerned the improvement of the uranium conversion factor, and above all those savings in building and running costs which could be made through increasing their size, thus achieving greater specific power: the aim was to move from output in the order of 200 MW to power stations which would develop 500 MW.

Towards the development of fast-breeder reactors there came an intermediate stage, with the development of a series of reactors of intermediate types. Among these were the heavy-water reactors, among which we find the Orgel (Organique - Eau Lourde) series developed at Ispra, the CANDU reactor (Canadian Deuterium Uranium) on which the Canadians were working, high-output gas-cooled

reactors, and aqueous suspension reactors. Some of these were developments of reactors from the preceding generation, moving towards improved energy-producing performance, whilst others were new prototypes which would lead, practically as well as theoretically, to the development of fast neutron reactors:"In this context it must be noted that the future of fast reactors is conditional on the production of a considerable initial reserve of plutonium, which in Europe can only be built up through the prolonged use of thermal reactors with a high rate of combustion, such as heavy water reactors."[36]

Fast breeder reactors have no moderator, and for this reason are also called "fast neutron" reactors. Such reactors are characterised by very high specific power and are able to convert fertile material (usually uranium 238) into fissile material, thus obtaining a net increase in fissile material. Furthermore, it was foreseen that fast breeder reactors would be able to use as fissile material the plutonium which was a by-product of the production of electricity in traditional nuclear power stations. Fast neutron reactors thus presented two considerable advantages: they led to a notable reduction in the amount of uranium required to produce electricity, and they reduced the costs of thermal power stations by providing a profitable use for the plutonium produced in them.

About 50% of the research budget approved for the first two five-year programmes was devoted to research on reactors. Euratom's first research in this field took place as part of the studies undertaken by the Organisation for European Economic Co-operation (OEEC) into second-generation reactors. The Commission was represented both on the Management Committee and in the Technical Group charged with the supervision of work and research at the boiling heavy water reactor in Halden, Norway. The Community also contributed 43. 3% of the budget for a gas-cooled, high-temperature, graphite moderated reactor, the Dragon project, which was to be built at Winfrith Heath in Great Britain. Another project concerned a homogeneous aqueous suspension reactor (SUSPOP) for which EURATOM signed an agreement with the N. V. tot Keuring van Electrotechnische Materialen (KEMA) in the Netherlands, for the building of an experimental reactor. In association with the Belgian CEN, EURATOM took part in the development of the high flux reactor BR2, built in Mol for materials testing. Finally, in 1962 EURATOM signed a contract of association with the French Atomic Energy Commission (CEA) for the design, construction and management of the experimental fast neutron reactor Rapsodie, which was to be built in Cadarache.

Participation agreements were the means by which EURATOM intervened directly in the promotion of the nuclear industry. In exchange for financial participation in the building, commissioning and exploitation of a nuclear plant, the Commission was able to make the fullest use of knowledge thus acquired. In total, for the period 1958-1967, only seven contracts of this kind were concluded; the total cost was, all things considered, very low (to give an idea of the scale of expenditure, around 3. 7 million U. A. were foreseen for the five contracts signed in 1965).These contracts conferred the status of Joint Undertaking on the Italian power stations in Garigliano and Latina, the Franco-Belgian plant in Chooz, the Dutch plant in Dodewaard and the German establishments in Gundremmingen, Lingen and Obrigheim: all power stations of the American type (BWR and PWR) with the single exception of the one in Latina which was of the English type (gas-graphite), and all with power inferior to 300 MW. Three contracts formed a part of the EURATOM/USA

agreement, and of the total seven, three focused on construction and the remaining four on the exploitation of the power stations. A similar type of contract was used by the Commission when it took part in the planning, building and running of the nuclear research ship *Otto Hahn*, launched in Kiel in June 1964.

Although these partnerships did not represent, from the industrial point of view, an unsustainable economic burden, they were challenged by many on a point of principle. The EURATOM Commission favoured these partnerships for obvious reasons: if the aim of the Community was to assist in the rapid nuclear industrialisation of Europe, leading in a short time to some degree of self-sufficiency in energy, then research should be extended to cover the construction and running of full-scale power stations. The Community should also support scientists and technologists in their acquisition of comprehensive knowledge. Opposition came from the two principal Member States, France and Germany, whose reasons were, however, quite different. For the Germans, the intervention of a supra-national body like the Commission ran the risk of falsifying the free workings of the market, and participation agreements were hidden forms of subsidy to national projects of a kind expressly prohibited by the Treaty. For the French, on the other hand, the Community intervention, which was based on an agreement with the United States, tended to favour the development of plants on the American model, to the detriment of the Franco-British type, in what was called during the 1960s the "guerre des filières", the war of rival technologies.

The research and development programme encompassed by the agreement between the United States and EURATOM was essentially concerned with improvements in the operation of the American-type power stations (enriched-uranium, light water reactors) which were being built as a result of the same agreement, as well as studies aimed at reducing the costs of the fuel cycle and the recycling of plutonium. The programme was expected to last for ten years and to cost, in the first five years, a hundred million dollars divided equally between the two parties. This was followed, in 1964, by a second agreement with the United States regarding a programme of research into fast breeder reactors. Other agreements of the same kind were reached in 1959, with Canada for research into heavy water reactors (CANDU- Canadian Deuterium Uranium) and with Great Britain for the exchange of information regarding the development of natural uranium reactors, gas cooled and with graphite moderators, on which both France and Britain were actively working. The agreement with Great Britain, however, represented an act of "non belligerence" rather than a real agreement to collaborate. The English, in fact, had sought in many ways to oppose the Continental nuclear projects, for example by vigorously supporting the creation of ENEA within the OEEC. In the years to come, the English position would change, but the French veto of Britain's application for membership of the EEC in 1963 brought relations between the two sides of the Channel to breaking point again. Two other agreements, of lesser importance, were concluded with Brazil and Argentina, in 1961 and 1963 respectively.

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4. POLITICAL DEVELOPMENTS AND THE SECOND FIVE-YEAR RESEARCH ROGRAMME

As we have seen, EURATOM was set up amid a great deal of ambiguity regarding its actual aims; however, this was not an insurmountable problem: as soon as it was realised that, contrary to the views of the "three wise men", nuclear electricity was not yet an economic proposition, it became possible to return to the inspiration of the Spaak report and to concentrate on nuclear research and development until the economic climate improved. In the meantime, the interested states could naturally continue to develop working power stations, and EURATOM too had the opportunity to start acquiring technical experience by taking part in the construction of a limited number of nuclear plants, particularly in the area covered by the agreement with the USA. Such a proposal was made in 1961: "Despite the current abundant supplies of traditional energy sources, no-one argues with the proposition that nuclear energy ought to become the indispensable supplement to traditional fuels. A more realistic evaluation of the economic prospects of nuclear energy than the optimistic ones of a few years ago leads us to emphasise Euratom's research role, without overlooking the importance of establishing full size reactors built and managed on an industrial scale. Research is essential to the progress needed in order to resolve the problems which we will continue to face until such time as nuclear energy becomes competitive."[37] This project ought not to have presented any problem, since it required no institutional reform, and the spirit and the letter of the EURATOM Treaty should have allowed such a reorientation of the Community's aims. France and Germany, which were already developing substantial industrial programmes of their own, certainly supported the project, but it was the smaller countries that rejected it, because in their eyes EURATOM was primarily a tool for nuclear industrialisation. A policy based almost exclusively on research was effectively adopted from 1962 by the new president of EURATOM, Pierre Châtenet. However, during these years it was the political problems of the Community which had the greatest influence on the development of EURATOM.

In mid-1958, soon after the EEC and EURATOM Treaties came into effect, Charles De Gaulle returned to power in France as a result of the Algerian crisis. His opinions of European integration were quite clear and well publicised, and set the tone for the whole decade to come: the state alone was sovereign, any federalist aims were to be excluded a priori, and Europe could exist only as a meeting place for legitimate national governments. And, while he did not actually denounce the Treaty of Rome, as might well have been expected, France tried by every means at her disposal to reduce Europe's influence. On the other hand, as one of the major political players in the Community, France was able to use it with some success for her own diplomatic manoeuvres at an international level and to protect her own economic interests, particularly in agriculture, via the Common Market. As for EURATOM, it is possible that France's decision to remain within the Community was no more than inertia, or was perhaps due to a belief that if it was kept on a tight rein, EURATOM could be of use to France in the nuclear field.

What is certain is that Gaullist nationalism profoundly affected the Community spirit which was beginning to develop in the new European institutions: "In the (European Economic) Community, it really seemed that the principle of reciprocity, which usually underpins all international treaties, had been permanently replaced by a state of continuous negotiation, a sort of dynamic equilibrium. In this atmosphere it was not necessary to balance every concession with another. But such a method, by its very nature, presupposes that the parties concerned have a permanent relationship of trust."[38] It was intrinsic, too, to the process of progressive integration, that every State could be confident that any concessions it made would be rewarded in the near future. This system was now replaced by one of "synchronisation", which demanded that every agreement made in a given sector would have an immediate counterpart in other areas. This system depended on the agreement of the two biggest Community powers, France and Germany, and was intended to strike a balance between their divergent interests, between the needs of French agriculture and German industry. In EURATOM, which was a Community focused on just one sector, this balance of interests was even more difficult to achieve.

This situation led to protests from Italy and the Benelux countries, protests which in EURATOM took the form of a demand for a *juste retour*. The men who had signed the Treaty of Rome had intended to establish EURATOM for the common good, in collaboration with all the Six. In this new situation in which France and Germany were pursuing their own national programmes for nuclear industrialisation, the minor countries demanded that their financial support for EURATOM should be immediately reflected in contracts for their national industries and research centres, or, to put it another way, by EURATOM investment on their territory. The most striking features of this situation were well described by Jean-Jacques Salomon: "In this 'marriage of convenience', the parents of the bride have one priority: to get the dowry back. Because of their doubts about the match, and the lack of equality between the partners, they fear (and not without reason) that the goods will be shared unequally."[39] If the European programme for developing the nuclear industry had disappeared over the horizon, what possible interest had those countries with no major programmes of their own in financing the research of EURATOM, which could only benefit the national industries of France and Germany? The French reply was that the imbalance in nuclear industrial development had pre-dated the creation of EURATOM, and that what the smaller countries could legitimately expect was the acquisition of knowledge and technology, not contracts. These would instead go to the most experienced centres, following strictly economic criteria. This problem was fundamentally a political one, but it was made worse by the fact the EURATOM, unlike the ECSC, had no financial resources of its own. Its survival depended on the political will and decisions of the Member States, which had to approve an annual research budget and contribute to it in proportions fixed by the Treaty: Belgium 9.9%, Germany 30%, France 30%, Italy 23%, Luxembourg 0.2%, the Netherlands 6.9%.

To understand the nature of the Community's problems in the wake of France's new position, it might be helpful to quote part of a conversation between Etienne Hirsch, President of the EURATOM Commission,[40] and General de Gaulle. This took place in 1961, when France was erecting a series of obstacles to prevent security checks being carried out at her atomic installations. The Treaty had given the responsibility for these checks to EURATOM, and from a Community point of

view this was a source of justifiable pride: the United States, as the country which supplied the enriched uranium, had to decide who should carry out inspections to ensure that fissile material was only being used for peaceful ends, and the fact that her choice had fallen on EURATOM showed the extent to which negotiations between the United States and EURATOM took place on an equal footing. But even here, de Gaulle's judgement differed radically from that of Euratom's head.

"G. (de Gaulle): France has no intention of supplying information on questions of national defence to anyone, and especially not to EURATOM.

H. (Hirsch): The information which we have asked for is expressly allowed for by the Treaty, and the Commission is responsible for ensuring that the Treaty is carried out.

G: I didn't make this Treaty...

H: Nor did I.

G. I accepted this Treaty, these Treaties, and I don't intend to discuss them. But you must realise that since then, the situation has changed. France is now engaged in a great atomic arms manufacturing programme, and must preserve these vital defence secrets."[41]

Hirsch also tells that he discovered that after the meeting, General de Gaulle inquired as to when Hirsch's mandate at EURATOM would expire, and immediately dictated a note that his mandate should not be renewed. And so it came about. In January 1962, another Frenchman assumed the Presidency of EURATOM: in place of Hirsch, a disciple of Monnet, the Gaullist Pierre Châtenet, was appointed, who remained in the post until the Community executives were merged in June 1967. This became known as the "Hirsch case", a policy clash which saw France on one side and the other five countries of the Community on the other, and the settlement of the problem had very important effects on the institution: it sanctioned the principle whereby all the important decisions taken by the Council of EURATOM had to be approved unanimously, thus giving each government the right to a veto. The same principle was ratified by the EEC Council with the so-called "Luxembourg compromise" of January 1966, which put an end to the "empty seat" crisis.

The second five-year research programme (1963-1967) represents a continuation, and, for some aspects, the actual implementation of the preceding programme, given that a large number of the original schemes did not get underway until 1962. From an economic viewpoint, the programme received a budget of 425 million U.A., double the amount allowed for the first five-year period, to which must be added the unspent 20.5 million U.A. from the first programme. The areas of research remained essentially unchanged, but there were much greater opportunities for research "by direct means" since most of the Joint Research Centre establishments were now in operation, and they received about half of all the money intended for research. The staff of the JRC would increase from the 1500 present at the beginning of 1963 to 2530 at the end of the five years: in total, the scientific and technological personnel of EURATOM, the workers at the JRC plus the researchers engaged on external projects, was

set to pass from 1900 to 3200 between 1963 and 1967, conditional upon EURATOM succeeding in recruiting scientists and engineers. They, apparently, preferred the conditions of employment they found in other nuclear establishments, both public and private, despite the excellent financial conditions offered by the Community. Euratom's recruitment difficulties arose from the reluctance of researchers to move, partly because of the inadequacy of the European transport network, but mostly on account of the political uncertainties which hung over the project, making career prospects in national research centres seem more secure.

Annexe II to the second programme distributed the grant among 18 objectives: the Ispra installation (75 million U.A.), the European Institute for Transuranic Elements in Karlsruhe (28 million U.A.), the Central Bureau for Nuclear Measurements (CBMN) in Geel (11 million U.A.), the Petten establishment (27.5 million U.A.), the Orgel programme (57 million U.A.), fast reactors (73 million U.A.), gas-cooled high-performance reactors (31 million U.A.), the BR2 reactor (12 million U.A.), experimented reactors (29.5 million U.A.), fuels retreatment (14 million U.A.), radioactive waste management (5 million U.A.), reactors of new types (9 million U.A.), marine propulsion (7.5 million U.A.), radioisotopes (5 Million U.A.), plasma physics and fusion (31 million U.A.), health protection and biological studies (17 million U.A.), training and education (3 million U.A.) and the diffusion of information and general documentation (9.5 million U.A.). Like its predecessor, the second programme provided for a broad range of research activities and once again ran the risk of spreading its resources too thin.

Presenting the general outlines of the second five-year programme, Jules Guéron, Euratom's research director, identified the Orgel reactor, high-temperature gas-cooled reactors, and fast-neutron reactors as the three main objectives of Community research. Next to this, in the field of industrial developments, was further research on light water reactors undertaken under the agreement with the United States, and also the option of setting up a completely new initiative. There were many varying proposals for the development of a working reactor but Guéron judged them to be somewhat risky. On the one hand, a completely new kind of reactor would pose serious technical difficulties and require at least 400 million U.A. (practically the entire EURATOM research budget) from the first experiments to the finished product, a fully operational reactor. On the other hand, even building small industrial power stations seemed to Guéron a serious error: "To take an example, perhaps a little far-fetched, who would imagine that the construction and operation of a nuclear-propelled fishing vessel could represent a step towards the advent of a nuclear merchant fleet? Wouldn't such an initiative, on the contrary, risk making the entire enterprise look ridiculous?". [42] In substance, therefore, the plan was to leave the further development of experimented types of reactor to national ventures, and to concentrate instead for the medium term on reactor types little studied at national level (the Orgel project). EURATOM would also take the initiative in long-term projects such as breeder and fusion reactors, which were too expensive to be tackled except at a Community level.

The Ispra installation concentrated its efforts on Orgel (Organique - Eau Lourde): the ultimate aim was to develop a new type of power reactor, in the hope that it might become the first of a wholly European line of reactors. The project consisted in the construction of a second-generation prototype reactor, characterised by the use of natural uranium as fuel, a heavy water moderator, and

an organic liquid as coolant. In the Orgel project the prototype[43], due to be ready by the end of the decade, would be preceded by an Orgel critical experiment (ECO) to evaluate its "neutron balance" and by the construction of a reactor experiment[44] named Essor (Essai Orgel). The numerous Ispra laboratories, including its computing centre, were also engaged for the most part in the Orgel project. To give an idea of the relative importance of the Ispra centre and the Orgel project, it is worth noting that the second five-year programme provides for 75 million U. A. to be spent on Ispra and a further 57 million for Orgel, whilst the other JRC laboratories disposed of 66. 5 million between them. This substantial investment presupposes that the Community should contribute to the development of the European industry, by undertaking research into a reactor which was of general interest to Member States but which they themselves were unable to develop: "There are those who think it unwise to chose a particular type reactor and concentrate our efforts on it, claiming that to do so is to put all our eggs in one basket. On the other hand it can be convincingly argued that, if we dissipate our energies on a variety of small projects, however promising, the organisation of such research is likely to lose that unity of purpose essential to its success. The decision to support the Orgel project is based on this second line of reasoning . . ."[45]

The establishment in Petten (the national research centre in the Netherlands, which had been ceded to EURATOM) was also a general-purpose installation, and a high flux reactor (HFR) was built there for materials testing. Its research was to focus on problems associated with high-temperature gas-cooled reactors, and in particular on the use of thorium. The Central Bureau for Nuclear Measurements (CBMN) had its headquarters in Geel, Belgium, near the national centre in Mol, where there were also Eurochemic plants and a high flux reactor. The Office had the task of measuring physical constants extremely precisely, and improving the methods of taking such measurements; to this end it had at its disposal large apparatus, such as a Van de Graaf accelerator, and a linear accelerator, and undertook research in the field of the physical measurement. The European Institute for Transuranic Elements was based in Karlsruhe, in the precincts of one of the German Federal Republic's national research centres. Initially devoted to basic research, it then specialised in the study of plutonium as a fuel (the use of plutonium in fast reactors, and the reintroduction of plutonium into the fuel cycle in thermal reactors), co-ordinating all the research into transuranic elements conducted by the JRC's external contracts. The Karlsruhe centre was the last to come on stream, in 1965.

Whilst setting up its own structures for nuclear research, the Commission was anxious to reassure Member States of its intentions, which were to cover any gaps in national research programmes, contributing to them through the expertise acquired in Community projects. EURATOM was not, did not wish to be nor ultimately could be in competition with national initiatives: "Every Member State continues to carry out the research which it has undertaken on its own initiative; EURATOM is the point where national projects meet and together integrate with the Community programme. The EURATOM programme is a sort of key stone, enabling us to co-ordinate and complete, over the coming five years, the many national projects at a Community level."[46]

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5. TOWARDS THE CRISIS

In 1964, it was decided to revise the budget of the second five-year programme, initially because the rise in the cost of goods and services in the Member States of the Community had made the original grant inadequate. The Commission was asking for an additional 50 million U.A. in order to fulfil its research programme. At the meeting of the Council of Ministers in May 1965 (and, contrary to normal practice, this was attended by Foreign Ministers instead of ministers in charge of science and technology, a fact which underlines the essentially political nature of these discussions), the debate was transformed into a clash of opinions as to the ends and means of the Community itself, reopening the question of the *juste retour*. The meeting took place against a background where, on the one hand, oil prices were particularly low, making it hard for the nuclear industry to take off; while on the other hand, now that the European industry had reached its industrial phase, Member States were arguing bitterly over the future role of EURATOM and the choice of reactor type on which to concentrate their joint efforts. Even the General Reports, usually so careful to smooth the angles and hide the causes of friction between States, or between States and the Commission, expressed the seriousness of the clash: "Discussions of modifications to the programme have been difficult, because so many different points of view must be reconciled; the differing stages of nuclear development, and varying economic and industrial conditions of the six countries inevitably led to different assessments of the importance of the actions to be pursued."[47] In the Council the quarrel was general. France accused EURATOM of wasting its resources on too many unimportant research projects, of assigning contracts following the principle of *juste retour* instead of criteria of efficiency and economy, and of having scattered the JRC's establishments throughout the Community, again on the principle of the *juste retour*. The consequence was a lack of co-ordination of activities, even within the JRC. But France also expressed annoyance on political grounds: EURATOM had put up so weak a defence against American commercial aggression. The first French criticism was upheld by Belgium and Germany, and the three countries put forward a Community programme which contained a much smaller number of research actions, but of a very high quality, enabling Europe to establish superiority in key areas (reactors of the Orgel type, fast reactors and fusion). Germany, on the other hand, attacked state control of the French type, and insisted on greater liberalisation of the nuclear market, in which the initiative should come above all from the industry itself. Finally, Italy and the Benelux countries urged EURATOM to promote rapid nuclear industrialisation based on American reactors, which were at the time the cheapest on the market. This position was clearly unacceptable to France.[48]

The debate over the *juste retour* runs in parallel with the argument over the type of power station to favour, and how best to encourage its development. Already, during the third UN conference on the peaceful uses of nuclear energy, which took place in 1964, it had been noted that European nuclear programmes were once more being carried out at a national level. It was also clear that the difference of opinion over the choice of technology (the American light water reactor versus the Franco-British natural uranium - gas-graphite reactor) was apparently insoluble. In this "guerre des filières" the Commission's uncertain position came under fire. In its first Indicative Programme for nuclear industrialisation, in 1966, the Commission wrote: "At

present none of experimented reactors in the Community at large seems to present a decisive advantage.The experimented natural uranium (gas-graphite) reactor and the lightly enrichment uranium (light water) reactor have reached a similar stage of realisation and of industrial development, with similar prospects for both productivity and the consumption of fissile material."[49] Clearly, the Commission was trying to maintain a neutral, equidistant position, commenting only on technological aspects, but this neither helped the decision-making process nor improved the Commission's status as an independent body speaking on behalf of the Community.

As for the second five-year plan, a compromise was finally reached.The financial position was frozen: the revised budget for the second five-year plan increased from 425 to 430. 5 million U.A. , creating many problems in succeeding years for the continuation of various programmes. Furthermore, a system of *douzièmes provisoires* was set up, under which expenses had to be approved on a month-by-month basis. This meant that no new project could be undertaken. From the point of view of research policy, the Commission and governments agreed upon a further narrowing of direction, which saw research and development concentrated on a limited number of priority areas. Thus 34. 8 million U. A. were diverted from other projects and channelled into the Joint Research Centre's Ispra establishment, for work on the Orgel project, the fast reactor programme, and work relating to controlled thermonuclear fusion. Member States seemed unable to come to an agreement over a common policy for the nuclear industry, and had no intention of entrusting it to EURATOM.This had the effect of slowing down the development of research, starving it of adequate finance and directing it increasingly towards areas most removed from the market: advanced reactors, fast breeders and fusion. For its part, Italy apparently achieved a small "national" success, guaranteeing a *juste retour* in the form of increased funding for the Ispra centre and the Orgel project.

The revision of the second five-year programme made it plain that any "community spirit" had vanished from EURATOM, to be replaced only by a "juxtaposition of national egos" which it would be difficult to reconcile. EURATOM entered a limbo from which it would never emerge as an independent institution. In 1967 the Treaty came into force, merging the executives, establishing a single Council and a single Commission for the three Communities. Euratom's activities were divided between separate administrative bodies, leaving to the Joint Research Centre the management of nuclear projects.Although the European Atomic Energy Community still existed in law, it became part of a vast whole, and its industry, energy and scientific and technology policies had to take this new situation into account. It was therefore decided not to set up a third multi-annual Research Programme, but to extend the previous one until 1968, while waiting for a decision over the role which nuclear research would play in the wider context of scientific and technological research.The wait was longer than had been foreseen, and a new four-year programme (1973-1976) was not adopted by the Council until February 1973. In the meantime, it was impossible to start any new initiative; only the JRC's work was continued, along with work carried out under contracts of association, such as those involved in the Dragon project, biology and fusion.A novel introduction in the financial year of 1969 was the setting up alongside the "joint programme" of a series of "supplementary programmes". These were *à la carte* programmes in which governments could participate or not as they chose. For example, the operation of the high flux reactor

in Petten was managed under a supplementary programme involving only the Dutch and German governments.

The fate of the Orgel project is symbolic of the break-up of EURATOM. Despite the interest shown by the United States in organic liquid cooling,[50] and despite the budget increase approved in 1965 for Ispra's activities in general and the project in particular, Orgel made no substantial progress. On the one hand, EURATOM was prevented from concluding a co-operation agreement with the USA by the opposition of France, which refused to allow Europe to "sell out" her superiority in the field of heavy water technology to her American competitors. On the other, the construction of a prototype demanded more resources than the project was then able to provide. In October 1965, a symposium on Orgel was held at Ispra, in the hope of finding industrial partners for the European project. This was the first time that Orgel had been presented to industrialists from the nuclear sector, who had already taken their basic investment decisions years earlier and who could only be interested in an Orgel reactor if it presented obvious economic advantages over their current installations, which was evidently not the case. Although Orgel was probably technologically sound, the economic advantages of Orgel could not be demonstrated, the more so since Essor had not yet come on stream and the whole project was not at a very advanced stage, whereas various types of light water reactor had been on the market for several years already. In 1967, the Commission put the industrial design of an Orgel prototype out to tender; only the consortium which had built the experimental Essor reactor responded. However, this was just the last vain attempt at keeping the project alive, and it was officially abandoned by the Council in June 1969. All that was left of the project was the Essor reactor, which came into operation in 1967 and was at the same time handed over to the Italian State on the basis of Article 6c of the EURATOM Treaty ("The Commission may place installations, equipment or expert assistance at the disposal of Member States, persons or undertakings, either free of charge or against payment").[51]

The industrial and energy position of the Community was very different from that which the "three wise men" had envisaged, ten years before. Instead of the 15 million kWe from nuclear sources which had been predicted for 1967, by 1968 the Community had 17 operational nuclear power stations generating a total power of 2. 2 million kWe. The nuclear industry of the 1970s would move forward on a national basis, or through agreements between Member States, entirely outside the scope of EURATOM, and the preferred technology would be that of the light water reactors developed under licence from American firms. Germany proved to be the country which benefited most from her participation in EURATOM and the collaboration agreements with the United States. KWU, founded in 1969 through the merger of the nuclear sector of AEG and Siemens, became the most important nuclear company in the Community and entered into direct competition with American industry both in the European market, and in some cases outside it. In France, de Gaulle's successor separated the military programme, which had by now reached its main objectives, from the energy programme. The national electricity company, EDF, chose American technology for its working reactors, the construction of which was carried out by a new company named Framatome; French research concentrated instead on fast reactors. Belgium, Italy and the Netherlands also set up their own national programmes and entered into numerous agreements with France and Germany for specific industrial projects.

The Commission presented a discouraging summary to the Council, on 9 October 1968, which may stand as an epitaph for EURATOM: "The founding Treaty of the European Atomic Energy Community was intended to establish the conditions in which the nuclear industries could develop. Ten years later we must admit to having achieved very few of its aims. It is true that Euratom's actions have often been fruitful within their limits, but the Community generally has not succeeded in co-ordinating, and even less in drawing together into a coherent whole, the efforts of Member States. The dispersion of research and development programmes throughout the Community has been an obstacle to the effective realisation of a common nuclear market. Member States have reserved finance for their own industries, and orders from public institutions have been placed with national companies. Orders from electricity producers, too, have gone to national construction companies. The development of the nuclear industries within the Community have thus not benefited from the suppression of border tariffs and quotas which followed the EURATOM Treaty. This sequence of events has led to the present crisis, which is not only the crisis of EURATOM, but is a crisis in the development of the nuclear sector."[52]

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NOTES

1 Only in 1994 would CERN and the Commission of the European Community sign an agreement for scientific co-operation.

2 A separate case is that of Great Britain, which, thanks also to its special relationship with the United States, set up significant scientific and technological research programmes, particularly in the nuclear field. Such programmes had civil as well as military objectives.

3 The European Movement was born in October 1948 as a confederation of organisations, parties, trade unions and other groups promoting the unity of Europe. On the European Movement and the initial period in the European integration process see, for example, Jean-Pierre Gouzy, *Les pionniers de l'Europe communautaire*, Centre de recherches européennes, Lausanne, 1968.

4 Raoul Dautry, quoted in Dominique Pestre, "The first suggestions, 1949-June 1950", in A. Hermann, J. Krige, U. Mersits and D. Pestre, *History of CERN. Vol. I: Launching the European Organisation for Nuclear Research*, North Holland, Amsterdam, 1987, p. 75

5 The literature on functionalism and neo-functionalism is vast; very useful is Reginald J. Harrison, *Europe in Question*, Allen & Unwin, London, 1974.

6 The fullest account of the history of the ECSC is Dirk Spierenburg and Raymond Poidevin, *Histoire de la Haute Autorité de la Communauté Européenne du Charbon et de l'Acier*, Bruylant, Brussels, 1993.

7 On the research of the ECSC, see the General Reports on the Activities of the Community, particularly the third (1954-1955).

8 Belgium, France, the German Federal Republic, Great Britain, Greece, Italy, the Netherlands, Sweden and Yugoslavia, soon followed by Switzerland, Denmark and Norway. By 1994, there are nineteen countries participating in CERN.

[9] For the history of the proposed European Defence Community, see E. Fursdon, *The European Defence Community: A History*, Macmillan, London, 1980.

[10] Quoted in Dominique Pestre, "French attitudes to the European laboratory, 1949-1954" in A. Hermann, J. Krige, U. Mersits and D. Pestre *History of CERN, Vol. 1: Launching the European Organisation for Nuclear Research*, North Holland, Amsterdam, 1987, p. 341.

[11] This discussion is primarily based on a paper by John Krige and Dominique Pestre, "The how and why of the birth of CERN", in A. Hermann, J. Krige, U. Mersits and D. Pestre *History of CERN, Vol. 1: Launching the European Organisation for Nuclear Research*, North Holland, Amsterdam, 1987, pp. 523-544.

[12] Robert Jungk, *Die große Maschine. Auf dem Weg in eine Andere Welt*, Scherz Verlag, Bern and Munich, 1966.

[13] This section, on the period 1948-1958, is in large part an expansion of an unpublished paper by John Krige.

[14] Pierre Uri, quoted in Jules Guérons and René Foch, "Les réalisations", in Maurice Flory (pref.) *Les cadres juridiques de la coopération internationale en matière scientifique et le problème européen*, Actes des colloques d'Aix en Provence et Nice 1967-1968, CEC, Brussels, 31 May 1970, p. 160.

[15] The theme of the ambiguity and the problems caused by the abrupt changes in Euratom's objectives was initially brought up by Jaroslav G. Polach; see his *European, Its Background, Issues and Economic Implications*, Oceana, New York, 1964.

[16] An instance of a particularly extreme position can be found in an article by Bernard Lavergne, who propounded the opinion that EURATOM was the result of a plan by Pope Pius XII and the United States, acting through the good offices of Schuman and Monnet respectively, to destroy France and create a German hegemony in Europe. His article, with the rather explicit title "L'escroquerie de l'Euratom, nouvelle C. E. D. ou M. Jean Monnet aspirant au pouvoir absolu en Europe occidentale", appeared in *L'année politique et économique*, no. 129, January-March 1956, pp. 1-47.

[17] EURATOM, *Seventh General Report - 1964*, March 1965, p. 14.

[18] For the problems encountered by the ECSC in trying to "decartelise" the industry in the Ruhr, see for example John Gillingham, *Coal, Steel, and the Rebirth of Europe, 1945-1955. The Germans and French from Ruhr Conflict to European Community*, Cambridge University Press, Cambridge, 1991.

[19] Alexander King, "Science and Technology in the New Europe", in Norman Kaplan (ed.), *Science and Society*, Rand McNally, Chicago 1965, p. 473.

[20] For an analysis of the various reports produced at this time on European energy requirements, see N.J.D. Lucas, *Energy and the European Communities*, Europa Publications, London 1977, particularly pp. 10-29.

[21] For this project, see also Dirk Spierenburg and Raymond Poidevin, *Histoire de la Haute Autorité de la Communauté Européenne du Charbon et de l'Acier*, Bruylant, Bruxelles, 1993, pp. 458-61.

[22] Commission of the European Atomic Energy Community, "Agreement for cooperation between the government of the United States of America and the European Atomic Energy Community (EURATOM) concerning peaceful uses of atomic energy" *O. J. E. C.* 19 March 1959, p. 312.

[23] Louis Armand, Franz Etzel and Francesco Giordani, *Un objectif pour EURATOM*, EURATOM Commission, May 1957.

[24] See, for example, EURATOM, *First General Report, 1958*, 21 September 1958, pp. 41-42.

[25] With the passing of time, for reasons which we will see, the name of the Community's laboratories changed from the Joint *Nuclear* Research Centre to the Joint Research Centre. For simplicity's sake it will be referred to throughout as the JRC.

[26] EURATOM, *Fourth General Report*, 1961, p. 9.

[27] Jean-Jacques Salomon, "European Scientific Organisations", in Eric Moonman (ed.), *Science and Technology in Europe*, Penguin, Harmondsworth, 1968, p. 78.

[28] Emile Noel, *Working Together - The Institutions of the European Community*, European Documentation Centre, CEC, Luxembourg, 1991 , p. 32.

[29] For an analysis of the AEA, see Roger Williams, *The Nuclear Power Decisions: British Policies 1953-78*, Croom Helm, London, 1980, particularly pp. 21-26.

[30] Until 1971, when the United States announced the end of fixed exchange rates, a Community Unit of Account (U. A.) was worth 0. 88 grams of gold, i. e. one US dollar.

[31] EURATOM, *Fourth General Report - 1961*, p. 16.

[32] Felice Ippolito, *Intervista sulla ricerca*, Laterza, Bari, 1978, p. 44.

[33] For these figures, and those which follow, see Michel Carpentier, "Les contrats d'Euratom. Les d'une expérience communautaire", in Maurice Flory (préface par), *Les cadres juridiques de la coopération internationale en matière scientifique et les problèmes européennes*, Actes des colloques d'Aix-en-Provence et Nice 1967-1968, CEC, Brussels, 31 May 1970, p. 495.

[34] For a brief presentation of Euratom's research activities in this field, see Fernand van Hoeck, "Radiazioni e traccianti nella ricerca agronomica", *Bollettino EURATOM*, No. 1, 1962, pp. 15-18.

[35] This is obviously only an "impressionistic" assessment, but for the period in question we are not in a position to produce quantitative analyses of the scientific production of EURATOM, while the regular evaluation of the results of its own research programmes was not undertaken by the Community until the 1980s. As for the activities of the JRC in the years 1974-1985, the number of its publications, and the frequency with which they are quoted has been analysed; the conclusions of this study are that, although the number of publications and their impact is considerable, these results were achieved at great expense, and the efficiency of the JRC is thus called into question. In this regard, see Giovanni Napolitano, "Le politiche CEE di cooperazione in campo nucleare" in Cristiano Antonelli and Laura Pennacchi (eds.), *Politiche dell'innovazione e sfida europea*, Franco Angeli, Milano, 1989, pp. 239-70.

[36] EURATOM, *Seventh General Report -1964*, p. 35.

[37] EURATOM, *Fourth General Report*, 1961, p. 15

[38] Bino Olivi, *L'Europa difficile. Storia politica della Comunità Europea*, il Mulino, Bologna, 1993, p. 85.

[39] Jean-Jacques Salomon, "European Scientific Organisations", in Eric Moonman (ed.), *Science and Technology in Europe*, Penguin Harmondsworth, 1968, p. 78.

[40] Etienne Hirsch had succeeded Louis Armand, the first President of the Commission, when the latter fell seriously ill a few months after taking up his post.

[41] Etienne Hirsh, *Ainsi va la vie*, Fondation Jean Monnet pour l'Europe - Centre de recherches européennes, Lausanne, 1988, p. 169.

[42] Jules Guéron, "EURATOM et le développment de l'énergie atomique dans la Communauté européenne", *Energie Nucléaire*, vol 4, n. 4, 1962, p. 264.

[43] "By prototype reactors we mean reactors whose nature, construction and size are such that their development and operation enable us to commission industrial reactors of the same type with confidence." EURATOM, *Second General Report*, 1959, p. 38.

[44] "By reactor experiments we mean those intended for the initial testing of a technology, or which are very distant variants of previously tested types", EURATOM, *Second General Report*, 1959 p. 39.

[45] J.C. Leny, "Il progetto Orgel", *Bollettino EURATOM*, n. 1, 1962, p. 3.

[46] EURATOM, *Sixth General Report*, 1963, pp. 7-8.

[47] EURATOM, *Eighth Annual Report - 1965*, p. 7.

[48] This account of the clash of opinions at the Council of Ministers in May 1965 is based in its essentials on Lawrence Scheinman, "EURATOM: Nuclear Integration in Europe", *Research and Publication*, n. 563, May 1967; and Philippe Marka, *La coopération dans la recherche dans las Communauté européenne et de l'énergie atomique*, Université de Paris II (Thèse d'Etat), Grenoble SRT, 1977.

[49] Commission of the European Atomic Energy Community, "First Indicative Programme for the European Atomic Energy Community", *OJEC*, 28 April 1966, p. 1153.

[50] During the third Geneva Conference in 1964, the United States launched a project for the application of nuclear technologies to the desalination of sea water ("Water for peace"), and the European type of plants seemed particularly indicated for it. On this subject, see Alvin M. Weinberg, "Chapters from the Life of a Technological Fixer", *Minerva*, vol. 31, No. 4, 1994, pp. 379-454.

[51] For the Orgel affair, see Henry R. Nau, *National Politics and International Technology, Nuclear Reactor Development in Western Europe*, The John Hopkins University Press, Baltimore, 1974, particularly pp. 157-83.

[52] Secretary General of the Commission, "Survey of the nuclear policy of the European Communities", *Supplement to the Bulletin*, n. 9-10, 1968, p. 5.

CHAPTER TWO

THE SEVENTIES

1. THE TECHNOLOGICAL GAP

The mid-1960s witnessed the emergence of a debate in Europe about what came to be known as the "technological gap"[1] which separated European countries from America. Although the post-war years had been a time of exceptional economic growth in Western Europe, it was suddenly realised that simultaneous developments in the United States were not only quantitatively greater, but of a different kind. While Europe lost time over reconstruction and self-congratulation on regaining its well-being, in America technology was revolutionising industry and society: the organisation of work was being transformed, new sectors were created from thin air, and the pace of innovation was unprecedented. As for the actual reality and extent of this "gap", opinions differed, but there can be no doubt that this debate was of fundamental importance to the development of science and technology policies at both national and European and Community level, even involving Great Britain, which was the most technologically advanced European country in many areas, and which had applied to join the European Communities.[2]

One of the best-known products of this debate is *Le défi américain* by Jean-Jacques Servan-Schreiber. The book has a highly dramatic format, which made it a best-seller at the end of the 1960s. The initial scenario is gloomy: without most Europeans noticing it, a war has broken out, one not fought with weapons and armies, but nonetheless real and with potentially equally serious consequences. There was an American challenge, a technological war to be fought not with dollars, oil, steel production and modern machinery, but with imagination and organisational talent. Although "General Motors, after all,

isn't the Wehrmacht; the fight for the ownership of Machines Bull isn't Munich; and the supersonic Concorde jet isn't the battle of Sedan",[3] the confrontation is a bitter one and Europeans would need all their strength if they were to win it. But at the moment the European reaction seemed too slow and even moves in the right direction could fail if Europe remained unaware of what was at stake. If the Common Market were to remain a mere free trade area, unsupported by adequate political and economic institutions, this could only help her rivals: "Fifteen years from now the world's third greatest industrial power, just after the United States and Russia, may not be Europe, but *American industry in Europe*. Already, in the ninth year of the Common Market, this European market is basically American in organization."[4] And unlike Europeans, Americans were well aware of the potential of this "new Far West", as was shown by an anonymous "American industrialist from Frankfurt" who declared: "The Treaty of Rome is the sweetest deal ever to come out of Europe. It's what brought us here. We're happy to be here. We're making money. And we're going to make a lot more. Whether the European negotiations in Brussels move ahead or not, prospects in commerce and industry are better for us here than they are in the United States."[5]

Although our author overemphasises in order to arouse wounded *Euro-nationalist* feelings, his analysis of the situation and the remedies he suggests are not far removed from those proposed by other observers. American industry seemed to enjoy substantial advantages compared with that of Europe: a larger scale, substantial ability to raise finance, higher productivity, massive investment in research and development, financial support for innovation from the Federal government. Technological "spin-offs" in the civil sector from the huge government investment in military and space research were also of prime importance. Another characteristic of the United States was the process which came to be called "cross-fertilisation" between government initiatives, research and development in large companies and research projects in the universities, so that inventions swiftly became first technological innovations, and then products on the market. At the basis of this extraordinary process of economic development led by constant innovation was a different American attitude to education and training, an understanding of the importance of human capital: in America, "ideas are not ornaments but tools to change the world. And nothing is more *profitable* than a good idea. In the United States adult education is considered an investment, not a form of humanitarianism."[6] A concrete example of the close ties which bound research and technological development in the United States, to which European observers often referred, was represented by Route 128 in Boston, where numerous small businesses working in the field of high technology had sprung up around the Massachusetts Institute of Technology. They were often founded by teachers from MIT, who worked either for the government or for private industry using abilities and knowledge derived from the academic field. The "technological gap" thus existed both in well-established industrial areas requiring massive investment and organisation on a continental scale, and in the field of technologies at the cutting edge, technologies not yet in existence, which needed instead a lively intellectual environment and a more flexible availability of capital to allow the development of small dynamic companies.

In Servan-Schreiber's opinion, the so-called "technological gap" was above all a "management gap" caused by an inability to foster intelligence and stimulate talent. This was due to training programmes which were insufficient and restricted to a minority, and to the preservation of rigid hierarchical struc-

tures, particularly in the universities (and the Americans liked to joke about this characteristic: "the professor in Europe is often close to God and far from the students").[7] One effect of the "gap", which led, predictably, to its widening, was the so-called "brain drain" from Europe to America: this was a rather important phenomenon during the 1960s, but one which progressively vanished during the following decade.[8] European limitations are particularly noticeable in new areas such as aviation and above all in the computer industry, a new industrial sector whose products, according to Servan-Schreiber, would soon transform all other areas of the economy. While the United States approached what Daniel Bell called the post-industrial society, "in which the organisation of theoretical knowledge becomes paramount for innovation in the society, and in which the intellectual institutions become central in the social structure"[9] Europe, like Rome or Byzantium, was preparing for decadence and a future of under-development.

Faced with the commercial and technological offensive of the United States, individual European governments had proposed and tried out, at a national level, three different policies, or a combination of them. The first consisted in encouraging those American companies which had European subsidiaries and which had profited from the advantages offered by the Common Market to find new markets; taken to its logical conclusion, such a policy would lead to the establishment of an American economic empire in Western Europe and lead eventually to a loss of sovereignty by the states themselves. The second policy was to acquire the technological know-how from the USA, abandoning research and innovation and retaining only industrial production; although Europe neither could nor should compete in all the key sectors, and it was reasonable to obtain some expertise from abroad without the need to set up long and expensive R&D projects in every field, such a policy would eventually lead to an unhealthy technological imbalance between the two shores of the Atlantic in the long term. The third option was a rigidly protectionist policy which would exclude all American investment in Europe; and although European industries at the cutting edge needed some initial protection for a limited period, this policy too would eventually lead to an increasing technological gap on the continent. The obvious inadequacies and possible dangers of these policies suggested a different approach, the Community option: if European states wanted to meet the American challenge they must join forces, creating a whole which would be greater than the sum of their parts.[10]

In the meantime, governments too began to draw attention to the gravity of the situation and to the need for a common European involvement in the area of research and development. If the 1958 French proposal for a European Science Foundation had met with widespread indifference, in the 1960s suggestions for participation and action succeeded each other with increasing urgency. As usual, many such proposals came from Paris, since the French were most sensitive to the American threat and the need for independent European policies; but in the face of the technological challenge cries of alarm and suggestions came from all the countries of Europe and from the Community itself. In October 1966, Robert Marjolin addressed the European Parliament on behalf of the Commission, stating that "If the Six remain as they have been for a generation, the principal importers and the first exporters of intelligence in the world, they will condemn themselves to a progressive underdevelopment which will soon make their decline irreversible."[11] To avoid such a decline, Italian Foreign Minister, Amintore Fanfani, had suggested to the NATO Council in June of the same year that the United States should launch a "technological Marshall Plan";

a little later, more realistically, the British Prime Minister, Harold Wilson, proposed a European Technological Community to exist alongside the Economic Community or to be absorbed into it. The new Community would naturally be enlarged to include Britain, whose technological "dowry" was considerable, and other countries from the European Free Trade Area (EFTA).

Christopher Layton, who was to become Altiero Spinelli's *Chef de Cabinet* at the European Commission, analysed some of the initiatives undertaken at a European level in high technology and basic research, and subsequently proposed some lines of development for a European Community enlarged to include Great Britain in a book published in 1969.[12] In his view, it was above all essential for Europe to continue to act decisively in those areas in which it had succeeded in maintaining a pre-eminent position in the world: CERN should proceed with the construction of its new 300 GeV accelerator; EURATOM and Great Britain should co-ordinate their efforts in the field of fast reactors, and to create a European company to run the plants already in existence for the enrichment of uranium (Capenhurst in Britain and Pierrelatte in France). In the field of aviation co-operation in single projects on bilateral (Concorde) and trilateral (Airbus) agreements should be superseded by a long-term industrial strategy, in both the civil and the military sectors. The space industry had perhaps the least encouraging development at a European level during the 1960's: here the European Launcher Development Organisation (ELDO) had worked on the development of a rocket which, had it been built, would have been unable to transport the satellites planned by the European Space Research Organisation (ESRO). The two space organisations, in Layton's view, ought to be joined in a European Space Authority able to co-ordinate the different research and development activities and to represent Europe in the international organisation concerned with communications (Intelsat). In the computing sector, European governments should encourage the creation of one or more consortia between the major computer companies to enable them to compete with the Americans, and in particular with IBM. An integrated transport system should be developed across the continent and should include the building of the Channel Tunnel. For basic research, Layton proposed the creation of a European Science Foundation, the launching of an oceanography programme and the setting up of centres of excellence in molecular biology under the protection of the European Molecular Biology Organisation (EMBO), which was founded in 1963. Finally, student mobility ought to be encouraged: all university studies should involve a period of study in another European country. In Layton's judgement, projects of this kind would only become feasible if the decision-making centres of Europe could be joined, if the European Communities assumed new powers. The Council of Ministers should be the decision-making body for science and technology policy, with the collaboration of the Directorates-General responsible for scientific and industrial affairs. Apart from the sectional agencies, two new institutions should be set up: a *Technology Fund*, which would finance all non-sectional projects, and a *Marriage Bureau* to encourage the amalgamation of companies in different European countries. The Common Market should be enlarged by the addition of Great Britain and other countries, and as a matter of urgency it should become a real economic union, with uniform legislation in patent law and social matters, harmonisation of fiscal systems, and common standards. Finally, the states should abandon their policies of supporting national businesses and launch a *"Buy European Policy"* which would encourage the formation of European companies large enough to compete in the world market.

2. COST AND COMMUNITY POLICY

As we have seen, the three Treaties which established the European Communities allowed for the financing of research and development projects only in the fields of nuclear research, coal and steel, and agriculture. During the 1960s, however, it became necessary to respond to the American challenge, rather than passively watch the apparently inevitable decline of Europe caused by the widening gap between the economic and technological development of the Old World and that of the more dynamic societies of America and Japan. In July 1963, the EEC Commission made the first of a long series of recommendations to Member States on the subject of strengthening co-operation in the fields of science and technology: "In all countries, and to an ever-increasing extent, governments are intervening to prompt the development of scientific research and technological progress. It would be helpful if the efforts of each country could be compared at a European level. It should also be possible to establish optimum conditions in which measures taken in individual countries may complement and mutually reinforce each other; to study ways of improving the spread of information; and to maximise the effectiveness of measures taken at a national level by combining the efforts of the Member States."[13]

At the beginning of 1964, the Council of Ministers of the EEC set up a Medium-term Economic Policy Committee, composed of experts from the Member States and representatives from the Commission. The fall of the main barriers to internal trade and to the customs union impelled Member States to establish common economic policies, or, at least, co-ordinate national approaches to regional, agricultural and technological policies. Naturally, different countries at that time had national policies which differed radically: for example, the French planned economy stood in contrast with the more *laissez-faire* policy pursued in Germany. However, it would be absurd to imagine that the setting up of the Committee and the development of a medium-term economic policy could imply the adoption by the Community of planning in the French style: the Community was in any case a very long way from having any such powers. "The question at issue was not whether to have a Community plan, but whether to draw up an outline of economic policies, both national and Community, relevant to the medium and long term development of the members, and related to quantitative projections of the probable evolution of their economies, with a view to working out common policies, and harmonizing and coordinating national policies, in directions favourable to the various objectives of growth, price stability, full employment and equilibrium of external payments."[14] The Committee would look for ways in which to encourage the fulfilment of these objectives.

It was within the Medium-term Economic Policy Committee that a working group was set up, in March 1965, to examine scientific research and technology policies (the PREST or Maréchal group, from the name of its president, who was also director of the French agency for science policy). Its mission was to "examine the problems involved in developing a co-ordinated or common policy for scientific and technological research; and to propose measures enabling such a policy to be set up, bearing in mind the eventual possibility of co-operation with non-member countries." This group, too, consisted of national experts who were formally independent of their respective governments, and four Com-

munity representatives.[15] Its first task was to produce a report suggesting areas in which a science and technology policy might be established, the direction such a policy could take, and possible ways of encouraging the adoption of this policy at a European level. The Maréchal report was presented at the first Council of ministers responsible for scientific affairs on 31 October 1967, and then published as an appendix to the Second Programme of the Medium-term Economic Policy Committee. Following discussion of this report the Council recommended the speedy adoption of three structural measures: the adoption of standards suitable for the creation of European companies; the creation of European patents; and the harmonisation of the tax treatment of companies. These proposals, which were designed to encourage the emergence of businesses on a continental scale able to compete effectively with large American businesses, were accompanied by the setting up, within the new unified Commission, of a Directorate- General for Industrial Affairs (DG III). More specifically with reference to R&D policy, the Council authorised PREST to examine the possibility of coordinating policies in seven areas (computers, telecommunications, transport, oceanography, metallurgy, pollution and meteorology), to assess the prospects for extending co-operation to non-member states, and to present a new report by March 1st 1968.

The Maréchal group was organised in expert working groups to analyse the seven priority areas indicated by the Council, but a serious political crisis in the Community forced it to suspend its work indefinitely. In December 1967, France vetoed the accession of Great Britain and three other applicants (Denmark, Ireland and Norway) to the European Communities for the second time. In the Council, France remained isolated politically, but she remained the greatest Community power and the protests of the other five countries were unable to influence events. The only explicit act of revolt against France's anti-communitarian policies was the decision by Italy and Holland to boycott PREST meetings, since tensions between France and her partners focused above all on industrial and technological development. In point of fact, France would not accept British involvement in the Community's R&D projects and more particularly refused to allow her presence, as a candidate for membership, at PREST meetings.

However, the political situation changed rapidly and seriously weakened the position of France in international, and particularly Community, affairs. On the one hand, the May 1968 Revolution undermined the power of the government internally; on the other, the Warsaw Pact invasion of Czechoslovakia in August 1968 spelled the end of de Gaulle's hopes for a "Europe from the Atlantic to the Urals" in which the collapse of the power blocs would allow France to lead wider European policy in all fields.

In this new political situation, the problem of the composition and purpose of PREST - of marginal significance in the new perspective offered by the enlargement of the Community - was speedily resolved. During the Council of 10 December 1968 it was decided to resume the work of PREST, and 1 March 1969 was fixed as the date for the presentation of the report which had been commissioned in 1967. Other European countries, including those which had applied to join the Community, were unable to attend the working group meetings, but would in future be able to take part in the projects which PREST proposed. The Aigrain Report, named after the new president of PREST, was presented in April 1968 and contained 47 proposals for research to be undertaken in the seven areas

previously identified; there were, among others, plans for a high-performance computer, for the standardisation of software, electronic aids for motor traffic, a gas turbine engine for trains, a giant hovercraft, development and standardisation of meteorological instruments, and numerous suggestions for the battle against air and water pollution. In October 1969, after these 47 proposals had been evaluated by the Committee of Permanent Representatives (COREPER)[16], the Council of Ministers approved 30 of them and invited five additional European states (Sweden, Switzerland, Austria, Spain and Portugal) to take part, together with Member States and those who had applied for membership.

In the meantime, the political climate in the Community had somewhat relaxed and the Hague Summit in December 1969 marked the relaunch of the Community enterprise. President de Gaulle resigned in the summer, and his successor, Georges Pompidou, although nominally continuing Gaullist policies, showed signs of an increased openness towards his European partners. During the Summit a number of decisions were taken with regard to the Common Agricultural Policy, Community resources, the enlargement of the Community to include the candidate states and economic and monetary union. Although the questions of research and development were not at the heart of discussions at the Summit, the final Declaration stated: "With regard to the Community's technological activities, the Heads and State and Governments reaffirm their intention vigorously to pursue the Community's schemes aiming to co-ordinate and encourage industrial research and development in the most important areas, particularly by means of Community programmes, and to provide the necessary financial means."[17]

Although this is only a rather general declaration, it nevertheless demonstrates that the governments of the Member States acknowledged the importance of R&D to economic and industrial growth. On the other hand, it talks of Community *programmes* but fails to mention the suggestions of the Aigrain group. For the first time we have signs of friction, to which we will have to return, between the promoters of Community research policies and those who favoured an intergovernmental approach. It is clear that PREST's proposals are strictly intergovernmental, the more so since they involve countries not belonging to the Community. This tendency became even more pronounced in October 1970, when the Council established a permanent committee to be called COST (Scientific and Technological Co-operation), composed of senior officials from the fifteen nations which had responded to PREST's invitation.

The COST conference of 22 and 23 November 1971 was attended by 19 countries, with the addition of Finland, Greece, Yugoslavia and Turkey , and also by the Community as the original promoter of the initiative. The commissioner responsible for industrial and scientific affairs, Altiero Spinelli, a stubborn opponent of any intergovernmental agreement, described the meeting thus: "Nineteen states and the Commission sit crowded round a huge circular table to watch the mountain give birth. For exactly four years a committee of senior officials, to which the Commission acts as a secretariat, has worked on joint research projects. The programme has finally taken the form of seven so-called concerted actions, with each of which one state or another (not always the same) has undertaken to collaborate and exchange information, but little more, with the others. The total annual sum for these projects, which are to last for between two and five years, is barely six million dollars. The mountain has given birth to

a mouse."[18] Even harsher critics of the initiative suggested that the COST conference ushered in an era when the preparation of projects cost more than the projects themselves.

Notwithstanding the reservations expressed even by the Commission, the COST conference approved its first seven projects: 1) Information Science: the development of a European informatics network (COST 11; signatories: France, Great Britain, Italy, Yugoslavia, Norway, Portugal, Switzerland, Sweden and EURATOM); 2) Telecommunications: research on microwaves for communications (COST 25; signatories, France, Italy, Yugoslavia, the Netherlands and Switzerland); 3) Metallurgy: research on materials for gas turbines (COST 50; signatories: Austria, France, Germany, Great Britain, Italy, Luxembourg, the Netherlands, Sweden, Switzerland and the ECSC); 4) Materials: research on desalination plants for sea water (COST 53; signatories: Austria, Belgium, France, Germany, Great Britain, Italy, Yugoslavia, Luxembourg, the Netherlands and Spain); 5) Environment: research into the physical and chemical behaviour of sulphur dioxide in the atmosphere (COST 61a; signatories, Austria, Denmark, France, Germany, Great Britain, Greece, Italy, Yugoslavia, the Netherlands, Spain and the ECSC); 6) Environment: analysis of the pollution of microorganisms in water (COST 64b; signatories: Denmark, France, Great Britain, Germany, Ireland, Yugoslavia, Norway, the Netherlands, Portugal, Spain, Switzerland); 7) Environment: treatment of effluent (COST 68; signatories, Denmark, France, Germany, Great Britain, Italy, Yugoslavia, Norway, the Netherlands, Sweden and Switzerland, to whom were subsequently added: Belgium, Finland and Turkey). The structure of the initiative is *à la carte*, with each country taking part in, and contributing financially to, those projects in which it is interested. To make the arrangements even more flexible, each agreement allows for countries to decide to participate at a later stage. Each agreement contains a brief description of the research programme, to be drawn up by committees formed by the participating countries, and the total amount of money which each state will contribute. The research was to be carried out in public or private laboratories, but where it took place in an industrial research centre, the company concerned must contribute to the financing. Each separate agreement also contained legal provisions to protect rights of ownership should the research lead to discoveries which could be patented.

The role of the European Community in the COST initiative is somewhat ambiguous. As we have seen, the proposal for COST was initially made by a Community committee, for Community countries; and its extension to non-member states was called for because the majority of Community countries wanted to involve Great Britain in the efforts to establish a European research policy. Further, although the strictly intergovernmental character of COST relegated Community bodies to secretarial functions, from a political point of view, COST represented "a form of international organisation whose independent existence, given its extremely simplified structures, could only be justified through a direct link with other organisations endowed with a firm political and administrative structure, i.e. the European Communities."[19] Finally, the direct participation of two Communities in some COST projects raised legal difficulties, because the Treaties which established the Communities had not allowed for their involvement in research in such areas.

In October 1972, a new Summit of Heads of State and Government took place in Paris, and decided that the Communities should adopt a series of new common policies in the

fields of the environment, the regions, social policy, industrial and energy policies, technology and education. These were spheres with which the original Treaties had not been concerned, and the adoption of policies in such areas therefore seemed to demand a reform of the institutions. However, mainly at the request of Great Britain, which was set to join the Community and did not want the Treaties revised before they had been ratified by its Parliament, an agreement was reached on the basis of a very broad application of Article 235 of the EEC Treaty, which stated: "If action by the Community should prove necessary to attain, in the course of the operation of the common market, one of the objectives of the Community, and this Treaty has not provided the necessary powers, the Council shall, acting unanimously on a proposal from the Commission and after consulting the European Parliament, take the appropriate measures." Until the endorsement of the Single European Act in 1986, this fallback formed the legal basis for all Community activities in the fields of science and technology.

The final declaration of the Paris Conference described the ventures to be undertaken in the R&D sector thus: "It is important to define our objectives and to safeguard the development of common policies in the field of science and technology. Such policies will involve the co-ordination, by Community Institutions, of national policies, and the joint implementation of policies which are of Community interest. A plan of action should therefore be established by 1st January 1974, with a precise calendar for its execution and with appropriate means to carry it out."[20] Once again, the emphasis is on joint Community action rather than intergovernmental initiatives, and for the first time a date is set for the presentation of Community proposals in this field.

It is in this new scenario that the COST initiative came under debate. At the end of 1973, the Belgian government presented a Memorandum to the Council asking that no further COST projects should be endorsed, and suggesting that the entire Community approach to research policy should be reviewed. Belgian critics focused on procedural matters, and on COST's relationship with the Community's Joint Programme. Firstly, "the COST procedure is long, complicated, and relatively inefficient, requiring in the case of many Member States (...) the approval of national parliaments... Furthermore, the procedures which are specified for such co-operation often differ from one project to another." In the second place, problems are created by the ambiguous role of the Community: its participation in some of the projects means that those Member States who chose not to take part are nevertheless forced to make a financial contribution. The same is true of Community expenses involved in running the Secretariat of COST, an activity not provided for in the Treaties since COST is an intergovernmental organisation. Thirdly, those projects which have been set up have run into difficulties both with the proper circulation of information and with industrial ownership. Finally, the Belgian Memorandum touches on the central problem of the relationship between COST and the Community programmes: "COST projects are often similar or closely related in content to the integrated projects of the Joint Programme. This state of affairs tends to increase confusion and indeed duplication, subordinating the content of the Joint Programme to extra-Community interests and finally progressively depriving the Joint Programme of its intrinsic value".[21]

Clearly, the question posed by the Memorandum is whether COST is a Community forum or merely a coming together of intergovernmental agreements. In the first case the Community could play the role of secretariat,

but only for projects of obvious Community interest which were consistent with other Community initiatives in the scientific and technical fields. In the second case, although COST had been set up as a result of an early experiment in Community collaboration, it must find a different institutional setting. Initially the second of these approaches seemed to prevail: "Clear indications of the shift in focus are evident in the characteristics of COST: the absence of any member from the Commission (compare PREST); parity between member and non-member states; and the provision of a secretariat by Council rather the Commission."[22] In later years, however, some of the organisational and procedural difficulties outlined by the Belgian government were resolved. Although it maintained its essentially intergovernmental character, COST eventually strengthened its links with the Community, and set out to complement rather than compete with Community programmes. In particular, the General Secretariat of the Commission took over the provision of secretariat services to COST in 1978, and the Community took part in several COST projects via concerted action, thus financing not the research itself but the costs of administration. And in the meantime, as had been promised in Paris, the Community was laying the foundations of its own science and technology policy.

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3. 1970-1972: THE FIRST REFORM OF THE JRC

In 1970, Altiero Spinelli became Commissioner for Industry, Research and Technology, and for the Joint Research Centre. He was faced with two main problems to solve. The first of these was the restructuring of the JRC which had been in a state of crisis for the past two years; the second, to reorganise the Directorate-General of which he was head, so as to enable him to impose new policies in the fields of industry and research.

The abandonment of Orgel, the most important EURATOM and JRC project, had heralded a period of deep crisis, marked by annual programmes which excluded any fresh initiatives. The two specialised centres, in Karlsruhe and Geel, were able to survive by pursuing routine and previously authorised research. The situation was much more serious in the two all-purpose centres, Petten and Ispra, which had no real projects on which to work. Spinelli entrusted to Pietro Caprioglio, Head of Ispra, and to Giulio Guazzugli, Director-General, the task of drawing up a programme for the reform of the JRC. At the same time another group of "wise men", composed of Pierre Ailleret, Hendrik Casimir, Heinz Mayer-Leibnitz and Giorgio Ruffolo, was also set up charged with devising proposals for the reformation of the Centre. Towards the end of 1970, Spinelli brought forward proposals for new staff contracts and made some suggestions for reforms which would improve the mobility of researchers, and which would make it possible to terminate their contracts or to move them from one job to another on the basis of their ability rather than their titles. These proposals prompted a protest strike at Ispra which lasted from the 26th of November to the 7th of December. Spinelli arrived at Ispra a few days later. He described his meeting with the general assembly of the workforce: "I told them that I recognised that I was, at that moment, deeply unpopular, and I also recognised their conviction that my plans are aimed at dissolving the JRC. I explained to them that the JRC was dying when I took the matter in hand, and that had I wanted it dead, I would simply have left it alone. I explained all of my plan, and the reasoning behind the new staff contracts. [...] After the meeting with the staff, I had a second closed meeting in the management offices, with Caprioglio and the heads of the research division. They asked me to come to an agreement between the Commission and the Italian Government to prevent another occupation, which is dangerous in a nuclear establishment. I asked them to get ready to plan the future programme of the JRC after the reconstruction."[23]

The Ailleret group produced a restructuring proposal which geared the activities of the JRC to fundamental research rather than industrial development; this coincided with the last period of Châtenet's management of the Centre. The JRC should only get involved when action at a Community level was obviously necessary. It should undertake fundamental research and every establishment should have funds for "free research" into new ideas; it should not undertake large industrial projects, but only encourage them, and, if asked, collaborate in them. For its part, the Commission suggested that the JRC should become an integral part of the future development of science policy and Community technology, and that its management should have greater independence.[24] In the reorganisation of the Directorates- General which the Commission announced on 13 January 1971,

the headquarters of DG XV, devoted to the JRC, was moved to Ispra (but not for long, for in 1974 it was transferred back to Brussels). DG XV was to maintain responsibility for direct research, whilst indirect research would come under the competence of DG III (Industry). Furthermore, the official title of the Community laboratories would become Joint Research Centre, with no further reference to nuclear research. Although responsibility for both direct and indirect research policy remained with the Commission, the general management of the JRC now assumed much greater responsibility for research programmes, and acquired more extensive management powers. Finally, the Commission prepared a three-year plan for the JRC to be presented to the Council, calling for the final closure of Essor; a clampdown on complementary programmes in which Member States could take part or not as they chose; and the employment of 100 new staff, between researchers and other workers.

Such proposals did not have an easy time at the EURATOM Council which met to decide on them on 6 December 1971. What follows is Commissioner Spinelli's account of the meeting: "The sitting lasted from ten in the morning until half past midnight, with two short breaks for meals. Four delegations gave our proposals whole-hearted support. The Italian delegation *livre un baroud d'honneur pour Essor;* but was on the verge of lining up with the other four. Their grievances, however, weakened this coalition. The French delegation remained firm in its determination to reject the programme. The only common programme they would accept involved the 100% functioning of Karlsruhe, a reduction to 80% and 12% at Geel and Ispra respectively, and the closure of Petten. The difference should be made up by complementary programmes, as they say in Community jargon, which means paid for by the others, particularly Germany. And the cost of the infrastructure, which is nearly 80% of the JRC's budget, should be divided up among the programmes. But the Germans would not accept this, and the Commission, whose spokesman I was, did not modify its proposal. [*Author's note:* It was suggested that we should only approve an annual programme, based on 1971, or the first year of the proposed Three-year Plan. The Commission refused.] Then there arose the question of what would happen if there was no programme. They asked me; and I answered that, if there were no programme, there would remain all the ruinous expenses (wages, salaries, maintenance) which the Commission would have anyway, even if they were not built into the budget. Boegner, [*Author's note:* the French Permanent Representative to the European Communities], woke up. He had just realised that we had arrived at the point where, without a programme, France would pay more than it would have to pay if we had almost any programme. And he asked us to decide at once that if we did not succeed in setting a new programme by the end of the year, we should carry on for the following two months with last year's programme. The others refused to give this undertaking. Boegner then announced that in that case he would not take part in the drawing up of the provisional plan. He tried to claim that, if there were no plan, then the Commission would have to dismiss all the staff, but he was brought with reluctance to accept that only the Council could decide to dismiss them."[25] At the following sitting of the Council, held on the 20th of December, an annual programme was adopted, as in previous years: "The Council has finally approved an annual programme which is a pointless renewal of the previous year's programme, which itself was the renewal of the programme from three years before that, with a few irrelevant corrections. They have added a few non-nuclear projects, but under joint French-Dutch pres-

sure these are in the form of contracts between the JRC and individual states. There was an attempt to reduce the personnel, which I resisted. If the programme is conservative, we must conserve not only useless projects like Essor and HFR but also the personnel. I succeeded. and finally we finally gave work (though in a manner without much significance) to everybody."[26]

The idea that the JRC could be involved in non-nuclear research was accepted in principle at the Paris Summit of Heads of State and Government in December 1972: and it was anticipated that nuclear research would evolve in the direction of the safety sector. After this policy decision had been made at the highest level, a new Joint Research Centre programme for the coming years was agreed on 5 February 1973. The programme covered the period 1973-1976, and contained very many of the modifications which the Commission and the JRC's own representatives had suggested over the preceding three years. The JRC would concentrate on long-term research projects into the safety of nuclear fission, but would abandon its work on industrial nuclear development. It would also concentrate on public service activities for the Community, on the model of the Central Bureau for Nuclear Measurements (CBNM) in Geel. Under Article 6c of the EURATOM Treaty, the Essor reactor would be placed under the responsibility of the Italian government; the complementary programmes would be not abolished, but severely reduced; and research programmes in non-nuclear sectors would be set up under Article 235 of the EEC Treaty. The Centre's personnel, however, was to be reduced in real terms (1582 scientific and technical staff , in 1974) despite the hiring of new staff from the three countries which had just joined the Communities.

This agreement was the result of a compromise reached with much difficulty by the Council between three groups of governments: those which proposed the simple closure of the JRC, which, however, had not been provided for in the Treaty and was thus very difficult to achieve; those which still retained a European perspective on the development of some areas of nuclear research; and those governments which were anxious to defend the pre-existing JRC establishments in their countries. The position of the Commission was summed up rather brutally by Spinelli:"If the Council had been able to close the Centre, fine; but since it could not, it was better to have a programme of progressive reform, however imperfect it would unavoidably be, rather than to carry on as things were".[27] In Spinelli's plan, the reform of the JRC did not represent a continuation or a relaunch of EURATOM, but instead a first step - administratively indispensable - towards the wide-ranging research policy towards which he was working.

There were two principle directions for research policy in the work of PREST. The first, which had been expounded in the Maréchal Report, leaned towards a centralised policy at Community level which could profit from the "economies of scale" which were to be had at a continental level. The second was that which, through the Aigrain Report, had led to the COST initiative, or to a series of intergovernmental agreements which represented a scientific Europe *à la carte*. As the new Commissioner Spinelli, a convinced federalist, worked towards a Community programme and tried to prevent almost any involvement by the Commission and the Communities in intergovernmental agreement. His position, in a nutshell, was: if the governments want to come to agreements among them-

selves, let them do so, but they should not expect help from us. Instead, according to Spinelli, the decision-making processes in the area of industrial and technological development need to become more centralised. In a speech to the European Parliament on 21 April 1971 he affirmed: "To start with, the increasing rate of technological evolution requires of our countries an increasingly vigorous response. This is so not only in large areas at the cutting edge of technology, but in all areas of industry, including traditional ones. It is also evident that some countries have devoted disproportionate efforts to large prestigious projects, to the detriment of programmes of more modest appearance which are of greater interest from a social and economic point of view. Even more important is the fact that the era of spontaneous technological development is coming to an end. In the course of the last twenty years large industrial states have supported research projects on the basis of circumstances, on the hypothesis that all new technologies, especially spectacular ones, deserve support. Now we realise that the richest country in the world has started to question the rationale of this policy. From this point of view, the abandoning of the SST [*Author's note:* the Supersonic Transport project of the American Boeing company] doubtless marks the start of a new and more rigorously selective period. If the USA realises that it cannot simultaneously conquer space, build a supersonic aircraft, improve conditions of life in its large conurbations and preserve the environment, then obviously Europe should become equally exacting in its choice of projects, eliminating duplication and as far as possible avoiding spending ten or fifteen years on what others have done before them.[28]"

Commissioner Spinelli's first move was to reorganise the Directorates-General for which he was responsible, so as to make them better able to create strong links with industry on the one hand and research and development on the other. He therefore incorporated all the services connected with industrial development into DG III. This corresponded to the need, frequently expressed during discussions on the technological "gap", to create a strong link between research and industry without repeating the mistakes of EURATOM. It also had more prosaic legal reasons. In order to adopt a research policy (and this was true of regional, social, industrial and energy policies too), it would be possible to reform the Treaties, but this would take time and a greater degree of consensus than existed at the time between the Six. Alternatively, Article 235 of the EEC Treaty could be put to the service of any Community aims which had already been defined, and thus applied to economic development. As we have seen, this path was chosen; and the reorganisation of the DGs was a necessary consequence.

While the reorganisation of the Directorates-General got underway, a Task Force for research and development was formed, with the job of setting out a research programme to cover several years. A priority was to conduct a census of research already undertaken, to decide what projects could be adopted by the Community, and to show how they would tie in with the industrial policy which the Community had to set up. Secondly, the Task Force was to conduct a survey in Member States. They were to examine public research centres, the universities, and industries concerned with advanced technologies, in order to identify possibilities and obstacles, readiness to participate in Community research and development programmes, and resistance to them.

The plan for the forthcoming years was to come under four separate headings: 1) direct research undertaken by the JRC; 2) Community finance (community budget, or finance

from the European Investment Bank) for research and/or development; 3) the co-ordination and harmonisation of national programmes; 4) financial participation by the Community in joint projects with non-member states. In the course of its investigations, the Task Force was to pay particular attention to the following areas: advanced reactors, the enrichment of uranium, thermonuclear fusion, nuclear research into the safety of reactors and radioactivity, electronics and information science, materials, measurements both nuclear and otherwise, space, and the environment.[29]

Although it was not to replace research and development policies in the Member States, the Community should be in a position to become involved effectively whenever the situation required greater efforts than individual countries could make. Spinelli therefore proposed to set up two new institutions: the European Research and Development Committee (CERD), and a European Research and Development Agency (ERDA). The CERD, consisting of high-level experts in the areas of science, law and economics, would evaluate and propose joint programmes, where necessary in conjunction with national science policy officials. ERDA was a more ambitious project: on the model of the American NASA, the Agency was to have its own funding in order to directly finance and evaluate projects. These projects might be entrusted directly to the JRC or carried out at research and industrial centres in Member States. These two institutions were to assume all the responsibilities for directing and proposing research which had previously been distributed among various committees at different levels, whether in nuclear or non-nuclear fields. Such centralisation would allow a better evaluation of the appropriate level at which each action should be taken: whether national, Community, or in collaboration with non-member states. Finally, the creation of ERDA with its financial independence would increase the Commission's powers, and improve its ability to move rapidly and flexibly, without requiring every single decision to be taken at the Council of Ministers. But Spinelli's proposal were only accepted in part. The CERD was set up on 4 April 1973; with 21 independent members, it was to be a seedbed of ideas and initiatives, but without any real powers it would in time become just another of the many consultive committees which exist at the Commission. ERDA would never see the light of day.

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4. 1973-1974: THE "EUROPEAN SCIENTIFIC AREA" PROJECT

On the 1st of January 1973, Great Britain, Ireland and Denmark officially joined the European Communities. A fourth government, that of Norway, had signed the Treaties of Accession, but in a referendum a majority of the Norwegian people rejected the proposal that their country should join the Community, being particularly concerned that there were insufficient guarantees for the future of her agricultural and fishing interests. Following the enlargement of the Communities, the Commission too increased in size, and the various portfolios were redistributed. Responsibility for research, science and education, as well as for the JRC, went to Ralf Dahrendorf. At the same time, all research activities were allocated to Directorate-General XII, under the directorship of Günter Schuster. Industry and technological affairs remained the remit of Directorate-General III under the policy direction of Commissioner Spinelli. We may note in passing that this last decision, which was taken mainly for administrative reasons, rather obviously ran directly counter to the often-proclaimed necessity of drawing research and industry closer together. This linchpin, vital for technological development, would for the most part be overlooked in Community activities throughout the 1970s.

Spinelli's policies were entirely concentrated on his attempts to increase Community powers and on rejecting out of hand any intergovernmental shortcuts. He was convinced that the time was ripe for vigorous Community action in the field of R&D. Ralf Dahrendorf, however, was more cautious, perhaps more "realistic". The new Commissioner's starting point was his realisation that the Community's only direct efforts in the fields of research and development, Euratom's work organised with the Joint Research Centre, had not yet completely recovered from the serious crisis of the period 1968-1973, and that in practice research in Europe was conducted by the individual states: "So, for example, in 1972 the total amount of money spent by the (then six) Member States amounted to about 4.500 million U.A. (this figure includes all public funding for civil and military research during 1972), of which only 91 million U.A. were allocated to Community research (76 million U.A. of which went to EURATOM)".[30] In his Work Programme, Dahrendorf, whose responsibilities had been extended to include education, proposed research projects set in a general context of cultural development. Signalling from the very beginning the distance which separated him from his predecessor, he asserted that "for Europe, science and education form part of a medium and long-term strategy for the future. We must be clear in this regard that the mere fact of an action being taken at a European level is not enough. For this reason we should establish standards which will determine what tasks rightly belong at a European level." As regards basic research, the aim should be to set up a "European Scientific Area" which would result in greater co-operation between Member States. It would therefore be necessary "to increase the mobility of researchers within the Community; to facilitate international contacts within the setting of the Community; encourage joint actions in Europe and co-operation projects; to draw up a register of laboratories suitable for carrying out research at a European level and to create a network of professionals working in these laboratories; to guarantee the co-ordination of ef-

fort in the case of expensive long-term projects; and to make particularly expensive installations function to common advantage. The Community should also support the efforts made to set up a European Scientific Foundation, and continue its involvement in research with non-member states.

Research and development, in Dahrendorf's view, should be focused on two great objectives: improving the quality of life, and regenerating European industry. In the medium term, therefore, the necessary tools must be available to provide for growth in European companies and to make a useful contribution to policies in other areas of the Community (energy, assistance for developing countries, industry, information science, agriculture, the regions, social policy and ecology). Dahrendorf also emphasised the importance of creating infrastructure for handling and distributing information, and the collection and processing of data, at a Community level. These were scientific services which "could make a considerable contribution to the rationalisation and acceleration of the process of change," and he would therefore support the work of the Committee for Scientific and Technical Information and Documentation (CIDST) which had been set up by the Council in 1971. In general, it was foreseeable that "for many years yet ... the research and development work of the Community will continue to be carried out, generally speaking, by Member States on the basis of national decisions". It was therefore essential to have the necessary means to co-ordinate these national policies, so as to avoid useless duplication, increase the efficiency of the work undertaken, improve the spread of information, and harmonise procedures. In this context the JRC should become an "efficient multipurpose tool of the Community", whose tasks would be to undertake R&D in those fields where it made most sense to operate at a Community rather than a national level, and in those areas presenting particular risks or which were particularly remote from any industrial application. The JRC should also help the Community on technical questions, undertake research for third parties, become involved in some basic research (for example, on transuranic elements) and "increasingly become a point of contact and exchange of ideas for European researchers and technologists". However, since it was unlikely in the short term that the Council would greatly increase the JRC's funding, Dahrendorf suggested that a large part of the Community's R&D work should take the form of "indirect action", conducted, therefore, by Member States in the form of technical and scientific research contracts, industrial development contracts, contracts of association, joint undertakings and concerted actions.

In the short and medium term, Dahrendorf proposed to set up a research programme for long-term forecasting, called "*Europe + 30*": "The Commission should systematically organise a concerted action to study European developments in the chief areas over a flexible time-scale of about thirty years. The results of this "*Europe + 30*" study should determine what action the Community takes in many fields." This "research on research" ought to be carried out through the setting up of a "Planning Office" at the Commission. As for the Community's policies in the various sectors, Dahrendorf suggested setting up or pursuing research related to energy problems (nuclear fusion, problems connected with nuclear energy, and non-nuclear energy sources), industrial development (aeronautics, information science, transports, new materials and the traditional sectors) and the protection of the environment. The main instrument for the realisation of Community R&D policy, and, above all, for the co-ordination of national policies, should be a "Committee for

the Co-ordination of Scientific and Technological Research", whose members would be high-level national officials, to be set up in place of PREST; while the CERD would be given a consultative role with reference to basic research and the work of the JRC.

January 14th 1974 is a historic date for R&D in the European Communities. Following the request made by the Heads of State and Government at the Paris Summit of 1972, the Council adopted four Resolutions in the fields of science and technology.. These resolutions were fundamentally based on the Commission's proposals and were not especially ambitious, but they were the first of their kind and a large number of future Community initiatives would be based upon them. The first Resolution was general in character and concerned "the co-ordination of national policies and the definition of projects of Community interest in the areas of science and technology." In order to co-ordinate national policies effectively, the Council invited Member States to join in a collaboration which would consist above all in their giving the Commission, at appropriate times, all the necessary information. The projects of Community interest could involve non-member states, and some degree of co-ordination should be established in cases of co-operation with, or within, international research organisations. The Scientific and Technical Research Committee (CREST), formed from representatives of the Member States and the Commission, would help both the Council and the Commission to fulfil these tasks. Despite the fact that the word "co-ordination" had disappeared from the name of the Committee, the business of the successor to PREST, during an experimental period which lasted from 1974 to 1976, was almost exclusively in the area of the co-ordination of national policies and the gathering of information about national and international programmes.

The second Resolution concerned the collaboration of the Communities in the establishment of a European Science Foundation (ESF), to be modelled on the American National Science Foundation, to oversee the development of fundamental scientific research. The idea of a foundation of this kind came from a request put forward by the Commission to set up a kind of research council which could provide both the Commission and the Council with a consultancy service in matters of basic scientific research. However, despite the interest of Commissioner Dahrendorf, basic research was not a Community priority, and the Foundation project, on which various research councils and European academies were working, provided for a diffuse structure and the participation of scientific organisations from 16 countries: eight from the Community (Luxembourg being excluded), plus Austria, Greece, Yugoslavia, Norway, Portugal, Spain, Sweden and Switzerland. On this point, Dahrendorf wrote : "Considering the particular nature of basic research, which needs to be supported and encouraged rather than organised and planned, and given that collaboration often extends beyond the confines of the European Community, we need to find at a Community level a satisfactory response to the problems which are posed by this type of research."[31] For all these reasons, the Foundation was not a Community institution; nor at this period could it be. However, the Commission took part in the working group charged with drawing up the statute for the European Science Foundation (ESF) and, with the Resolution of the 14th of January 1974, the Council welcomed its birth and expressed a wish for close collaborative links between it and the Communities. The European Scientific Foundation, with the participation of the national research councils of 15 countries, held its inaugural meeting at

Strasbourg on the 18th of November 1974.[32]. The ESF was to encourage European scientists to work together in areas of common interest, to co-ordinate the use of machinery and laboratories, and to identify new areas which might benefit from this co-operative approach. The Foundation would also organise conferences and study groups, and encourage exchanges between researchers in different European laboratories.

The third Resolution of the Council established the necessity for the Community to have its own science and technology policy which would integrate the research programmes already set up by the Communities with specific projects advanced by the Commission, working together with the Scientific and Technical Research Committee (CREST), for the consideration of the Council. These projects should be chosen above all on the basis of their usefulness to Community objectives, both generally and in particular areas. Such projects might be direct, indirect or common projects, and might also involve non-member states. The fourth and last Resolution set up a specific venture, which was in a way preparatory to the formulation of a Community science and technology policy. It was the study which Dahrendorf had proposed of the development of Europe over the next thirty years (*Europe + 30*) and on the feasibility of establishing permanent forums within the Community for technological forecasting and evaluation. This was only a preliminary programme, to last for one year, on the basis of which the Commission had to present fresh proposals to the Council.

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5. THE FIRST RESEARCH AND DEVELOPMENT ACTIVITIES (1974-1979)

When, in 1974, the Community took the first timid steps towards establishing its own research and development policy, political and, above all, economic circumstances were far from favourable. The oil crisis, followed by the Arab-Israeli War of October 1973, plunged the economies of all Western countries into a critical situation and brought about the final crisis of the monetary "snake", which had been designed as the first stage on the road to economic and monetary union. The difficult economic situation prompted European countries to make huge cuts in their budgets, including those of scientific and technological research. At the Community level the Common Agricultural Policy was upheld because it was the only policy with its own resources; but the new policies settled upon at the Paris Summit of 1972 (environmental, regional, social, industrial and technological policies) were brought to a standstill. From a political point of view, moves towards the construction of Europe were stalled, stranded between the risk of dissolution and hopes of a relaunch.

The world crisis also brought to maturity a series of reflections on the model of economic development and its limitations; there was a growing need to think in global terms in a world which had become too small to sustain progress based on limitless expansion and on the waste of non-renewable resources. Thus the themes of the environment and its protection, the demographic explosion, and the relations between North and South were all pushed into the limelight. The interweaving of the economic crisis with reflections on the ultimate aims of technological development aroused questions about the type of research which had been the subject of investment over the previous twenty years, and whether it were possible to pass from "big science" to a kind of research that was less expensive and more responsive to the needs of ordinary people. Was it still possible or even reasonable to continue to invest in space research, simply for motives of power and prestige? Were not the risks of nuclear development too high compared with the possible economic advantages, with public opinion increasingly concerned about the development of potentially uncontrollable technologies? Should not research be concentrated, first and foremost, on those world-wide problems which threatened the very existence of the planet?[33]

In this context, and also as a result of the Milan Symposium on Scientific and Technological Policy in the European Community of May 1976, the Commission proposed in 1977 a broadening and diversification of Community research. The JRC would finally assume the new role of providing a public service infrastructure for research, principally in the fields of the safety of reactors, radiation protection, new energy sources, and the conservation of the environment and of resources. Energy research continued to absorb the largest share of the Community research budget but this too was to diversify and to be directed towards alternative sources of energy: in particular solar energy for the short to medium period, and fusion in the long term. New areas were opening up or receiving a fresh impetus: agriculture, medicine, molecular biology and the environment.

As requested by the Council in 1974, the Commission presented a review of all the work undertaken up till then, and a series of directives for the future.[34] The Commission's document first identified four general objectives for science and technology policy, which correspond to the political aims of the Community: 1) The long-term supply and conservation of resources, such as raw materials, energy, agricultural resources and water supplies; 2) the promotion of economic development through the competitiveness of industry at an international level; 3) the improvement of living and working conditions; 4) the protection of the environment and of natural resources. It was quite plain that the Community alone could not begin to cope with such enormous problems: the financial means were not available (in 1977, the Community research budget was 188 million EUA[35], equivalent to between 1 and 2% of public money spent on R&D in Member States, and no substantial increases were expected during the next four-year period), nor was there the political will (the Community did not want to put itself forward as a tenth European state in competition with the Member States). The primary responsibility therefore lay with the Member States, and the Community's function was to intervene if and when the states would not take this responsibility or were unable to do so alone. As for technological development, however, in the Commission's view, European industry needed to take on R&D projects at a continental level, and was prepared to do so. It was governments which continued to defend what they saw as priority national interests, and which put a brake on European initiatives. Another one of the Community's tasks, the particular responsibility of CREST, was the co-ordination of the Member States' R&D policies, and here the Commission's difficulties were almost insurmountable: "How is any policy of coordination possible when even in the Member States the planning of research projects and programmes remains partly uncoordinated? How can there be a policy of coordination when the Member States are unwilling to commit themselves in this respect?"[36]

In the wake of the Resolutions of 14 January 1974, the Commission was obliged to establish a comprehensive research policy in spite of these difficulties and limitations. It seemed the right moment to place individual projects in a wider frame of reference, reflecting the long- term structural policies of the Communities. An urgent task was that of defining a set of criteria for the evaluation of existing programmes and choosing future ones: "Should this or that research project or programme be carried out by the Community? Will it contribute to the development of a common research policy for Europe?"; to answer these questions, the Commission identified a set of criteria for making such choices, drawn up at three levels. The first level, the most general, was legal and political and required that any decision be in accordance with the three Community Treaties and with the Council's Resolutions on the subject of scientific and technological research. The second level embraced four general criteria:[37] 1)Efficiency: there should be Community intervention wherever this would promote the rationalisation of effort and allow greater efficiency (an example is controlled nuclear fusion research); 2)Transnational research: Community research was necessary in all areas which by their very nature do not concern a single country (examples are transport, information, the environment and telecommunications); 3)The size of the market: involvement in those areas, such as aerospace and computing, where the R&D costs are very high and the products require larger than national markets; 4)Common requirements: projects which may satisfy needs common throughout the Community (examples include environ-

mental protection, urban and land use planning, standardisation and radiation protection). The third and final level consists of eleven criteria which are for the most part subdivisions of those described at the preceding level: they run from the greater efficiency of Community intervention through the ability to encourage new areas, to harmonisation. This was not really a systematic list of criteria upon which the decision to intervene could be made, as the Commission claims in its Communication to the Council. Rather it was an *ex-post* justification of the choices which the Community had already made. But we will now see how, in 1977, the Commission presented Community involvement in the six great areas of energy, resources, the environment, living conditions, services and infrastructure and industry; and how it intended to develop these areas in the future,[38] always bearing in mind that at this time very ambitious projects were often realised at a very modest level from a financial point of view. In relation to some of the areas covered we will also take note of some non-community research bodies and institutes which were set up in Europe during this period.

Energy. Only the oil crisis of 1973 could bring home to Europe how dramatic the situation was: if the unchecked waste of resources were to continue, then within a few decades the foundations of economic and social development would be in danger of collapse. It was vital to become aware of the finite nature of natural resources, and of the limits which must be put on growth and development. Given this, the Commission's energy research policy needed to be ready to move flexibly so as to be able to respond to the various demands which Western society would make on it in the short, medium and long term. It was necessary not only to develop new energy sources, increase the productivity of existing sources, and encourage energy savings, but also to study actual energy needs and to assess the consequences for both man and the environment of alternative kinds of development. In the fossil fuel sector (coal, lignite and hydrocarbons) the Community conducted research on coal, and particularly on gasification processes. It should also set up studies of off-shore drilling and the exploitation of oil deposits. EURATOM, although it had given up its direct involvement in the development of reactors, continued its research in the nuclear field via the Joint Research Centre, paying particular attention to safety problems: radiation protection, the safety of reactors and the storage of radioactive materials. In this field, the Community could be especially effective, since it already had adequate infrastructure and vast experience. Since it was not directly bound to industrial interests, the Community was able to carry out inspections as an independent public service. Although energy production from nuclear fusion could not be realistically expected before the next century, European studies in the field were very advanced due to co-ordinated action at Community level. However, to compete with the USA and the USSR it was now necessary for Europe to build the Joint European Tours (JET). In the medium to long term, the Community still had to carry out research into new energy sources: wind power, wave power, geothermal power, and above all solar energy and hydrogen production *by synthesis from water*. Meanwhile in the short to medium term it was important to concentrate on research into energy savings. In these areas Community actions were prompted by criteria of economic savings, efficiency, and the encouragement of new sectors which, from the start, should take care to avoid conflicting development in the different European countries. In 1978, the Community spent nearly 70% of its research budget, which amounted to some 230 million EUA, in the field of energy.

Resources: In the area of raw materials, Community research was geared to geological studies and the improvement of techniques of prospecting, extracting and processing minerals, above all with reference to copper, zinc, lead, phosphates and uranium. In the second place, in association with environment policy, Community research was concerned with the recycling of materials of domestic, industrial, and agricultural origin and from forestry. Agricultural research had been conducted by the European Economic Community since 1958, but now had to turn from the specific studies it had undertaken so far towards research of a wider scope, for the benefit not only of the agricultural industry but also of regional development and environmental and energy policies. There must be studies of more rational land use, the reduction in the use of pesticides and fertilisers, and on the effects of intensive agriculture on soil and water. Agricultural research could take advantage of information gathered by satellite surveys: the JCR's establishment in Ispra, in conjunction with the Directorate-General for Agriculture, was already realising a plan to use information provided by NASA's Landsat-2 satellite for agricultural purposes. Finally, water was identified as a fundamental and scarce resource, which the Community's scientific and technological research should help to preserve. In 1978, a very small proportion of the Community research budget was directly allocated to resources: 2.3% to research on raw materials, and 1.1% on agricultural research.

Environment: In 1973, the Community had set up a Common Environmental Policy, which it had justified on the grounds of the transnational character of the problems which had to be faced, and because of the danger that unco-ordinated national policies could create obstacles to the free movement of goods and unrestricted competition in Europe. A programme of research over several years centred on the effects of pollution on both man and the environment, on the improvement of measuring techniques for pollutants, on developing the administration of information about pollution, on the development of "clean" technologies, and on the long-term effects of human activities on the environment and the climate. In this area, the Community was also able to stimulate and direct new research, encouraging the adoption of consistent environmental standards throughout the continent and providing answers to an increasingly anxious public. In 1978, 5.2% of Community research funds went to finance environmental studies.[39]

Living and working conditions : In the programme for Community research sketched out in 1977, allowance was made for future research into social policy matters. There should be research into the social consequences of technological development, emigration, the demographic situation and changes in demographic patterns, and the methods of social analysis themselves. However, if we exclude the first and only concerted action project on the growth of large conurbations, which was approved in February 1978, social research was to remain a dead letter in the Community until the Fourth Framework Programme was approved in 1994. Nevertheless, in addition to the FAST studies which will be discussed in the next chapter, the Commission launched two initiatives which were related to social research. The first was ESIST (European Society and its Interactions with Science and Technology) a subcommittee of the CERD. Between 1976 and 1982, it organised a series of activities intended to encourage debate on the relationship between science and society, and on the evolution of European and Community research. ESIST's proposals would play an important role in the reorganisation of Commu-

nity research and development during the first half of the 1980s.[40] The second initiative was a piece of research into public perceptions of scientific and technological progress in Europe, commissioned by ESIST itself from two researchers from *Eurobaromètre*, the Community programme responsible for opinion polls. The main results of this investigation were somewhat unexpected: the citizens of the nine Community countries shared an extremely positive image of research, for its benefits to the quality of daily life, and unreservedly supported the Europeanisation of scientific and technological activities.[41]

The European University Institute, which was founded in Florence in March 1975, deserves a separate mention. The EURATOM Treaty, signed in Rome in 1957, had provided for the creation of an institute at a university level, apparently intended for the training of nuclear scientists and engineers who would be needed in the new industry. Nevertheless, as early as 1959 it was thought the exact sciences should be joined by the humanities, since the development of European unity urgently needed links to be forged between economics, jurists, historians and political scientists, who unlike physicists and engineers do not share a common language. The Council had the task of establishing the nature of the institute and its working methods, and choosing a location for it, but for many years it proved impossible to reach a compromise between the Member States. The relaunch of the Communities, marked by the Hague Summit in 1969, brought about the signing of a preliminary agreement, which subsequently led to the signing in 1972 of the Convention which set up the European University Institute. The Institute was an intergovernmental, not a Community, institution to which all the Member States adhered. By then, Community interest in the training of nuclear scientists was lukewarm by comparison with its enthusiasm fifteen years earlier, and it was therefore decided to devote the University Institute exclusively to research into the social sciences. From 1976, the European University Institute carried out research principally but not exclusively of a Community character, and offered courses and seminars leading to masters' degrees and research doctorates (PhD) in history, economics, law and political sciences.[42] In September 1993, the Robert Schuman Centre was established within the EUI, to pursue the research work on European construction which was formerly conducted by the European Policy Unit and the *European Culture Research Centre*.

Medicine and molecular biology were also considered in association with living and working conditions. In the Community's plans, Community medical research was to concentrate on early diagnosis and prevention, rather than on treatment. Three interdisciplinary areas of particular interest were identified: epidemiology, medical biology and bio-engineering. For the first Community research programme three topics were chosen: the collection and analysis of congenital deformity, the study of ageing, and artificial oxygenation during surgical operations. In the fields of molecular biology and genetics, the Community's actions sought to complement those of two other European organisations: the European Science Foundation (ESF) of which we have already spoken, and the European Molecular Biology Organisation (EMBO). The EMBO was set up in 1963 by the Nobel Prize winner John Kendrew, who feared that the excessive splintering of European research efforts in the field would cause Europe to lag seriously behind the United States. The Organisation was initially funded by the Volkswagen Foundation and was supported, from 1970 onwards, by twelve governments which formed a European Conference for Molecular Biology. It was structured on the

model of CERN. During the 1960s, it was mostly occupied in the organisation of courses and seminars and in awarding research grants; in the following decade, EMBO directed its efforts principally towards the creation of a European laboratory: the impression was that molecular biology was being transformed into "big science" and needed increasing expensive and complex equipment which should be brought together on one site.[43] The first laboratory project was very ambitious, demanding the recruitment of 150 scientists and engineers with an annual budget of 8-9 million dollars; this programme was rejected; but a majority nevertheless agreed to set up a European laboratory. In 1972, Heidelberg was chosen as the headquarters of the laboratory, while the Deutsches Elektronen Synchrotron of Hamburg made available its X-ray source and the Institut Laue Langevin of Grenoble (ILL - an intergovernmental research institute for physics, chemistry and biology financed by France, Germany and Great Britain) would provide a neutron source. The European Molecular Biology Laboratory (EMBL) was completed in 1977, and began work on its research programme the following year under the direction of John Kendrew.[44]

If the fundamental biological research was mainly entrusted to EMBL, the Community's research, according to the projects brought forward by the Commission in 1977, was to focus its attention on genetic engineering for agricultural and bio-industrial applications, and on bio-technology for the production of new substances from micro-organisms and cell structures; it was also to examine the molecular aspects of diseases such as leukaemia, cancer and arteriosclerosis. Research into radiation protection which had been started at EURATOM now aroused new interest for the numerous applications of nuclear technology in many fields, including the medical. The Community programme covered the evaluation of the risks of radiation and environmental contamination, the short- and long-term effects of ionising radiation, and dosimetry. Overall, in 1978 the "living and working conditions" sector received 6.7% of Community research spending.

Services and infrastructure : The entire Community apparatus for research and development aimed to present itself as a service, and this was particularly true of the JRC. Two initiatives, however, were of particular importance from this point of view: the Community Bureau of References (BCR), an indirect action programme begun in 1973 to provide measurement services and standards across many sectors of industry, and the Committee for Scientific and Technical Information and Documentation (CIDST).

CIDST set itself, as a chief objective, the creation of a European network (Euronet) for the transmission of scientific and technical data. Through two successive action plans, (1975-1977 and 1976-1980) and in collaboration with two other European projects, COST 11 (European Informatics Network) and the SDS network (the Space Documentation Service of the European Space Agency), CIDST worked on the establishment of a network of connections between data banks. Such an objective had to overcome the many difficulties posed by the differences which existed between natural languages, computer technologies and programming languages. The Community Euronet-Diane network (Direct Access Network for Europe), set up in collaboration with national postal and telecommunications organisations, was officially inaugurated on 13 February 1980: thanks to this, more than 1000 European organisations could access 120 scientific and technical data banks. The problems of translation between European languages which the realisation of Euronet faced led in 1982 to the adoption of a programme

known as Eurotra, which financed linguistic research and carried out studies for setting up an advanced European machine translation system (on the model of Systran) which had begun in 1976.

Industry : Despite the Commission's proposals, which we will discuss in the next chapter, the Community had not yet arrived at a common industry policy, nor did industrial research really exist. The most ambitious project concerned aeronautics, but the programme put forward by the Commission in 1977 was rejected by the Council. European co-operation, therefore, was pursued exclusively at an intergovernmental level, principally with the Airbus project in the civil field, and in a few military programmes. Space research, however, had now been entrusted to the European Space Agency (ESA), founded in 1975, which inherited the work of two organisations from the 1960s, the European Space Vehicle Launcher Development Organisation (ELDO) and the European Space Research Organisation (ESRO).[45] Within the Community, proposals for future industrial research involved work in the fields of information science, telecommunications, and transport. According to the figures for 1978, research into the international competitiveness of European industry absorbed about 6% of the Community R&D budget, but this percentage includes the costs of the Community Bureau of References (BCR).[46]

The Community's research activities during this period assumed three forms, which have remained practically unchanged today: direct action, indirect action, and concerted action. The first two derived from those used during the EURATOM research; the third represents a new departure. Research by direct action was carried out by the Joint Research Centre and was totally financed from the general budget of the Communities. Indirect action referred to research activities contracted out to public research centres or private laboratories in Member States; for these the Community generally paid about 50% of the cost. In concerted actions, the Communities guaranteed and financed only the co-ordination of the research (reimbursing travel expenses, meetings etc) and the circulation of the results of the research. This last type of financing also provided an opportunity to evaluate the usefulness of individual projects which might subsequently be the object of indirect action, where this seemed to be in the Community's interests.

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6. PLASMA PHYSICS, FUSION AND THE JOINT EUROPEAN TORUS

During the second half of the 1940s, laboratories in Great Britain, the United States and the Soviet Union began to study plasma physics, with the explicit intention of learning how to control nuclear fusion so as to use it as an inexhaustible energy source. This research was veiled in secrecy, in part because of its possible military implications, but also because scientists did not discount the possibility that there might soon be a technological breakthrough which could lead to the commercial use of the new energy source. Contacts between research groups in the three countries were therefore practically non-existent. The Chairman of the First International Conference on the Peaceful Use of Atomic Energy, held in Geneva in 1955, extolled the potential uses of atomic energy obtained from fusion and with some exaggeration claimed that this energy would probably be available within twenty years. This seemed an excellent reason for continuing with the research in competition with the laboratories in other countries. A first indication of the probable scale of the difficulties to be overcome in the search for controlled fusion came during a 1956 conference at Harwell, the principal English centre for research into thermonuclear fusion, when the Soviets unexpectedly presented the results of their experiments on magnetic bottles, although they were still a military secret. In the following years, new experiments received a great deal of publicity, and much interest was aroused by the English experiments carried out with a machine named ZETA, although the results were to prove largely illusory.

1958 was an important year for research into nuclear fusion. At the Second Geneva conference, the international Community decided to "declassify" the results of research in the sector. On the one hand, the military applications no longer seemed so obvious, and on the other, the most eminent nuclear scientists emphasised the vast extent of the scientific and technological problems presented by fusion. [47] Controlled thermonuclear fusion was not for tomorrow, nor for the forthcoming decades: it would have to wait until the next century. Nevertheless, this greater realism over the time scale and the difficulties involved in no way dampened interest in scientific and technological research which might still lead in the future to a safe, clean, limitless energy supply. Meanwhile, at the beginning of the year the Rome Treaties became law; one of these set up EURATOM. In the fifth annexe to the Treaty, which dealt with the initial research and education programme, nuclear fusion appears in both the chapter regarding the work of the Joint Research Centre (with a budget for equipment of 3.5 million units of account.) and in the chapter concerned with research to be undertaken through external contracts (with a budget of 7.5 million U.A.)

As regards indirect action, EURATOM moved initially in the direction of the European Organisation for Nuclear Research (CERN) in Geneva, which since its inception in 1953 had acquired a solid reputation for research in the field of high energy physics, and which was regarded as a model for European co-operation in basic research. In the summer of 1958, Louis Armand and Jules Guéron had talks with representatives of the CERN Council, which led to the establishment of a "European Study Group on Fusion" with the task of taking a census of research programmes into plasma physics set up throughout the world, evaluating them, and putting

forward suggestions for the co-ordination of European fusion programmes.[48] In March 1959, the Study Group, whose Secretary was John Adams, later the director of the English Research Centre for Nuclear Fusion in Culham, presented a report in which the conclusions of the Second Geneva Conference were confirmed: priority must be given to deepening the knowledge of plasma physics, since in the short term there was no possibility of building a fusion reactor. The report also stated that no large equipment seemed to be necessary, so that it was not appropriate to create a supra-national laboratory in where European research activities could be concentrated. Instead it was necessary to train nuclear physicists, of whom there was a great shortage in Europe, more effectively, and to increase the mobility of scientists between European laboratories. Although the presentation of the report signalled the end of close co-operation between EURATOM and CERN, the Study Group continued to meet regularly until 1964, putting large numbers of scientists working in the field of nuclear fusion in contact with each other, whether or not they had links with EURATOM.

In the meantime, EURATOM was undergoing internal organisation. The department concerned with fusion was entrusted from September 1958 to Donato Palumbo, professor of theoretical physics. Two opposing views of the way in which research into fusion should be organised immediately emerged. On the one hand, Guéron, the Director-General for research, was inclined to concentrate on research at the Joint Centre which was then being set up, or otherwise to entrust its co-ordination to the French Commissariat à l'énergie atomique (CEA), which at this time was the most important European nuclear research institution. On the other hand, Palumbo proposed that the Commission should take responsibility for the co-ordination of existing activities in Member States: handing this research over to the JRC would only add a further research programme to those already set up. Furthermore, the JRC should be working on technological research whereas, for the present, the fusion programme would have to be confined to basic research into plasma physics. Putting to one side the JRC option, EURATOM agreed upon a contract of association with the CEA's centre in Fontenay-aux-Roses in 1959. This contract allowed for the possibility that there might later be sub-contracts to other laboratories in Member States. Indeed, the following year the Italian laboratory in Frascati signed a contract with the CEA for research into fusion. Problems unexpectedly arose with the arrival of German laboratories on the scene. If, owing above all to her military research, France was the clear leader in European nuclear fission, this was not the case in the field of fusion, where Germany was probably the most advanced country due to her large number of first- rate theoretical physicists. Faced with the impossibility of persuading the Germans to agree to sub-contract under the French institution, EURATOM resumed the direct co-ordination of the sector, reaching agreements for contracts of association directly with the various Member States' laboratories. In this way, the contract with Frascati was renewed, and three new associations were created with the German laboratories in Garching (IPP) and Jülich (KFA), and the Dutch laboratory in Jutphaas (FOM). At the end of 1962, there were contracts of association with five laboratories and four countries, and their co-ordination was given to the *Groupe de Liaison,* which was composed of the heads of the laboratories concerned and representatives of the Commission. They were joined by specialised Advisory Groups, and the Committee of Directors of the laboratories, which had executive functions.

The 1960s was a time of uncertainty from a scientific point of view in the field of thermonuclear fusion, and laboratories throughout the world seemed to be working in the dark as they tried to develop systems for controlling the instability of plasma at high temperatures. While the Commission sought to encourage exchanges of researchers between the various centres by means of study scholarships, the laboratories associated with EURATOM concentrated on the study of instruments of measurement, on magnetic bottles of different designs and on methods of heating plasma. The turning point came in 1968, when Soviet scientists at an international conference in Novosibirsk presented the results of experiments conducted with their Tokamak T3, a toroidal machine with magnetic containment. The results seemed to be too sensational, and they were greeted with scepticism because the measuring instruments which the Soviets used were rather rudimentary. Nevertheless, the team from the Culham laboratory sent to Moscow to verify the results of the experiment with more appropriate equipment confirmed that the results were genuine. Throughout the world the Tokamak was hailed as the high road towards controlled thermonuclear fusion.

Although from the technological and scientific point of view, new and promising prospects were opening up in research on thermonuclear fusion, the political and institutional situation of EURATOM was not so rosy. 1968, it will be remembered, was a year of deep crisis for the Community and for the Joint Research Centre in particular. It was impossible to approve a third research plan for the forthcoming years, and in fact all research and development activity was interrupted. The stalemate was to last until 1973. However, two programmes were to survive. These were the biological programme, and the thermonuclear fusion programme. After a year's suspension, all the contracts of association were renewed, and a new one was agreed between the Commission and the Belgian laboratories at the Royal Military School and the Université Libre de Bruxelles (ULB). In 1971, the Council approved a new five-year "Controlled Thermonuclear Fusion and Plasma Physics" programme for the period which ran from 1 January 1971 to 31 December 1975. Despite the difficulties of EURATOM, the work undertaken with the Associations managed to retain that minimal continuity which was to prove essential to the most ambitious future programmes.

At the beginning of the 1970s, the associated laboratories focused their energies on projects concerned with the construction of several Tokamaks. Like all scientific research programmes, this did not aim simply to repeat experiments conducted elsewhere, but hoped to go further, taking previous research as a starting point. In the case of thermonuclear fusion, this could be achieved by building larger machines and/or through superior performance. With the help of the Commission, which designated the construction of Tokamaks as a priority area, and therefore provided privileged funding amounting to 45% of the cost, the construction of three machines was begun. These were: Pulsator in Garching, a relatively small Tokamak intended to improve diagnostics; FT in Frascati, a more ambitious machine, with a very strong magnetic field; and TFR in Fontenay-aux-Roses, a rather large Tokamak built in great haste, which was already producing exceptional results at an international level by 1974. At the same time, the Commission also set up a programme to improve the mobility of scientists involved in the field of thermonuclear fusion who wanted to work in other European laboratories for a time (between 2 and 18 months). This programme, which involved a thousand researchers, was very effective in creating

relationships among plasma physicists, and in reinforcing the "European Fusion Club" which the contracts of association had created.

During this period, scientists also began to work on the idea of a much larger machine which could not be built by a single laboratory, but which would call for the collaboration of all the European research centres.[49] In October 1971, at the suggestion of the Tokamak Advisory Group, a working group was set up on the joint European Tokamak (JET WG) charged with identifying the tasks which a large European Tokamak would be expected to undertake. In the spring of 1973, the group, led by Lorenzo Enriques, presented its final report outlining the main parameters of the experiments, and defining its principle objective, which was to study plasma in conditions close to those which would pertain in a fusion reactor. The project was cautious on the whole so as not to start by frightening the countries which would have to finance it. At the same time, it was more ambitious than any of the schemes on which French and English laboratories (the Culham laboratory had signed a contract of association with EURATOM in 1973) were working separately. The *Groupe de Liaison* put forward a recommendation to the Commission that the Council should approve the start of the planning phase of the European Tokamak, to be financed with funds from the current plan for fusion and the associated laboratories. The machine which was to be built was officially named *Joint European Torus* (JET). Unusually, the project was approved by the Council within a few months, and in the autumn of 1973, a team of about thirty scientists from various European countries was already at work on the design of the great machine.

Under the guidance of Paul-Henri Rebut, who had already directed the construction of the TFR in Fontenay-aux-Roses, the planning work went ahead swiftly, leading to the presentation of a nearly definitive report in May 1975. Whilst respecting the general outlines of the proposals which had been put forward by the Enriques group, the Tokamak which was now proposed was almost twice the size of the one originally suggested (but had, therefore, a smaller magnetic field), with an oval rather than circular section. The construction costs were expected to amount to 135 million U.A., a sum which it was subsequently decided would be divided between EURATOM (80%), the host country (10%) and the associated laboratories (10%). The problems which now had to be resolved were of an organisational character and concerned in particular the legal structure which the enterprise should assume, the status of the personnel who would be involved in its construction and in the experimental use of the apparatus, and the location of the machine. From 1976, the Advisory Committee on Fusion (ACF) took over from the *Groupe de Liaison*, and played a key role in these decisions. While the *Groupe de Liaison* had been rather informal and was made up exclusively of scientists working on the fusion programme, the new Committee took a more traditional, bureaucratic form, being composed of national representatives from the countries associated with the project as well as scientists. The ill-humour of the JET scientists grew when the ACF, acting mostly under French pressure, decided that the direction of the building would not be entrusted to Rebut, who would keep the title of Technical Director, but to an external administrator. The choice fell upon Hans-Otto Wüster, a German scientist with much experience in the administration of scientific projects, which he had acquired working with CERN in Geneva, and whose contribution to the successful construction of JET would be crucial.

As to the legal structure, the chief countries, France, Germany and Great Britain, proposed that a company registered legally in the host country of the Tokamak should be set up. This was in the hope that the initiative should be as far as possible independent of the Commission in Brussels, to which they attributed previous lack of success in the nuclear field, as well as complaining of onerous administrative procedures. The other countries, which were joined between 1976 and 1979 by two non-member states, Sweden and Switzerland, instead regarded the involvement of EURATOM as necessary to guarantee their involvement in the project and to forestall the authoritarian tendencies of the leading countries. The level of the Community's financial contribution rendered the ostentatious exclusion of the Commission from the management of the project impracticable, and a compromise was therefore worked out by means of the Joint Undertaking provided for in the EURATOM Treaty. Occasionally used, as we have seen in the first chapter, to lend a European flavour to industrial projects in the nuclear sector in Member States, the title Joint Undertaking was now given for the first time to a European experimental project. As to the project's staff, the problems were of two kinds: deciding the level of salaries, and the opportunity to return to the laboratories from which they came when the JET project reached its conclusion.The first problem arose because JET personnel would be taken on by the Communities and by the host country, and this would in turn create great problems which remain unresolved even today, due to the huge differences in salary which were established. As to the second difficulty, scientists and engineers on secondment to JET were guaranteed a "return ticket", including pension rights and the chance to advance their careers, which would make participation in the great experiment more attractive.

However, the problem which tormented the JET project longest, and which would bring it close to a premature demise, was that of the site. The search for the site most suitable for JET began in May 1974 when the ad hoc committee sent all the laboratories involved in the project a questionnaire in order to assemble information on the availability and characteristics of possible sites. In September of the same year, seven sites were suggested: Cadarache and Grenoble in France, Garching and Jülich in Germany, Mol in Belgium, Culham in Great Britain, and, at the Commission's prompting, Ispra in Italy. On the basis of the criteria established by the questionnaire (power of local electrical systems, safety measures for radioactivity, supporting infrastructures, social aspects), Ispra seemed the most suitable location. However, resistance to the JRC's site was very strong both in the scientific Community and in political circles outside Italy: after the crisis at the end of the 1960s, Ispra carried with it a reputation as a scientifically unreliable research centre in an environment which was, from a socio-political point of view, particularly unstable. Having set Ispra aside, with promises to set up a new fusion laboratory instead, competition was restricted in practise to the two chief centres which already had expertise in fusion: Garching and Culham. Since neither the Advisory Committee nor the Commission made any suggestions, the choice of the site passed to the Council of Ministers, an intergovernmental body, where the debate was transformed into a clash of politics and prestige between Great Britain and Germany. Six meetings of the Council of Research Ministers, two meetings of the Council of Foreign Ministers and a meeting of the European Council were needed, before finally, on 25 October 1977, Culham was chosen as the site of JET.[50] The decision was not reached on the basis of agreement over the Communities' science policy, but thanks to the fortunes of another "jet", the

Lufthansa plane hijacked over Mogadishu by the Red Army Faction; in token of his gratitude for the help provided by the English in securing the release of the hostages, Chancellor Schmidt showed himself willing to settle a series of outstanding disagreements between the two countries in a friendly manner, among them the dispute over JET, which was thus allotted to Great Britain.[51]

The JET Joint Undertaking was officially born on 30 May 1978, and created a plasma current for the first time on 25 June 1983. Between these two dates a large number of extraordinarily complex problems relating to both scientific and technological difficulties were resolved in order to build the most advanced Tokamak in the world. All this was accomplished while respecting the deadlines and within the budget which had been set. EURATOM, the main source of finance for the project, had allowed 102.4 million U.A. for JET within its fusion budget for 1976-1980, and 145 million U.A. within the 1979-1983 programme. Although such figures were far from insignificant in the context of the Community's research and development budget, which was at this time decidedly modest, compared with other "big science" projects the cost of building JET had not been particularly high. It must be noted, however, that compared with other machines, for example synchrotrons, which once built could be used for a potentially infinite number of different experiments, a Tokamak is itself the experiment, and once the experiment has reached its end the machine must be dismantled since it is radioactive if tritium has also been used. Of course the time required for such an experiment is not measured in days or weeks. JET operated with increasingly valuable results from 1983 until November 1991, and during this period the use of the machine enabled European scientists to acquire basic knowledge and know-how, indispensable for carrying out studies which should lead to the ignition of plasma and thence to the production of energy through controlled thermonuclear fusion. Furthermore, during these years various aspects of the Tokamak were improved and transformed; in particular, several systems were tried for the additional heating of plasma (electro-magnetic waves, particle beams) and diagnostics developed tremendously, becoming one of the most important and expensive elements in the entire machine. On 9 November 1991, in a demonstration using tritium, JET produced 2 megawatts of power whilst confining the plasma for a period of two seconds. Such a result had not previously been obtained, and was only surpassed in December 1993 by the TFTR at Princeton in the United States. In view of this success, it was decided to prolong the activities of JET (which became operative again in 1994) for some years, in an attempt to reach the energy break-even point (where the energy generated by the Tokamak should be equal to that required to run it).

Since 1988, the European Community, the United States, Russia and Japan have been working on a project for an experimental reactor, known as ITER (International Thermonuclear Experimental Reactor), which should succeed in igniting plasma. It is of interest here to note that, in a scientific and technological project of international dimensions Europe is held to be a partner of the first rank, and that she is seen as a single body. Fusion was the first area in which the Commission, via contracts of association, mobility contracts, free access to information and an ambitious technological project, succeeded in creating a solid network between European research centres and effectively co-ordinating them.

Donato Palumbo, who was in charge of fusion research at the Commission for 28 years, made a departure speech at a symposium on fusion in which he recalled some of the basic stages in the development of the Community's action with its successes and mistakes: "Mistakes: certainly I have made many and I will not attempt to list them! But I can at least mention a permanent source of hesitation and perhaps of mistakes ...We have been presented with a task - the realisation of fusion - and, to mention just the plasma aspect, this means the achievement of a certain n, theta E, Ti etc. without having the necessary physics basis to do it. This situation generates a continuous conflict between performance and understanding and, in general, the major pressure has, even for political reasons, been put on the achievement of performance. Many times I was have been tempted to propose a change in the trend, but each time I said to myself 'too late - now we must go ahead'"[52] In this passage, Professor Palumbo mentions the tension between scientific understanding and technological achievement as a possible source of error and uncertainty, but when we examine the events of the JET project, the suspicion occurs that just this tension, the need to advance constantly over largely unknown territory, was one of the essential ingredients of its success.

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NOTES

1 The expression appears for the first time in documents published by the Organisation for Economic Co-operation and Development (OECD), which published various studies on this topic during the second half of the 1960s. Here we will principally be concerned with the analyses of the "technological gap" made by Jean-Jacques Servan-Schreiber and Christopher Layton, a choice which was principally influenced by the fact that both authors identified the European Communities as the key to the solution of the problem.

2 After France first vetoed Britain's entry in 1963, discussion between London and the Community took place mostly within the Western European Union (WEU) and the Council of Europe. In September 1967, the Consultative Assembly of the Council of Europe received an interesting report on the importance of British membership for the creation of a European Community that would be able to compete technologically on equal terms with the US; but two months later de Gaulle used the French veto once again, and it was not until 1973 that Britain entered the European Community. For the proposals of the Council of Europe for technological co-operation in Europe, see Council of Europe (Rapporteur: Mr. Reverdin), *Scientific and Technological Aspects of the Extension of the European Communities*, Doc. 2279, Strasbourg, 1967.

3 Jean-Jacques Servan-Schreiber, *The American Challenge*, Avon, New York 1969, p.32

4 ibid., p.35

5 ibid., p.39

6 ibid., p.222-223

[7] Antonie T. Knoppers, "The Causes of Atlantic Technological Disparities", in Atlantic Institute, *The Technology Gap: US and Europe*, Praeger, New York 1970, p.146. Opinions of this kind are very common among American commentators, see for example the contributions on European scientific institutions in Norman Kaplan (ed.), *Science and Society*, Rand McNally, Chicago, 1965.

[8] On the "brain drain" see, for example, Keith Pavitt, "Technology in Europe's Future", *Research Policy* vol. 1, n. 3, July 1972, particularly pp. 219-20

[9] Daniel Bell, "Introduction" to Herman Kahn and Anthony J. Wiener, The Year 2000. A Framework for Speculation on the Next Thirty-three Years, Macmillan, New York 1967 p. xxvii

[10] For an analysis of the various options, apart from Servan-Schreiber's work, see Sir Anthony Meyer and Eric Moonman, "The Political Implications of a Co-ordinated S. and T. Policy", in Eric Moonman (ed.), *Science and Technology in Europe*, Penguin, Harmondsworth, 1968, pp. 148-61

[11] Robert Marjolin, "*La Recherche scientifique et technique*", Strasbourg, 18 October 1966 (CESB, Speeches Marjolin, No. 66/002), p. 5

[12] See Christopher Layton, *European Advanced Technology: A Programme for Integration*, Allen & Unwin, London, 1969, in particular pp. 264-67

[13] Commission of the European Economic Community, quoted in Communautés européennes, *La Communauté européenne face a la recherche et la technologie*, Presse et information, Bruxelles, s.d. (1969?), pp. 17-19.

[14] G.R. Denton, "Planning and Integration: Medium-term Policy as an Instrument of Integration" in G.R. Denton (ed.), *Economic Integration in Europe*, Weidenfeld and Nicholson, London, 1969, p. 335

[15] The composition of PREST is: two members for each Member State except Luxembourg, which has only one; two representatives of the EEC, one from EURATOM, and one from the ECSC.

[16] COREPER, composed of diplomatic representatives from the Member States, has the task of preparing the deliberations of the Council of Ministers.

[17] Quoted in Commission of the European Communities, *General Report*, 1969, p. 224.

[18] Altiero Spinelli, *Diario europeo 1970-1976*, il Mulino, Bologna, 1991 and 1992, p. 229

[19] A. Sacchettini, "La cooperation européenne dans le domaine de la recherche scientifique et technique", *Revue Trimestrielle de droit européenne (COST)*, 10, n. 31, July-September 1974, p/ 449

[20] The quotation is translated from Bino Olivi, *Da un'Europa all'altra*, Etas Kompass, Milan, 1973, p. 198, a work in which the entire text of the Final Declaration of the Paris Summit is included with a commentary.

[21] The text of the Belgian memorandum in published in Jean-Luc Roland, *A review of COST cooperation since its beginning*, DG XII, Commission of the European Communities, Brussels, 1988, p. 18.

[22] Aked, N.H., and Gummett, P., "Science and Technology in the European Communities: The History of the COST Projects", *Research Policy*, 5, 1976, p. 276.

[23] Altiero Spinelli, *Diario Europeo 1970-1976*, il Mulino, Bologna, 1991 and 1992, pp.81-82

[24] For the proposals of the group of "wise men" see Philippe Marka, *La coopération dans la recherche dans la Communauté européenne de l'énergie atomique*, Université de Paris II (Thèse d'Etat), Grenoble SRT, 1977, in particular p. 117

[25] Altiero Spinelli, *Diario europeo 1970-1976*, il Mulino, Bologna, 1991 and 1992, pp. 236-37. It seemed both interesting and useful to quote this long passage from Spinelli's *Diario europeo* both for its intrinsic interest and because it is one of the few direct testimonies available of discussions in the Council of Ministers, whose meetings take place strictly behind closed doors. However, it must be remembered here that precise and reliable information on the work of the Council and on Community life in general is provided daily by the international press agency "Europe", whose head office is in Brussels, and which was founded in December 1952.

[26] ibid., pp. 241-42

[27] Altiero Spinelli, *Diario europeo, 1970-1976*, il Mulino, Bologna, 1991 and 1992, p.352.

[28] Spinelli's speech of the 21 April 1971 can be consulted in the Historical Archives of the European Communities, (doc.1 of Deposit 1) at the European University Institue, Florence.

[29] For Spinelli's directives of 4.1.1971, see document 243 of Deposit I, in the Historical Archives of the European Communities, at the European University Institute, Florence.

[30] This quotation and those which follow are taken from Ralf Dahrendorf, *Research, Science and Education: Scientific and technical Information. Working Programme of Mr Ralf Dahrendorf, Member of the Commision*. CAB/X/17/73-1, 1973.

[31] Ralf Dahrendorf, *op. cit.*, p.15

[32] By 1993, the Foundation would unite 54 institutions from 20 European countries: institutions dedicated to the organisation of basic research in natural science, in biomedical science, in social sciences and the humanities.

[33] The book which had the greatest influence on this debate is probably Donella H. Meadows, et al., *The Limits to Growth.*, Report of the System Dynamics Group (MIT) for the Club of Rome project on the Predicament of mankind, Universe Books, New York, 1972.

[34] See Communication from the Commission to the Council (30 June 1977), "Common Policy in the Field of Science and Technology", Supplement 3/77 to the *Bulletin*, CCE, Luxembourg 1977.

[35] In the period from 1971 to 1979 the European Communities used a number of units of account for its different policies, of which the European Unit of Account (EUA) was one. It maintained parity with the dollar.

[36] Communication from the Commission to the Council (30 June 1977), "Common Policy in the Field of Science and Technology", Supplement 3/77 to the Bulletin, CCE, Luxembourg, 1977, p. 11.

[37] A revised version of these criteria, which became known as the "Riesenhuber criteria", will be found in the documents relating to the First Framework Programe approved in 1983, and to successive framework programmes.

[38] The basic reference document is once again the Communication from the Commission to the Council (30 June 1977), "Common Policy in the Field of Science and Technology", Supplement 3/77 to the Bulletin, CCE, Luxembourg, 1977.

[39] Both Community environmental policy and research in the environmental sector will be covered in greater detail in the fourth chapter.

[40] See, for example, the records of the Compiègne seminar of October 1978 published in ESIST: *La science et la technologie européennes face aux défis de la société d'aujourd'hui* , CCE, Luxembourg 1979. Another important meeting was organised in Strasbourg from the 20-22 October 1980, on the theme "Research and Development in the EEC: Towards a new Phase of Common Policy".

[41] See Helene Riffault and Sylvie de la Beaumelle, *Science and European Public Opinion: a Poll Carried out in the Countries of the European Community* DG XII, Brussels, October 1977; and Sylvie de la Beaumelle, *Les attitudes du public européen face au développement scientifique et technique*, DG XII, Brussels October 1978. *Eurobaromètre* would carry out further polls of this kind in 1989 and 1992.

[42] For an eyewitness account of the events which led to the creation of the EUI, see Etienne Hirsch, *Ainsi va la vie*, Fondation Jean Monnet pour l'Europe - *European Research Centre*, Lausanne 1988, particularly pp. 163-66.

[43] With hindsight this impression can be seen to be largely mistaken: molecular biology, a science which entailed an intensive exchange of information, calls not for large laboratories but rather for good communications systems which allow it to develop through networks.

[44] The information concerning EMBO and EMBL comes principally from Graham Chedd, "*A New Lab for Europe?*" New Scientist and Science Journal, 18 February 1971, pp. 350-52; and Ros Herman, *The European Scientific Community*, Longman, Harlow (UK), 1986, particularly pp.139-41

[45] For the first phase of European space research see John Krige and Arturo Russo, *Europe in Space 1960-1973, From ESRO and ELDO to ESA*, ESA SP-1172, Noordwijk, 1994.

[46] The data on the allocation of money within the Community R&D budget for 1978 can be found in Kurt-Jurgen Maass, *The European Community's Research Policy*, European Documentation, Luxembourg, July 1980.

[47] See especially the speeches of Lev Artsimovitch and Edward Teller in Actes de la deuxième Conférence international des Nations Unies sur l'utilisation de l'énergie atomique à des fins pacifiques, *La fusion contrôlée: théorie et expériences*, vol. 12, United Nations, Geneva, 1958.

[48] About contacts between EURATOM and CERN, this account is principally based on Dominique Pestre, "Another aspect of CERN's European dimension: The 'European Study Group on Fusion', 1958-1964", in Armin Hermann, John Krige, Ulrike Mersits, and Dominique Pestre, *History of CERN*, vol. 2, North-Holland, Amsterdam, 1990, pp.416-27.

[49] On the planning and construction of JET, the principal sources used here are Denis Willson, *A European Experiment*, Adam Hilger, Bristol, 1981; and E. N. Shaw, *Europe's Experiment in Fusion. The Jet Joint Undertaking*, North-Holland, Amsterdam, 1990.

[50] For the part played by the Commission in the final stages of the negotiations over the siting of JET, see the testimony of its President: Roy Jenkins, *European Diary 1977-1981*, Collins, London, 1989.

[51] For an account of events following the hijacking, see the article "A Tale of Two Jets" in *The Economist*, 265, 22 October 1977, published in Denis Willson, op. cit., p. 103.

[52] Donato Palumbo, "The Work of the European Commission in Promoting Fusion Research in Europe and Response by Prof. D. Palumbo", *Plasma Physics and Controlled Fusion*, vol. 29, n.108, 1987, p. 1472.

CHAPTER THREE

HIGH TECHNOLOGY AND THE FRAMEWORK PROGRAMME

1. Industrial Policy and Technological Development

Industrial policy was one of the many policy areas not covered by the Treaty establishing the European Economic Community. In 1967, a Directorate- General for Industrial Affairs was created within the unified Commission, but its aims were not clearly defined. However, by the 1970s, the completion of the customs union made it obvious that new policies leading to the creation of a real internal market, and eventually to economic and monetary union, were needed. The primary objective was to establish conditions in which Community businesses could exploit the advantages of both the existence and the size of the Common Market. In 1972, a meeting of the Heads of State and Government defined new areas for Community action, including industrial policy.The Commission had already presented some projects for medium-term economic policy programmes, and in 1970, had sent the Council a memorandum on Community industrial policy which came to be known as the *Colonna Memorandum*[1] (in reference to its author, the Commissioner

responsible for industry, Guido Colonna di Paliano). Already in this Memorandum a large number of matters were examined which were to become central to the life of the Community in the following years; many of these are still important today.

The *Colonna Memorandum* identified certain themes which seemed to be of fundamental importance to the development of the Community. Firstly, the completion of the Single Market called for the elimination of technical obstacles, such as the disparities between national laws protecting workers, consumers and the environment. Standards would have to be harmonised in order to remove many obstacles to transactions within the Community, and to prevent industries from having to adapt their products to the differing demands of national markets. Investment, and the buying and selling of businesses, were also impeded by the existence of fiscal borders, and the relevant indirect taxation regimes would have to be harmonised, and tax rates brought closer together. However, a real Common Market would not exist until there was a genuine liberalisation in the field of public and semi-public contracts, with governments giving up their policies of buying national products and choosing instead the best supplier regardless of nationality. This was particularly important in the advanced technological sector: "The healthy development of advanced technological industries cannot be guaranteed within the framework of closed markets ... [A concerted approach to purchasing policies] would tend to guarantee the effective working of the single market in technologically advanced goods, without excluding enterprises in non-member States, on condition that there be real reciprocity, and always remembering the importance of maintaining a certain balance in the technological and industrial development of the various regions of the Communities."[2] Secondly, the whole institutional setting in which business operated would have to be harmonised, leading to a unification of the Community in the areas of law, taxation and finance. While paying great attention to the protection of effective competition, the Commission felt that it was important to support the processes of amalgamation which were underway, and from a legal point of view this meant creating regulations for European companies, adopting the same legislation relating to groups of companies throughout the states, and bringing national company laws closer together. From the financial point of view, the situation was characterised by the lack of a real common market in capital, and by the scarcity of that venture capital which was needed most by the most innovative companies. The Commission attempted to speed up the process of economic integration, and in 1973 presented the Council with a detailed programme[3] of legislation relating to industrial and technological policy for approval within the next few years. The document remained a dead letter, however, and it was not until 1985 that the Council committed itself to the establishment of the Single Market, which finally came into being in 1992 on the basis of a programme not dissimilar to that presented in 1973.

The *Colonna Memorandum* also tackled three topics which were more narrowly related to industrial policy: the restructuring of business, its consequences, and economic relations with non-member states. By "restructuring" was meant, primarily, the processes of amalgamation which were under way at national level; however, "the size of the national market is often insufficient, and, for advanced technological sectors particularly, access to sufficiently large markets is only possible through mergers with businesses in other countries"[4] International competition could only be faced by forming trans-national

European companies, which should be encouraged using public money for industrial development in the technologically advanced sectors. While acknowledging that small and medium-sized companies are more dynamic, more flexible, and readier to exploit new ideas and opportunities, in the case of advanced technologies the *Memorandum* identified international mergers as the high road to competitiveness in world markets. The Community should strengthen these new large businesses through its technological programmes and by instituting Community development contracts, although it should also pay attention to the risks inherent in intergovernmental financing and to those arising from the adoption of the principle of the *juste retour*. The reference is obviously to the EURATOM research and development programmes, the failure of which weighed heavily on the chances of future Community initiatives in other industrial sectors: "If the Commission condemns the principle of the "fair return", it still cannot ignore the need to keep a certain equilibrium between the industrial interests of Member States in such delicate areas. Nevertheless, if Member States will accept that this balance of interests should be sought on the widest possible basis, that would be great progress."[5]

One of the first effects of restructuring was the loss of jobs in areas of industry which were in decline. It was hoped that the loss would be offset by the creation of new jobs in more dynamic sectors. In general, the economies of European countries needed to establish ways of encouraging professional and geographical mobility in the workforce, and had to make the most of the opportunities offered by new technologies. Three courses of action seemed urgent in this respect: the use of indicators for technological forecasts; an examination of the criteria according to which research was divided between publicly owned centres, universities and industry, and a greater diffusion of technological knowledge. The Commission's document also put forward some suggestions, aimed at business, to overcome the managerial gap which seemed to separate European and American companies. Companies should set themselves long-term objectives, instead of leaving this task to governments alone; they should pay more attention to the market as to production; they should adopt quantitative management methods in the decision-making process; and they should guarantee greater involvement on the part of the workforce in management decisions. Finally, as far as international trade was concerned, a progressive and balanced liberalisation of commerce with other industrialised countries should go hand in hand with a steady and orderly transfer of some industrial activities to the benefit of developing nations.[6]

In the 1970s, to talk of industrial policy was to refer to two large groups of industries: on the one hand, the traditional industries in difficulties, such as the textile industry, ship building, and iron and steel; on the other, new high-technology industries. These two groups needed very different kinds of public intervention, and in general the Community tended to urge the states to encourage the development of new industries at the cutting edge, rather than rescue obsolete companies at all costs, while safeguarding employment and guaranteeing gradual instead of drastic change. In the traditional sectors, as well as establishing a degree of protectionism, national governments tried to restore competitiveness through research and development projects. In this area, Community intervention was very limited: the ECSC continued its own research in the steel sector; there were suggestions from the Commission, which were never followed up, that there should be R&D projects for shipbuilding; and the EEC

intervened in a few isolated and sporadic cases as a result of lobbying pressure from the respective industries in the fields of textiles, shoemaking and hydrocarbons.

Of much greater interest were the interventions which occurred in the high- technology sectors, and in particular in the three areas identified by the Colonna Memorandum: "electro-nuclear, aerospace, information technology". In the first chapter of the present work we discussed at length the Community's research and development programmes in the nuclear sector, but it is important to repeat here that Euratom's was an industrial project in which neither industry nor markets had been involved. Euratom's nuclear programmes were exclusively dictated by the "technological push" and the approach was strongly interventionist, paying attention neither to the industries which would have had to build the European nuclear reactors, nor to the needs of the possible purchasers of the plants, the national electricity companies. The second sector, aerospace, experienced notable developments in the 1970s in Europe, though outside any Community control.

In the area of information technology, the 1970s saw many interventions on the part of European governments to defend their national industries, threatened by the invasion of large American companies and by IBM in particular, and the consequent setting up of what came to be known as "national champions". Between 1966 and 1980, France launched three successive *plans calculs* for the development of the information technology industry, and national semiconductor industries were heavily subsidised by the state. Similar programmes were also launched in Germany and Great Britain, along with policies which called on public bodies, companies and citizens to buy only national products. As well as subsidising research and development programmes, governments became actively involved in encouraging mergers between national companies in the sector. The effect of these protectionist policies are vividly described by former Commissioner for Industry, Altiero Spinelli: "When I held the position now held by Mr Davignon I noticed that in this area every country has a awesome industrial bureaucracy, through which a sort of league was set up between the information technology industry and the postal, telegraphic and telephone administrations; the latter watched over the industry, and industry followed the programmes of the administrations, and the whole thing was tied together by the fact that help that was given to these industries maintained the cycle. This whole process soon became parasitic, uncompetitive and inward-looking."[7] On the one hand the national champions ended up being too small to compete with American industries, and on the other they were restricted to their national markets, which in turn were also too small. However, the history of attempts to come to agreements between the national companies is a one of failure. In 1969, a consortium called Eurodata was formed between ICL (GB), CII (F), Philips (NL), AEG-Telefunken (D), Saab (S) and Olivetti (I) to supply computers to the European Space Research Organisation (ESRO), but the initiative petered out in the face of German resistance. In 1973, Siemens (D) Philips (NL) and CII (later to become Bull, F) decided to launch a joint venture, Unidata, to produce a new line of computers, but this attempt was also soon to be abandoned because of the difficulties of working together, and because France decided to pursue her own national strategy through an agreement between Bull and Honeywell.

After the project, which never really got underway, to build a large European computer, the Commission presented a first Action

Plan for the information technology (IT) sector in 1976. Presented once again, with minor modifications, in 1978, the programme was approved by the Council in September 1979. It was a programme for the years 1979-1983, which called for "measures for standardisation, co-ordination of public contract policies, and support for the development of collaborative projects for the applications of information technology, software and related products."[8] The programme had a planned maximum expenditure, over four years, of 25 million U.A. As for the use of the networks, and in particular the development of Euronet-Diana, the Community programme allowed for a continued collaboration in the "European Information Network" (COST 11) by the Joint Research Centre and COST, which involved many countries, including some outside the Community. At the same meeting, the Council of Ministers approved a resolution inviting the Commission to prepare proposals for Community action in the field of microelectronic technology.

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2. ESPRIT

"The negotiations over the programme were having a rocky ride, and a certain number of states were in favour but believed that it could be done at no expense, which is a more delicate matter".[9] Etienne Davignon, the Commissioner responsible for the internal market and industrial affairs from 1977 to 1981, and for both industry and science and technology from 1981 to 1985, refers here to the negotiations leading to the approval of the Community programme for information technology. Indeed, it often happened that Member States agreed in principle on the need for this or that Community programme, but jibbed at paying for it. This was the more so in the case of innovative programmes such as ESPRIT (European Strategic Programme for Research and Development in Information Technology) at the start of the 1980s. ESPRIT represents a watershed in the history of Community intervention in research and development, because it differed fundamentally from previous initiatives: it involved business in the sector from the very first. It was the industry itself which suggested those areas on which Europe should concentrate its efforts in order to achieve the leap forward which would enable it to compete internationally.

The end of the 1970s saw rapid development in the field of information technology by Japanese business and also in newly industrialised countries, particularly in South-East Asia. European companies in the sector were too small for the necessary investment in research and development, and were confined to their respective national markets. If the states' policies creating large "national champions" had partly solved the first of these problems, the subsequent competition produced within Europe only accentuated the difficulties caused by the narrowness of domestic markets. Besides, in the IT industries, as in other high-technology industries (aerospace, biotechnology, new materials), European firms tended to conclude international agreements with American companies rather than European ones, thus endangering their chances of independent development. To reverse these tendencies, a Community programme needed to set three objectives: to encourage co-operation in research and development among European companies in those areas which the industry itself considered to be of strategic importance; to provide industry with the basic technologies necessary for international competition; and to develop European standards which would allow industry to benefit from the size of the continental market. The means by which the Commission proposed to pursue these aims was the setting up of research associations within the industry. The birth and activities of these associations should be encouraged through state, or, in this case, Community intervention.

In 1979, Commissioner Davignon made the first contacts with the main European electronics companies to test the water as to the prospects and needs of the sector. However, these contacts with research directors and other managers at intermediate level were not especially encouraging, and so, in February 1980, the Commission decided to call a meeting of senior executives from ten companies to discuss the future of information technology in Europe. The interest which was shown by the heads of these companies in a possible Community initiative persuaded Davignon to set up the Information Technologies Task Force (ITTF), as a body within the Commission but independent of the existing Directorates-General.[10] At the end of 1981, the first "Round Table" meeting took place, attended by the 12 largest European Information Tech-

nology companies: ICL, GEC and Plessey from Great Britain; AEG, Nixdorf and Siemens from Germany; Thomson, Bull and CGE from France; Olivetti and STET from Italy; and Philips from the Netherlands. In a letter to Davignon, the Big Twelve analysed the situation, and declared themselves convinced of the urgent need for forms of co-operation at a European level: "The figures for Europe's position in the markets, which show that European industry has only 10% of the world market and less than 40% of its own internal market, are extremely unencouraging. Not only is the situation worrying in itself, but the weakness of Europe's position in the markets shows that the volume of sales and profits is insufficient to allow the investment essential to safeguard the future. Even worse, everything suggests that the situation, rather than improving, is likely to deteriorate. [...] Unless together we can carry out a sufficiently large industrial programme, the greater part, if not the whole of the existing IT (Information Technology) industry could disappear within a few years." [11] The problems of the IT sector were discussed both at the Economic Summit held in Versailles, from 4 to 6 June 1982, and in the Council of Ministers at the end of the same month; in August, the Commission presented the Council with a proposal for the pilot phase of the ESPRIT programme, which the Council approved in December.

Four years of intense activity were thus needed on the part of the Commission before the pilot phase of ESPRIT could be launched, but the obstacles to be overcome had not been insignificant. Firstly, there was a strong and deep-rooted mutual distrust between the European companies: they had always regarded their continental counterparts as competitors to be beaten, and whenever collaborative agreements with other firms had been shown to be indispensable, they had looked across the Atlantic, or else to Japan; whilst the few attempts at European co-operation had regularly failed. Nevertheless, the crisis had now been dragging on for years and government interventions had proved insufficient: there was no alternative to collaboration. Then there were the doubts of the Big Twelve about the Commission: they did not hide their scepticism over the ability of Brussels bureaucracy to run efficiently so ambitious a project for industrial innovation in a sector as dynamic as Information Technology. The *ad hoc* creation of a task force was due to the insistence of the companies concerned. Finally, there was the traditional resistance from governments, all the stronger because a strategic industry was involved. Here too, the crisis situation evident both in the industry itself and in the national policies which tried to resolve it played an important part. However, the Commission's strategy outflanked the governments and proved decisive. Through its direct contact with the major European electronics companies, the Commission was in the first place able to gather information on the situation in the sector at the source, and on the needs of the industry, so that it could present specific, rather than general, projects. Secondly, although the Commission put forward programmes which were on a European scale and with European links, the programmes were essentially built on the aims of the "national champions" on whose research the respective governments had previously based their strategies. This being the case, Member States could not reject the proposals of the Commission without refusing to support their own largest companies.

The kind of research which the ESPRIT programme was intended to finance was called "precompetitive" or in some cases "prenormative". It is not easy to provide an exact definition of "precompetitive". It was a kind of no-man's land between basic and industrial research. It was industrial research,

but sufficiently distant from the market: its results would not be products ready for commercial exploitation. The choice of "precompetition" arose from a complex search for an equilibrium between the various interests involved. In practice, precompetitive research was the research which industries, at the time when ESPRIT was set up, would agree to undertake together: the work which companies - rivals but the day before - thought was free of excessive risks in terms of the eventual ownership of the results of joint research, and thus free of risk to their own commercial positions; research, furthermore, which would not tie them down in the long term. Secondly, "precompetitiveness" seemed to play a part in reassuring governments about the Commission's intentions. Although it was involved in industrial policy and economic development, in a strategic sector, the "precompetitive" nature of the research being financed meant that the Commission would not gain too much power at the expense of the States. Along with these political and economic reasons, there was a legal reason for adopting the concept of "precompetitiveness". Article 85 of the EEC Treaty, which deals with competitiveness, explicitly forbids agreements which could lead to monopolies or near-monopolies: "The following shall be prohibited as incompatible with the Common Market: all agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade ... and which have as their object or effect the prevention, restriction or distortion of competition" with the exception of those agreements that contribute to "promoting technical or economic progress".

The uncertainties and the caution of both companies and governments were such that the Council's decision of 21 December 1982 was to set up a pilot phase to last only one year initially. Its results were to be carefully evaluated by a group of experts before new and greater commitments could be entered into. The Council identified 16 pilot projects, belonging to three areas of Information Technology development (micro-electronics, software, and advanced data processing); two kinds of applications (office systems and factory automation); and systems and infrastructure for the dissemination and exchange of information. The Community's contribution to these projects was 11.5 million ECU[12], equal to 50% of the entire cost of the research, while the remaining 50% was provided by the participants in the programme. In each individual project there must be at least two companies involved, from different Member States. Participation on behalf of universities or public and private research centres was not compulsory, but from the first it was considerable. In February 1983, the invitation to tender was published; about 600 companies and research bodies responded, putting forward a total of 145 proposals. Expert groups evaluated the proposals in each area of research, and in May the first contracts were signed, for 36 specific R&D projects. Predictably, the Big Twelve who had taken part in the formulation and preparation of the programme were represented in 70% of the projects approved. The running of the research consortium was entrusted to a project leader, while the Commission maintained the power of control and monitoring of management and results. The latter were to be owned jointly by all the participants in a single project, and companies involved in other ESPRIT projects would have privileged access to these results. "Given that the response of industry, the universities and research institutions to the pilot phase had been of high quality and have shown a high level of interest"[13] the Council approved the first phase of ESPRIT for the years 1984-1988, assigning it 750 million ECU, despite the fact that at first both Great Britain and Germany had expressed many reservations as to the cost

of the programme, which they judged to be excessive. To give some idea of the scale of the programme, the Review Board estimated that the entire 1500 million ECU to be spent on ESPRIT represented 6% of total Community investment by industry in R & D for Information Technology. Each year, the Commission was to present a Work Programme, drafted in collaboration with a management committee made up of two representatives from each Member State; a consultative committee, composed of experts in the sector; and the Executive Committee created by the Big Twelve.

The programme's main focus was unchanged with respect to the pilot phase (although the sector relating to an infrastructure for the exchange of information was eliminated) but the specific areas had grown from 16 to 27 in 1984, and to 30 in 1985. This meant that the programme became much more open and flexible: almost all areas of IT were covered, so that there was a great deal of freedom for researchers to identify and invent new projects worthy of Community attention. Between the beginning of 1984 and the end of 1986 there were three invitations to tender: 226 projects were approved, involving 240 companies (57% of which belonged to the category of small and medium-sized enterprises) and 210 research bodies.[14] Around one in five of the proposals made to the Commission received financial aid: from this it seems obvious that there was enough demand for a programme of this type, that its existence had been drawn to the attention of potential users, and that they had considered it sufficiently credible to involve themselves in it. Despite the "precompetitive" clause, with the passing of time co-operation crept closer to the market: the percentage of projects resulting in the manufacturing of prototypes went up from 13% in 1983 to an average of 20% in 1984-1985. Further, many ESPRIT projects were involved in the setting of standards ("pre-normative" research), which had a direct influence on the commercial potential of a product, and still others led to products and processes which stood a good chance of coming onto the market within a year or two of the end of the project. As to the type of participation, 11.6% of ESPRIT I projects involved only companies from the Big Twelve; 50.7% involved Big Twelve companies together with some smaller firms; and the remaining 37.7% of projects were undertaken only by companies other than the Big Twelve. Research bodies took part in 71% of ESPRIT I projects.[15]

When the Council set up ESPRIT, it was decided that the first evaluation of the programme should take place after two and a half years, or when 60% of the funding had been spent: "The very positive response of industry and the scientific world to the first two invitations to put forward proposals in 1984 and 1985 means that the projects already chosen on the basis of these invitations will use up almost the entire allocation of funds for the first five year period of the programme"[16] For this reason, the ESPRIT Review Board was set up; its members were A.E. Pannenborg, A. Danzin and H.J. Warnecke, and their task was to evaluate the advancement of the programme, and, in particular, to assess the objectives, the management of the programme, the means of communication between the participants, the spread of information and relationships with national programmes. On 15th October 1985, the Review Board produced its own report, based on a series of interviews with 131 bodies, including firms, universities, research institutes, and national administrations, and on answers to a questionnaire completed by 238 participants. Its judgement of the programme was very positive. The co-operation between firms, universities and research bodies was considered very

profitable, and there were the first signs of a willingness to pursue joint research and development even outside ESPRIT. Despite the fact that the costs for general expenditure, necessitated by research between large numbers of partners in different countries, had gone up, participants had noticed an increased profitability of research. The projects regarding standardisation, which were contributing to growing European influence in international negotiations on standards, proved particularly useful.

The intervention of the Commission and its Task Force for Information Technologies (ITTF) were judged to be effective. As to the areas in which ESPRIT intervened, the Review Board recommended that they be reorganised, reducing them from five to three (micro-electronics, software and applications) to increase the ultimate flexibility of the whole programme, and drew attention to some gaps (electronics for general consumption, optoelectronics, and peripheral devices). Criticisms of the programme's organisation focused on its excessive fragmentation, with too many small projects, and an overall lack of coherence between the various projects. Management, on the other hand, also had its weaknesses: it took too long to sign contracts and make payments, an unnecessary pile of paperwork was demanded from participants, and the systems for the exchange of information were inefficient. The report recommended that ESPRIT should pass on to its second phase, perhaps with greater finance, in order to support finalised demonstration projects, to set up stable centres of excellence for research and development, and so that the programme might be more widely publicised.

The money made available for the second phase of ESPRIT, for the period 1988-1992, was twice the amount allowed in the first phase, reaching 1600 million ECU; and the programme also saw some changes along the lines suggested by the Mid-Term Review Board.[17] There was a shift in research towards the market: the number of projects for the development of prototypes continued to grow, reaching 30% of the total for 1989. And greater attention was paid to market demands, with an increase in research on applied technologies. Small and medium-sized firms were represented in a larger number of projects, and received a higher proportion of the overall budget. More ambitious projects, consortia with fewer participants, and a better flow of information were other objectives which the programme established. The new programme also differed from ESPRIT I in allowing the possibility of financing 100% of the costs of universities' and research centres' participation; the proposal that the programme be enlarged to include all the countries involved in COST; and a review of the question of the ownership of the results of research, based on a less rigorous interpretation of the "precompetion" principle whereby only partners directly financing a project could benefit from its results. The third phase of ESPRIT (1990-1994) was brought forward to coincide with the setting up of the Third Framework Programme; the Community budget was 1350 million ECU, to be distributed over five areas: micro-electronics; data processing systems and software; automated systems for use both at home and in the office, and peripherals; computerised production and engineering; basic research. The Council, approving ESPRIT III, underlined how important it was that the programme should succeed in co-ordinating with, and working effectively with, EUREKA (which will be discussed in the next chapter). In the field of microelectronics, the Council was especially anxious to see co-operation with the Joint European Submicron Silicon Initiative (JESSI).

ESPRIT has had three main beneficial effects on the European information technology industry and its development. Above all, the Community programme has in many cases allowed research to reach the "critical mass" held to be indispensable for the profitability of research and development. This came about thanks to the demolition of a series of traditional barriers separating the various disciplines, which stood in the way of contacts between firms, research centres and universities, and made it hard for researchers in different countries to communicate with each other. Secondly, in an industry characterised by rapid change, ESPRIT has led to a reduction in uncertainties for firms, because it has allowed a more rational sharing of risks, and because co-operation has at least in part modelled the development of the market. Finally, thanks to the creation of links between different sectors, ESPRIT has extended considerably the range of applications of information technology in both traditional and innovative areas. The electronics companies have increased their contacts not just among themselves but also with companies and organisations belonging to very different sectors which also use information technology: telephonic and aeronautic companies, car manufacturers, firms in robotics, mechanics, and chemicals, as well as banks, insurance firms, health centres and other enterprises in the service sector. There is no doubt that, overall, ESPRIT and the other Community programmes in the area of technological innovation have created a more open, less diffident atmosphere in which European firms have discovered that co-operation and competition are equally necessary and possible in the field of high technology. "I was happy, recently, to talk to the director of the European laboratory of a large firm making electronic equipment, I asked him what he thought of the ESPRIT programme. He replied: I'm pleased that it brings me in some money, but that's not the important aspect; if I were to show you my appointments diary from 5 or 10 years ago, and my diary today, you would see that it looks completely different. 5 or 10 years ago almost all my meetings with scientists or technologists took place on the other side of the Atlantic; now, they are almost all on this side of the ocean. ESPRIT has transformed the outlook for scientific relationships."[18] In the European IT industry of the second half of the 1980s, R&D co-operation with non-European countries was still most substantial in absolute terms; but ESPRIT has had a considerable psychological impact on the sector, bringing an increase in agreements between European companies, to the detriment even of agreements between firms within a single country.

Criticisms of the ESPRIT programme have been of two main types. On the one hand, ESPRIT has been accused of reformulating the policy of "national champions" at a Community level: for these critics, ESPRIT has merely transferred the power of the Big Twelve to the continental stage. From many national monopolies, encouraged by protectionist policies, we have passed to a European oligopoly, under the protection of the Community. Americans talk of a "Fortress Europe" for the IT industry. This tendency, however, weakened considerably in the ESPRIT II programme, where the influence of the Big Twelve on the design of the programme and their involvement in specific projects were both noticeably diminished, leaving more scope for small and medium-sized firms.

On the other hand, the "precompetitive" nature of the programme has also been challenged: according to some, such investment is wasteful, since what is really necessary is investment in research which will lead directly to products ready to go onto the market. The economic side effects of the ESPRIT programme are difficult to quantify, if we exclude

the direct financing of half of every project by the Community, but it is unquestionable that the response of industry has been unfailingly positive, and that as time passed the programme drew closer to the market. Furthermore, such criticism takes no account of the fact that "precompetion" in itself ruled out very little, and that whenever companies wanted to work together at other levels they were always able to find a way to do so, either within or, more easily, outside ESPRIT. Nevertheless, much of the statistical evidence suggests that more than a decade after the launch of ESPRIT, the European information technology industry was not much more competitive than before. While some believe that its own structure left ESPRIT unable to give adequate support to the development of industry in the sector, others defend the programme, pointing out that inadequate funds were made available given the size of the problems it was supposed to tackle. Yet others hold that the economic impact of a research and development programme of this kind can only be judged in the longer term.

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3. THE FIRST FRAMEWORK PROGRAMME (1984-1987)

Great disorder reigned in Community research affairs at the beginning of the 1980s. In the preceding decade, despite the Council's resolutions of 1974, there was no Community policy on science and technology. Governments were on the whole opposed to any extension of Community activities in the area, and every single programme had to be unanimously approved by the Council either by reference to Article 235 of the EEC Treaty, or on the basis of the EURATOM and ECSC Treaties. In such a situation Commissioner Guido Brunner and Director- General Günter Schuster had to adopt a pragmatic approach, taking advantage of a crisis in some sector or other, or citing public interest in a particular field of research, in order to try to persuade the Council to accept new Community initiatives. In this way, the main body of research originating in EURATOM, with nuclear fusion in pride of place, was gradually joined by research programmes in energy, environment, health, textiles, fishing, raw materials, and many others. These programmes were often on a very reduced scale, and there were absolutely no links between them.

Between 1982 and 1983, Commissioner Davignon, working with the new Director-General Paolo Fasella, with Codest (a committee which will be discussed later in relation to programmes aimed at promoting the mobility of researchers), and with CREST , began an attempt to reorganise the individual research and development activities and to include them in a more comprehensive plan which might serve as the basis for a real policy for science and technology. Drawing together all the separate research and development programmes in the field of technology in a Framework Programme designed to last over several years, the Commissioner intended to provide the Community with a means of selecting and orchestrating scientific and technological aims; a means of planning which could co-ordinate Community and national activities; and a means of financial provision.

Rejecting a linear interpretation of the process of technological innovation, the Commission wanted to create an organisation which reflected in its administration the complexity of the development process. From this point of view, the Framework Programme resembled a multi-dimensional matrix in which all the single programmes found different points of intersection with each other and with other Community policies. The importance of the system did not lie in the sum of the individual programmes, but rather in their interaction as they worked together towards the aims of Community policy in the fields of agriculture, industry, communications etc. Individual programmes should be of interest to many sectors, and thanks to their inclusion in the wider context provided by the Framework Programme they would be able to adapt very flexibly to meet specific aims and new demands. All the single programmes gathered together by the Framework Programme would be prepared and approved at the same time, guaranteeing their subsequent beneficial interaction.

The first step was to select seven scientific and technological objectives, corresponding to as many more general Community aims: to promote competition in agriculture and in industry, to improve the management of raw materials and energy sources, to better living and working conditions, and to improve the effectiveness of the Community's scientific and technological potential. In the expecta-

tion that, in future, procedures for the approval of projects could be harmonised, the Commission began by joining together in action and research programmes (RAP) all those R&D programmes with shared objectives, regardless of their origins, be they JRC projects, co-ordinated research, or cost- sharing contracts.

As to the relationship with national research and development activities, both public and private, the Commission established certain criteria for deciding which interventions seemed to require the Community to take overall responsibility. These criteria, known as the "Reisenhuber criteria" from the name of the German research minister who presided over their formulation, prefigure the principle of subsidiarity which would be one of the cornerstones of the Maastricht Treaty. There were four specific criteria (in 1987 a fifth was added, regarding social and economic cohesion, and in 1994 another dealt with the mobility of researchers and the co-ordination of national policies) which would justify Community involvement:

"- research conducted on so vast a scale that single Member States either could not provide the necessary financial means and personnel, or could only do so with difficulty;

- research which would obviously benefit financially from being carried out jointly, after taking account of the additional costs inherent in all actions involving international co-operation;

- research which, owing to the complementary nature of work carried out at national level in a given sector, would achieve significant results in the whole of the Community for problems to which solutions call for research conducted on a vast scale, particularly in a geographic sense;

- research which contributes to the cohesion of the common market, and which promotes the unification of European science and technology; as well as research which leads where necessary to the establishment of uniform laws and standards."[19]

The First Framework Programme for the years 1984-1987 was approved by the Council on 25 July 1983. From the point of view of planning and of financial provision, this was by and large a dress rehearsal. Under existing laws it was not possible to approve the allocation of finance for research in general, so that the 3750 ECU allowed for the Framework Programme corresponded to the sum of all the separate budgets for programmes already approved together with the allocations requested for the projects which the Council was putting forward. Nevertheless, the Framework Programme represented a considerable step forward in the rationalisation of programmes already underway and in planning for the medium term, both in terms of identifying scientific and technological priorities and in planning future financial involvement.

Analysing the changes in expenditure priorities between 1982 and 1985, we find that the most striking change is the drop in spending on energy research, which passed from 65.5% to 50% of the Community total, primarily in favour of research into industrial competitiveness, which rose from 17% to 32%. A considerable part of the research was still undertaken by the JRC (direct action), but more than half of the Community budget now went on indirect action, that is to concerted

actions and above all to shared cost contracts. Concerted actions, in which the Community only financed the cost of maintaining the contract between the partners and the organisation of regular meetings, were used for the co-ordination of national research and COST actions. In shared-cost contracts, Community participation did not normally exceed 50% of the total cost of a project, as was the case with ESPRIT, though exceptionally, as in the case of JET which was a Joint Undertaking, it reached 80%.

The increased Community interest in industrial innovation is announced also by the setting up in 1984 of the Industrial Research and Development Advisory Committee (IRDAC) at the Commission. The new Committee replaced CORDI, set up in 1978, which had carried out the same consultative role but which was made up of members chosen by European industrial organisations (principally, the Union of Industries of the European Community) on a national basis. The sixteen members of IRDAC, however, were independent experts chosen by the Commission for their ability and experience in the field of industrial research and development.

In 1984, therefore, the Commissions's consultative committees for research and development were also reorganised into a more coherent arrangement. Firstly, there was CREST, made up of national representatives, which had the task of co-ordinating national and Community actions and which also functioned as a "hinge" between the Council and the Commission, standing in an advisory capacity to both institutions. Then there were two committees made up of independent members, IRDAC and Codest, which assisted the Commission in its decisions regarding, respectively, industrial innovation and scientific and technological research. Finally, in the definition, preparation, management and co-ordination of all its research, development and demonstration activities, the Commission was assisted by 12 management and co-ordination committees (CGC). Made up of national experts and Commission representatives, these new committees replaced the specialised committees of CREST, most of the consultative committees for the management of programmes (CCPM) and the Concerted Action Committee (COMAC). whose tasks often overlapped one another. Three committees dealt with industry (industrial technology, laws and regulation, biotechnology), one was concerned with raw materials, and three with energy (reactors and the safety and control of fissile matter, the combustible cycle, and the treatment and storage of nuclear waste, non-nuclear energy sources). One committee was concerned with development aid, two with health and safety (medicine and health, radiation protection), and the last two respectively covered climate and environment, and linguistic problems.

Turning our attention to the Framework Programme, it must be pointed out that some specific programmes were only approved after a long delay, whilst others were later abandoned: despite the Commission's efforts at rationalisation, and the constraints which the selection criteria placed on the "Europeanisation" of science and technology, Community research was far from plain sailing. Some Member States were emphatically opposed to Community management of R&D activities, and during the Versailles summit of June 1982 , they re-opened discussion of the intergovernmental option as the best route for European collaboration. For the moment, therefore, the Programme could only represent the direction in which the Commission meant to go, and the Council's approval did not yet guarantee the approval of Member States for the more decisive role which the Communities wished to take in the field of

research and development. Only the success of ESPRIT and the other programmes for industrial innovation, to be discussed below, and the efficacy of the Framework Programme as a means of planning over several years, would be able to transform the attitudes of these governments in this matter, and would lead, with the Single European Act, to the inclusion of research and development among Community policies.[20]

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4. TECHNOLOGICAL INNOVATION

The projects for technological innovation which were set up under the First Framework Programme represent the chief new development in Community research and development. The preparation of these projects was simplified by the fact that, for the first time since 1973, the Commissioner for industrial affairs, Etienne Davignon, was also responsible for research policies during the period 1981-1985. Several R&D projects which had originally been conceived in the context of industrial policy, a policy which some Member States rejected as a matter of principle, could now be redefined in a new context, that of scientific and technological policy, where the "precompetitive" principle guaranteed that the Community authorities would respect the rules of competition. Each of these new programmes had its own distinct character, but the basic inspiration was the one which had caused the Commission to launch the ESPRIT programme, and the objectives too were similar: to involve industry in setting up programmes, to ensure that companies took responsibility for programmes through cost-sharing, the fostering of co-operation between companies, and the expansion of collaboration between businesses, research centres, and universities. All this, naturally, should operate in a European dimension: all the programmes demanded that the consortiums should be made up of participants from at least two different countries. In the section of the Framework Programme dedicated to industrial competitiveness, the new technologies were divided into three main areas: industrial technologies, information and communications, and biotechnology.

a) Industrial Technology

Within the First Framework programme, the area of industrial technology research covered a series of activities which had started at different times, in different settings. There were programmes under the supervision of the JRC, such as the "Nuclear measurement and reference materials", which was pursued at the Geel establishment, or the "Materials at high temperatures" programme at Petten, the metallurgy research conducted by the ECSC, a small textiles programme, and various COST projects for research into agricultural food production and materials at high temperatures.

The real change, however, came from the Basic Research in Industrial Technologies for Europe programme (BRITE), which was the key Community programme for industrial innovation, prepared and run by DG XII and its Directorate for technological research, under the leadership of Hendrik Tent. The most important characteristic of this programme was that it was not tied to any one sector: the general objective of BRITE was to raise the technological level, and thus the competitiveness, of all European industries, without distinguishing between advanced and traditional industries; the programme was implicitly designed to overcome this distinction. The precompetitive research financed by the programme had to be innovative, but given that the essential criterion was the industrial usefulness of the results of research, even new applications for existing technologies could be regarded as innovations and thus could be pursued. On the whole, the research financed under the BRITE programme was multi-disciplinary, and was directed towards the development of the so-called generic technologies, technologies whose potential applications in many different sectors could not always be

foreseen at the start of the research and development programme.

BRITE was the first Community programme for technological innovation which was open to participation from all industries, and, therefore, it was above all aimed at the small and medium-sized firms which formed an essential part of the productive base of European industry. Obviously, BRITE was quite different from, and complementary to, ESPRIT. Where the information technology programme was limited to one sector, Brite's approach was wider; where ESPRIT concentrated on a certain number of particular problems, identified in advance, BRITE aimed to develop generic technologies, in relation to both products and the production process; whereas ESPRIT was born out of the needs of the Big Twelve companies in the sector, BRITE was launched after discussions with hundreds of firms in order to identify the areas in which research was most in need of stimulation, and in which private industry was prepared to invest to acquire new understanding and know-how.

The first BRITE programme (1985-1988) was organised via shared-cost contracts, and had a budget of 125 million ECU, of which 65 million came from the Community and 60 were to be invested by the participating companies. Nine areas of research were to take priority: 1) reliability, wear and tear, and deterioration; 2) laser technology; 3) new junction techniques; 4) new methods of inspection; 5) computer-aided design and manufacture (CAD/CAM); 6) new materials, particularly polymers; 7) the science and technology of membranes; 8) catalysis and particle technology; 9) new production techniques for manufacturing in flexible materials. More than five hundred proposals were received in response to the Commission's invitation to tender, involving around 1700 research bodies and demanding a total investment of around 900 million ECU. The selection process was therefore particularly rigorous, with only one project in five taking part in the programme. 67% of the budget approved went to industry, 22% to research centres, and 11% to the universities. Of the sum allocated to industry, 31% was paid to firms with less than 500 employees, companies formally designated as small or medium-sized enterprises. Some of these smaller companies, however, were the R&D subsidiaries of much larger bodies. As for the rights to exploit the research, these were to be the property of the firms which had carried it out, but in some cases, there were procedures to allow some of this information to be made available to other participants in BRITE and other Community programmes.

The first programme received a very positive assessment:[21] the technical standard of the research was considered very high, the response to the call for proposals was - as we have seen - massive, and almost all the participants held that their work could not have been carried out without the support of BRITE. The industrialists involved foresaw a rapid commercial return from the research; links between industries were forged and strengthened, new links were established between industry and the universities; the involvement of many small and medium-sized firms had led them, in many cases for the first time, into shared research activities with companies from other countries; the smallest and least technologically advanced Member States had received proportionally more of the funding available than had the other states. The most serious problems of the programme, however, were threefold: its obvious underfunding, insufficient attention to the marketing of the "products" developed, despite the perhaps excessive optimism of in-

dustrialists, and the still relatively low number of small and medium-sized firms participating.

In 1986, The Commission set up the EURAM programme (European Research in Advanced Materials) to undertake studies of the new materials which, in the First Framework Programme, had been considered, along with research into improving the management of raw materials, and received 30 million ECU. Subsequently, with the start of the Second Framework Programme in 1987, the programme was significantly strengthened; "Advanced Materials Science and Technology" had at its disposal a total budget of 220 million. Materials research was multi-disciplinary, drawing on expertise in fields such as metallurgy, chemistry, solid state physics, crystallography, ceramics and polymer science. Its applications were of prime importance in sectors such as aerospace, information technology and atomic energy. In these vanguard sectors of industry, materials research had already taken major steps forward, but new materials were generic technologies *par excellence*, and EURAM, like BRITE, set out to develop a series of advanced materials with many different industrial applications. The research covered three main areas: metals (with studies, for example, of alloys of aluminium, magnesium and titanium, of new materials for electronics, and of the metallurgy of dusts) ceramics for engineering purposes (particularly for gas turbines and high temperature internal combustion engines), and composite materials (of organic, metal and vitreous origins).

In 1989, BRITE and EURAM were merged, and the new programme (1989-1992) received Community finance of 250 million ECU. The areas of intervention were reorganised thus: 1)advanced materials technology; 2)design methods and quality control of both products and processes; 3)application of production technologies; 4)technologies for production processes, 5)aeronautics. Plainly the main new development in the BRITE/EURAM programme was the inclusion of this fifth area, focused on just one sector of industry. Previously, during the course of the 1970s, the Commission had unsuccessfully presented various projects for the development of the aeronautics industry. The aeronautics programme was prepared through meetings, beginning in 1986, between the Commission and representatives of some of the main companies in the sector, who were worried about the slow development of technology in Europe compared to the United States and Japan, and about American threats to restrict the publication of the results of their own research in the field of aerospace. On the basis of these discussions and some study reports the Commission produced its own proposals for a programme, which received Council approval for a limited two-year exploratory phase, with a budget of 35 million ECU. The programme studied aerodynamics, acoustics, flight equipment, and systems of propulsion.[22] The aeronautics programme would be expanded in BRITE/EURAM II, (1990-1994).

Because of their particular nature, the BRITE and EURAM programmes played an important role in drawing the Commission's attention to the need for intervention to bring a larger number of small and medium-sized firms into research programmes and, more generally, to promote the use of new technologies by all European companies. After a pilot phase set up in 1983, the Commission strengthened the SPRINT programme (Strategic Programme for the Transnational Promotion of Innovation and Technology Transfer), the aim of which was to spread technological innovation throughout Europe and to set up networks, formed above all of small and medium-sized enterprises, to transfer the results of research and development, starting with

those obtained in the Community's programmes for industrial innovation. Criticisms were levelled directly at BRITE/EURAM, that a programme designed specifically to encourage research and development activities in small and medium-sized companies should have succeeded in involving relatively few of them, and had in fact worked above all to the advantage of large firms.[23] In response to these criticisms, the Industrial Research and Development Advisory Committee (IRDAC) proposed setting up the Co-operative Research Action For Technology (CRAFT) as a sub-programme of BRITE/EURAM; CRAFT was started up in 1992, to stimulate technological innovation in small and medium-sized firms which lacked the capacity to carry out their own research.

b) Information Technology and Telecommunications

We have already discussed ESPRIT, the first and most important Community programme in the field of information technology; as for telecommunications, Community intervention was at first embodied in the RACE programme, (R&D in Advanced Communications Technologies for Europe). "Telematics"[24] or the convergence of telecommunications and information science, appeared at the end of the 1970s to be the most important line of industrial development for the future. It was a sector in which Europe could compete on equal terms with both the United States and Japan, but in which international competition was very keen and technological progress particularly rapid, so that no-one could hope to enjoy the fruits of success for long. The situation became more complex and diversified with the decision of the American government to break the monopoly of AT&T on the American market. The dismembering of AT&T in 1982 led to an intensification of competition between the giants in the sector, and to a huge increase in the number of services and products on the market. The European situation was characterised on the one hand by the strong positions of the "national champions", some of which had close collaborative relationships with American firms, and on the other by the control of transmission networks by the national post and telecommunications administrations. As in many other sectors, the greatest European limitations came from the fragmented market, the lack of common laws and standards, and the consequent lack of continent-wide infrastructure capable of rapidly developing the services demanded by the market, such as the transmission of data and images, electronic mail, and the interconnection of data banks.[25]

Community policy in telecommunications, outlined in 1984 and redefined in 1987,[26] was very ambitious. Above all, it proposed to establish European standards for equipment and terminals, which would allow these products to develop a true common market. In this field, the creation in 1988 of the European Telecommunications Standards Institute (ETSI), modelled on CENELEC (European Committee for Electrotechnical Standardisation), was a notable success. A second objective was the co-ordination of the development of continental infrastructure: all the countries of Europe were to adopt the same standard (ISDN - Integrated Services Digital Network) when they converted their telephone networks to a digital system. For the development of telecommunications in the less economically advanced areas, the Community established the STAR programme (Special Telecommunication Action of Regional Development) in 1986; while for the electronic data transmission for commercial purposes a programme was launched in 1987 for the creation of a network of services with a

high added value (TEDIS - Trade Electronic Data Interchange Systems). Besides this, the Community proposed to co-ordinate policies of the postal and telecommunications administrations of Member States in international negotiations.The final objective was to transfer responsibility for the entire telecommunications sector to the Community in 1995, while the sector should be entirely deregulated by 1998, national resistance and technical difficulties permitting.[27]

In the field of R&D, the Community sought to put itself at the service of the broader aim of the Europeanisation of telecommunications, but it also tried to avoid the many duplications inevitably caused by the fragmented situation, since research in this area could be extremely expensive. In telecommunications, unlike information science, the main involvement with the Community was not with businesses but with public authorities, and the Commission defined its research and development project in close contact with them.The research and development programmes in telecommunications were prepared and managed by the Information Technologies Task Force (ITTF) set up by the ESPRIT programme and, from 1986 onwards, by the restructured Directorate-General XIII, under Director-General Michel Carpentier.

The pilot phase of RACE, which was approved in July 1985, and lasted eighteen months, had as its main objective the definition of basic technologies for the realisation of the new integrated broadband communication networks (IBCN), which were eventually to replace the current system of data transmission (ISDN). The 32 projects chosen, which involved the collaboration of 109 organisations, principally covered integrated circuits, optoelectronics, switches and specially designed software; the work was co-ordinated by three groups handling, respectively, "networks", "terminals",and "services". However, the programme was very small (the budget was around 40 million ECU, 20 of which came from the Community) and its main aim was to create a climate of trust and co-operation between the various telecommunications administrations, and between these and industry, in a sector in which all previous attempts at collaboration had been stillborn.

For the first phase of RACE, in the setting of the Second Framework Programme, the Commission proposed a Community budget of 800 million ECU, which a Council decision of 14 December 1987 reduced to 550 million. The programme was still to be jointly funded (so that the total budget was about 1.1 thousand million) and drew together businesses, university research centres, and telecommunications operators.The technical aims of the programme remained unchanged, but they were reorganised into three large areas: strategies for the development and adoption of broad band communications systems, IBCN technologies, and prenormative functional integration.The first area covered all the strategic problems posed by the co-ordination of operators, by the availability of new services, and by the gradual transition to the new system. The second area, more strictly technological in nature, included research and experimentation on software, the man-machine interface, and new subsystems. The last area co-ordinated the standardisation of technological projects in the second part of the programme, and ensured that the RACE programme was consistent with the activities of ESPRIT and the national and international programmes linked to the IBCN project.

In 1989, as part of the Second Framework Programme, three programmes were launched to respond to the often reiterated demand that Community research and development should not merely react to the real or

imagined technological gap which existed between Europe and the United States or Japan, but should attempt to draw up its own new directions for research and new applications of public interest for the new technologies. Grouped together under the heading of new services of general interest,[28] the programmes were: DELTA (Development of European Learning through Technological Advance), which was dedicated to the application of the new telematics technologies to teaching; DRIVE (Dedicated Road Infrastructure for Vehicle Safety in Europe), to develop telematic instruments for road traffic; AIM (Advanced Informatics in Medicine), for the application of information technology at a European level in medical research and health systems.

c) Biotechnology

Biotechnology may be defined as technology based on the life sciences, or as the science of the application of biological processes. The European Federation of Biotechnology (EFB), which has existed since 1978 as a forum for professional associations and academic institutions from all over Europe, offers a more exact definition: "the integrated use of biochemistry, microbiology, and engineering sciences to realise technological applications based on the properties of micro-organisms, the cultivation of cell tissues, and other biological agents."[29] In many of its developments and applications, biotechnology makes ample use of contributions from other areas of science and technology, and can be seen as multi-disciplinary research. However, it must be remembered that, from a scientific point of view, biotechnology is founded on a unified body of knowledge and techniques which are the result of contemporary biological research. The fragmentation of biotechnology studies between different scientific institutions, as happens in many European countries, is thus the result of bureaucratic inertia which prevents the merging of similar research with diverse applications, rather the result of a difference in scientific approach.

From an industrial point of view, applications for biotechnology can be found in many sectors: agriculture, food production, chemistry, pharmaceuticals, medicine and environmental protection. At the beginning of the 1980s, this multi-sector character obliged industrialists and politicians to consider the question of whether biotechnology could be regarded, in economic terms, as a single industry - whether, in fact, such an industry either existed or should exist. In the United States and Japan this question was answered unhesitatingly in the affirmative, whilst European industrialists in pharmaceuticals, chemistry, and the agricultural industries seemed much more sceptical. Commissioner Davignon, however, was convinced of the need to develop this new industry, above all because of the new prospects it might afford to the Common Agricultural Policy, which was in increasing difficulties; and in December 1984, he called a meeting of the principle firms working in the field of biotechnology. The outcome of this initiative was the European Biotechnology Coordination Group (EBCG), set up in 1985, which united the associations of five industries (chemicals, pharmaceuticals, agricultural food production, enzymes and agrochemicals) and became involved in discussions with the Commission as its main partner in the preparation of biotechnology research and development programmes.[30]

Community interest in biotechnology research dated back to the middle of the 1970s, and a biomolecular engineering programme had been set up in 1982. BEP (1982-1986)

was a very small programme, with a budget of 15 million ECU for around a hundred training contracts and as many shared-cost research contracts; the research work centred on a series of genetic engineering projects with applications in agriculture and the agricultural food production industry. It was only with the new five-year plan, BAP - Biotechnology Action Plan, launched in 1985, that the industrial plan Davignon hoped for began to be carried out, although the Community's financial support still fell short of what was necessary. The programme was allocated 55 million ECU, and a further 20 million ECU were made available when it was revised in 1987. BAP had two medium to long-term objectives: to create the infrastructure for biotechnology research in Europe, and to eliminate the obstacles which slowed down the transformation of the results of research into processes and products which could be used by agriculture and industry. Numerous research projects were launched into the study of potential environmental risks and their regulation. In collaboration with DG XIII and the ESPRIT programme, BAP also established projects in support of the bio-informatics programme (data banks, mathematical models and specially designed software), and for the collection of biotic materials. However, the panel which assessed the programme[31] considered that, in view of their crucial importance, such activities should in future be extended and strengthened.

In basic research, the most important scientific result of BAP was the determination of the sequence of chromosome III of yeast (*Saccharomyces cerevisiae*): this was the first analysis of the complete sequence of an entire chromosome ever carried out. The choice of yeast for this first experiment in describing a complete sequence was influenced by the fact that it has a relatively small genome, and is besides an organism which had already been studied in depth, particularly in Europe. It was also selected for its biotechnological applications because of its use in the agricultural food production industry and in pharmaceuticals. The article in *Nature*[32] in which the results of this Community research appeared was signed by 147 researchers attached to 35 European laboratories. As the number of laboratories involved clearly shows, the Commission had decided that the organisational structure should be a network, rather than entrusting the work to a single or a small group of research centres. The main advantage of this strategy consisted principally in that it allowed the programme to call on the services of the most motivated and expert researchers in the field from every laboratory; and the network had led to a remarkable transfer of expertise between the participants in the research consortium. The main risk, on the other hand, was that the fragmentation of the analysis would lead to the use of sequencing techniques which were not perfectly identical, and that this in turn would lead to unreliable results. However, the check which was carried out on 22% of the chromosome, which had been analysed independently by at least two laboratories, removed any concerns on this point. By the end of the 1990s, thanks to parallel activities in many laboratories, mostly in Europe but also in the United States and Japan, all sixteen chromosomes of yeast will have been sequenced, allowing a more thorough examination of the function of the very large number of new genes discovered.[33]

Parallel to the approval of the BAP programme, the Council decided to set up a concerted action which was entrusted to CUBE (Concertation Unit for Biotechnology in Europe). The idea came from the FAST programme (which will be discussed below) and fitted into the analysis of the "bio-society", that society which awaits us in the near future but

which remains entirely to be defined:"In this new field, the Commission's role is above all to help anticipate the opportunities which will call for joint action, and to avoid or resolve the conflicts and problems which will arise in the field of policy, now and in the future."[34] CUBE's work encouraging concerted action took place at a national level, between Member States, and between the Community and developing countries; at an institutional level, between firms and universities, and between the Community, the European Biotechnology Federation (EFB) and the European Biotechnology Coordination Group (EBCG); and, at an inter-institutional level, between the various services of the Commission (agriculture, research, industry etc.)

The most innovative aspect of the Community's biotechnology programmes was the creation of the European Laboratories Without Walls (ELWW). Biotechnology is an area of research of a markedly interdisciplinary nature: biotechnology, for example, calls on knowledge from disciplines as diverse as biology, physiology, cytology, membrane biochemistry, the chemistry of proteins and carbohydrates, genetics and still others. It is most unlikely that a single research centre, or in many cases even a single country, would have access to the necessary human and material resources to tackle such interdisciplinary research. The ELWW are transnational associations which bring together research groups in universities, companies and public institutions (a typical group might unite six research centres and three companies), involved in the resolution of a specific problem of biotechnology, pooling their various specialist knowledge.Their work takes place amid a continuous exchange of data, biological material and scientific personnel, with meetings of all the interested parties every six months; the results of the research are published jointly. In 1987 there were 11 European Laboratories Without Walls; at the beginning of the 1990s, the number had grown to 35.

Earlier programmes had been essentially academic in character and of limited cost; in the Bridge (Biotechnology Research for Innovation, Development and Growth in Europe) programme, larger projects were added.These programmes were drawn up in collaboration with the Industrial Research and Advisory Committee (IRDAC). These new "T-projects" aimed to reach the critical mass of researchers required to solve certain basic European problems, allowing agriculture and industry to enjoy the results of developments in biology. Each project could cost between 2 and 4 million ECU a year, to be financed half by the Community and half by the many laboratories, including industrial laboratories, which were involved (one of these programmes was for the complete sequencing of other chromosomes of yeast).[35] Bridge covered the period 1990-1994, and had a budget of 100 million ECU, divided thus: 38.25 million ECU for basic research carried out by ELWW (N-projects); 38.25 million ECU for targeted research projects (T-projects); 12 million ECU for training programmes; 2 million ECU for research undertaken in conjunction with COST; 9.5 million ECU for concertation. All Bridge projects, not just those which were part of COST, were open to EFTA countries.[36]

During the course of the 1980s, Community involvement in biotechnology allowed the creation of a close network of transnational collaboration which has undoubtedly strengthened the European system of research. By the beginning of the 1990s, various sectors were coming to maturity and Community research also diversified. On the one hand, basic genetic research was attached to the medical programmes and the new Human Genome Project; on the other, research oriented towards industry in the broadest

sense was development in the Bridge projects and in two new programmes launched in 1988/89. The first was ECLAIR (European Collaborative Linkage of Agriculture and Industry through Research), the main objective of which was to put the new scientific knowledge of biology at the service of agriculture and industry: transferring technologies from agriculture to industry (various projects concerned with the development of new species and organisms) and from industry to agriculture (for example, new production processes applicable to agriculture) and to develop the two sectors jointly. In particular the programme hoped to make a contribution to the severe problem of agricultural surplus in Europe, one of the weightiest items in the budget of the Common Agricultural Policy. Since the prices of many agriculture products were falling because of worldwide overproduction, and, thanks to technological innovations, the same was happening to the costs of conversion, it was becoming increasingly convenient to use agriculture produce as raw materials for industry. The second programme, FLAIR (Food-Linked Agro-Industrial Research), was specifically concerned with agricultural food production and thus with the food industry. From 1993, many areas of research formerly covered by ECLAIR and FLAIR were taken over by the AIR programme (Agro Industrial Research), which undertook research into fishing, horticulture and forestry as well as agriculture and agro-industry.

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5. STIMULATING SCIENTIFIC POTENTIAL AND HORIZONTAL ACTION

In the Framework Programme, under the heading of "Improvement of the effectiveness of scientific and technical potential", a series of actions were brought together, proposed by the new Committee for the European Development of Science and Technology, which were even more markedly multi-national, multi-sectoral and multi-disciplinary in nature than other Community programmes. In addition to the stimulus programmes and the programme to encourage mobility among researchers, we will here examine two other activities, described as "horizontal" because they were designed to service all the Community's other scientific and research programmes: forecasting and evaluation.

a) Stimulus programmes

On 6 December 1982, the Committee for the European Development of Science and Technology (Codest) was created, composed of 21 independent experts (to be increased to 24 with the accession of Spain and Portugal to the Community), resembling in this respect the CERD which it replaced. However, Codest had a much more precise mandate than its predecessor: to assist the Community in its policy of encouraging the scientific and technical potential existing in the Community, through a systematic analysis of the requirements and opportunities of Member States in the field of science and technology. Although Codest's objectives were relevant to the whole area of research and technological development, its actions were particularly focused on basic research.

Codest's main point of reference was a series of reflections on the research and development situation in Europe which had been begun by the CERD and its subcommittee ESIST. These reflections focused on the need to find new sources of inspiration for science and technology policy, moving on from the narrow objective of reducing the technological gap with respect to the United States. The current situation of Community research was well described by Ilya Prigogine: "Applied research in Europe today is in a dramatic state of dependency. We are paying now, and we will continue to pay heavily, for our failure to provide the investment necessary to establish an adequate industrial infrastructure in the key sectors. Unable to benefit from that trickling down of technological results which comes with investment, recompensing our efforts and encouraging further investment, we are forced instead to finance the more dynamic approach of other countries from whom we buy and hire the products and services of these industries: for example, satellite carriers and information technology. As for pure research, whatever indicators we adopt (citation in journals, scientific acknowledgements, etc), European research is being reduced to following a path over which it no longer has any control."[37] These "defensive" objectives are not compensated by other more positive aims: the reference to the lack of independence in European research implies an acknowledgement of the importance of formulating objectives and finding solutions to social and economic problems appropriate to Europe, rather than simply following development trends established elsewhere. This idea is repeated particularly forcefully by André Danzin: "To go on the offensive is to

refuse to be overtaken, sometimes without hope of recovery; it is to take the initiative; it is to force the others to follow; it is to preserve our own freedom".[38]

Codest's proposals sprang from the conviction that the scientific potential of the Community was remarkable, and of high quality, but that this potential was insufficiently exploited due to the many barriers which still existed in Europe. The limitations of national initiatives meant that communication and co-operation between scientists working in different parts of Europe were inadequate, and caused both unemployment and low levels of specialisation among young scientists. While scientists who wanted to co-operate with other research laboratories looked overseas to set up agreements, European research centres remained under-used. And the risk of a brain drain was always present. In the view of Codest, only an action at Community level, and hence on a larger scale, could ensure a better relationship between supply and demand in the world of scientific research. Ilya Prigogine proposed setting up what Ralf Dahrendorf had called the "European scientific area": "A change of scale, the opening up of an area in which ideas and researchers can circulate, could lead to the 'qualitative leap' which European research needs to free itself from the institutional framework which imprisons it. This is why I believe that the European Economic Community is the right setting in which to rethink our research activities: the societies of Europe constitute a varied, wide and sufficiently homogenous area in which to create the multiplicity of scientific institutions which we need."[39]

The experimental phase of a programme called "Stimulation" was launched in June 1983. The programme, which was designed to "stimulate" basic research and the mobility of researchers, aimed to provide grants to scientists who wanted to collaborate on projects, preferably of a multi-disciplinary nature, in other European countries; to make post-doctoral grants available to young researchers wishing to attend specialised courses abroad [40]; to encourage the twinning of laboratories in different countries and to establish networks of centres of excellence in Europe. In the experimental phase, with a budget of 7 million ECU, the privileged areas of research were: pharmaco-biology, solid state physics, optics, combustion, photometry/ photoacoustics, climatology, and interfaces. In the second phase (1985-1988), with a budget which had risen to 60 million ECU, the areas covered were: chemistry, biocommunications, earth sciences, optics, mathematics and data processing, oceanography and marine science, the chemistry and physics of surfaces, and instrumentation. In SCIENCE, which was the third phase of the programme (1988-1992), and had a budget of 167 million ECU, the process of liberalisation reached its conclusion: all the exact and natural sciences were included. Besides this, two programmes were set up in 1989 to support the study of economics (SPES) and to improve access to major scientific installations. Over the course of a decade, Stimulation and Science provided the finance for 642 bursaries and research grants, 2576 twinning arrangements between laboratories, and 3884 other operations (targeted research projects), creating enduring networks between research centres all over Europe. The programme also led to important results in many areas of scientific research, including non-linear optics (the EJOB project), magnets (CEAM - Concerted European Action on Magnets, the second phase of which involved collaboration with the EURAM programme), and studies of the brain (the BRAIN action, Basic Research in Adaptive Intelligence and Neurocomputing).

The distinctive characteristic of these programmes was the fact that they were wholly based on the "science push", initiatives coming from within the European scientific Community itself. Stimulation and the programmes which followed tried to choose the best research centres and put them in contact with each other, to finance the research which they themselves wanted to undertake, and at the same time to train young researchers, allowing them to work in another Member State. With the stimulus programme, the Community hoped to act as a catalyst for the scientific energy already available in Europe, rather than to provide the finance for some specific research and development project, however important it might ultimately be.The idea that the Community should not act as an additional Member State, but should carve out a role for itself in multiplying the effectiveness of existing national projects, had always been an element in its various research and development programmes, but Stimulation was the first programme to concentrate its efforts exclusively in this direction. The programme's strategy, clearly, was also the result of a very prosaic observation: the Community's resources for investment in research and development were extremely limited; but just as the growth in exchanges caused by the Single Market had encouraged European economic development, so too might the creation of a European scientific area without frontiers enable the scientific Community to make the necessary qualitative leap.

Over the years, an increasing amount of money was made available for the programmes dedicated to stimulating scientific and technological potential, and this allowed a growing number of contacts between members of the European scientific Community. Within the Third Framework Programme, stimulus actions were brought together in a new "Human Rights and Mobility" programme, but it must be recognised that one of the original aims set out by the Council in 1983 was at least partly abandoned: the encouragement of research groups working at an advanced level on highly innovative projects which were unable to attract sufficient financial support. The stimulus programme, in accordance with the Codest project, included the financing of "free" research, that is of basic or applied research projects which were too original to find a place within pre-existing national and Community programmes.The EJOB project is an important example of this, demonstrating that free research could lead to scientifically and industrially important results. During the 1990s, some free research projects, defined in this context as "explorative research", would be included among the activities of the Joint Research Centre (JRC) and the Community's "Research training through research" actions would preserve a considerable margin of freedom for young scientists to choose both where they worked and the content of their researches.

b) Forecasting

As readers will remember, in 1974, the Council had approved a proposal put forward by Commissioner Dahrendorf to set up an experimental research programme in the field of scientific and technological forecasting and assessment. The study, called *Europe Plus Thirty*, was conducted by a team of around fifty researchers under the guidance of P. Aigrain, and sought to answer two basic questions: 1) was it useful to conduct research into possible long-term developments, as an aid to the Community's decision-making process? 2) should the Communities set up their own department to assess technology, along the lines of the American Office of Technological Assessment created in 1972. The answer to the first of these questions, which came in a re-

port presented in September 1975, was positive: the report suggested the creation of a research group, initially made up of around fifteen people, whose task would be to provide forecasting over a time-span of at least five years. The answer to the second question was negative. It was thought that the forecasting office itself should also carry out technology assessment, and the study group therefore advised against the creation of an *ad hoc* office. Studies should involve all areas of long-term relevance to the future of the Communities, not only science and technology, and should become an integral part of the decision making process. The office should be attached to the Commission and financed by it. It should make both quantitative and qualitative assessments, should gather the results of research undertaken elsewhere, and finance other studies, as well as carrying out its own researches. But what exactly are forecasting and technology assessment?

According to the authors of *Europe Plus Thirty*, in a world of ever more rapid and radical changes, it had become essential to provide decision makers with "maps" showing the range of possible choices, and clearly separating the possible from the impossible. Avoiding "any naive tendency to 'believe' a projection, as if it were a prediction",[41] the authors suggested that *futuribles*, models of the future,[42] should be worked out: possible scenarios the feasibility of which would depend on the objectives and the means chosen. A forecasting office should describe the possible results of different combinations of means and ends; although the decisions about what these means and ends should be must always rest with politicians as the democratically elected representatives of the citizens. At a Community level studies on long-term prospects (over a period of between 5 and 30 years) could carry out two important functions: to contribute to the identification of objectives leading towards European integration, since this seemed to be a political end in itself, and to outline aims for the various other European policies and possible means to achieve them.

Technology assessment, on the other hand, is defined in the *Europe Plus Thirty Report*, as the "advance evaluation of potential and unintended social, environmental and other effects of the application of existing or foreseen technologies".[43] It was to make a contribution to the knowledge of the collateral effects, unpredicted and sometimes damaging, of technological innovations, thus helping to relieve the tensions arising in industrialised countries between the use of the new technologies and the needs and aims of society as a whole. In 1987, worries of the same kind prompted the European Parliament to set up a programme for the assessment of the Community's scientific and technological strategies (Scientific and Technological Options Assessment - STOA).

An indirect action programme, designed to last for five years, was set up in 1978 at the Commission, with a Community budget of 4.4 MECU and a staff of ten people. With this decision the Council entered into an experimental phase in forecasting studies, at the end of which the option of creating a real institute for forecasting and technology assessment could be considered. The programme was called Forecasting and Assessment in the field of Science and Technology (FAST); the name alone reveals how limited the scope of the programme was compared to the proposals put forward by *Europe Plus Thirty*. The Group had given a central role to forecasting, of which technology assessment was only a small part: only as a result of serious forecasting studies in all areas could the new technologies be reasonably assessed. FAST, on the other hand, was primarily concerned with science

and technology; the remit of the institution was to "contribute to the setting of long-term objectives and priorities for Community research and development, and thus to a coherent long-term policy in the field of science and technology".[44] Although the three priority areas of research (supply of resources; technical and structural changes; social changes) were very wide, FAST's research was to be directed towards specific problems, and to respond to the practical requirements of Community institutions and Member States. As for the organisational structure, however, this was to adopt the advice of the 1975 study, trying to set up networks, as flexible and informal as possible, of study groups scattered throughout the countries of the Community, organised on the basis of the individual needs of each separate research project.

The basic results of the first phase of FAST's research were presented in 1982, and were later published under the title *Eurofutures*. The document analysed three major themes which seemed to be of primary importance to European societies: work and employment in the context of the technological changes in progress; information technology in its industrial and social aspects; and the emergence of biotechnology.[45] In its discussion of information technology, FAST underlined the industrial relevance of the ESPRIT programme, in the preparation of which it had been involved, but criticized the scant attention which ESPRIT paid to the socio-economic needs which technological developments ought to serve: "It is deplorable that these aspects (the techno-industrial and social challenges) should so often be treated separately, or even as though they represented conflicting aims. The new technologies will only become a powerful instrument for growth when the needs of society and of individuals directly influence their development from the earliest stages."[46] Agreeing with the theory advanced by Danzin, FAST maintained that the Community should rediscover its own originality, and act more independently, redirecting its research and development policies towards the anticipation of problems, and opening up new avenues of research, instead of merely reacting passively to external initiatives, making up for mistakes and delays in an attempt to overcome once and for all the real or assumed technological gap.

The FAST II programme (1983-1987), which as a "horizontal action" formed an integral part of the First Framework Programme, and which had at its disposal a Community budget of 8.5 million ECU, tried to move from the examination of technology itself in favour of its potential applications and their impact on European society and industry. Research was concentrated on five themes: 1) the transformation of relations between technology, work and employment, with particular reference to new kinds of interaction between man and machine; 2) the integrated development of renewable natural resources, based on an improved integration of agriculture, energy and environment policies; 3) the new communications industry and its social and industrial effects, and the need for vast communications networks at a Community level; 4) the future of the food production system, in its relations with agriculture, biotechnology and health; 5) transformations in the service sector and the progressive "dematerialisation of production".[47] Each area is subdivided into a certain number of more specific research activities, in their turn made up of many projects entrusted to one or more European research institutions, with a Community budget amounting to 50% of the cost. In some cases, however, FAST used networks instead of research contracts to spread already existing knowledge in certain fields. There were networks between research centres which had already finished, or had set up, research

which was of interest to FAST, and a Community network (12+1) which linked national centres engaged in forecasting and technology assessment.[48]

The assessment report of FAST II[49] exposed a fundamental ambiguity present in the Community's programme of forecasting and assessment from the start: who exactly had commissioned the research, and what level of analysis did this client require? The FAST group had constructed a global model of the changes in progress in certain sectors and their probable socio-economic consequences, which could potentially be used by all the services of the Commission and policy making institutions of the Community. However, the assessment panel's investigation revealed that as a rule each Directorate- General wanted to undertake its own strategic analysis of its areas of interest, and therefore required more specific and focused research, closer to technology assessment than to forecasting. In the opinion of the assessors, FAST should have considered DG XII and DG XIII as its clients, and should therefore have played a more incisive part in planning Community R&D activities, actively participating in the drawing up of the Second Framework Programme.

In the context of the Second Framework Programme, in 1989 a new programme, known as Monitor, was approved to unite all the Community's horizontal actions in the field of strategic analysis, forecasting and assessment in the area of science and technology. Strategic analysis was entrusted to the newly set up SAST programme (Strategic Analysis in Science and Technology), charged with undertaking more technical analysis upon direct request from the services and committees of the Community. FAST instead was able to follow its own wider research interests, into development prospects for science and technology and the objectives which Community research and development policy could pursue.

As we shall see in the final chapter, a fresh approach to forecasting and strategic studies in the Community was set in motion by the need to find new mechanisms for the effective co-ordination of research and development policy in Member States. To this end, the European Technology Assessment Network (ETAN) was set up, alongside the JRC's technology forecasting institute and its science and technology Observatory, based in Seville. ETAN was to involve the collaboration of all the main national centres engaged in the field of forecasting.

c) Assessment

"Research is costly, choices are difficult and any mistake made in research and innovation policy has heavy financial repercussions. All those in positions of responsibility in the public sector or industry therefore endeavour to develop a tool that informs them of the scientific and technological health of the undertaking they are managing, gauges the results of its efforts and assists them in framing a strategy and then taking decisions."[50] The evaluations of research and development programmes regularly undertaken by the Commission were in response to this need for a continual check on the efficiency and effectiveness of the choices made, and form an important source of information, which is also made available to the Parliament and the Council, upon which to decide future directions.

The first signs of the Community's interest in evaluation can be detected in a seminar, "The Evaluation of Research", organised by the Commission in Copenhagen, in June 1978. Although a first Community research

and development programme (Energy saving, 1975-1979) had undergone assessment already the year before, it was not until 1983 that the Council approved an action plan for assessment. The Council's decision established assessment as an integral part of research and development policy, and of the process of formulating, carrying out and revising programmes. The action plan allowed for an external assessment of programmes at their end, and in some cases halfway through, in addition to the internal evaluation which went on during the programme in order to keep a check on the progress of the work. Between 1979 and 1987, 24 assessments were completed of as many Community research and development programmes.[51]

The retrospective assessments are carried out by a panel of independent experts, about fifteen people including scientists, industrialists and administrators, and last from six to twelve months. The assessment group gathers information on the programme under examination primarily through meetings with the Commission's own staff, project managers, national experts and the potential users of the results of the research. In many cases, questionnaires are also sent to those participating in the project. The retrospective evaluation covers five basic aspects: an analysis of the context of the programme: the scientific and technological review of the programme and the quality of its results; the management of the programme from an administrative point of view; the impact of its results in the relevant sector and in relation to Community objectives; a series of recommendations regarding the exploitation of the results and in anticipation of any subsequent work on the programme. For the assessment of concerted actions, including COST actions, the Commission chose the more straightforward method of holding a hearing, based solely on interviews with active participants and carried out principally to check on the level of co-ordination achieved.

A problem often encountered by DG XII in its assessment work is that of the pace of political, technical and bureaucratic decision making: delays in starting an assessment often meant that the assessment report was not ready when the Council was due to decide whether or not to continue a programme and what modifications, if any, were necessary. For its part, the European Parliament took up the criticism of the way in which the panels were selected: they should not be made up simply of people from outside the Commission, but from individuals who could guarantee the real independence of the panels. The problem here was at times that of striking a balance between the level of specialist knowledge required by at least some panel members, and the more general representation of differing points of view within the assessment group. A secondary and perhaps unforeseen effect of the institutionalisation of the assessments was that it led the Commission to try to assign a precise task to every single research and development programme, since in order to carry out a successful and useful evaluation of a programme it had to have a well-defined objective.

The assessment activities were carried out side by side with some theoretical research on methodology, as the Council's decision of 1983 had recommended. A basic distinction which emerged from these studies was between assessment itself, which examined the programme, that is the institutional structure of research, and on the other hand the evaluation of the work of the researchers, which should be subject to the normal process of peer review. The process of assessment should concentrate on the added value of the programme, which is to say, on those aspects of research which would not have been car-

ried out in the absence of the programme itself.[52] For a more systematic study of the assessment process, its objectives and its methodology, the Support Programme for a European Assessment of Research (SPEAR) was established in 1989 as part of the wider Monitor programme which already included, as we have seen, FAST and SAST.[53]

From 1985 onwards, DG XII also set up a series of evaluation studies which were quite different from the assessments of individual programmes of which we have spoken so far. These were Impact Studies, which attempted to evaluate the overall impact of Community research and development policy on Member States: whether on government policy and industrial strategy, or on scientific, industrial and technological activities at national level. Whilst gathering the figures for national participation in Community programmes, the primary aim of these studies was to analyse the ways in which Community research and development policies were viewed by all those taking part in research at a national level, the reactions which these policies aroused, and their influence on national research and development policies. As well as the state-owned bodies involved in R&D, Impact Studies examined the views of all research centres, universities and industries, regardless of whether or not they took part in Community programmes, whether their research proposals had been rejected, or whether they had never shown an interest in participating at all; in fact, the entire fabric of national scientific research. After a series of studies in the second half of the 1980s covering practically all Member States, but carried out by national panels on the basis of criteria which were independently arrived at, the Commission decided to harmonise these criteria so that a new series of studies could provide results which would be more easily comparable. During a seminar on Impact Studies in June 1991[54], the adoption of a uniform methodology for these inquiries was discussed, but its limits were also stressed: an accurate study of the impact of Community policies at national level had to take into account the variations which each country presented, both at policy level and in the way in which research was structured and organised. Besides, it became apparent that unlike the assessments of single programmes which had primarily technological and scientific objectives, Impact Studies had to reflect a wide range of direct and indirect effects not only on national research and development policies but also on a nation's internal cohesion, and on Community cohesion, on the other policies which the Community carried out in conjunction with its science and technology policy (transport, environment, energy and so forth), and on the competitiveness of European industry, paying particular attention to the small and medium-sized enterprises in each country. This last point, the economic impact of R&D, was perhaps the most complex and delicate problem, but it was nevertheless crucial to the decisions regarding the continuation of programmes: how could this impact be calculated? What were the objective indicators which could be set beside the subjective judgements and expectations of the industrialists who benefited from research and development activities? What sort of time frame was necessary (5-7 years, 10 years, etc.) for the benefits of investment in R&D to start to show? From this point of view, what differences were there between various industries? On the basis of the directions which emerged from this first assessment exercise, a new series of studies was set up investigating the impact of Community programmes on individual countries (completed in mid 1994), and at the same time other studies were carried out: on the impact of research and development on small and medium-sized firms, on social and economic cohesion, and a third

study, under the direction of DG XVI (regional policy) on the impact of the Structural Funds on research and development potential within Member States. The Impact Studies offered information on the ways in which national institutions and firms used the research and development opportunities provided by the Community, and at the same time provided the Commission and other Community institutions a reasoned appraisal of the "added value" of Community policy to European research. They have created an important body of knowledge on the ways in which Community and national policies interacted and were thus important instruments in the attempt to co-ordinate them.[55]

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NOTES

1 Commission of the European Communities, "Principles and general guidelines of an industrial policy for the Community", COM(70)100 final, *Supplement to Bulletin*, 4, 1970 (hereafter called the *Colonna Memorandum*).

2 *Colonna Memorandum*, op. cit., p. 14.

3 Commission of the European Communities, "Memorandum from the Commission on the technological and industrial policy programme", *Supplement to the Bulletin*, 7, 1973, pp. 17-23.

4 *Colonna Memorandum*, op. cit., p. 17.

5 *Colonna Memorandum*, op. cit., p. 19.

6 For a brief analysis of the Colonna Memorandum in relation to following developments in Community industrial policy, see Pippo Ranci, "Introduzione" to Roberto Malaman and Pippo Ranci (eds.), *Le politiche industriali della CEE*, il Mulino, Bologna, 1988, pp.7-13; also of interest is the article in the same volume by Ilaria Galimberti and Stefano Kluzer, "I programmi tecnologici europei e il loro impatto sull'Italia", pp. 99-215.

[7] Spinelli, *Discorsi al Parlamento europeo 1976-1986*, il Mulino, Bologna, 1987, pp. 80-81.

[8] Commission of the European Communities, *Tenth Annual Report*, 1976, p. 207.

[9] Etienne Davignon, "Introduction" to Hubert Curien and Filippo Maria Pandolfi, *La politique européenne de recherche*, lecture given on 23 February 1989, Collection des Conférences de la Fondation Paul-Henri Spaak, Brussels, 1989, p. 3.

[10] The Information Technologies Task Force would be incorporated, in 1986, into DG XIII which up to then had been concerned with scientific and technical information.

[11] Letter quoted in Michel Albert, *Un pari pour l'Europe*, Seuil, Paris 1983, pp. 157-58 (from the Author's translation)

[12] The ECU (European Currency Unit), which is at the heart of the European Monetary System (EMS) created in 1979, replaced the various units of account used in preceding decades. The value of the ECU is based on a "basket" of currencies of Member States. The 2 January 1979 one ECU was worth 1.388 American dollars; on 1 February 1995 the ECU was worth 1.253 US dollars; but in the period 1983-1985 the dollar reached a very high value with respect to the ECU (on 1 January 1984, for example, an ECU was worth 0.83 US dollars). "MECU" is used for a million ECU.

[13] "Council Decision of 28 February 1984 concerning a European Programme of research and development in information technology (ESPRIT)", *OJEC*, 9 March 1984.

[14] This information is from Margaret Sharp, "The Community and New Technologies", in Juliet Lodge, (ed.), *The European Community and the Challenge of the Future*", Pinter, London, 1989, p. 209. Other sources give slightly different data; in cases where the information is very different, however, this is probably due to the fact that the same participating bodies were counted more than once if they were involved in more than one project.

[15] Data and estimates from Lynn Krieger Mytelka, who has thoroughly researched the evolution of ESPRIT; see her article, "States, Strategic Alliances and International Oligopolies: the European ESPRIT Programme", in *Strategic Partnerships, States, Firms and International Competition*, Fairleigh Dickinson University Press, Rutherford, 1991, in particular pp. 187, 200.

[16] "Communication of the Commission to the Council and the European Parliament, regarding the evaluation of the initial results of the ESPRIT programme", COM (85) 616 final., p. 1.

[17] See "Resolution of the Council of 8 April 1986 regarding the mid-term review of the ESPRIT programme, *OJEC*, 29 April 1986.

[18] Hubert Curien, "Exposé" in Hubert Curien and Filippo Maria Pandolfi, *La politique européenne de recherche*, Lecture given on 23 February 1989, Collection des conférences de la Fondation Paul-Henri Spaak, Brussels, 1989 p. 20.

[19] Council of the European Communities, "Resolution of 25 July 1983 on the Framework Programmes for research, development and demonstration activities of the Community, and on a first Framework Programme 1984-1987", Annex II, Criteria for choice, *GUCE* 4 August 1983.

[20] For further information on the first Framework Programme, see Commission of the European Communities, *Community Research and Technology Policy: Developments up to 1984*, CEC, Brussels, 1985.

[21] See Y. Farge, et. al., *Evaluation of the first BRITE Programme (1985-1988)*, CEC, Luxembourg, July 1988.

[22] See Z et. al., *Evaluation of Specific Activities relating to Aeronautics (BRITE/EURAM - Area 5 - 1988/90)*, Interim Report, CEC, Brussels, July 1990.

[23] A recent study, commissioned by the group evaluating BRITE/EURAM, on the direct and indirect effects of participation in the programme, confirmed that it was the biggest companies which benefited most from the research undertaken. See "Summary of the Report by BETA Consultant", in O. Schiele et. al., *Evaluation of the BRITE/EURAM Programme (1989-1992)*, CEC, Luxembourg, February 1993, pp. 117-21.

[24] This neologism comes from the report on information science to the President of the French Republic, edited by S. Nora and A. Minc in 1978; see S. Nora and A. Minc, *L'informatisation de la société*, La documentation française, Paris, 1978.

[25] As we have seen in the preceding chapter, the Community was the European pioneer in this area with the creation of Euronet/Diane, a network of scientific and technical data banks. For communications between Brussels, Luxembourg and Strasbourg, the Community had instead established a

system known as INSIS, Interinstitutional System of Integrated Services.

[26] See particularly, Commission of the European Communities, *Towards a dynamic European economy: Green Paper on the development of the Common Market for telecommunications services and equipment*, COM (87) 290 final, Brussels, 30 June 1987.

[27] For an analysis of the principle issues concerning the European telecommunications sector, see Michel Carpentier, Sylviane Farnoux-Toporkoff and Christian Garric, *Les Télécommunications en liberté surveilleé*, Lavoisier, Brussels, 1991.

[28] The EURET programme (European Research for Transport) appeared under the same heading; it was managed by the Directorate General VII (Transport), and was not primarily concerned with information technology but with research in the transport sector (railways, roads, maritime and air).

[29] European Federation of Biotechnology, September 1982, quoted in FAST, *Eurofutures. The Challenges of Innovation*, Butterworths, London, 1984.

[30] For a more detailed discussion of the European and Community perspectives on the development of biotechnology in the mid 1980s, see the speeches made at the conference organised by the Centre for European Policy Studies and the Commission, collected in Duncan Davies (ed.), *Industrial Biotechnology. Issues for Public Policy*, CEPS, Brussels, 1986.

[31] See Charlotte af Nalmborg, et. al., *Evaluation of the Biomolecular Engineering Programme - BEP (1982-1986) and the Biotechnology Action Programme - BAP (1985-1989)*, CEC, Luxembourg, 1990.

[32] S.G. Oliver et. al., "The complete DNA sequence of yeast chromosome III", *Nature*, vol. 357, 7 May 1992, pp. 38-46.

[33] For further information, see Alessio Vassarotti and André Goffeau, "Sequencing the yeast genome: the European effort", *TIBTECH*, vol. 10, Jan/Feb 1992.

[34] FAST, *Eurofutures. The Challenges of Innovation*, Butterworths, London, 1984.

[35] For the T-projects, see Dreux de Nettancourt, "The T-Projects of Bridge, a New Tool for Technology Transfer in the Community", *Agro-Industry High-Tech*, vol. 2, 1991, pp. 3-9.

[36] For biotechnology programmes the principle sources are Etienne Magnien, "Biotechnology rhymes with Europe", *Plants Today*, March-April 1989, pp. 69-74; Mark F. Cantley and Dreux de Nettancourt, "Biotechnology research and policy in the European Community: the First decade and a half", *FEMS Microbiology Letters*, 100, 1992, pp. 25-32; and Ioannis Economidis, "An Overview of the Biotechnology Research Activities in the European Community", CCE-DG XII, Brussels, s.d.

[37] Ilya Prigogine, preface to André Danzin, *Science et renaissance de l'Europe*, CEC, Brussels, 1978.

[38] André Danzin, *Science et renaissance de l'Europe*, CEC, Brussels, 1978.

[39] Ilya Prigogine, "Remarques introductives" in ESIST, *La science et la technologie européennes face aux défis de la société d'aujourd'hui*, DG XII, Luxembourg, 1979, p.29 (from the Author's translation).

[40] A small programme of study grants for training in research had already been established within EURATOM in 1958, and had been extended to new disciplines in 1968.

[41] *Europe Plus Thirty Report*, CEC, Luxembourg, 1975, Part 1, p. 12.

[42] The French neologism *futuribles* comes from Bertrand De Jouvenel, a Memeber of the Europe Plus Thirty group, who proposed it in *L'art de la conjecture*, Paris, 1958.

[43] *Europe Plus Thirty Report*, CEC, Luxembourg, 1975, Part III, p. 2.

[44] "Council decision of 25 July 1978 on a research programme of the European Economic Community on forecasting and assessmentin the field of science and technology (1978-1982) - Annexe", *OJEC*, 16 August 1978.

[45] The chapter on "Bio-society" in the FAST report contains many ideas which as we have seen were subsequently adopted in the Community's second biotechnology programme.

[46] FAST, *Eurofutures. The Challenges of Innovation* , Butterworths, London, 1984

[47] For a concise account of the research projects undertaken by FAST II, see Maurizio Rocchi, "Scienza, tecnologia e società: prospettive e sfide per l'Europa" in Alberto Conti e Maurizio Rocchi, (ed.), *Il futuro dell'Europa nella ricerca scientifica e tecnologica*, CNR, Rome, 1989, pp. 51-101.

[48] For the organisational aspects of FAST's research, see Riccardo Petrella, "Scientific and Technologi-

cal Eurofutures, an Introduction to FAST", in "European Research - Framework Programme 1987-1991", *Nouvelles de la Science et des Technologies*, (English edition), vol. 5, n. 4, October 1987, pp. 75-82.

[49] See R. Chabbal et al., *Evaluation of the Community Programme on Forecasting and assessment in the Field of science and Technology*, 2 vols., CEC, Luxembourg, September 1988.

[50] R. Chabbal, *Organization of Research Evaluation in the Commission of the European Communities*, CEC, Luxembourg, 1988, p. 1.

[51] For the data regarding Community assessment programmes, see B. Bobe and H. Viala, *Une décennie d'évaluation de la R&D à la Commission des Communautés européennes (1980-1990)*, CEC, Brussels, 1990.

[52] For an interesting analysis of the process of assessment, see once more R. Chabbal, *Organization of Research Evaluation in the Commission of the European Communities*, CEC, Luxembourg, 1988.

[53] For some of the results of SPEAR, see Jacques Removille and Remy Barré (eds.), "Proceedings of the International Conference on 'Output Indicators for the Evaluation of the Impact of EC Research Programmes'", *Scientometrics*, vol. 21, No. 3, 1991.

[54] For a summary of the conclusions reached on this occasion, see AXION, *National Impact Studies of Community R&D Policy. Specifications for Future Studies*, Brussels, 1992.

[55] As we shall see in the final chapter, the co-ordination of national and Community policies was to become, in the years 1993-1994, a fundamental component of Community research and development policy.

CHAPTER FOUR

TOWARDS THE SINGLE MARKET

1. The Single European Act

While during the 1960s the grand promises of EURATOM were shattered by the diverging interests of the Member States, the European Economic Community did manage to bring one of its basic objectives to fruition without much fanfare: the creation of a customs union among the Six. Indeed, the process that had been organised in stages - in order to respond better to the demands of traditionally protectionist countries such as Italy and France - moved forward quickly with the active support of industry in all the Member States. In mid-1968 - one and a half years ahead of schedule - internal tariff barriers were removed and a relatively low common external tariff was implemented for industrial products, a move that had been hoped for by the Germans, and by the British, who were on the verge of joining the Community. The customs union was to serve as the foundation for the four freedoms which the European Economic Community set out to ensure for people and enterprises: the freedom of movement of goods, services, capital and people. The next step would be to remove non-tariff barriers

hindering such movements among countries of the Community, but this step could not be taken due to political and economic problems which continued to worsen throughout the 1970s.

The enlargement of the EEC to include Great Britain, Denmark and Ireland failed - in part due to internal political reasons in Great Britain - to give any impetus to the process of European integration and coincided with the oil crisis that radicalised the scope of intra-community differences. In the absence of a common energy policy or of any more general political agreement, the European countries' response to the challenge thrown down by the oil-producing countries was fragmented. During the subsequent economic crisis, the European countries engaged in protectionist policies that had the effect of at least partly renationalizing markets. Since the adoption of quotas and tariffs was prohibited by the Common Market accords, governments resorted to non-tariff barriers, such as subsidies to companies in crisis, public acquisitions reserved for national companies, and special rules and regulations - all measures which were intended as a de facto obstacle to a country's own market for goods produced abroad. Only towards the end of the decade - in a more favourable economic climate, despite the lull caused by the second oil crisis in 1979 - did the process of liberalising markets have a chance to pick up steam again with renewed vigour. One sign of this turnaround was the famous ruling by the Court of Justice on the "Cassis de Dijon" case of 20 February 1979: the Court decided that in principle the Member States must recognize the production and marketing regulations adopted by their Community partners, and remove technical obstacles to imports. In other words, the Court sanctioned the principle that if a product is allowed onto the market of a Member State, then it must be able to move about freely in the other Member States too.

Despite the overall improvement in the economic situation, the beginning of the 1980s still featured what at the time was called Europessimism or Eurosclerosis. The Community framework was, in fact, less than idyllic. The cost of the Common Agricultural Policy continued to spiral upwards, absorbing virtually all of the Community's resources, while its results hardly seemed satisfactory and were the target of increasingly severe criticism. Industrial policy was non-existent, while intra-Community trade in goods ran up against obstacles greater than those encountered 10 years previously, so much so that the French economist, Michel Albert, wrote: "There is no *European* industry. Calling it the second largest in the world is like trying to add apples and oranges. An industry is defined by the contents of its market. While Europe has set up a customs union, it still has to create a true single market for industry."[1] Generally speaking, the initiation of new policies was hindered by the lack of economic resources at the Community's autonomous disposal and by the rigidity of the treaties establishing the Community. This rigidity was not counterbalanced by the political will of governments - which met periodically in the European Council - to get the process of European integration moving again. The first institutional reaction to this state of affairs came from the European Parliament, first elected by universal suffrage in 1979. The proposal (known as the "Spinelli Project") was to come up with a new Treaty to replace the three existing treaties that served as a genuine constitution for the European Union which the Heads of State and Government had said they wanted to build back in 1972. The project, drawn up between 1981 and 1983, is pre-federal in nature and calls for a new balance of powers among the Community's institutions, in addition to a

broadening of its powers.[2] Despite Parliament's failure, the need for reforms that would successfully invigorate the Community machinery, especially where the completion of the single market was concerned, was thenceforth viewed as a crucial matter in all Community institutions.

The initiative to complete the Single European Market was taken over by the new president of the Commission, Jacques Delors, who on 14 January 1985 told the European Parliament that the Commission's main political duty was to eliminate all of Europe's internal borders by 1992. According to the *White Paper on the Completion of the Internal Market*,[3] the freedom of movement and of economic initiative in Europe came up against three types of barrier: physical, fiscal and technical. Physical frontiers are all the checks carried out on people and goods, and have survived the creation of the customs union. These checks entail very high costs in terms of waiting time for carriers and in terms of the bureaucratic commitment by public administrations. Moreover, they are - from the psychological point of view - tangible evidence that the union of Europe has not been achieved. Fiscal barriers consist chiefly of substantial disparities between value-added taxes and other indirect taxes in the various countries - differences which will have to be gradually harmonized as far as possible. Technical barriers are perhaps the most serious and the most pervasive: for each category of product each country lays down an entire series of technical regulations and standards to ensure quality and safety, but a lack of compatibility between these technical regulations is a formidable obstacle to intra-European trade. The problem is especially serious in high-technology sectors, where the high costs of research and development and the short life-cycle of products mean that it is too costly - and de facto impractical - to adapt to every single national market when faced with competition from the Americans and Japanese, who have access to markets that are much broader and more homogeneous. Lastly, the *White Paper* sets out two other objectives to be pursued in order to achieve real economic integration in Europe; namely, the elimination of discriminatory practices in public acquisition and procurement, together with the elimination of state subsidies; and the single market for services.

Where essential intervention is concerned, the Commission presented a timetable for the adoption of 282 regulations and directives[4] which, by the end of 1992, should have led to the creation of the Single Market. The task of showing the advantages to be derived from the completion of the Single Market was entrusted to a committee on the "Cost of non-Europe": the removal of non-tariff barriers could lead to a saving of ECU 200 billion per year for the European countries, if carried out in accordance with the Commission's proposals. Countries' gross domestic product would thus grow substantially for a number of years against a backdrop of heightened competitiveness on international markets, higher employment and lower consumer prices.[5]

The Single European Act, which was approved in February 1986, and entered into force in July 1987, reformed the three treaties of the European Communities. From the institutional point of view, the Single Act formalizes the practices of the European Councils - the highest political body in the Community - with regular meetings of Heads of State and Government. The presidency of the Council was given to one Member State at a time for a six-month period on a rotating basis. Cooperation was also initiated in foreign policy, albeit on a rather uncertain footing. The European Parliament acquired a few more

powers and, in particular, a procedure was set up for co-operation between the Council and Parliament on decisions regarding the Single Market, social policy, economic and social cohesion, scientific research and technology, that is any decision not requiring unanimity but only a qualified majority of the Council of Ministers. The main new feature introduced by the Single Act was in fact the broad extension of the areas in which the Council can express itself as a majority: while beforehand more than two-thirds of decisions had to be taken unanimously (with the almost exclusive exception of decisions regarding agriculture), now only one quarter of decisions require a unanimous vote by the Council of Ministers. This led to the definitive shelving of the Luxembourg compromise of 1966, a *gentlemen's agreement* requiring a unanimous vote of the Council virtually every time vital national interests were at stake, thus giving every government a right of veto that was not provided for in the Rome accords. Furthermore, the Single Act officially introduced a series of policies, including policy on science and technology,[6] that fell within the scope of the Community's powers. While from the political and institutional point of view the reforms did not seem especially radical, the Single Act represented a formal commitment by each Member State to complete the Single Market. On the other hand, in particular following the accession to the Community of three southern European countries (Greece in 1981, Spain and Portugal in 1986) with relatively fragile economic structures, the Single Act also set out policies of "economic and social cohesion" which, in particular via the Structural Funds (the social fund, regional fund and agricultural fund) should enable the homogeneous development of all of Europe's regions.

The Single Act added a Title VI to the EEC Treaty with a view to legally covering research and technological development activities: the Community undertook to implement research, development and demonstration programmes, thus promoting co-operation with industry, research centres and universities; to promote co-operation with third countries and international organisations; to disseminate and use the results of research; and to give impetus to the training and mobility of researchers. Article 130i presents the general outline of the organisation of Community research: "A multiannual framework programme, setting out all activities of the Community, shall be adopted by the Council (...). The framework programme shall: establish the scientific and technological objectives to be achieved (...) and fix the relevant priorities; indicate the broad lines of such activities; fix the maximum overall amount and the detailed rules for Community financial participation in the framework programme and the respective shares in each of the activities provided for". The framework programme must be adopted unanimously by the Council of Ministers, subject to consultation of Parliament and the Economic and Social Committee, whereas its activation via specific programmes is adopted by a qualified majority of the Council in co-operation with Parliament. Provisions are made for possible complementary programmes in which only a few Member States will participate, co-operation with third countries and international organisations, and the creation of joint undertakings.

The objectives set out by the Single Act for Community research are primarily economic. The scientific and technological foundations of European industry must be bolstered in such a way that they boost its competitiveness internationally and promote geographically homogeneous development. In particular, the Single Act has established a close link between research and the completion of the Single Market: the Community encourages co-operation between companies

(including small and medium-sized companies), research centres and universities, "aiming, notably, at enabling undertakings to exploit the 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 obstacles to that cooperation" (Article 130f). Many Commission directives concerning the completion of the Single Market have a direct impact on science and technology. Genuine economic integration requires common standards and norms, a step which can be achieved through the reciprocal recognition of national standards, or through harmonization. Both the development of new technologies and their rapid commercialization require that the national organisations in charge of creating standards and industries work in a coordinated manner and set homogeneous standards at European level "upstream" of the production process. In the area of information technologies, the ESPRIT project has worked efficiently in this direction, concentrating many of its own research efforts on standardisation projects, and in 1983 European industries in the sector created the "Standards Promotion and Application Group" (SPAG). A similar approach holds for intellectual property rights on the results of technological research: the harmonization of such rights at Community level should noticeably encourage investment in research and development, thus offering industry a broader market, but one which is just as secure as national markets. Other directives concern state aid for research and policy on public procurement contracts: in this area, the Community is seeking where possible to prevent any state intervention that unfairly favours research and technological development by national companies, a practice which distorts free competition at Community level. On the positive side, Community directives seek to encourage the mobility of researchers by removing both legal obstacles (the mutual recognition of professional qualifications) and social security obstacles, and by implementing language and vocational training initiatives. Lastly, there are provisions to ensure that the Structural Funds can be used to develop the scientific and technical bases of the Community's less developed areas.[7]

Even though this is not the appropriate place for confronting the dilemma of whether neo-functionalist theories can still prove useful in analysing European integration, it is our opinion that Community research and development activities have anticipated - and not only chronologically - the decisions that carried along the project to complete the common market by 1992. Judging by the success of programmes such as ESPRIT, RACE and BRITE/EURAM, the major European industries can see that national policies of protecting markets not only run counter to the *laissez-faire* initiatives of many European governments but always prove to be less effective and, in the long run, are doomed to lose out. The road to take would appear to be that of competitiveness on the global market, and this can be encouraged by the European economic integration promised by the Treaties of Rome in 1957. Secondly, the new Community high-technology programmes for the 1980s were no longer "top down", but rather the fruit of collaboration between the various sectors interested in technological research. Although formally "precompetitive", they were essentially market-oriented. The problem of standardisation at European level was therefore the focal point of many programmes. In the second half of the 1980s, the completion of the common market and the strengthening of the Community's technology policies represented two processes that moved forward in parallel, strengthening each other. On the one hand, the push forward toward integration of markets led to the approval of the Single Act

and, consequently, the institutionalisation of the system of framework programmes and their reinforcement. On the other hand, however, it would seem that the success of technological co-operation, stimulated by the Community within a number of high-tech sectors in European industry, was definitely one of the prerequisites for the European governments to decide to commit themselves to the completion of the Single Market.[8]

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2. EUREKA

On 17 April 1985, President of France, François Mitterrand, proposed a programme for technological co-operation among the European nations in order to compete with similar American and Japanese initiatives. Three days later, the French Foreign Minister, Roland Dumas, sent a letter to his counterparts in Western Europe asking them to join the programme, which was to be managed by a very flexible and non-bureaucratic structure, and which was to also involve European countries that were not members of the Community.The programme was introduced under the name EUREKA: "It may be worthwhile at this juncture to offer an explanation (other than the reference to Archimedes) for the choice of the name EUREKA. 'Eu' stands for Europe, 'Re' for research, and 'K' for 'koordination'. Participants were reluctant to allow the 'A' to stand for 'agency' because this might have raised images of yet another international bureaucracy. Therefore, it was suggested that the 'A' in EUREKA represent 'action'."[9]. The French proposal for a European technology programme has to be placed within a broad context that includes Commission initiatives to create a technological Community, previous French initiatives in the field of intergovernmental technological co-operation, and the launch of the so-called "Star Wars" programme by the American government.

From the Community point of view, Mitterrand's initiative was a clear political signal: France and other European governments were not prepared to entrust to the Community the planning of technological development in Europe. Intervention at Community level accounted for only a part of what the Member States wanted to achieve in this field. The battle between Community and intergovernmental research, which in the 1970s saw the COST action prevail over the Commission's proposal to establish a European research and development agency, has never ended. In June 1985, the Commission suggested creating a new European Community concerned solely with technological development, bringing together and enhancing activities already initiated by the existing Communities and co-ordinating national activities, but the very existence of EUREKA forced the Commission to rethink the size of its own ambitions. Where technology was concerned, the importance of what in the 1970s was called "Europe à la carte" (and which is now called "variable geometry Europe") was reconfirmed: there were a number of initiatives in which any country, whether or not a member of the Community, could decide to participate.

Furthermore, as early as 1982, during the economic summit in Versailles, at the initiative of France, the G-7 and the European Community commissioned a working group formed specially for this purpose to draw up a report on actions in the area of technological development that could favour economic growth and new employment. The report[10] highlighted the importance of direct support by the states for technological research and international co-operation, and the need for governments to remove all barriers that hinder cooperative research and the diffusion of the products derived from innovation. It then defined four areas of intervention in which the Member States could have taken action by concluding co-operation agreements: the management of energy resources (photovoltaic solar energy, controlled thermonuclear fusion, photosynthesis and fast breeder reactors), the management of food resources (agri-food technologies and aquaculture), improvement of the living and working conditions and

environmental protection (remote sensing, high-speed trains, town planning for developing countries, robotics, the impact of new technologies on mature industries, biotechnologies, advanced materials and standards, the application of new technologies to education, training and culture and the acceptance of new technologies by the people), and basic scientific knowledge (biological sciences, high-energy physics and exploration of the solar system). Each project was to be assigned to one or more countries which would then play an organizational role. It was clearly suggested that bilateral or multilateral co-operation among all Western countries was the most appropriate manner in which to implement projects.

The Strategic Defense Initiative (SDI), better known as the "Star Wars" project, was a mission-oriented military programme with foreseeable civilian spin-offs in many high-technology sectors. The project was first put forward by the U.S. President, Ronald Reagan, in March 1983. In his televised message to the nation, the American president asked the scientific Community to mobilise on a massive scale - comparable to the mobilisation in the 1960s that led to the conquest of the moon - in order to create a defensive system to protect the United States from possible Soviet missile attacks: "I am calling on our country's scientific Community, on those who gave us nuclear weapons, to now turn their immense talents to the cause of humanity and peace in the world and to give us a way of rendering these nuclear weapons powerless and obsolete." Comments from many quarters, even in the United States, were sceptical if not downright negative.[11] From the strategic point of view it should be noted that in a world in which peace is based on the "balance of terror" any change can be dangerous, especially if the initiative is presented as exclusively defensive. Even though, counterintuitive at first, the reasoning used up to that time by the two superpowers saw the development of antimissile systems as a greater danger to peace than the mere expansion of their respective nuclear arsenals: with the ABM Treaty of 1972, the United States and the Soviet Union agreed not to expand the arms RACE to include defensive systems and the American proposal for a space shield clearly ran counter to the spirit - even if not counter to the actual letter - of the Treaty. From the technological point of view, the project seemed impossible to carry out: the problems to be overcome were of a complexity never before tackled, and the Soviet Union's countermoves were unpredictable. And even if the "shield" had actually been set up, it was intended to protect American territory from earth-based intercontinental missiles, but it could do nothing to counter other weapons systems, such as bombers, submarines and cruise missiles, thus proving totally useless in the final analysis. Despite the many criticisms, the American administration moved forward, allocating $26 billion for a five-year research and development programme. Even admitting that the ultimate aim could not be achieved, the financing involved was enormous for research into lasers, X-rays, particle beams, electromagnetism, expert systems, etc., that is into technologies that would surely have civilian applications.

When the United States suggested that European countries should take part in the Strategic Defense Initiative through their own industries, the replies were, generally speaking, rather cautious, with the partial exception of Great Britain. From the military and political point of view, the proposal made no sense to the European countries: faced with an immediate deterioration in relations with the USSR there was not even the possibility - for geographical reasons - that in some hazy future the "space shield" could protect Euro-

pean territory. On the other hand, the military project seemed so implausible that right from the start all interest was focused on the potential for technological development. However, from this point of view too, there was no lack of European doubts - which France expressed. Indeed, for Europe it meant participating in a secondary role in a project the agenda of which was completely set in advance by the United States. Even the benefits in terms of knowledge and know-how of new technologies were not a sure thing: it was possible that the United States would simply end up assigning research work only to those European companies which already had a technological edge in a given sector, thus promoting technology transfer towards the United States only... In the end, however, of the major European countries only France refused to participate at all in SDI, while Great Britain, Germany and Italy signed memoranda of understanding with the United States so that their public and private companies could conclude research contracts linked to "Star Wars".

EUREKA was therefore another French initiative for European co-operation at intergovernmental level, confirming that in France's view this level is just as important as the Community level. But is was also a specific European response to SDI and to what was perceived as American arrogance because of the timing and the way in which European participation was suggested. The political motivations of the launch of the EUREKA programme can be seen firstly in the lack of details regarding the organisation, plans and aims of the European programme. Initially, it was simply said that Europe intended to co-operate where technology was concerned. Secondly, this co-operation would go hand in hand with the birth of a new organisation - i.e. EUREKA - instead of using already existing instruments. COST, for example, brought together more or less the same European countries and had development projects in the same sectors that EUREKA was to cover. Moreover, it would not have been especially complicated to change its structure in order to encourage greater participation by industry. Indeed, the Commission wrote in this respect: "The relatively unknown COST programme, established in 1970 with third countries in Europe, has proven fruitful and has led to the introduction of a vast network of S&T co-operation with the initiation of variable-geometry projects and the association of third countries with the Community."[12] However, EUREKA was clearly an attempt to say to the world that Europe and its governments were serious about running in the "technological race", and from a political point of view, COST could achieve sufficient prominence.

The European Technology Conference (first EUREKA meeting), held in Paris on 17 July 1985, brought together 17 European countries: the 10 Member States plus Spain and Portugal (which were not yet official members of the Community), and five member countries of the European Free Trade Area (Austria, Finland, Norway, Sweden and Switzerland). The Commission of the European Communities is also a member of EUREKA. France presented a working paper entitled *La renaissance technologique de l'Europe* which put forward five priority activity areas for EUREKA: information technology (Euromatic), robotics (Eurobot), communications (Eurocom), biotechnology (Eurobio) and new materials (Euromat). During the second EUREKA ministerial conference, held in Hanover in late 1985, definite objectives and priorities were set out for the programme. Technological and industrial co-operation between companies and research centres in different countries was to be concentrated on "projects aimed at developing products, systems and services that use advanced technologies and

which potentially have a worldwide market."[13] The aims of the programme are exclusively civilian and the participation of the neutral countries Austria, Finland, Sweden and Switzerland is evidence of this, as well as a guarantee. The five technological areas defined in Paris were further bolstered by environmental protection (Euroenviron), energy (Euroenergy), lasers (Eurolaser) and transport (Eurotrans).

The structures and arrangements for the programme's operation were set out during successive ministerial conferences held at least once a year in different European cities. The conference itself, comprising ministers from the member countries and representatives of the European Commission, is the main political body responsible for the programme. Its tasks are to set objectives and rules of operation for EUREKA, to officially award "EUREKA status" to individual projects, and to assess their results. The conference is assisted in its work by a high-level group comprising national officials. National coordinators are at work in every EUREKA country. They forge contacts between companies and research centres, on the one hand, and between the conference and national governments, on the other. The national coordinators asses the acceptability of research proposals and also decide the amount of the public contribution to each project, while complying with the arrangements independently set out by their governments. EUREKA projects do not actually benefit from international sources of financing, and companies and institutions are asked to find the resources needed for research projects on their own. Individual governments may therefore decide if and how to contribute financially to support initiatives undertaken by their own companies: on average, the public contribution to all the projects is 35% of the total cost, varying between 0 and 50%; usually, the longer the project and the further removed from the market, the higher the amount.[14] The EUREKA secretariat is located in Brussels. Originally it was very small, comprising some 15 people. The costs are shared by all the members, including the European Commission. The secretariat serves exclusively as a clearing house, providing information about the existence of projects and putting potential partners in touch with each other.

The response from industry and the European countries to the EUREKA initiative has definitely been positive. While the Hanover meeting announced the approval of the first 10 projects and Turkey's membership, in London in June 1986 there were 62 new projects and Iceland became the 19th EUREKA country. New projects have received "EUREKA status" at each new ministerial conference. In late 1988, some 213 EUREKA projects were announced with the participation of around 1,200 R&D actors, worth a total amount of around ECU 4 billion. The majority of these projects last four or five years. Although in order to be accepted projects must involve companies and research centres belonging to at least two different European countries, the average project sees participation by five organisations from three countries. Two-thirds of the participants are industrial companies (60% from large enterprises and 40% from small and medium-sized enterprises) and one-third from research organisations.[15] The sectors in which the greatest number of projects - and a good share of the funding - is concentrated are robotics and information technology. Many projects have dealt with biotechnology, but their unit costs are relatively low, while the transport sector has the most costly projects. In mid-1991, there were more than 500 projects with EUREKA status, for an overall total of more than ECU 8 billion.[16] Recently, three Eastern European coun-

tries joined EUREKA: Hungary in 1992, Russia in 1993 and Slovenia in 1994.

Despite the fact that EUREKA is in a sense a limit set by governments on the Community's technological ambitions, an effort has been made right from the outset to highlight the potential complementarity between the new intergovernmental initiative and the Community framework programme. The Hanover Declaration of Principle explicitly states that Eureka's aim is not to replace Community programmes, but rather to broaden them and complement them, and generally speaking complementarity can be found in particular in the precompetitive nature of Community programmes and the opposing competitive nature of EUREKA initiatives. In fact, with the benefit of hindsight, Eureka's existence can also be justified by the requirement to fund, at European level, development projects close to the market, without violating stringent Community competition rules overseen by Directorate-General IV (Competition). Secondly, EUREKA and the Community programmes differ in how they define and select research projects: EUREKA takes an exclusively bottom-up approach, with companies that propose research topics that will initially be weighed up by the appropriate national bodies, while Community programmes are top-down in terms of the areas of research and bottom-up in terms of individual projects, without any filter at national level.

The European Parliament raised many objections to EUREKA, stressing how, on the one hand, it would probably merely duplicate actions already initiated at Community level, and, on the other, how it was a completely inadequate response to similar American and Japanese initiatives. Antonio Ruberti, President of EUREKA from June 1989 to May 1990, emphasised the complementarity between Community programmes and EUREKA projects: "The European Community must continue the important work that it has undertaken within a global framework that encourages precompetitive research, in particular in its so-called horizontal programmes, while EUREKA must remain R&D-oriented for products responding to market needs. There is convergence - not divergence - between the European Community framework programme and the EUREKA projects."[17] The Commission, through its participation in the management of the programme, has sought to develop as far as possible the aspects of complementarity and to ensure a certain degree of co-ordination. This has been done either via the development within EUREKA of projects initiated at precompetitive level within Community programmes - as is the case for some ESPRIT projects in the field of information technology and three RACE projects in the field of telecommunications - or via the Commission's direct participation in EUREKA programmes, instead of creating its own programmes: between 1985 and 1993, the Community participated in 27 EUREKA projects, and notably in the JESSI project (microelectronics) and the high-definition television project (HDTV).

The Joint European Submicron Silicon Initiative (JESSI) was launched in 1988 by Siemens, Philips and SGS-Thomson to develop integrated circuits in a bid to win more of a market share in the semiconductor industry, where Europe controls just 10% of world production. The project has attracted another 32 participants, including companies and research organisations, and has received direct support from the Commission, which funds 25% of the total project (another 25% is provided by interested governments, and the remaining 50% by industry).[18] The HDTV project dealt with the feasibility of a European system for HDTV production, transmission and reception, in competition with a similar Japanese project. Some 60 European organisations

from 11 countries work in close co-operation with the Commission to define technical standards that could become the common standards at world level for all high-definition television services. The Community's contribution was especially important with respect to what the EUREKA initiative defines as "support measures": the definition of common standards, the liberalisation of national public procurement contracts, the development of new instruments for the private financing of high-technology projects (*venture capital*)[19], and the removal of all barriers between industry and universities. Also, the Joint Research Centre is a member of some consortia involved in EUREKA projects, especially those linked to environmental research and industrial safety.

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3. THE SECOND FRAMEWORK PROGRAMME (1987-1991) AND THE NEW REFORM OF THE JRC

Karl Heinz Narjes was Commissioner for Industrial Affairs, Information Technology, Research and Science, as well as for the Joint Research Centre from January 1985 to January 1989. His main task was to consolidate and, if possible, increase the Community's patrimony in the field of science and technology. There were no longer any question marks hanging over the programmes initiated by his predecessor, since they had received the unanimous support of all involved - i.e. industrialists and scientists - and the support not only of the European Parliament but also governments which, after meeting in June 1984 in Fontainebleau, recognised the importance and effectiveness of Community technology initiatives. As we have seen, 1984 was also the year in which these specific programmes were systematically arranged within the framework programme that would make it possible to better define the more general objectives which the Community set itself in this field.

Ahead of the European summit to be held in Milan in late June 1985, the Commission prepared a memorandum[20] in which it proposed creating a genuine European technological Community. Confronted with the technological challenge that had in the meantime assumed a global dimension, the memorandum asked the Community to implement a technological strategy that would enable it to benefit most from the potential synergy between Community and national programmes, and from the European dimension. Whatever strategy European governments adopted, there would be a need for financial resources far exceeding what was at that time available to the Community for research and development. A legal framework was also needed, of course, which included the possibility of adopting multiannual framework programmes.

The tools for implementation suggested by the Commission were the same as those already being used: direct action taken by the JRC, shared-cost indirect action, concerted action and programmes for exploiting precompetitive research; some EURATOM instruments, such as complementary programmes, limited participation in national programmes and joint undertakings; and some instruments already proposed in the past, such as European agencies, along the lines of the ESA model.

As we have seen, the idea of a new "Technology Community" did not meet with success; and, with the advent of the Single Act, science and technology policy would instead find place in the EEC Treaty. At the Milan summit it was announced that science and technology would in future be allocated at least 6% of the Community's total budget, but France also proposed launching the intergovernmental programme, EUREKA, which as we have seen, emerged as a potential competitor to Community programmes. When, in 1986, Commissioner Narjes proposed the figure of ECU 10 billion for the new multiannual framework programme, equivalent to 5% of the Community's annual budget, negative reactions from the governments were not long in coming. Great Britain and Germany in particular were clearly opposed to such a substantial increase in the research budget, since they were keen to check Community spending in all areas. The Commission's proposals between 1986 and 1987 were progressively re-

duced to 7.7, 6.8 and 5.7 billion ECU, always facing fierce opposition from the British Prime Minister, Margaret Thatcher. Finally, on 28 September 1987, nine months behind schedule, the Council agreed on a budget of ECU 5.4 billion for the framework programme for 1987-1991, with a clause imposed by Great Britain to the effect that 10% of the total amount would not be spent before 1992, the sixth year (*sic*) of the five-year plan. Spending on research and development therefore accounted for less than 3% of the total Community budget (agriculture continued to represent the main spending item, absorbing almost 70% of the total), equivalent to 1.8% of what the Member States spent on research.

In line with the idea that led to the adoption of the framework programme as the main instrument of Community research policy, efforts were made to define potential synergy and interaction between research and development actions in sectors considered to be of primary importance at Community level, especially with respect to the development of the Single Market. The Commission memorandum had defined 10 priority sectors: information technologies, biotechnologies, new materials, lasers and fibre optics, major scientific instruments, broadband telecommunications, new means of transport, space, the conquest of the marine environment, and education and training technologies. It should be noted that this list does not include the energy sector, which although important as a financial commitment, is no longer considered a priority sector. High levels of interdependence can be seen, for example, between telecommunications and space research, between information technologies and research into lasers and fibre optics, between innovation in means of transport and research into new materials, and between training technologies and research into artificial intelligence. Some sectors are already covered by Community programmes, such as ESPRIT, RACE and BRITE. New initiatives will have to be taken for the others, bearing in mind the existence of EUREKA, other multilateral programmes and national programmes. In a paper dated September 1985, the Commission reiterated yet again what would become known as the *principle of subsidiarity*: "It must be clear that with the implementation of R&D activities the Community does not intend to confront all the requirements for achieving these objectives. In fact it considers that where national or multilateral programmes and activities capable of meeting these objectives already exist, it is not necessary to develop new initiatives at Community level."[21] On the basis of this principle, the Commission, in its proposals for the Second Framework Programme, resized the scope of its own projects for space research, an area in which the European Space Agency was already active, and with regard to major scientific tools it put forward a project aimed at gaining optimum use from existing tools.

Although the start-up of the specific programmes was delayed by controversy surrounding the total budget, and financial resources were not as great as had been hoped, the activities comprising the Second Framework Programme did not differ greatly from those suggested two years previously by the Commission. Specific activities were presented within eight major categories of action: 1) Quality of life: health, protection against radiation and the environment; 2) Towards a single market and an information and communications society; information technologies, telecommunications and new public facilities (including means of transport); 3) Modernisation of industrial sectors: science and technology in manufacturing industries, science and technology in advanced materials, raw materials and recycling, technical standards, measuring methods and reference materials;

4) Exploitation and optimisation of biological resources: biotechnology, agri-food technologies and the competitiveness of agriculture and the management of agricultural resources; 5) Energy: fission (nuclear safety), controlled thermonuclear fusion, and non-nuclear forms of energy and the rational use of energy; 6) Science and technology at the service of development; 7) Exploitation of the sea-bed and the optimisation of marine resources: marine sciences and technologies, and fisheries; 8) Improvement of European S&T co-operation: incentives, optimisation and utilisation of human resources, use of large-scale facilities, forecasting and assessment of other support actions (including statistics), and the dissemination and use of S&T research results. With the increase from ECU 4.5 billion allocated in the First Framework Programme to ECU 5.4 billion in the second, all areas of activity saw an increase in the resources allocated to them, with the exception of energy research and research for developing countries. In the Second Framework Programme there is as a matter of fact a further shift in resources from research in the energy sector (21.7% of the total) towards research into industrial innovation, in which the Community invested more than 60% of its research budget, if we add together categories 2 (42.2%), 3 (15.7%) and 4 (5.1%) from the list above. Compared with the previous programme, expenditure rose for the sectors included in the categories Quality of Life and Improvement of European S&T Co-operation, albeit at the same time continuing to account for a still marginal percentage of the framework programme's total budget (7% for the first, 5% for the second).

Once the hurdle of approving the budget had been cleared, the specific programmes proposed by the Commission were approved with remarkable speed by the Council and Parliament. In accordance with the new procedure introduced by the Single Act, the Council could decide such matters by a qualified majority "in co-operation with the European Parliament" (Article 130q). Parliament now had the means to influence the Council's decisions in the area of research. The European Parliament's Committee on Energy, Research and Technology (CERT) played an important role with respect to both agreement on the framework programme - in contrast with resistance from Great Britain, France and Germany - and with regard to the speed with which it enabled specific programmes to start up, despite fears that the co-operation procedure with the Council could prove a source of major delays. Where the main strategic lines of the Community's involvement in S&T were concerned, Parliament lent its own support to the change of direction already initiated by the Commission. Further emphasis had to be placed on the shifting of resources to projects for industrial innovation, the impetus of which originated from the market (i.e. "market pull"), along the lines of the ESPRIT model, to the detriment of grand projects whose only *raison d'être* came from "technology push". Nevertheless, even industrial competitiveness was not felt to be the sole objective toward which research and development should lean: in Parliament's view, priorities were also supposed to include social objectives, such as the cohesion between the different regions of the Community, the well-being and health of the citizens and the preservation of the environment.[22]

The planning and management of specific programmes were entrusted to the Commission, and in particular to Directorates-General XII and XIII, both under the responsibility of Commissioner Narjes, although some research programmes were still managed by other Directorates-General outside the framework programme. DG XII was the Directorate-General "historically" in charge of research and devel-

opment. It adopted a rather open and flexible approach and also took care of basic research apart from industrial innovation, where it created a dense network of relations with small and medium-sized enterprises. DG XIII was the direct descendent of the Task Force on Information Technology created by the previous Commission to launch the ESPRIT and then the RACE programmes. It had a more interventionist style, a strategic approach to innovation in the areas of information technology and telecommunications, and was constantly interacting with industry. In 1989, DG XII employed around 580 officials, and just as many (around 560) worked for DG XIII.

With the Second Framework Programme, a new theme made its official appearance on the Community R&D scene: economic and social cohesion, an objective introduced to the EEC Treaty by the Single Act. The four criteria of choice which justify a Community research action, drawn up in 1983 (the so-called "Riesenhuber criteria"), were bolstered by a fifth: "research which contributes to the strengthening of the Community's economic and social cohesion, as well as to the promotion of its harmonious and widespread development, while maintaining its consistency with the objective of technical and scientific quality."[23] However, at first glance, the new criterion would seem to be a possible source of tension: the pursuit of economic and social cohesion, or of the development of Europe's less favoured regions,[24] and of scientific excellence, appear to be two obviously valid objectives taken individually, but they are not necessarily coherent. Indeed, the criterion of scientific excellence is born of the rejection of the principle of *juste retour*, according to which each Member State should be allocated R&TD contracts in proportion to its financial contribution, and therefore seems all the more at odds with the idea of "positive action" to benefit this or that region.

The Community's solution to this potential contradiction is based chiefly on the use of the Structural Funds to reinforce the technical and scientific foundations of the most backward regions by modernising research, training and manufacturing structures at local level. In this way, all regions of the Community should gradually find themselves on an equal footing in the competition - which is decided solely on the basis of scientific excellence - to obtain funding for research and development projects. The best-known example of the virtuous circle which can be triggered by the interaction between the use of the Structural Funds to create scientific organisations and R&TD policy, is the Crete Research Centre: founded thanks to financial support from the Community, this laboratory soon became a centre of excellence in the field of biology, and as such has played an active role in many Community research and development programmes.

The creation of high-level research infrastructure in peripheral areas has the subsequent positive effect of slowing down, and potentially reversing, the brain-drain from the least-favoured regions to more advanced regions both inside and outside Europe. The maintenance of human potential is clearly an essential prerequisite for developing research activities at local level. Initiated in 1990 by DG XVI (Regional Policies), the Directorate-General responsible for managing part of the Structural Funds, Stride (*Science and Technology for Regional Innovation and Development in Europe*) is a Community programme whose specific aim is to enhance regional capacity for research and development, seeking - among other things - to improve the level of co-ordination between the activities of the framework programme and of the Structural Funds.

More generally, however, it should be stressed that the same transnational organisation of Community research makes its own contribution to cohesion by putting research centres from less advanced regions (and from every area of scientific and technological endeavour) into contact with existing centres of excellence in Europe. In this respect the group in charge of assessing the impact of the framework programme on Community cohesion wrote: "The Panel finds that the Framework Programme is contributing substantially to the establishment of an integrated, transnational research community of academic, industry and government researchers. (...) What has also impressed us greatly, is the apparent cultural change and modernisation which is affecting the RTD system of the Less Favoured Regions, under the influence of participation in the Framework Programme, as well as the stimulus which it has provided for the emergence of new protagonists in the RTD area."[25]

Following the reforms of 1971-1973, and with the approval of the new multiannual programme for 1973-1976, which shifted the centre of gravity of the research carried out by the Joint Research Centre from nuclear development to safety problems and opened up the field of non-nuclear research (the environment, remote sensing, materials, etc.), the JRC entered a calmer phase, during which its multiannual programmes were approved without great difficulty: the 1977-1980 programme had a budget of 346 UA and the 1980-1983 programme saw its budget rise to 510 million UA. During the same period, however, two important opportunities arose for reviving the JRC that probably would have offered it the chance to acquire a greater presence on the European scientific scene. We talked about the first of these opportunities in Chapter Two: when the time came to choose the headquarters for the JET Joint Undertaking, despite the fact that the ad hoc committee had pointed to Ispra as the site best suited for the construction of the European Tokamak,[26] the opposition voiced by the leading European countries, and to a great extent by the scientific Community involved in fusion research, scuppered the candidacy for the establishment of the JRC. At the end of the day Ispra came away with merely a participatory role in the fusion programme.

The second opportunity arose a few years later, following the nuclear incident at Three Mile Island in the United States. As early as May 1979, the Commission had set up a group of experts on nuclear safety with the task of studying the reasons for and consequences of the incident. In the JRC programme for 1980-1983 nuclear safety became an absolute priority, with almost half of total funds spent on this alone. Within the programme on reactor safety, plans were made for the Super-SARA project. This was a project proposed by the Italians to use the Essor reactor at Ispra to study the behaviour of fuel in the event of a loss of coolant in a reactor's cooling system. To this end, it was planned to return the management of Essor to EURATOM as of 1 January 1981, with an allocation of around 40 million EUA within the JRC multiannual programme and total spending of approximately 110 million by 1986. The feasibility studies were concluded and the programme was given the go-ahead by the Council in May 1981. Less than two years later, however, faced with rising costs now estimated at almost ECU 300 million, the Council decided to definitively abandon the project. For the second time, Ispra's scientific and technological ambitions - linked to the Essor reactor in Super-SARA, as they had been in the 1960s in the Orgel programme - were frustrated by the decision to abandon its most important development project.[27]

In July 1981, the Commission decided to incorporate the JRC general management into DG XII in an attempt to further integrate the JRC into its science and technology policy. Consequently, the following year the Centre's administrative structure was reformed. For the 1984-1987 multiannual programme, included in the First Community Framework Programme, the Council earmarked ECU 700 million for the JRC and launched an early-retirement programme aimed at overhauling the staff working there in the hope that younger researchers boasting new and varied areas of specialisation could revive the institution. Despite this the changes were apparently not incisive enough for the JRC to be able to respond to the new tasks assigned to it by the Single Act of promoting Europe's industrial competitiveness; criticism mushroomed in many Member States. In 1986, the Commission asked a group of industrialists to look into the possible future role of the JRC: according to the committee of industrialists, chaired by Harry Beckers, Research Director at Shell, the JRC's main problems stemmed from a vague definition of the relationship between the customer of the research (the Commission) and the supplier of the research service (the JRC), thus leading to a situation where the JRC would not have a great deal of responsibility. The relationship should be made more linear (the customer defines the research it needs and pays for it; the JRC carries it out), and the potential customer base should be diversified to include companies, national government agencies and other Directorates-General at the Commission, and not just DG XII.[28]

The Commission document *A New Outlook for the Joint Research Centre*, from October 1987, proposed a radical reform of the Centre to be carried out over a decade. Generally speaking, the aim was to incorporate the Community research centre into the process of completing the Single Market launched by the Single Act, thereby making it available to improve European industrial competitiveness, while at the same time maintaining a number of "historical" research programmes, such as those concerning nuclear safety and the environment. The JRC was to remain within the Community system and the Commission would continue to be its main customer, via the framework programme. Nevertheless, the document suggested that the Centre should offer its own "specialised, neutral and independent scientific potential" to a large number of national organisations and industries, in addition to various departments at the Commission. It was hoped that by 1991 the funding for the JRC from the execution of Community-specific research programmes would not exceed 60% of the total, and that this figure would fall to 50% by the year 2000. This should be achieved thanks to "a clearer distinction between the management of programmes and the management of funds: the utmost autonomy will be given to the operational scientific units which will bear full responsibility for executing at all levels - be it scientific, administrative or financial - the tasks relevant to it."[29] The matrix structure (specific projects/disciplinary departments) should be abolished and in its place new specialized institutes should be created. The aim was to create a lighter, more flexible and more economical structure which was better suited to new and changeable tasks, and which could make it possible to give up useless activities or those that had reached their natural conclusion. Although provisions had been made as early as 1973 for temporary contracts linked to specific projects, the reality was that programmes were pursued indefinitely and therefore the contracts with research staff were automatically renewed. Now the Commission was stressing the need for temporary contracts to become truly temporary and for many of them not to be renewed.

The Council, in co-operation with the Parliament, which presented a number of amendments on the basis of a report drafted by the Committee on Energy, Research and Technology (CERT)[30], approved in June 1988 the guidelines for reorganisation of the JRC suggested by the Commission. There remained, however, the ambiguity - already present in the Commission document - of the relationship with the customer: on the one hand it was stated that the customer/contractor principle should be applied to all of the JRC's activities, while on the other hand it was recognised that this was not so simple since the final customer of the research services carried out by the JRC is the Community as a whole.[31] The Council emphasised, however, its request that the activities of the JRC no longer be specific programmes within the framework programme, but that it should carry out scientific and technical work for other Commission departments and for third parties. For the period 1988-1991, the Council earmarked ECU 251.7 million for the JRC to carry out specific programmes on behalf of the European Economic Community, and ECU 448.3 million for research activities related to EURATOM. These were direct research activities - falling within the scope of the Second Framework Programme - into environmental protection, remote sensing, industrial hazards and standardisation in the EEC ambit; and protection against radiation, standardisation, reactor safety, radioactive waste management, security and management of fissile materials, research into plutonium and actinides and controlled thermonuclear fusion, in the EURATOM ambit (to which should be added a complementary programme concerning the Petten high-flux research reactor, which was funded exclusively by the Netherlands and Germany). In addition, for the same four-year period, the Council made provisions for the JRC to be able to undertake scientific and technological support activities for the various Directorates-General of the Commission worth a total of ECU 120 million, and to provide services to third parties worth ECU 130 million. All of these activities were entrusted to new institutes set up on the four JRC sites under the leadership of a General Management based in Brussels. The Central Bureau for Nuclear Measurements and the Institute for Transuranic Elements kept their traditional headquarters, in Geel and Karlsruhe respectively. The Institute for Advanced Materials was assigned to both Petten and Ispra, while the Institute for Systems Engineering and Informatics, the Centre for Information Technologies and Electronics[32], the Environment Institute, the Institute for Remote Sensing Applications and the Institute for Safety Technology were all given their own headquarters in Ispra. Ispra was also officially home to the Institute for Prospective Technological Studies, but the new institute would only assume its full functions as a strategic studies centre in the technical and scientific domains and as a technological observatory after it was transferred to Seville in the second half of 1994.

In subsequent years, the JRC's work evolved in the direction indicated by the Council, covering four separate - at least from the accounting standpoint - sectors of intervention: research for specific programmes in the Third Framework Programme, support for Commission departments, contract research work for third parties and exploratory research. In 1992, participation in specific programmes was still the JRC's main activity, accounting for 65% of its annual budget, or ECU 274 million. The various institutes participate in five specific programmes according to their own areas of specialisation: industrial technology and materials technology, measuring and testing, the environment, nuclear fission safety and fusion. The JRC's scientific and technical support activities for other Community policies gradually increased, accounting for 22%

of the JRC's budget in 1992. It focused primarily on energy, environmental and agricultural policies - therefore involving research contracts concluded between the JRC and Directorates-General VI, XI and XVII for specific research or technical support services. Research on behalf of third parties - although constantly growing - was still just a minor item on the JRC's balance sheet, comparable in terms of size to the management of the Petten high-flux reactor. This item also included participation in EUREKA projects. Exploratory research covered a series of small, targeted projects the duration of which could not exceed three years. It was a form of "free research", a preliminary investigation into areas that seemed promising. (The JRC had been allowed to engage in "free research" after the first reforms of the early seventies).

In order to gain a clearer view of the layout of JRC activities let us look at a specific area of research. In environmental research (an argument which we will tackle on a more general level in the following section), for example, four institutes are involved in research activities falling under the specific Community programme. The Environment Institute naturally plays a central role and, within the context of international programmes on global change, launched a European project on biogenic emissions in the Mediterranean area (BEMA) in 1992. It also acts as a networking station for the EASOE (*European Arctic Stratospheric Ozone Experiment*) project's observation system. This project examines the destruction of the ozone layer in the Arctic region. The Institute for Remote Sensing Applications also participates in both projects, while the Institute for Safety Technology and the Institute for Systems Engineering and Informatics carry out research activities into industrial hazards, especially chemical hazards. Where support for environmental policy is concerned, the scientific and technical assistance activities carried out by the JRC on behalf of DG XI deal with the drafting of regulatory provisions on chemical pollutants, air pollution, water quality, chemical residues, industrial hazards and incidents. With activities on behalf of third parties, such as national or regional administrative offices, the Environment Institute and other JRC institutes offer their know-how in the environmental field and the facilities of their specialised laboratories for research into pollution, the collection of data on chemicals and the monitoring of environmental quality.

The process of integrating the JRC into the fabric of European research, a process which the reform of 1988 had hoped to trigger, did make some progress: the JRC plays an important role in supporting Community policies. In some areas, its institutes have assumed the role of European "centres of excellence" capable of providing high-level services to any potential customer. In addition, its network of collaborative efforts with national research centres and in international projects has expanded considerably.[33] Nevertheless, as Jean-Pierre Contzen, JRC's Director-General since 1986, explains, this process must continue to take maximum advantage of every opportunity offered by scientific and economic development: "Even in Europe there are reasons for maintaining a strong potential in terms of research centres, but on one condition: these centres must agree to adapt to the inevitable development of the environment in which they operate. These changes must lead to a greater opening up to the outside, to stronger interaction with academia and socio-economic operators, shedding the mentality of the arsenal and of the self-sufficient and self-producing fortress."[34]

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4. MEDICAL AND ENVIRONMENTAL RESEARCH

In presenting the Second Framework Programme, Paolo Fasella, Director-General of DG XII, wrote: "Economists found out some time ago that technological research and development plays a central role in the economic development process. If used judiciously, science and technology are capable of making a major contribution to the expansion of general well-being and improvement in the quality of life of the individual and of society as a whole. Science itself puts us in a better position to understand and correct the negative and undesirable effects of certain technological activities on the earth's environment and on human health."[35]

Although the Second Framework Programme was initiated to coincide with the coming into force of the Single European Act, which anchored research activities to industrial development and the completion of the Single Market, there were many specific programmes which went beyond exclusively economic objectives. In fact, the Single Act merely gave legal recognition to the existence of shared-cost programmes for industrial innovation created in the first half of the 1980s, but in the meantime a number of trends had become important and would go on to develop more completely in the 1990s, being legally enshrined in the Treaty of Maastricht. The demands of society were assuming greater centrality; greater synergy was being sought between various technologies, sectors and disciplines; and greater attention is being paid to the creation of European "networks". Before delving into some of the aspects of the evolution of Community research in the areas of medicine and the environment - areas where these trends were assuming particular importance - it may be helpful to point out to what extent the institutions of the Community, in keeping pace with the expansion of research into new areas and with its quantitative growth, have also committed themselves to encouraging research and the debate on some of the ethical, social and legal implications of technological innovation, especially in the field of life sciences.

Bioethics covers a vast area of issues concerning all the direct and indirect effects - whether predicted or not - which new technologies born of research in biology could have on society in the broad sense of the term. Since some technologies, especially biomedical technologies, have an immediate impact on the life and identity of individuals, or on the forms which animal life can assume, they also have *direct* bioethical implications. Such technologies include the analysis of the human genome, prenatal diagnosis, research on human embryos, gene therapy, in-vitro fertilisation and even the creation of transgenic animals and the patentability of forms of life. Other technologies, such as those linked to the emission of genetically altered organisms into the environment, growth hormones in breeding, or new foods do not in themselves raise ethical questions, but instead they have *indirect* bioethical implications due to their potential impact on the environment and health, or even due to their socio-economic impact - for example with regard to production and employment in agriculture, or development in the Third World.

Liaising closely with the Council of Europe, the first European organisation to deal regularly with such issues, the Community's institutions have intervened in bioethical matters on many occasions. The work done

by the European Parliament, beginning with the first debate in 1984 on the proposal to boost Community research programmes in biotechnology (BAP), has since concentrated mainly on the problems linked to genetic manipulation and artificial fertilisation, leading to the approval in 1988-89 of two resolutions on the main ethical and legal aspects of these techniques. The European Foundation in Dublin, an institution which seeks to improve living and working conditions in collaboration with the Commission's DG V (Social Affairs), has instead carried out a number of studies into the social impact of biotechnologies.

The Community has taken part in international conferences dealing with bioethics topics: from the first one held in Japan in 1985 to the Rome conference (1988) and the Brussels conference (1989) on ethical problems linked to the mapping of the human genome and environmental bioethics. In collaboration with the German minister for research and technology, the Commission itself has organized two conferences at European level on ethical problems linked to the use of human embryos in medical and biological research. In 1991, the Commission set up three groups to deal with different facets of bioethics: a working group on the ethical, social and legal aspects of the analysis of the human genome; a similar working group on human embryos and research; and a more stable group of consultants which deals with all the ethical implications of biotechnologies. Lastly, it should be noted that in biotechnology and biomedical research programmes, account is taken of the ethical implications of the activities carried out, and in the "Human Genome Analysis" programme (1990-1991) part of the research funds are intended for studies into bioethics.[36]

a) Medicine

Medical research is a good example to highlight some of the features of new trends in Community research. At Community level medical research is carried out almost exclusively through concerted actions encouraging the creation of dense and solid research networks. This sector of research has proven interesting for other reasons too: it highlights the need for a European dimension for certain kinds of research, such as epidemiology in particular; it shows how the Commission is able to take autonomous and timely action in response to the compelling needs arising in society, as was the case with AIDS; and lastly, medicine has seen one of the first experiments in using new information technologies and telecommunications for social ends.

The state of medical research in Europe was marked in the 1980s by consistent and growing investments (albeit considerably less than the investments made by the United States), and intervention of a quite high quality, but extremely fragmented. Medical research was carried out by small teams in hospitals, universities and research centres, often without any co-ordination at national level. This state of affairs led quite naturally to a great deal of duplicated research work and to an inefficient allocation of the available human and financial resources. The Community's contribution, which was launched in 1978, was aimed at putting the best European researchers in a number of research sectors in contact with each other and co-ordinating their work. Research itself continued to be financed by the Member States, while administrative costs incurred through "concertation" were borne by the Community. More specifically, Community funding covered the following activities: a central office that serves as a secretariat; meetings, seminars and confer-

ences that may involve just a few researchers or every member of a "network"; short exchanges of or visits by researchers from various laboratories; exchanges of data, laboratory equipment and devices which are especially costly; the dissemination of information and the publication of research results; and the creation of common instruments (these *centralised facilities* can consist of data banks, or the provision of specialised services such as product quality control, or the preparation and distribution of experimental materials).

The study on "avoidable death" is an interesting example of prevention-oriented medical research, according to the approach favoured by the Commission (as we saw in Chapter Two), which clearly benefits from the European dimension. By "avoidable death" we mean deaths caused by diseases which in many cases are not fatal if medical attention and health care are forthcoming and adequate. On the basis of European averages, and after an enormous job involving the standardisation of data, researchers from the 10 Member States created a genuine Atlas illustrating the geographical variations of the "survival rate" for certain diseases for the period 1974-78.[37] The higher death rate from the diseases under consideration (e.g. some infectious diseases, some forms of cancer, appendicitis, etc.) or at the time of birth (maternal and perinatal mortality) can be due to inadequate health education, medical negligence or deficiencies in health care systems, but the Community study does not seek to define such causes. The Atlas aims to serve as a simple warning bell, signalling the existence of the problem to the national, regional and local health authorities, which then have the task of initiating further studies and making any improvements to their own health services with a view to limiting as far as possible the number of "avoidable deaths".

Within the Second Framework Programme, a new research programme was launched in the medical and health sector (1987-1991). The general aims of the programme remained fundamentally unchanged: collecting a broader mass of data in less time thanks to Europe-wide co-ordination, harmonising research procedures and methodologies in order to enable the data to be compared immediately, and disseminating knowledge regarding medical technologies. There were six research sectors: cancer, AIDS, health problems related to ageing and lifestyle, medical technologies and health services. The programme took the form of 143 concerted actions (and thus the same number of networks), involving 4,973 research groups[38] belonging not only to the 12 countries of the Community but also to some of the COST countries (Austria, Finland, Norway, Sweden and Switzerland).[39] Cancer research, which received 27% of the total of ECU 65 million allocated to the programme, was part of a broader Community action called "Europe against cancer", launched by the European Council of Milan in June 1985. This included initiatives to harmonise legislation in the area of the trade and advertising of tobacco, nutrition information campaigns, new directives on protecting workers from carcinogenic substances, health education programmes, and programmes for training health care personnel.

Today, AIDS is universally recognised as an extremely serious disease and vast sums are allocated around the world to research into preventing and treating it. Nevertheless, the interest in and awareness of the disease were quite different back in 1983 when the Commission organized a first meeting of European AIDS experts and the European Parliament began discussing the matter. This led to the Parliament asking the Community, in its resolution dated 20 January 1984, to make a commitment to AIDS research. At that time the

prevailing prejudices classified it as a disease of little interest since it only affected socially excluded groups. In fact it would take another four years for the Council to give its authorization to start up the AIDS research programme.

The concerted AIDS research action launched in late 1987 involved 612 research teams, 82 of which belonged to non-Community COST countries. These teams were co-ordinated - with respect to the scientific aspect - by a working group comprising some of the top European specialists. The programme was structured in four parts: 1) control and prevention of the disease; 2) immunological and viral research; 3) clinical research; and 4) the project for the European vaccination for AIDS (EVA). At a time when effective treatments and vaccines have not yet emerged, the contribution in terms of knowledge made by the European Centre for the Epidemiological Control of AIDS had been crucial. The centre is based in St. Maurice, near Paris, where it collects, analyses and redistributes data from 31 European countries. For AIDS too, the medical research co-ordination programme is part of a vast Community action concerning the exchange of "experiences, notably in the field of information for making the public more aware and health education, common appraisal of the suitability of potential measures as far as regulations are concerned (rules for the notification of the disease, more or less systematic screening, restrictions in people moving around or settling down, etc.) as well as the problems posed by the incompatibility of some of these measures with respect to the fundamental rights of EEC citizens; international cooperation in the fight against AIDS, and especially cooperation with Third World countries particularly affected by the epidemic."[40]

The new public facilities covered in the chapter of the Second Framework Programme devoted to information and telecommunications technologies include the AIM programme (*Advanced Informatics in Medicine*), the main objective of which objective is to create an integrated environment at European level for health information. More than 100 universities and research centres, some 30 companies, especially telecommunications and pharmaceuticals companies, and some 30 hospitals, health care operators and other potential customers of the services covered in the study participated in the first 42 research and development projects, which were concluded during AIM's exploratory phase ending in mid-1990. The potential applications of telematics concerns the entire health sector, from medical research to administration. To give just a few examples, the research financed by AIM has involved the remote exchange of know-how and knowledge, tools and services for home help, the transmission of data and images for medical purposes, the use of electronic cards in health care, legal and regulatory problems, and the protection and confidentiality of health information. AIM's contribution to the creation of a Technical Committee on Medical Informatics within the European Committee for Standardisation (CEN) was especially important. The services developed by AIM and, above all, the development of supercomputers could prove to be especially useful for epidemiological studies of AIDS and other diseases, as well as for genetic sequencing and mapping developed either within Community biotechnology programmes or within the "Human Genome Analysis" project.[41]

As we have seen, the Community medicine programme, financed to a great extent by co-ordination contracts, has a "network" organisational structure which it could be interesting to discuss briefly, starting with the

criticisms that such a model has to face. The working group assessing the medical programme, for example, wrote: "The Panel is impressed by progress that has been made in the beginning of new 'collegial networks' of research workers across Europe, in the initiation of some Community data bases and in the opportunities for short-term training. Definitive data on the outcomes of the fourth medical and health research programme are not yet available, but many of the participants have indicated that the creation of networks is a very limited objective. The Panel, in interpreting the Council decision of 1987 which laid out the objectives of the Programme, has assumed that increased collaboration was a means, rather than the ultimate goal of the MHR4."[42] Concerns of this kind are very widespread, particularly if research concerns technological innovation where research results should be represented by products for the market. Of course, even in basic research - or medical research - the ultimate aim is not collaboration in itself but tangible scientific and technological results, such as a cure for cancer or an AIDS vaccine. Nevertheless, the hypothesis underlying the concept of the network is that Community investments, which are relatively scarce and not very likely to grow significantly in the near future, have a greater chance of having an impact in the medium or long term by ensuring collaboration between research centres and scientists, who currently work in an extremely fragmented manner, rather than with what would have to be rather casual investments in one laboratory or one sector or one specific area of research.[43]

To see the results arising from a network it really is essential to take a medium to long-term view. The very *construction* of the network presents considerable technical problems: "Each concerted action brings together an average of thirty teams belonging both to national systems with specific characteristics and to different professional environments. They need to get to know each other, to define a common language and ensure that their data are comparable. These may appear to be simple problems, but they have major practical implications: harmonization of terminology and laboratory practices, setting-up of "common services" or "central facilities", etc. This structuring phase can take several years...".[44] The wager is that the network, once built, would become a new player in the research domain: a collective actor that should represent something more than the mere sum of its parts. The network can be a more effective and efficient player in the field of research than current players because, first of all, it can more easily prevent the duplication of research activities, purchases of equipment and materials, and the creation of data banks, and because not only information flows more easily within it, but also people and "products" (i.e. samples, reagents, software, etc.). To the possible objection that in any field of research a certain level of competition can prove positive and productive, the response is quite simply that collaboration is favoured, but never is it imposed: if two groups are working on the same problem, but with different approaches, nobody will ask them to invent improbable compromises in order to draw their research programmes closer together.

b) Environment

Speaking in 1989 to an audience of scientists meeting for a conference on bioethics, Jacques Delors said: "No environment policy, not even the most fundamentalist or the most antithetical to productive values, can do without the tool of science and technology. You know that better than anyone else. So I will only labour the point to reiterate that we have a crucial need for this tool if we are to be able

to make assessments, formulate models, foresee the evolution of damage and to recall that the research efforts that have to be made to this end will only make sense within a framework of broad international cooperation, for this will serve as a guarantee of rational and verifiable scientific assessment."[45] Postponing the opinion on the actual availability of irrefutable scientific guarantees where the environment is concerned, two themes touched on by the Commission President seem particularly interesting and useful for introducing aspects of environmental research within the Community framework: the links between environmental policy and research policy, and the necessarily international aspect of a substantial proportion of environmental research.

At the European Summit in Paris in October 1972, i.e. just a few months after the first United Nations Conference on the Environment held in Stockholm, the Heads of State and Government stressed the importance of an environmental protection policy in the Community and invited the Commission to submit an action programme by the middle of the following year. As a result, the environmental policy was born at the same time as research policy (not limited exclusively to the nuclear sector) as part of the Community's attempted revival, which would soon be frustrated by the oil and economic crises of the mid-1970s. Moreover, as no provision was explicitly made for either policy in the treaties, they were initiated on the legal basis of Article 235 of the EEC Treaty and, where the environment is concerned, on the basis of Article 100 on the harmonisation of legislation to protect the operation of the common market since "environmental" regulations and standards, which were too different from one Member State to another, would hinder the free movement of many products. The links between the two policies were quite evident. On the one hand, environmental policy needed data and information - which were still scarce in Europe and not very uniform from one country to the next - for its own regulatory actions in the fields already defined as having priority status. On the other hand, environmental research should provide the scientific and theoretical knowledge to make environmental policies effective and to define new areas of intervention.[46]

In Europe, as in the rest of the world, environmental policies initially arose out of an awareness that economic development had "social" costs that were not anticipated. The pollution of the Rhine, which flows through much of the Community, and the pollution of the Mediterranean, which serves as the Community's southern boundary, were the first two wide-reaching phenomena that alarmed public opinion and European governments. In addition to what have now become "chronic" forms of pollution, there have been - over the years - a number of cases of "acute" pollution: the Seveso and Amoco Cadiz chemicals incidents are two examples that had a major impact at Community level. The first environmental policies, and related activities, were therefore a reaction to those incidents which have had an impact on the environment and an attempt to remedy ecological imbalances. Only with time would environmental policies and research move towards the preventive "protection" of the environment.

"Pollution does not recognise national borders" is a cliché that contains one undeniable truth: for example, it would be hard to imagine an operation to clean up the Rhine that did not involve the co-operation of at least France and Germany. This rather obvious remark lies at the heart of the initial European actions in the area of environmental research. It will be recalled that three of the first nine COST actions approved in November 1971 dealt with the environment: the

physicochemical behaviour of SO_2 in the atmosphere (COST 61a); the analysis of organic micropollutants in water (COST 64b); and the processing and use of sewage sludge (COST 68). In 1973, at the same time as the launch of the first environmental action programme, these actions - later to become part of the Community's "concerted action" - were bolstered by the action taken directly by the JRC and by contract research.

The JRC's multiannual programme (1973-1976), the first following the reform, made provisions for non-nuclear research activities as well, but it was clear that after 15 years of nuclear research any diversification would have to be gradual. From the environmental point of view, however, the nuclear know-how accumulated by the JRC, and by the Ispra facility in particular, was a resource of potentially major importance. By completely abandoning the development of the nuclear industry, other JRC programmes featuring a strong environmental aspect could be developed, especially programmes linked to reactor safety including studies on the mechanics of serious incidents and their prevention, studies on the thermohydraulics of coolant in relation to incidents, studies on the instantaneous detection of breakdowns, studies on the reliability of systems and structures, and studies on reactor dynamics. Research into the disposal of radioactive waste and protection against radiation was continued, while a new programme on the decommissioning of obsolete nuclear stations was launched.

Apart from nuclear matters, studies were launched at Ispra into environmental sampling, and more specifically a data bank for chemicals. This led to the creation of ECDIN (*Environmental Chemical Data and Information Network*), which was put to the test for the first time with the Seveso incident. The work of gathering data and information was then continued and expanded by Directorate-General XI (Environment, Nuclear Safety and Civil Protection), which, since 1985, has been developing a major project to create an information system on the state of the environment and natural resources in the Community. The project is called CORINE (*Coordination des informations sur l'environnement*). The first task of the European Environment Agency (EEA), founded in Copenhagen in November 1994, will be to continue the co-ordination of environmental monitoring and the collection, harmonisation and dissemination of data and information on the environment, both within the Community and with other national and international organisations. The Agency will not, however, have any regulatory functions.

Indirect research within the scope of the first (1973-1975) and second (1976-1980) environmental research programmes consisted of very small contracts concerning a wide array of topics in four areas of research: the dissemination and the effects of pollutants; the management of environmental information (within the ECDIN project); the reduction of pollution; and environmental protection. With the third environmental research programme (1981-1985) there was a sharp increase in financial resources, from the previous multiannual programme's ECU 16 million to ECU 42 million: ECU 34 million for environmental protection, and ECU 8 million for climatology. The adoption of the climatology research programme can be viewed as evidence of the Commission's definitive acknowledgement of the fact that environmental research must not only keep under control already recognised sources of pollution, in limited contexts, and intervene where the situation appears to have been compromised, but must also take action to prevent pollution and develop "clean" technologies. The shift in emphasis toward prevention went hand in

hand with an increase in the duration of the research: from the short period that was typical for cleaning up the environment, to the long period for the complex impact of man's activities on the biosphere.

The first environmental research evaluation report[47], which gave highly positive overall opinions about the results achieved by Community research, either directly or as a stimulus for national research, highlighted the need for greater consistency between the various forms of action (direct, indirect, concerted), on the one hand, and between the Community's environmental policy and its research programmes, on the other. In the framework programme 1984-1987, the three forms of action - although approved separately by the Council - were bundled together under what was initially called the Research Action Programme for the Environment; and the Single European Act will actually consolidate the arrangement - at least financially. With regard to environmental policy, the Single European Act does recognise - albeit with certain ambiguities[48] - its status as a Community policy. As a consequence, environmental protection must be mentioned as one of the objectives of all Community research and development programmes. The Single Act also confirmed the mainly preventive nature of Community environmental actions and highlighted the celebrated PPP (*Polluter Pays Principle*): "Community action for the environment shall be based on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay" (Article 130r). In its decision on the framework programme 1987-1991, the Council intervened on the relationship between environmental policy and research: the aim of environmental research is "to develop the scientific knowledge needed in the sectors of environmental protection, climatology and safety to activate Community environment and consumer protection policies, as well as to develop them further, and to make a contribution to other pertinent Community policies (energy, agriculture, industry and aid to developing countries)."[49]

The budget for environmental research rose steadily over the following years. The fourth programme (1986-1990) received ECU 75 million and made provisions for a new pilot project regarding the main technological risks. This project was linked to the requirements set out by the 1982 "Seveso directive" concerning the impact of serious chemical incidents. In the period from 1989 to 1992, environmental research was structured in two specific programmes that brought together the main projects that had already been initiated: the STEP programme (*Science and Technology for Environmental Protection*) had a budget of ECU 75 million, while the EPOCH programme (*European Programme on Climatology and Natural Hazards*) had a budget of ECU 40 million. While it is true that over the years the relative size of contract research had increased substantially compared to what it was in the beginning, the JRC's Ispra establishment continued to play a crucial role in Community environmental research, especially in the prenormative and prelegislative areas, as can be seen in the creation in 1988 of the Environmental Institute. Where "variable geometry" activities are concerned, the COST actions were joined by a number of EUREKA projects that were bundled together in 1989 under the heading "Euroenviron".

With the adoption in 1990 (as we will see in the next section) of the Third Framework Programme, the start of the new research and development programme in the environmental sector was also brought forward to 1991, and the approach adopted showed some changes. There were now four areas of inter-

vention: 1) participation in programmes concerning global change; 2) technologies and engineering for the environment; 3) research into the economic and social aspects of environmental problems; 4) natural and technological hazards. Thus, the study of the socio-economic relationship between man and the environment was introduced. These aspects are linked to the problems of economic development that is sustainable from the environmental point of view: the evaluation of natural and technological hazards, the economic evaluation of the impact on the environment, the socio-economic effects of the implementation of environmental policies, and environmental legislation. However, especially after the conference organised by the United Nations in Rio de Janeiro on the environment and development, research into global change - in an effort to respond to problems such as acid rain, the greenhouse effect and the reduction of ozone in the stratosphere - has taken on an absolute priority role in Community programmes too. In these areas the Community has the job of co-ordinating national research activities in the Member States and linking these activities to those already underway internationally by participating directly in programmes such as the WCRP (*World Climate Research Programme*) and the IGBP (*International Geosphere-Biosphere Programme*).

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5. THE THIRD FRAMEWORK PROGRAMME (1990-1994)

Many specific programmes in the Second Framework Programme had scarcely been set up when Filippo Maria Pandolfi, the new Commissioner for Science, Research and Technology, Telecommunications, Information and Innovation Industries, and the Joint Research Centre (from January 1989 to December 1992), decided to bring forward the start of a new framework programme to 1990, rather than change the programme underway at the time. His decision, based on a series of reports which he had commissioned from independent experts, led to the definitive adoption of the rolling programmes mechanism, whereby successive framework programmes overlapped each other by one or two years, thus making it possible to provide suitable financial planning and ensure the continuity of research activities. With a view to ensuring greater flexibility in terms of financing and programme content, the Commission also suggested focusing the framework programme on fewer lines of action, with a parallel reduction in the number of programmes, and subdividing the five-year budget into two parts, with the opportunity to adjust the programme's financial resources halfway through the period in question, in accordance with new situations and with the progress made by the programmes themselves. Along these lines, which would be accepted for the most part by the Council and become an integral part of the Third Framework Programme, an effort was therefore made to maintain the continuity of the programmes for sufficiently long periods, while at the same time making them more sensitive and capable of responding to outside changes, even going so far as to make provisions to scrap them if they proved to be of little use.

A joint position by the Council on the Third Framework Programme was reached in December 1989, but it ran up against outright opposition from the Parliament, which, on the basis of its powers to control the Community budget, invoked the "conciliation" procedure. The criticism levelled by the European Parliament, as expressed by its Committee on Energy, Research and Technology (CERT), focused first and foremost on the size of the budget for the Third Framework Programme. Faced with the Commission's initial proposal of ECU 7.7 billion and the Parliament's counterproposal of ECU 8.23 billion, the Council reached an internal consensus of ECU 5.7 billion for the period 1990-1994. This meant that, counter to the promise for a continual increase in the research budget to bring it up to 6% of the Community budget by 1997, funding for research and development would have remained equivalent to that provided in the previous framework programme, and indeed fallen in real terms in the second part of the framework programme (1993-1994) due to the spending commitments already made. Parliament then contested the allocation of funds that were not in line with any of its proposals and, in particular, the inadequate transfer of resources from nuclear energy research to non-nuclear energy, as well as the rather insignificant increases in funds for the environment, human capital and biotechnologies.[50] Parliament also had procedural objections, but faced with the Council's inflexibility it had to yield in order not to prejudice the start-up of the programmes. The delegation involved in the conciliation process with the Council explained why it unwillingly decided to approve the framework programme, thus: "The delegation does not believe that it should recommend to Parliament that it block the Commu-

nity's research activities, which it has been instrumental in initiating and which it has positively encouraged for many years. It recognises that time is of the essence if the funding proposed is to be adequately and effectively placed. Therefore it recommends the closure of the conciliation procedure, which can serve no further useful purpose, and reserves its right to pursue its decisions in this area within the budgetary procedure and in its consideration of the specific research programmes."[51]

The third "framework programme for Community research and technological development (1990-1994)" was approved by the Council on 23 April 1990. The specific programmes were reduced to 15, within six actions, which were in turn collected under three titles: dissemination technologies; management of natural resources; and exploitation of intellectual resources. The first title covers two actions: information and communications technologies, and industrial and materials technologies. Total funding for information and communications technologies was ECU 2.221 billion, slightly less than in the previous framework programme, but still the highest in absolute terms and equivalent to almost 40% of the framework programme budget. More than half of the funding goes to information technologies via the ESPRIT programme, while the rest is divided among communications technologies (RACE programme) and the development of telematics systems of general interest (AIM, DELTA and DRIVE). The financial resources for industrial and materials technologies increased slightly with respect to the period 1987-1991 - to ECU 888 million - and were divided among the "Industrial and Materials Technologies" programme, which absorbed around three-quarters of the funding via BRITE/EURAM, and the "Measuring and Testing" programme managed by the Community Bureau of References (BCR). The second title covered three actions: the environment, life sciences and technologies, and energy. The budget for the environment did rise - albeit not by much compared with the previous programme - to ECU 518 million: four-fifths of this went to the "Environment" programme, while the remaining one-fifth went to "Marine Sciences and Technologies", for which the programme known as MAST (*Marine Science and Technology*) has been started. The funding for the "Life Sciences and Technologies" action rose sharply compared with the previous framework programme, but it still had a budget of just ECU 741 million, equivalent to 13% of total funding. The action was divided up into four programmes: biotechnology, with the Bridge programme; agricultural and agro-industrial research (including fisheries); biomedical research and health, with the start-up of the Fourth Community Programme and of the "Human Genome Analysis" programme; and life sciences and technologies for developing countries, with the third STD (*Science and Technology for Development*) programme. The "Energy" action continued to lose financial resources compared to previous years, being allocated ECU 814 million, equivalent to around 14% of the budget for the Third Framework Programme[52], divided up among the "Non-nuclear energy" programmes (JOULE - *Joint Opportunities for Unconventional or Long-term Energy Supply* is the leading specific programme), "Safety of Nuclear Fission" (Protection against Radiation, Reactor Safety, Management and Storage of Radioactive Waste, Decommissioning of Nuclear Installations, and Remote Handling in Hazardous and Disordered Nuclear Environments - TELEMAN) and "Controlled Thermonuclear Fusion" which received more than half of energy research funding. It should be noted that these last two programmes were part of the EURATOM Treaty and therefore approved separately using a different procedure (among other things,

this procedure does not make provisions for co-operation with Parliament). The final title, "Management of Intellectual Resources", dealt with only one action and one programme, both called "Human Capital and Mobility," and was assigned a five-year budget of ECU 518 million. This represented the highest increase, proportionally speaking, compared to the previous framework programme. One percent of the budget of each programme (totalling ECU 57 million overall) was earmarked for a centralised action to disseminate and optimise the results, an action which was initiated by DG XIII with the VALUE programme (*Valorisation et Utilisation pour l'Europe*). Since 1988 this programme has dealt with the dissemination of Community research results that do not require legal protection, and with the best economic exploitation of those results that have been patented.[53]

The ways in which the Community participates in research actions have not changed substantially compared with the past. Direct actions receive full funding: for JRC's activities, which focus primarily on industrial and materials technologies, the environment and energy, the Third Framework Programme earmarked ECU 550 million, to which is added the funds which the JRC is beginning to receive for research commissioned by external customers and other Directorates-General at the Commission for scientific support. There are concerted actions, such as those planned for biomedical research, and to which the Community provides full funding for co-ordination costs only (travel, exchanges of information, publications, etc.). A large proportion of the Community's financial contribution goes, however, to contract research actions, whose costs are divided up: generally speaking, 50% for the Community, and 50% invested by the other participants in the programme, though non-industrial participants (universities and research centres) - which have accounting practices that are unsuited for this purpose - might receive a Community contribution to cover either all their marginal costs or additional spending. These "financial coparticipation" actions include all the programmes for industrial innovation, such as ESPRIT, RACE, BRITE/EURAM and Bridge.

In approving the Third Framework Programme, the Council indicated the six main concerns that have influenced the choice of its main guidelines:

- *improve industrial competitiveness while at the same time maintaining the precompetitive nature of Community actions;*

- *cope with the challenges linked to the completion of the Single Market for standards, thus boosting prenormative research;*

- *modify the attitude of industrial operators, by orienting it towards transnational initiatives;*

- *instil a European dimension in the training of staff engaged in scientific research and technological development;*

- *increase economic and social cohesion while ensuring the scientific and technical excellence of research projects;*

- *take account of safeguarding the environment and the quality of life.*[54]

It is clear that these "concerns" have points in common with the "Riesenhuber criteria" that were drawn up with regard to the First Framework Programme, and are an explanation of the general objectives set out for research and development. The first three objectives are linked strictly to the project to

complete the Single Market and to the more general objectives set out in the Single Act, while the other three have a somewhat novel nature, signalling the expansion of the aims of Community research and development policy, an expansion that would be legally sanctioned by the Treaty of Maastricht.

Between June 1991 and March 1992, the Council adopted - in co-operation with Parliament - the various specific programmes comprising the new framework programme. Only after approving each individual programme could invitations to present proposals go out. The proposals were evaluated by experts outside the Commission and, for the majority of the programmes, the percentage of proposals deemed to be "good" or "excellent" was very high, on average around 50% but reaching 70% for "Climate Change" in environmental research.[55] However, the budget constraints of the Third Framework Programme meant that only a small proportion of the best research proposals were actually financed (i.e. about 30%). Despite this tough selection process, in late 1992 the funds available to many programmes were drying up and without new funding it was predicted that the Community's financial support for research and development would collapse vertically, with harmful effects on programmes and teams directly involved in research activities.

As had been pointed out by Parliament and the Commission, the budget planned for the five years of the Third Framework Programme was too low and the hopes that the Fourth Framework Programme would have already started in 1993 - thus partly overlapping the last two years of the previous programme - were overly optimistic. In order to advance activities which in many cases had barely begun, the Commission proposed supplementary funding for 1993 and 1994 of ECU 1,600 million, to be concentrated in information technologies, telematics systems, industrial and materials technologies, the environment, biotechnology, agricultural research, non-nuclear energy and fusion. On 15 March 1993 the Council definitively approved a supplement of ECU 900 million for the Third Framework Programme, corresponding to an increase of 30.6% of the budget for actions in the field of energy and an increase of 13.3% in all other areas.

The events surrounding the financing of the Third Framework Programme reveal the continuing underlying tension between the Commission and Parliament, on the one hand, and the Member States on the other, regarding the relative importance which the Community's commitment to science and technology must assume. Each government is essentially trying to keep national control of technologies which it considers strategic and in which it has a competitive advantage over other countries, while at the same time being prepared to develop those technologies at Community level which it feels are less important. The result is that usually the governments in the Council of Ministers simply reach a compromise at the lowest possible level. Two fundamental issues are linked to the financing of Community R&D. The first regards the division of areas of competence in this domain between the Community and the Member States for which it seeks to apply the principle of subsidiarity, which we talked about earlier and to which we will return below with regard to the Treaty of Maastricht. The second is the one generally referred to using the term *additionality* or *attribution*: Should Community funding be considered an addition to national R&D budgets or part of them? This problem was initially raised in Great Britain since the Treasury has decided to at least partly integrate Community contributions into the budget item of spending on

national scientific research. At this point, since it is theoretically the Treasury itself which allocates Community funding to public research centres, the result may be that "a body which received Community funds in one year might well find its financial support from government reduced the following year".[56] The problem is rather complicated from the accounting and administrative point of view, yet if the practice were universally adopted, one likely result would be a further tendency to set very low limits on Community research and development spending. If Community spending is exactly equal to national spending, why on earth does the money have to travel to Brussels just so it can be sent back again? Furthermore, is there such a thing as "European added value", or are Community contributions simply supplementary - and rather more complex - funding for national programmes?[57]

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NOTES

1 Michel Albert, *Un pari pour l'Europe*, Seuil, Paris, 1983, p. 102.

2 See European Parliament, *Draft Treaty Establishing the European Union*, Luxembourg, 1985.

3 Commission of the European Communities, *Completing the Internal Market. White Paper from the Commission to the European Council*, COM (85) 310 final, Brussels, 14 June 1985.

4 *Regulations* are binding in every aspect and must be adopted by the Member States. *Directives* are obligatory for Member States only with respect to the aims they wish to achieve, while the forms and means for doing so are left up to the discretion of national parliaments.

5 See Paolo Cecchini, et al., *The European Challenge 1992: The Benefits of a Single Market*, Gower, Aldershot, 1988.

6 For a useful presentation of the Single Act, see Bino Olivi, *L'Europa difficile. Storia politica della Comunità europea*, il Mulino, Bologna, 1993, pp. 283-99.

7 This brief analysis of the effects of the completion of the single market in science and technology is based chiefly on Peter Collins and Josephine A. Stein, "Science and Technology and the Single European Market", unpublished, 1991.

8 Here we agree more with the interpretation given to ESPRIT and other community programmes by Margaret Sharp and Wayne Sandholtz, rather than with John Peterson's interpretation. Peterson attributes the success of the Community's technology policy to the decision to bring the "1992 initiative" to a rapid conclusion. In this regard see: Margaret Sharp, "The Single Market and European

Policies for Advanced Technologies", in Colin Crouch and David Marquand (eds.), *The Politics of 1992. Beyond the Single European Market*, Basil Blackwell, Oxford, 1990, pp. 100-120; Wayne Sandholtz, "ESPRIT and the Politics of International Collective Action", *Journal of Common Market Studies*, vol. XXX, no. 1, March 1992, pp. 1-21; and John Peterson, "Technology Policy in Europe: Explaining the Framework Programme and EUREKA in Theory and Practice", *Journal of Common Market Studies*, vol. XXIX, no. 3, March 1991, pp. 269-90.

[9] Hubert Curien, "The Revival of Europe", in Andrew J. Pierre (ed.), *A High Technology Gap? Europe, America and Japan*, Europe/America, no. 6, Council on Foreign Relations, New York, 1987, pp. 61-62.

[10] See Working Group on Technology, Growth and Employment, *Technology, Growth, Employment. Report to the Seven Heads of State and Government and to the Representatives of the European Communities*. La Documentation Française, Paris, January 1983.

[11] In a famous article McGeorge Bundy, George F. Kennan, Robert S. McNamara and Gerard C. Smith wrote in reference to SDI: "The end is unattainable, the means are harebrained, the costs are astronomical"; see "Star Wars or Arms Control: The Choice to the President", *Foreign Affairs*, vol. 63, no. 2, winter 1984-85.

[12] Commission of the European Communities, *Implementation of the Commission Memorandum "Towards a European Technological Community"*, COM (85) 530 final, Brussels, 30 September 1985, p. 16.

[13] *Déclaration de base d'Eureka*, Hannover, 6 November 1985; for official EUREKA documents, see Philippe Braillard and Alain Demant, *EUREKA et l'Europe technologique*, Bruylant, Brussels, 1991, pp. 119-64.

[14] For more information on methods and bodies providing national funding for EUREKA, see Philippe Braillard and Alain Demant, *EUREKA et l'Europe technologique*, Bruylant, Brussels, 1991, pp. 35-37.

[15] These are the figures presented by Xavier Fels, Director of the EUREKA Secretariat, in "EUREKA, a Model for the Future", *Science and Public Policy*, vol. 15, no. 6, December 1988, pp. 373-75.

[16] Other figures can be found in Giovanni Napolitano, "European Technological Cooperation: The Italian Participation in EUREKA", *Science and Public Policy*, vol. 15, no. 6, December 1988, pp. 376-82; and in John Peterson, "Assessing the Performance of European Collaborative R&D Policy: The Case of EUREKA", *Research Policy*, 22, 1993, pp. 243-64.

[17] Antonio Ruberti, *EUREKA News*, no. 7, January 1990, p. 5, quoted in Philippe Braillard and Alain Demant, *EUREKA et l'Europe technologique*, Bruylant, Brussels, 1991, p. 98.

[18] For JESSI see, for example, Michel Delapierre and Jean-Benoit Zimmerman, "Towards a New Europeanism: French Firms in Strategic Partnerships", in Lynn Krieger Mytelka (ed.), *Strategic Partnerships, States, Firms and International Competition*, Fairleigh Dickinson University Press, Rutherford, 1991, pp. 102-19; and Claire Shearman, *Science and Technology in Europe*, unpublished, April 1990, pp. 77-84.

[19] In this respect, and with regard to the European Venture Capital Association (EVCA) in particular, it is useful to consult Commission of the European Communities, *Improving Venture Capital Opportunities in Europe*, Proceedings of the Symposium held in Luxembourg, 3-5 October 1984, Kogan Page, London, 1985; and the more recent, Marie-Christine Adam and André Farber, *Le financement de l'innovation technologique. Théorie économique et expérience européenne*, PUF, Paris, 1994.

[20] Commission of the European Communities, *Towards a European Technology Community*, COM (85) 350 final, Brussels, 25 June 1985.

[21] Commission of the European Communities, *Implementation of the Commission Memorandum "Towards a European Technological Community"*, COM (85) 530 final, Brussels, 30 September 1985, p. 5.

[22] For some opinions by the European Parliament on the Second Community Framework Programme see, for example, Michel Poniatowski, "Europe's technological challenge: a view from the European Parliament", *Science and Public Policy*, vol. 15, no. 6, December 1988, pp. 383-93.

[23] Council of the European Communities, "Decision of the Council of 28 September 1987 concerning the framework programme 1987-1991", Annex III, *Official Journal of the European Communities*, 24 October 1987.

[24] In this context, the expression "less favoured regions" is taken to mean either some Member States (Greece, Ireland and Portugal), or economically backward regions in other Community countries.

[25] J.M.G. Caraça, et al., *Evaluation of the Effects of the EC Framework Programme for Research and Technological Development on Economic and Social Cohesion in the Community*, CEC, Luxembourg, September 1991, pp. V-VI.

[26] The evaluation of the committee on the six possible sites for JET was summed up in a table that is reproduced in E.N. Shaw, *Europe's Experiment in Fusion. The Jet Joint Undertaking*, North-Holland, Amsterdam, 1990, p. 55.

[27] For further information on the Super-SARA project, see Olivier Pirotte, Pascal Girerd, Pierre Marsal and Sylviane Morson, *Trente ans d'expérience EURATOM. La naissance d'une Europe nucléaire*, Bruylant, Brussels, 1988, especially pp. 325-36.

[28] See JRC Panel of Senior Industrialists, *An Industrial View of the JRC*, CEC, Brussels, 9 November 1986.

[29] Commission of the European Communities, *A New Outlook for the Joint Research Centre*, COM (87) 491 final, Brussels, 26 October 1987, p. 4.

[30] For the amendments proposed by the Parliament, see *Official Journal of the European Communities*, 11 April 1988, pp. 74-81.

[31] For a very critical assessment of the organisation and operation of the JRC, see Dick Holdsworth and Gordon Lake, "Integrating Europe: The New R&D Calculus", *Science and Public Policy*, vol. 15, no. 6, December 1988, pp. 411-25.

[32] The Centre was successively consolidated into the Institute of Systems Engineering and Informatics, thus there are currently eight JRC institutes.

[33] For a generally positive opinion of the development of the JRC's management and activities, see the report by Sir Hermann Bondi, *Evaluation of the Joint Research Centre in the Context of the New Approach as Defined in the Fourth Framework Programme of the Community Activities in the Field of Research, Technological Development and Demonstration*, CEC, 25 May 1994.

[34] Jean-Pierre Contzen, "Il CCR e le nuove prospettive europee nel campo della scienza e della tecnologia", *Acque & Terre*, Speciale ricerca, anno 4, no. 5, September-October 1993, p. 12.

[35] Paolo Fasella, "The Current State of Research and Technology in Europe", in "European Research - Framework Programme 1987-1991", *Nouvelles de la Science et des Technologies* (English edition of), Vol. 5, no. 4, October 1987, p 7.

[36] On bioethical questions see the report commissioned by the European Parliament's STOA programme: Fabio Terragni (ed.), *Bioethics in Europe*, EP - STOA, Luxembourg, September 1992.

[37] Walter W. Holland (ed.), *European Community Atlas of 'Avoidable Death'*, Oxford University Press, Oxford, 1988. A second edition of the Atlas, containing data for the period 1980-84, extends the analysis to cover the new Member States (Spain and Portugal).

[38] For this data, see Alan Maynard, et al., *Evaluation of the Fourth Medical and Health Research Programme (1987-1991)*, DG XIII, Luxembourg, July 1990.

[39] The data refer to April 1990. For other data and an in-depth analysis of the collaborative efforts that emerged from the Community's medical programme, see P. Laredo, B. Kahane, J.B. Meyer and D. Vinck, *The Research Networks Built through the MHR4 Programme*, CEC, September 1992.

[40] Fernand van Hoeck, Sergio Finzi, Philippe Bourdeau and Michel André, "The Quality of Life" in "European Research - Framework Programme 1987-1991", *Nouvelles de la Science et des Technologies* (English edition of), Vol. 5, no. 4, October 1987, p. 18.

[41] For further information on AIM, consult AIM, *Telematics Systems for Health Care*, CEC-DG XIII, Luxembourg, 1992.

[42] Alan Maynard, et al., *Evaluation of the Fourth Medical and Health Research Programme (1987-1991)*, DG XIII, Luxembourg, July 1990, p. VI.

[43] For an interesting analysis of the process of creating scientific cooperation networks, see Dominique Vinck, *Du laboratoire aux réseaux. Le travail scientifique en mutation*, FAST, CEC-DG XII, Luxembourg, 1992.

[44] P. Larédo, B. Kahane, J.B. Meyer and D. Vinck, *The Research Networks Built through the MHR4 Programme*, CEC, Luxembourg, September 1992, p. vi.

[45] Jacques Delors, "Une éthique de l'environnement", in *Le nouveau concert européen*, Odile Jacob, Paris, 1992.

[46] For an interesting analysis of the relationship between environmental policy and environmental research policy, see Angela Liberatore, "EC Environmental Research and EC Environmental Policy. A Study in the Utilization of Knowledge for Regulatory Purposes", *EUI Working Paper*, no. 89/407, Badia Fiesolana, San Domenico (Florence), 1989.

[47] See G. Fülgraff, et al., *Evaluation of the Community's Environmental Research Programmes (1976-1983)*, CEC, Brussels, 1984.

[48] In fact, only the Maastricht Treaty speaks of environmental *policy*, while the Single Act mentions community *action* in environmental matters. Indeed, all Council decisions in this matter must still be taken unanimously.

[49] Council of the European Communities, "Decision of the Council of 28 September 1987 concerning the framework programme 1987-1991", *Official Journal of the European Communities*, 24 October 1987, p. 7. For a general presentation of the Community's environmental policy, see Commission of the European Communities, *Towards sustainability. A European Community Programme of Policy and Action in relation to the Environment and Sustainable Development*, CEC-DG XI, Brussels, 1993.

[50] For some of Parliament's positions on the Community's overall research and development policy, see Michel Poniatowski (Rapporteur), *Report on Europe's response to the modern technological challenge*, European Parliament Session Document (PE 127.487/fin.), 21 April 1989.

[51] Statement by the parliamentary delegation of 12 March 1990, quoted in Glyn Ford and Gordon Lake in "Evolution of European Science and Technology Policy", *Science and Public Policy*, vol. 18, no. 1, February 1991, p. 48.

[52] However, outside of the framework programme, there was the simultaneous launch of the THERMIE programme (*Technologies européennes pour la maîtrise de l'énergie*), managed by Directorate-General XVII (Energy), with a budget of ECU 700 million for the period 1990-1995. THERMIE, with activities in R&TD and in economic demonstration, dealt with saving energy, optimising alternative sources, "ecological" technologies for transforming coal and other solid fuels, and research, transport and storage technologies for oil and natural gas.

[53] Over the years, as the names of the programmes mentioned in this section and elsewhere have shown, the Commission has skilfully cultivated the *art of the acronym*. For a complete list of the names of current programmes, see Bibliothèque, *Dictionary of Acronyms for European Community Programmes and Action Plans*, CEC, Luxembourg, April 1993.

[54] Cf. Council of the European Communities, "Decision of the Council of 23 April 1990 concerning the framework programme for Community research and technological development actions (1990-1994)", *OJEC*, 8 May 1990, p. 32.

[55] These figures are presented in the Commission's preparatory paper concerning the refinancing of the framework programme. See *Proposal for a Council decision concerning supplementary financing of the third framework programme of Community activities in the field of research and technological development (1990 to 1994)*, Brussels, July 1992.

[56] Roger Williams, "Collaboration in Science and Technology: Three Parliamentary Reports", *Science and Technology Policy*, June 1991, p. 10.

[57] For a more in-depth analysis of the problem, see Luke Georghiou et al., *The Impact of European Community Policies for Research and Technological Development Upon Science and Technology in the United Kingdom*, CEC, Brussels, September 1992, especially pp. 82-90.

CHAPTER FIVE

MAASTRICHT AND THE NINETIES

1. European Union and Political Co-operation

Over the last fifty years, the term "European union" has been the focus of debate as to what form European *political* co-operation should take. First invoked in 1948, by the Congress on European Unity held in The Hague, European union became an objective of the Community countries in 1972. The Heads of State and Government attending the Paris summit of that year declared that it was "their main objective to transform the complex of relationships between the Member States into a European union, before the end of the decade, with absolute respect for the treaties signed to date". Despite more than a decade's delay, in 1992, the Maastricht Treaty was signed, with the opening words, "By this Treaty, the High Contracting Parties establish among themselves a European Union".

As we have seen, the post-war international situation in which the European Communities were born was marked by a desire for reconciliation between the former combatants and the need to form a common front against the potential Soviet threat. Political progress within Europe itself was the product of inter-related and often conflicting forces. According to Altiero Spinelli, the proc-

ess of integration engaged in the 1950s and 60s was "the fruit of a tension between the radical vision of the federalists and the pragmatic achievements of statesmen. Without this tension, nothing would have been done. The vision of the federalists would have remained utopian had it not found some echo in the statesmen bent on restoring national democracies, and the basically conservative pragmatism of the statesmen would have produced nothing had they not been forced to meditate on the demands of the federalists"[1]. On the other hand, the actual construction of the Community was based on the functionalist approach of Jean Monnet, who believed that positive interaction between economic development and common interests would naturally resolve itself in a "more perfect union" of a political kind. Finally, there was a third level of tension, probably more difficult to resolve, between an essentially federal vision of political development and a confederal one, whereby the nation states would maintain their sovereignty intact, the Union taking the form of an extensive free trade area.

Following the birth of the ECSC, the first attempt to accelerate the political development of the Community occurred in the early 1950s, in the context of plans for a European Defence Community (EDC). The French proposal to create a European army was matched by an Italian plan to set up a European political community, which, in time, would integrate both the ECSC and the EDC[2]. The institutional structure proposed was not very different from that which the European Economic Community eventually assumed, but its functions and responsibilities were far wider, as it effectively constituted a political union of Western Europe in embryo. The demise of the defence project, following its rejection by the French National Assembly in August 1954, also signalled the abandonment of the political project in favour of more gradual (EEC) or sectoral initiatives (EURATOM). Another project for political co-operation was presented in 1961, but this time along strictly confederal lines, respecting the concept of a "Europe of nation states" so dear to General de Gaulle. This was the so-called Fouchet Plan, which provided for a political union of the six countries belonging to the three existing communities, to be based on inter-governmental co-operation in a new community working through a permanent political secretariat (the Commission). This project met with the same fate, however, General de Gaulle preferring to strengthen political co-operation with Germany, an arrangement formalised by the Franco-German agreement of 1963[3].

After General de Gaulle's exit from the political stage, things in the Community settled down and the time seemed ripe for a new, wide-ranging initiative. At the summit held in The Hague in December 1969, decisions were taken in respect of agricultural policy, community resources and the Parliament's powers with regard to the budget; it was decided to launch a process of financial and monetary union; and the Heads of State and Government undertook to study new forms of political co-operation, particularly in view of forthcoming negotiations with countries applying to join the Community (Denmark, the U.K., Ireland and Norway). The report presented in 1970 by the committee chaired by Etienne Davignon included plans for a widening of the Community's scope of activities the field of foreign policy, but without setting up an independent political community as envisaged in the Fouchet Plan. The Davignon report was approved by the Council of Ministers and, looking forward to a gradual extension of Community powers, the 1972 Paris summit heralded the future European Union. The Tindemans report, presented in 1975 but never approved by the Council, defined the implications of the project for foreign policy:

the European Union would cover all aspects of foreign relations; this would mean an end to the separation between ministerial meetings concerned with political co-operation and those concerned with policies provided for in the treaties; and the other Community institutions would be able to take an interest in all the internal and external questions affecting the Union. The Tindemans report was, however, vague regarding the specific powers to be assumed by the European Parliament when it came to be directly elected by universal suffrage at the end of the decade. For the time being, the Parliament's role was limited to involvement in the budget procedure and it had no effective legislative power: the political development of the Community was suffering from a "democratic deficit", to which the Tindemans report offered no speedy remedy.

During the period 1981-1983, the institutional committee of the European Parliament worked on the text of a treaty to institute a European Union, focusing on the two problems of Community foreign policy and the democratisation of European institutions. Their draft was the first organic text which, whilst maintaining the *acquis communautaire* (achievements to date), provided for a complete reform of existing institutions and supersedure of the earlier treaties. Approved by the Parliament on 14 February 1984, the plan envisaged a gradual transfer of powers from the Council to the Parliament, the two bodies effectively sharing legislative power. In this pre-federal perspective, the Council was to assume the functions of a Senate, while the Parliament would act as a lower chamber. Foreign and defence policy were to become the prerogative of the European Council. This was not unlike the arrangement proposed in the Davignon report, with international relations conducted on the basis of inter-governmental co-operation. In some areas of policy, such as the internal market, competition and agriculture, the Union was to have exclusive competence, while in sectoral matters (transport, industry, research, etc.) its competence would parallel that of the individual Member States. The role of the Parliament would be extended, particularly where approval of the budget was concerned (it being given a say on income as well as expenditure), and an increase in its own resources was intended to give the Union greater autonomy vis-à-vis the member countries. The powers of the Commission, essentially executive and initiatory, were confirmed and strengthened[4]. The draft document drawn up by the European Parliament was largely ignored, by both the national parliaments called to ratify the new Treaty and the European Council, which instead set about revising the treaties with a view to completing the Single Market. The process of reform eventually culminated, in February 1986, in the adoption of the Single European Act, to which we have already referred. It effectively codified the forms of political co-operation already being practised and introduced a procedure governing co-operation between Parliament and Council.

In the 1980s, the European Community was very similar to Germany as it had been in the 1960s: a giant in economic terms but politically a dwarf. And at the end of the decade, the vague forms of political co-operation approved by the European Council meeting held at Stuttgart in 1983 and formalised in the Single Act appeared totally inadequate to meet new challenges. The division of the continent into two blocs, decreed at the end of the war and confirmed in the 1960s by the pan-European Conference on Security and Co-operation in Europe (CSCE), an arrangement which for decades had seemed permanent and unchangeable, was swept away virtually overnight. The collapse of the Soviet empire led to the birth of new nations, the recovery of

unrestricted sovereignty by the nations of Central and Eastern Europe, the violent fragmentation of the Yugoslav Federation and the reunification of Germany. Faced with this sudden acceleration of historical events, which shattered the pre-existing European order, the Community, too, was forced to react and reconsider the forms of its "political co-operation".

Into this international context of profound change the European Union was born[5]. The Maastricht Treaty gave life to a composite construction supported on three "pillars" and held together by a single common institution: the European Council consisting of the Heads of State and Government of the member countries. The first pillar, the oldest and probably the most solid, was the European Community (still three Communities from a legal point of view). The second was foreign policy and joint security: these matters were to be the responsibility of the Council of Ministers of Foreign Affairs, to which the Commission could make proposals, while the Parliament was simply informed of decisions. The third pillar, internal affairs and justice, was strictly inter-governmental in character. The European Union, which in any case lacked legal personality, did not therefore replace the Community by extending its functions, but rather represented the broadest possible institutional framework, drawing together the spheres of competence of the European Council.

Where the first and most important "pillar" was concerned, the new element with the weightiest political implications was in the area of economic and monetary policy, with the resuscitation of a project (the Werner Project) originally launched way back in 1970. By a gradual process, with financial liberalisation and the creation of a European Monetary Institute as intermediate stages, the Community was to achieve economic and monetary union by 1 January 1999. At this point, all European monetary questions would come within the ambit of a European Central Bank (ECB) and a European Central Banks System (ECBS) consisting of the ECB and national central banks, all of which would be strictly independent of national governments. After a period of rigidly fixed exchange rates, the ECU would eventually become the official European currency. To achieve these objectives, the Member States undertook to comply with certain convergence criteria regarding public finance, the rate of inflation, and interest rates. Since then, the monetary crisis affecting the Community in 1992, which led in September of that year to the exit of the pound sterling and the lira from the European Monetary System (EMS), has aroused fears that it may not be possible for all the member countries to comply in all respects with the schedule for economic and monetary union.

The Maastricht Treaty brought several new areas of policy within the competence of the Community. Two in particular, already included in the Single European Act, assumed greater prominence: economic and social cohesion, and social affairs. The first, championed particularly by the Spanish government, was aimed at "reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions, including rural areas" (Art. 130 a) and was presented as an indispensable instrument in achieving the desired economic and monetary convergence. In addition to the existing Structural Funds, a specific fund was set up in support of the cohesion policy, to finance environmental projects and trans-European transport networks. It was also emphasised that cohesion was one of the fundamental objectives in other areas of Community policy, including research and technological development (R&TD). Social policy, in which

the U.K. chose not to be involved, was also accorded a Fund of its own, the aim being to improve the living and working conditions of European citizens along the lines set out in the 1989 Social Charter. Social policy also included education, vocational training and youth, while culture, health and consumer protection became matters of Community policy in their own right. Finally, the Maastricht Treaty set out a policy for trans-European transport, telecommunications and energy networks.

To settle questions regarding the respective competencies of the Community and the Member States in the various areas of policy, the Treaty introduced the concept of *subsidiarity*. The idea derives from the social teaching of the Catholic Church, where its purpose is to safeguard families against what might be considered undue interference on the part of the state. In the political field, the same principle governs the relationship between Länder and federal government in Germany. In Community affairs, the concept made its first appearance in the European Parliament's draft Treaty of Union in 1984. In the Maastricht Treaty, it is formulated as follows: "The Community shall act within the limits of the powers conferred upon it by this Treaty and of the objectives assigned to it therein. In areas which do not fall within its exclusive competence, the Community shall take action, in accordance with the principle of subsidiarity, only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States and can therefore, by reason of the scale or effects of the proposed action, be better achieved by the Community. Any action by the Community shall not go beyond what is necessary to achieve the objectives of this Treaty."

The principle is clear enough in the abstract, but in practice has given rise to differing and sometimes contradictory interpretations. This is due mainly to a lack of precision in the way the exclusive competencies of the Community are distinguished from those common to the Community and the Member States.

From an institutional point of view, the Maastricht Treaty has not wrought a profound change in the structure of the Community. The powers of the Parliament have been increased, but only to a limited extent: power of co-decision with the Council in some areas of policy, including research (to which we will return shortly), a supervisory role in relation to the budget, and the need for parliamentary agreement in the appointment of the Commission. As well as setting up a Committee of the Regions with consultative functions, the Treaty provides for European citizenship: "Every person holding the nationality of a Member State shall be a citizen of the Union". (Art.8 of Treaty). It confirms the rights of European citizens to become established, move within and reside in other member countries, and introduces certain new provisions governing the right to vote in local elections and elections to the European Parliament, diplomatic protection for European citizens when in non-EU countries, and the right of European citizens to appeal to the Parliament and to *Ombudsman* to ensure that their rights as citizens are respected.

In the face of the obvious need for a great leap forward in European political co-operation if the Community is to respond adequately to the greatly changed international situation, the second "pillar" of the Union appears decidedly weak, as the initial management of the Yugoslav crisis has demonstrated. In the area of foreign policy and joint defence (JFDP) the members of the Union have opted for "systematic co-operation" based on exchange of information, definition of common positions and co-ordination of their actions

within international organisations, and have agreed gradually to undertake joint initiatives. The main changes are in the area of defence: whilst respecting member countries' links with NATO, the Treaty provides for the Western European Union (WEU) to be integrated into the Union itself and become its military arm, and for a European army to be established in the future, with the existing Franco-German Brigade as its nucleus. The third pillar - co-operation in matters of policing and justice - has consequences for asylum policy, immigration from non-EU states, the fight against drug addiction, "Police co-operation for the purposes of preventing and combating terrorism, unlawful drug trafficking and other serious forms of international crime" (Art.K.1), and co-operation in matters of civil and criminal law. The Treaty provides for the creation of a European police bureau, to be known as "Europol". This ties up with the Schengen agreement, initialled in June 1990, providing for the opening up of internal frontiers to ensure free movement of persons, with a corresponding tightening of controls at the Community's external borders and the creation of an efficient communications system between the member countries' interior ministers[6].

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2. HOW THE MAASTRICHT TREATY AFFECTS RESEARCH

From a strictly formal viewpoint, the Maastricht Treaty has made very little change to the provisions of the Single European Act in terms of research and technological development. In substance, however, the two lines added to Art.130 f were, potentially at least, highly significant. Whereas the Single Act simply stated that "The Community shall have the objective of strengthening the scientific and technological bases of Community industry and encouraging it to become more competitive at international level", the Maastricht Treaty adds "while promoting all the research activities deemed necessary by virtue of other Chapters of this Treaty".

The first point to note is that the Treaty again made the Community, or Community policies in all sectors covered by it, central to the objectives of the Community's science and technology policy. It re-emphasised, at the highest juridical and institutional level, the idea which originally gave rise to the framework programme: the Community's R&TD policy should be, first and foremost, at the service of other Community policies. With this change to Art.130 f, the Maastricht Treaty also gave more obvious legitimacy to those research activities which, though already initiated under the auspices of the Community on the basis of Art.235 of the EEC Treaty, are not directly concerned with the competitiveness of European industry: for instance, medical and environmental research and protection against radiation, which in the Second Framework Programme were grouped together under the heading "Quality of life", and also basic research and the kind of unrestricted research encouraged by the Science programme. Another field opened up by the Maastricht Treaty was that of social science, an area long neglected by the Community. On the other hand, the new legislation did not impose any rigid constraints on future possibilities: any kind of research of apparent usefulness to any other end pursued by the Union could be promoted. And to the two concerns that have traditionally directed Community R&D policy - the conservation and improvement of human and material resources, and the need for autonomy and competitiveness vis-à-vis the USA and Japan - was added a third: the desire to respond to the social needs of European citizens and strengthen economic and social cohesion between the various European regions.

The new centrality given to the Community - now the European Union - was also evident in another change made to the Single European Act. Whereas the Act stated that "Member States shall, in liaison with the Commission, co-ordinate among themselves the policies and programmes carried out at national level", the Maastricht Treaty laid down that "The Community and the Member States shall co-ordinate their research and technological development activities so as to ensure that national policies and Community policy are mutually consistent." (Art.130 h). Over the years, attempts to co-ordinate national policies have always proved difficult and largely unfruitful, as those who have taken part in the COPOL (*Comparison of the R&D policies of Community member states*) meetings and studies regularly organised by the Committee for Scientific and Technical Research (CREST) in the second half of the 1980s will attest. Now, on the basis of the principle of subsidiarity, the existence of a supranational body the competence of which extends into the scientific and technological field is acknowledged, and attempts are being made to

redirect efforts towards co-ordination by basing them on reciprocal relations between the Union and national states.

Two other important changes affecting R&TD were concerned with defining its budget and approving the framework programme. Regarding the budget for the framework programme (which now includes *all* the Community's research and development activities), the Maastricht Treaty adopted the restrictive position suggested by the Council in its clash with the Parliament over the financial arrangements for the third programme: whereas the Single European Act stated that the framework programme should "fix the amount deemed necessary", it was now to "fix the maximum overall amount" (Art.130 i). The budget therefore cannot be augmented to meet needs which might arise in the course of pursuing the objectives of the Community's scientific and technological policy.

As regards decision-making procedures, it should first be pointed out that research and development is the only area of Community policy for which unanimous approval by the Council is required, in addition to a co-decision between Council and Parliament. Specific programmes may, however, be approved by a qualified majority in Council; in respect of such programmes, the Parliament is merely consulted and has no power of co-decision; nor does it co-operate in their adoption, as it did under the Single European Act. The co-decision procedure for approval of the framework programme is based on Art.189 b of the Maastricht Treaty and also applies to other areas of Community intervention (free movement of workers, right of establishment, internal market, education, culture, health, consumer affairs, trans-European networks and environment). It is a particularly long and complicated procedure, and for this reason has been much criticised. It provides for the final decision to be taken by the Council, but with the possibility of three readings and exercise of the veto on the part of the Parliament. As always, it is the Commission's task to put forward a *proposal*; the Parliament gives its *opinion*, and the Council must unanimously adopt a *common position*. If the common position adopted by the Council is approved by the Parliament, or the Parliament does not express an opinion within three months, the Council may then adopt the act in question. If the Parliament rejects the common position or proposes amendments, the *Conciliation Committee* is convened, which consists of the members of the Council, an equal number of members of Parliament, and representatives of the Commission. If the Conciliation Committee approves a *joint proposal*, this must then be ratified by both Council and Parliament, otherwise it will lapse; if it does not approve, the Council still has the opportunity to re-present its original common position, with amendments if appropriate, and this is considered to have been adopted unless the Parliament finally rejects it within six weeks. It will be apparent from this that the procedure is potentially very long, and its effectiveness depends entirely on the capacity of the three institutions to communicate continuously among themselves. The "trialogue", formally defined as "tri-partite inter-institutional dialogue between Council, Commission and Parliament", must necessarily be constructive and uninterrupted.

As for the direction taken by technological research and development policy in the aftermath of Maastricht, the positions adopted by the Commission were based on an analysis of the competitive position of Europe vis-à-vis the other two members of the "Triad" dominating the world economy, the United States and Japan[7]. In the Commission's judgement, from examination of patent applications and

the technological balance of payments, the relative position of European industry has shown a steady deterioration over the last decade, particularly in high-tech sectors of industry.This would seem to be at least partly the result of declining investment in R&TD in many European countries: compared with figures of 2.8% of GNP in the USA and 3% in Japan[8], the average for the Member States stands at around 2.1%.Whereas expenditure - mainly public - on "academic research" in Europe is relatively high, and evident in the existence of many "centres of excellence", private funding, which has more direct consequences for the competitiveness of industry, is less than in the USA and Japan.And another major factor in Europe's lagging behind would seem to be a lack of researchers and specialised personnel in such key sectors as information technology and electronics, systems engineering, bio-technology and advanced materials.All in all, the main problem afflicting European industries is the absence of a comprehensive innovation policy, which would make it possible a) to convert R&TD activities into actual inventions and innovations and b) to convert the latter into successful products.While the technological gap is most evident in electronics, Europe is nevertheless strong in certain areas, notably automobile manufacture, chemicals, pharmaceuticals and aerospace. Here at least, the continent can boast several "centres of competitiveness".A priority of the Community is to recognise and make the most of the many specialisations of the various European countries.

In keeping with the basically laissez-faire emphasis of the Maastricht Treaty's provisions in respect of industrial policy, the Commission recognised that ultimate responsibility and initiative in the industrial and technological field lies with businesses, with the market as the regulator and driving force of economic efficiency.There are, however, certain important tasks, besides regulating markets and ensuring the compatibility of European and international norms, that national governments and the Community itself must attend to. Firstly, though the original basis of the Single Market was a framework of legislation and regulations, it is now evident that material measures are required, with governments undertaking to build major trans-European networks in the transport, energy and telecommunications sectors. Secondly, national governments and the Community need to give more energetic support to technological research and development, as happens in the United States and Japan, despite the declared American aversion towards any kind of industrial or technological "policy". In any case, the "twin track"[9] of market deregulation on the one hand and support for technological collaboration on the other, like the dialectic between laissez-faire and central government intervention, have always been a part of Community life and have not necessarily proved incompatible.

To achieve the stated objectives, or "our ambitions" as the title of the Commission document proposing the financial programme for the period 1993-1997 (better known as the "Delors II package"[10]) puts it, the Commission proposed huge increases in Community expenditure on R&TD. In the context of a general and progressive increase in the Community's own resources, it was intended that expenditure on R&TD should increase from 2.4 billion ECU in 1992 to 4.2 billion in 1997, which represented almost 5% of the total Community budget.This was a large increase, over 70% in five years, but evidently in line with earlier Council decisions. The proposal was put forward by the Commission immediately after the Maastricht Treaty was approved, on the huge wave of political consensus surrounding the birth of the Union.This pro-Europe "state of grace" was, however, not to last.

The Danish "no" in the referendum to ratify the Treaty, the half-hearted (51%) French "yes" on the same subject, and the monetary crisis of September 1992 all helped create a less favourable atmosphere for proposals for further expansion of the Community, whether in financial or other terms.

At the European Council meeting held in Edinburgh on 11 and 12 December 1992, the Delors package was substantially approved by the Heads of State and Government, and with it the expenditure provisions for "internal policies", which, under the new Treaty, include technological research and development. The increase in the R&TD budget was not as great as the Commission proposed, but neither was it a case of "zero growth", with expenditure levels held at 1992 levels, as some governments had proposed. On the other hand, the European Council rejected the Commission's proposal to use the framework programme as the instrument of a more aggressive industrial and technological development policy which would partly abandon the principles of pre-competitiveness. (An initial working document on the Fourth Framework Programme had been prepared on the basis of this proposal)[11]. The final communique of the European Council meeting in Edinburgh stated that "Community support for R&TD should continue to focus on generic, pre-competitive research and should be multi-sectoral in application. EUREKA should remain the principal vehicle for supporting research activities which are nearer to the market, and the Commission should bring proposals to improve synergy between Community research activities and EUREKA. The Community should give priority to improving the dissemination of results among businesses, particularly small and medium-sized ones, ensuring the cost-effectiveness of investments and coordinating national programmes. These conclusions should be reflected in the consideration and adoption of the Fourth Framework Programme"[12]. Although the general aims of science policy are a variable product of interaction between such bodies as the Council of Ministers, the Commission and the Parliament, and, at the non-institutional level, the European scientific and industrial communities, these recommendations expressed by the Community's highest political authority were bound to have a determining influence on the structure of the framework programme.

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3. PREPARING THE FOURTH FRAMEWORK PROGRAMME (1994-1998)

In June 1992, Jacques Delors was confirmed as President of the Commission for a further two years, and when the new Commission was installed in January 1993, responsibilities for research and development were redistributed. The Commissioner for industry, Martin Bangemann, became responsible for information and telecommunications technology, with the result that both Directorate-General III (industry), which also took over management of the ESPRIT programme, and Directorate-General XIII (telecommunications, information market and exploitation of research) came under his control. New Commissioner Antonio Ruberti assumed responsibility for science, research and development (DG XII), the joint research centre (also DG XII), and human resources, education, training and youth (to be managed by a special Task Force). It thus fell to Commissioner Ruberti to formulate the Community's science and technology policy, and with it the principal instrument of that policy, the Fourth Framework Programme, setting out Community R&TD activities in the run-up to the year 2000. Preceded by wide-ranging consultation with European industry and the scientific community, the process of drawing up and approving the framework programme involved three main institutions: the Commission, whose task it was to present the proposals, and the Council and Parliament, which held joint powers of decision.

In April 1993, Commissioner Ruberti presented a working document on the Fourth Framework Programme[13], which concentrated on four main spheres of activity: 1) Research, technological development and demonstration programmes; 2) Co-operation with non-EU countries and international organisations; 3) Dissemination and application of the results of research; 4) Stimulation of training and mobility of researchers. The number of topics covered was reduced compared with the Third Framework Programme, and even more so compared with the proposals put forward by the outgoing Commission, falling from 35 to 20 under the first heading, and from 54 to 28 overall. This working document was prepared by DG XII in consultation with CREST and with help from the other Directorates-General involved in research and development, particularly DG III (industry) and DG XIII (telecommunications). Subsequently, on 16 June 1993, the Commission presented a "Draft Council Decision" on the Fourth Framework Programme. There were in fact two draft documents, since nuclear research activities still depended on EURATOM, which was not affected by the Maastricht Treaty, and all decisions on the subject therefore had to be taken separately and following different procedures.

These two draft documents constituted the basic text on which Council and Parliament had to work in arriving at a joint decision to adopt the framework programme. In theory, they could have made a wide range of amendments but, at this stage, the powers of the Commission are considerable, as Rolf Linkohr of the Committee on Energy, Research and Technology (CERT) explained at the time: "The Commission essentially presents a fait accompli in its proposal, which is well thought out, well argued, and coherent. It would be extremely difficult for Parliament to deconstruct this proposal and reassemble a significantly different one. Accordingly Parliamentary attention might more usefully be directed to the structural and organisational features which characterise EC research pro-

grammes, with a view to ensuring that the objectives of the Treaty on European Union are met"[14]. And of course, the same was true for the Council. The main area in which Parliament and Council could intervene was over the framework programme's budget, and the way funds were allocated to the various activities and sectors. The starting point was the Commission's proposal of 13.1 billion ECU for the five-year period 1994-1998, which represented 62% of the budget for internal policies, in line with the recommendation made by the European Council meeting in Edinburgh that somewhere between 50 and 66.6% should be devoted to research and development.

The inter-institutional dialogue leading to approval of the framework programme was subject to two time constraints, contingent but nevertheless important: the renewal of the European Parliament in June 1994, and the entry the new Commission in January 1995. Should the framework programme not be approved before the end of the life of the Parliament, dangerous delays might ensue, leaving the research programmes unfunded. And a similar situation might arise if the specific programmes were not ready for Council approval before the new Commission took office. Two steps were taken to avoid this problem: on the one hand, it was decided to set in motion the inter-institutional "trialogue", even though the Maastricht Treaty had not yet come into force; on the other, Commissioner Ruberti went ahead and presented the scientific content of the specific programmes in October 1993. These would not normally have been drawn up in detailed fashion until the framework programme had been launched, but in this way the Parliament was also allowed time to express its informal opinion on the specific programmes and was given a fuller context in which to decide on the framework programme as a whole.

The Council's work is conducted at various levels. The scientific and technical aspects of the framework programme are the province of CREST, a body consisting of representatives of the Member States which offers advice to both Commission and Council. Examination of the so-called "horizontal", or political and legal, aspects is entrusted to the working parties responsible for research and nuclear questions, which in some cases meet jointly. These two working parties are chaired by the delegation of the country holding the presidency of the Council at the time: in this case, respectively Denmark and Belgium for the first and second six months of 1993, and Greece for the first half of 1994. All the meetings are attended by at least one representative of the Commission, which supplies information and details on the proposals presented. The more political questions are discussed by the Research Council on the basis of documents prepared by the Committee of Permanent Representatives (COREPER). The COREPER also plays an important role as a filter between the Working Party on Research and the Council. To take an example, at the COREPER meeting held on 30 September 1993, it was decided that the more "technical" problem of relations between programmes formally dependent on the EEC Treaty and those deriving from the EURATOM Treaty should be referred back to the Working Party on Research for further discussion, while the more "political" problem of the future role of the JRC should be tackled by the Council.

Discussions between member countries in the context of the Working Party on Research are concerned mainly with the scientific and technological priorities of Community research, and therefore with the way in which financial resources should be allocated to specific programmes. In June 1993, the Danish presidency proposed the adoption of a method based on "fourchettes" (upper and

lower limits): taking the expenditure proposals formulated by the Commission as a starting point, the representative of the member countries would recommend maximum and minimum percentages for each specific programme. Attempts would then be made to gradually narrow the gap and arrive at a compromise figure on which all could agree. The joint Working Party meeting held on 15 September 1993 is a good example. Although compromises had nearly been reached on many programmes, in the case of information and telecommunications technologies positions still differed widely: Germany, France and Holland were proposing percentages higher than the maximum of 27%, Portugal a figure lower than the minimum of 24%, while the other countries were all somewhere within the limits[15].

A subject which had come up on several occasions was that of Preparation, Follow-up and Support Activities (APAS) in the scientific and technological field. For various reasons, a series of programmes and research and development initiatives had been funded apart from the framework programme. They included the SPRINT programme, concerned with the transfer of technological innovations, the high-definition television (HDTV) programme, and programmes launched on the initiative of the European Parliament to offer scientific support to the countries of Central and Eastern Europe and the former Soviet Union. A similar problem, though discussed separately because of its greater financial import, was that of THERMIE, a non-nuclear energy programme managed by DG XVII. The Maastricht Treaty stipulated that all research and development activities should come within the framework programme. It therefore needed to be decided how APAS fitted in, and how to share financial resources between them and similar specific programmes covered by the framework programme. In the energy sector, for instance, it was necessary to decide how resources should be shared between fusion, fission, Joule and THERMIE, and to discuss the appropriateness of integrating the two non-nuclear programmes. The Working Party also raised the question of the Parliament's intentions with regard to APAS. An answer was given by Claude Desama of the Committee on Energy, Research and Technology (CERT) in the course of an informal discussion between Council, Commission and Parliament: in compliance with the Treaty, the Parliament would undertake not to propose new APAS in the research and development field, but nevertheless reserved the right to set up new ones in support of other areas of Community policy, for instance industry or energy.

The Committee on Energy, Research and Technology (CERT) was the body chiefly responsible for amendments to the framework programme, but other parliamentary committees were also involved, expressing opinions on the basis of article 120 of the rules of procedure. The committees responsible for economic and monetary affairs and industrial policy, the budget, social affairs, employment and working conditions all had their say. The Parliament was very insistent that, with Europe suffering from an economic recession that was causing most member governments to restrict expenditure on research and development, if not reduce it in real terms, the Community budget must be increased rather than diminished. Investment in science and technology represented an investment in future economic development, and the Union should therefore pursue it, irregardless of economic cycles, so as to be able to compete internationally and climb out of recession. In the view of CERT, the Commission's proposal of 13.1 billion ECU for the Fourth Framework Programme was therefore barely sufficient, and represented an absolute minimum.

The decisive European Council meeting was held in Brussels on 10 and 11 December 1993, and ten days later the Research Council presented its joint position. This provided for a budget of 12 billion ECU for the framework programme, with the possibility of increasing the amount to 13 billion in the second half of 1996 if the progress of the programmes, the economic circumstances of the Union and the financial situation of the Community proved favourable. During its second reading of the draft decision, in February 1994, the Parliament was of the opinion that the Council had not taken sufficient notice of the forty or so amendments it had tabled, and in particular that the budget was far below the Union's real needs. This gave rise, for the first time, to the conciliation process between Council, Parliament and Commission provided for in the Maastricht Treaty. On 21 March, within the six-week deadline, agreement was reached: the overall budget was fixed at 12.3 billion ECU, to which a further 700 million might be added in 1996.

By invoking the conciliation process, the Parliament obtained an additional 300 million ECU for the framework programme, and influenced the way in which the funds were allocated: a victory for both Community research and the Parliament itself. With the new co-decision procedure introduced by the Maastricht Treaty, the Parliament's powers are, in theory, greatly increased. The outcome of the conciliation procedure illustrates how the political balance has in fact changed, with the Parliament fully intending to use all means at its disposal to give weight to its views in the Union. The process of approving the Fourth Framework Programme, completed successfully in under a year, has also shown that the co-decision procedure and the "trialogue" between Community institutions can be viable and effective. The importance of the Commission's contribution to the final happy outcome should perhaps be underlined: if Council and Parliament together generated the political will to arrive at an agreement, it was largely because the draft decisions on the form and content of the new framework agreement had taken sufficient account of the interests and needs of the member countries and of all those directly concerned in the research and development programmes.

Like the Commission's original draft, the Fourth Framework Programme covers four main spheres of activity. The first groups research programmes in the true sense of the word under seven general headings: a) Information and communications technologies; b) Industrial technologies; c) Environment; d) Life sciences and technologies; e) Energy; f) Transport; g) Targeted socio-economic research. The 15 specific programmes contained in the first sphere of activity are allocated more than four fifths of the total funding. The money is shared between them as follows (in millions of ECU): a) Telematics (843), Communications technologies (630), Information technologies (1932); b) Industrial and materials technologies (1707), Measuring and testing (288); c) Environment and climate (852), Marine sciences and technologies (228); d) Biotechnology (552), Bio-medicine and health (336), Agriculture and fisheries (684); e) Non-nuclear forms of energy (1002), Nuclear fission safety (414), Controlled thermonuclear fusion (840) (the two nuclear energy programmes come under the EURATOM Treaty); f) Transport (240); g) Targeted socio-economic research (138).

As the list of specific programmes shows, the framework programme continues to cover all the major fields the Community has been concerned with over the last ten years, and in absolute terms the funds allocated to them have generally increased, in some cases considerably so. Changes in the relative impor-

tance of the specific programmes are largely in line with past trends: the apparent increase in expenditure on energy research (up from 16.7% in the third, refinanced, framework programme to 18%) is due to the inclusion of research previously carried out in the context of the THERMIE programme[16]; the information and communications technologies sector continues to receive the lion's share of investment, but its relative importance is tending to diminish, from 39% to 28% of the total; while the percentages allocated to industrial technologies, environment and biological sciences remain virtually static. Research and technological development in the transport field, included for the first time in its own right, receives 2% of the overall budget. The targeted socio-economic research programme, in receipt of 1% of the total funding, is something completely new. It is concerned with three distinct sectors: evaluation of science and technology policy options; research on education and training; research into social integration and exclusion in Europe.

The other three spheres of activity are not sectoral in character and the activities they include have therefore been kept separate from those covered by the specific research, development and demonstration programmes. The second, concerned with co-operation with non-EU countries and international organisations, has been allocated a budget of 540 million ECU, though the amount originally requested by the Commission was considerably larger (790 MECU), to respond to the need expressed by several member countries for closer scientific collaboration with Eastern Europe. This signals an interest in new geographical areas and goes far beyond the objectives of the specific programme in aid of developing countries included in the Third Framework Programme. The third sphere, with a budget of 330 million ECU, plus approximately 1% of the resources allocated to each specific programme, is concerned with disseminating and exploiting the results of research. This represents a considerable boost to activities of this kind and had been requested in several quarters. The fourth and final sphere, Training and Mobility, is a continuation of the specific "Human capital and mobility" programme. It has been allocated a budget of 744 million ECU, a lower percentage than previously, but considerably more in absolute terms.

To conclude this brief analysis, we need to mention two new aspects of the Fourth Framework Programme, the first concerned with the Joint Research Centre, the second with assessment processes. The framework programme assigns two specific programmes to the JRC, representing a direct allocation of 900 million ECU. The JRC also continues to offer its *expertise*, to the various departments of the Commission and to third parties, on the formal basis of a client-contractor relationship. What is new, and represents a further step in "openness to the outside world", is that the Centre will now also be involved in indirect activities, i.e. other specific Community programmes, competing on equal terms with other European research centres.

In accordance with the terms of the Maastricht Treaty and the decision relating to the Fourth Framework Programme, the Commission initiated a revision of assessment practices, for both specific programmes and the framework programme as a whole. Firstly, in the coming years there is to be continuous monitoring of the specific programmes and the framework programme. This will be undertaken with the help of independent experts and will enable the Commission to present the European Parliament and Council with a progress report at the beginning of each year. Secondly, to ensure that assessment of the framework programme is completed by

the time future decisions need to be taken, it has been decided that the Commission will engage independent experts to undertake an external evaluation of the management and overall results of Community research and development activities carried out over each five-year period. When up and running, this system, together with annual reports, should provide a complete and accurate assessment on which to base proposals for the following framework programme.

Between 1974 and 1992, the Community's research and development budget showed steady growth (except during 1985-1986), and the rate of increase was distinctly higher than that recorded in the individual Member States over the same period. The Community's annual research budget in fact increased from 70 million ECU in 1974, to 284 million in 1980, approximately 600 million in 1984, 1.5 billion in 1990 and roughly 2.4 billion in 1992[17]. Compared with national expenditure on R&TD in the civil sector of the twelve Member States, the Community percentage increased from just over 1% in 1974 to 4% in 1992, with real sustained growth beginning in 1984. As a proportion of the overall Community budget, the research budget accounted for 1.8% in 1974, 2.6% in 1988, 3.1% in 1990 and 3.8% in 1992[18]. Although the period 1993-1994 was characterised by a reduction in spending on research, due to a lack of funding for the Third Framework Programme and uncertainties in the aftermath of Maastricht, the research budget as envisaged by the Fourth Framework Programme should again show an increase in 1995 and is expected to exceed 3.5 billion ECU in 1998.

In parallel with discussion of the Fourth Framework Programme, the Commission has been seeking to tackle the more prosaic, but nonetheless important, problem of how the Community's research and development programmes are managed. Management procedures constitute the first interface between the Commission and potential users, i.e. everybody involved in European research, and their effectiveness is therefore vital to the implementation of Community programmes. The need for changes derived in part from a big increase in the number of individual programmes, and their diversity. The first priority was therefore to standardise the different management procedures that had evolved over the years. However, any changes also had to take into account an important structural aspect of Community research: the Community does not fund individual organisations, but rather research consortia, which must necessarily be composed of bodies from different countries. Although on the one hand the variety and diversity of these consortia is a valuable asset, which the Community seeks to turn to advantage, on the other the resulting complexity is potentially a source of difficulties for the Commission and for the research bodies involved.

The first problem the Community had to tackle was that of publicising its research programmes. However, making contact with small and medium-sized businesses, universities and small-scale research institutions is not always easy, and awareness of Community programmes is not in fact as generalised as one might expect. For example, when asked why they had not taken part in the Community's medical and health programme, 70% of a small sample of top-level medical researchers answered that they had never heard of it[19]. Secondly, the Commission had to find ways of informing potential users of the characteristics of the individual programmes, application procedures and regulations. For this purpose, it has set up a Community-wide network of information centres (Euro-Info Centres), distributes an information bulletin to publicise its own R&TD programmes (RTD-INFO) and has created an on-line data-bank (CORDIS).

A series of initiatives was then put in motion to make it easier for small and medium-sized enterprises to take part in Community programmes. Many SMEs lack international contacts and have great difficulty in finding partners with whom to form a consortium. To solve this problem, the Commission has set up VALUE-Relay Centres in all member countries, and the ARCADE computer network, developed mainly for the Industrial Technologies and Materials Research programme (BRITE/EURAM). Taking as their model the BRITE/EURAM programme's Craft initiative, other Community programmes are now seeking to get round the difficulties encountered by SMEs in presenting complete and detailed projects demanding the commitment of significant resources.A two-stage procedure is envisaged: presentation of an outline project and, if this is accepted by the Commission, the award of a sum of money to enable the enterprise to present a full proposal.

Over the years, many scientists and industrialists involved in Community programmes have remarked on another series of problems which tend to make participation difficult: the lack of publicity given to competitions for research funding, uncertainty as to their timing, the excessive burden of paperwork involved, the restricted times allowed for the submission of proposals, and a lack of precise information as to the criteria adopted in selecting projects. In June 1993, the Commission looked into these questions, and there should be some definite improvements in the way access to programmes included in the Fourth Framework Programme is managed. Competitions for research funding will be announced four times a year, on fixed dates (15 March, 15 June, 15 September and 15 December); a minimum of three months will be allowed for the submission of proposals; the paperwork involved will be simplified, computerised and, as far as possible, standardised; assessment of the projects will be carried out by independent experts, employed on a rotating basis to ensure maximum transparency and provide an additional guarantee that research projects are assessed purely on the basis of their scientific and technological quality[20].

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4. CO-ORDINATION AND NEW COMMUNITY PERSPECTIVES IN R&TD

Defining and preparing the framework programme was only part of a far wider plan, the main aspects of which are set out in the Commission's White Paper on Growth, Competitiveness and Employment[21]. Starting in late 1991, the world economy entered a period of deep recession, and there was no mechanism to guarantee that, in an ever more competitive global economy, Europe could necessarily look forward to vigorous future growth. Still more serious in the Commission's view was the possibility that economic growth, when it came, might not be accompanied by a parallel increase in employment, and many factors seemed to indicate that this scenario was quite likely. If growth and employment were the two objectives for which the Commission invited the Member States to draw up effective strategies, the middle factor in the title of the White Paper - competitiveness - was the main instrument on which such strategies had to be based.

Stressing the contribution that the Single Market, completed in 1992, had made to the growth of the European economy in the second half of the 1980s, the Commission and its president, Jacques Delors, to whom should go the credit for the inspiration and approach of the White Paper, saw the rapid construction of infrastructure networks as the next objective to be pursued by the Member States: the free movement of goods, services, capital and persons had become largely effective; now it needed to be made efficient. It was for this reason that the Heads of State and Government, taking on board the Commission document at the European Council meeting held in Brussels on 10 and 11 December 1993, adopted an action plan for the creation of trans-European networks in telecommunications ("information highways"), transport (mainly railways and roads but also air and river traffic), and energy (with new networks for transporting gas and electricity).

The creation of trans-European networks, already indicated as a priority in the Treaty on European Union, was seen as a pre-condition of the continent's economic growth, but in the medium to long term European society would have to concentrate on eduction and training, on the one hand, and research and technological development, on the other, if it was to ensure the competitiveness of its industry and economy and, more especially, offer the possibility of employment to all its citizens. If growth did not lead to more jobs, there was the inevitable and unacceptable prospect that European society would be split into two, with the progressive *de facto* exclusion of the unemployed from full enjoyment of the rights of citizenship. In the view of the Commission, it was essential to invest in human capital, stressing the raising of general levels of education and adapting existing education and training systems to meet the need for continuous training - training that might well have to continue throughout a person's lifetime to keep pace with ever more rapid and unpredictable economic and social changes. Where vocational training was concerned, the role of central governments remained crucial, but businesses were also called to play a more active part, if they were to become more competitive. And the objective was to create a "society based on knowledge", or an "intelligent society", it was also important to make the best of Europe's cultural and scientific tradition, and the wealth represented by its internal differences, by giv-

ing education and training a more European slant.

Regarding research and technological development, the White Paper put forward three main suggestions: an increase in investment, more efficient exploitation of new technologies and of the results of research, and co-ordination of activities at continental level. The Member States invest far less in research and technological development than do their direct competitors, the United States and Japan, and have a lower percentage of qualified research workers and technicians. The Member States must be committed to a progressive increase in expenditure on R&TD, to bring overall European expenditure up to 3% of GNP, on a par with Japan. At the same time, the number of scientists, engineers and technicians must increase. In both these areas, however, national authorities also need to pay careful attention to the quality of their initiatives, ensuring that their human capital is trained to a high level in advanced and expanding sectors of the economy, and that research and technological development activities result in products that the market requires. As the Commission sees it, increases in quantity and improvements in quality will be achieved only if governments encourage a far greater direct input on the part of industry, particularly the small and medium-sized enterprises which are a vital component of the continent's productive base, and establish more stable and effective links between universities, research centres and enterprises.

The third objective - co-ordination - is the one that most directly concerns us, because it raises questions about the Community itself, and because it was the focus of the Commission and other Community institutions' interventions in the field of science and technology policy during 1994. There is practically no Community document - from the EURATOM Treaty to the Single European Act, taking in the resolution of January 1974 and the final communiques of European Council meetings concerned with science and technology - which does not solemnly affirm that co-ordinating the research and development activities of the Member States is a priority objective of the Community. For this reason, the proposals put forward in the Commission's White Paper and the new commitment expressed by the European Council meeting in Corfu (1994) might legitimately be greeted with a degree of scepticism. And yet, if we compare the present situation with that of the early 1970s, when the then Commissioner for Research, Ralf Dahrendorf, presented his project for a "European scientific area" based largely on close co-ordination of national efforts, we see that many things have changed, and that the new co-ordination strategies drawn up by Commissioner Antonio Ruberti are far more likely to achieve their goal.

On the purely formal level, we have already seen that the Treaty on European Union gives the Community a more central role in this field, with the Commission now having the task of promoting the co-ordination of policies and programmes in the scientific and technological fields between the Community and the Member States, rather than between the Member States themselves. Secondly, we should note that a further criterion (the sixth "Riesenhuber criterion") has been included in the Fourth Framework Programme, which can be invoked to justify a Community activity: "...research activities which contribute to the mobility or improvement of Europe's scientific and technical potential and activities which improve co-ordination between the various R&TD programmes, between national and Community R&TD programmes, and between Community programmes and work being carried out in other international contexts"[22]. Here we have, on the one hand, con-

firmation of the importance of co-ordination and, on the other, an acknowledgement that effective co-ordination can and must be based on the results of European - and primarily Community - co-operation.

The crucial difference, compared with the past, lies in the extent and generalisation of Community and European co-operation. The approval of the Fourth Framework Programme is a sign that Community intervention in the scientific and technological field is no longer a marginal factor, as it undoubtedly was twenty years ago. At the same time, other forms of European scientific co-operation have developed. Community and European co-operation is now a fixed point around which co-ordination can be organised. Moreover, the increase in funding granted to the new framework programme is itself an implicit acknowledgement on the part of Member States of the importance of the European "added value" created by Community co-operation in R&TD, and this at a time when most governments are making cuts in the amounts allocated to science and technology in their own national budgets.

The need for effective co-ordination of national and Community policies, which the Commission is seeking to promote, is very obvious if we consider the simple fact that the member countries allocate 13% of their public research and development budgets to European co-operation (Community framework programme, plus funding of such bodies as the ESA, ESRF, CERN, EUREKA, etc.): even partial co-ordination of the national research activities in receipt of the remaining 87% would have a significant effect on the efficiency and productivity of European research, particularly in limiting the waste of resources arising from duplication. Traditionally, the problem of co-ordination has been tackled by attempting to persuade the national ministers responsible for research and development to keep one another informed of decisions taken independently, but this strategy has proved politically difficult to manage. The Commission is now proposing a more dynamic approach involving progressive co-ordination of national programmes by an intensification of co-operation at three distinct levels: determining policies, implementing them in actual research activities, and at international level..

a) Co-ordination of European Policies

Where the more political dimension of co-ordination is concerned, that of determining research and technological development policies, the Commission writes: "One thing is clear: Member States decide Community policy together but determine their own national policies. Of course, there is some interaction between the decisions taken at these two levels: although the general guidelines for the Framework Programmes are directed towards action by the Community, they are based on what is known about the national priorities and have a definite impact on national perceptions and analyses of the situation. This impact in turn depends on traditions and the level of research attained in the individual Member States"[23]. To improve the interaction between the national and Community dimensions, the Commission suggests a series of measures, both technical and political.

If co-ordination is to be effective, it is first necessary to have information on national science policies and standardised statistics on research activities. Where analysis of the science policies of Member States is concerned, CREST has played an important role, particu-

larly through the COPOL initiative and in undertaking evaluation studies of the impact of the Community's R&TD policy in member countries, while Eurostat has presented statistics which also cover the field of science and technology[24]. In October 1994, the Commission presented its first report on science and technology indicators (*The European Report on Science and Technology Indicators 1994*). With regular updates, this could prove to be an important instrument in co-ordinating national policies.

For assessment and forecasting purposes, the Community has set up three new instruments which could in future play an important role in co-ordination: the "Evaluation of options in science and technology policy" programmes, which come under the heading of targeted socio-economic research; the JRC's European Science and Technology Observatory, based in Seville; and ETAN (the *European Technology Assessment Network*), which will bring together the main European bodies concerned with technological perspectives and strategic studies. Compared with earlier Community programmes in this field, such as FAST, the ETAN project is born with a clear bias towards co-ordinating national policies, rather than a limited concern for Community co-operation and programmes: its chief task will be to provide analyses, observations and forecasts, which, dr awn up in the widest possible European context, will offer a common basis on which the Member States can decide their own national policies in the field of science and technology.

On a more political note, the Commission is proposing that there be far more occasions when national officials responsible for science and technology can meet to discuss future prospects, and that meetings at ministerial level be held on a fairly regular basis. A precedent has already been set by the first informal meeting of ministers for science and technology held at Schwerin, Germany, in July 1994. On that occasion, the ministers met not to take decisions on Community policy but for a wider-ranging and less formal discussion of their national policies and the extent to which they could be pursued at European level. The Council of Ministers could also become the most suitable forum for defining science policies in sectors where organisations distinct from the Community are concerned, such as the ESA, the CERN or the EMBL, here too on the basis of a progressive convergence in the policies of the various countries involved. The fact is that, with Austria, Finland and Sweden joining the European Union, Switzerland taking part in the Community's framework programme on the basis of bilateral agreements, and Norway being part of the European Economic Area, the memberships to the various scientific organisations and to the Union are tending to coincide. There is therefore a possibility that, in this new situation, the European governments may try to unify some of the decision-taking processes and, in the context of the Council, seek greater co-ordination of their R&TD initiatives at the European level.

The Commission has also suggested that a major role in the co-ordination process could be played by CREST and by the new European Science and Technology Assembly (ESTA), albeit working at different levels and in different ways. CREST is made up of representatives of the member countries and over the years has become increasingly involved in preparing specific Community programmes. However, its original mandate, dating from 1974, was that of co-ordinating national policies. About the ESTA, we shall have more to say later in this chapter.

b) Co-ordination of Research Activities

When it comes to implementation of national policies, there are three main factors making for co-ordination of member countries' research activities: Community co-operation itself, the European networks, and the activities of certain European scientific and technical organisations.

1) Community Programmes

Community co-operation implies some co-ordination, since, by definition, it imposes a degree of convergence between national and Community R&TD activities. The committees responsible for each specific programme consist of representatives of the member countries, so that national viewpoints are expressed not only on the major goals, priorities and fields of Community research - that is at the level of the decisions taken by Council and Parliament regarding the framework programme and specific programmes - but also on the choice of projects to receive funding. This makes it possible to co-ordinate part of the activities of individual countries with those decided at Community level.

As the Commission sees it, there is also a need for better co-ordination between individual Community programmes which include research and development activities in aid of specific industrial sectors, such as aeronautics, motor car manufacture and ship-building. Closer integration of programmes in these fields would lead to development more in keeping with the requirements of industrial research. This proposal is in line with the fundamental idea of the framework programmes, which calls for interaction between specific programmes in the pursuit of complex scientific and technological objectives relevant for other Community policies too (agriculture, energy, the environment, regional development, etc.). Objectives of this kind cannot be achieved by an individual programme, as is evident in the sectors mentioned above. Research activities in aid of aeronautics, for example, include work on air transport systems, traffic management and aeronautical technologies, which come into various Community R&TD programmes: industrial and materials technologies, telematics applications, transport, energy, the environment and information technologies.

In the future, research activities might also be co-ordinated through *supplementary programmes* involving only a few Member States and Community *participation* in programmes initiated by Member States acting together. These two types of co-operation are envisaged by the Maastricht Treaty but have not yet been put to the test, except in the context of EURATOM. No specific form of funding was allocated to them in the Fourth Framework Programme.

2) The European Networks

In many fields, the 1990s have seen a change of metaphor: in earlier decades, the aim was to create a "space", economic, scientific and technical. Now the talk is far more likely to be of "networks": transport networks, information networks, intelligence networks. The change is not fortuitous or simply the result of a change in linguistic fashion, but indicates that certain objectives have been achieved and new priorities have now arisen: many barriers have been removed and a European space has been successfully created, but

it remains neutral; the problem is now to integrate it and link its parts. Where R&TD activities are concerned, networks are an important aspect of European research, regardless of any Community contribution to their creation or operation, and have an important part to play in co-ordinating the research activities of member countries. This is because the bodies involved in a network tend to be funded nationally, even though the research projects are set up on a transnational, and in many cases genuinely European, basis. For the first time, the Fourth Framework Programme distinguishes three types of network, with a structure more solid and lasting than the traditional academic networks: *consortia*, following the pattern adopted for the "Fusion" programme; *concertation networks*, like those organised with Community support for the bio-medical programmes; and *thematic networks*, with technological and industrial ends in view.

A pioneer in this type of networking is the controlled thermonuclear fusion programme EURATOM, which as far back as the early 1960s instituted close collaboration using association contracts to co-ordinate the activities of existing specialised centres. The model is a planetary one, with the Commission at the hub and the national centres organised around it. Whereas in other fields of nuclear research EURATOM was not successful in competing with national programmes, in this case the Commission succeeded in bringing together an European "*invisible college*" of fusion and getting the best scientists from all the member countries to collaborate in a truly European project. The Europeanisation of the venture subsequently put the scientists involved in this field in a strong position vis-à-vis national governments meeting in Council: the resistances that had prevented the development of so many EURATOM research programmes could not develop here. As a result, the fusion programme has always enjoyed massive funding, even in periods of institutional crisis for the Community, and thus been able to achieve indisputable technical and scientific successes.

Concertation networks, as well as stimulating and increasing the efficiency of research in a given discipline, as for instance in the medical field, can also help redirect and improve the organisation of some types of research. This is certainly true of European Laboratories Without Walls (ELWW): given the obvious need for an interdisciplinary approach to the Community's bio-technology programme, it has been possible to set up a series of networks based not on distinct disciplines but on the study of a theme or the solution of a specific problem. These have proved extremely productive. Networks have also been a key factor in the STIMULATION/SCIENCE programmes, and the successive "Human capital and mobility" programmes, helping to mobilise Europe's scientific potential. On average, these European networks include between 10 and 50 member bodies, the "twinning" of laboratories representing the individual meshes of the net. Extending the metaphor, the transnational networks also tend to depend on "nodes" , or research centres of key strategic importance, which can supply the special infrastructures essential to a particular field of research. Finally, the characteristics of the European Network for Research in Global Change (ENRICH) are particularly interesting where co-ordination is concerned. It is intended that this network, launched in early 1993 and co-ordinated by the JRC's Environment Institute, should link up all research centres concerned with climatic change, within the Community and in the countries of Eastern Europe (where environmental research is as yet in its infancy), and get them to participate together in major world projects.

Although less directly, joint funding contracts for technological innovation are also intended to create European networks: the hope - largely realised - of the originators of ESPRIT and the other programmes devoted to new technologies was that participation in Community programmes would create fruitful links between companies, research centres and universities, and that these links would outlive the programmes themselves, albeit in different forms. Although these probably cannot be called networks, we can say that habits of collaboration have been formed, of a kind which certainly did not exist at European level before the 1980s, neither between research organisations (both public and private), nor between companies operating in the same sector. More recently, however, research networks with a more permanent and, at the same time, more complex structure have also been created in the industrial field to develop certain generic technologies: the best known examples are those deriving from the BRITE/EURAM programme, such as the "clean" automobile project or various projects in the aeronautics field. A network type of organisation is also particularly important for small and medium-sized enterprises wishing to collaborate in research and development, because they generally do not have the financial sources or infrastructure needed to launch large-scale research projects.

3) European Scientific Organisations

We have already mentioned the prospects opened up by the possibility of a single political authority determining the main thrust of a truly European science and technology policy including both Community initiatives and initiatives taken by intergovernmental scientific organisations. Now is the moment to briefly examine the links which already exist between the Community and a number of European scientific organisations.

Many organisations have been set up in Europe since the war. The chief purpose of some is to encourage communication and contacts within the scientific community. One such is the European Science Foundation (ESF), responsible for setting up the first European networks in many areas of basic research in the 1980s, or the Academia Europea and the All European Academies (ALLEA). Then there are multilateral programmes, such as COST and EUREKA which co-ordinate and fund specific scientific and technological research projects. Finally there are institutions of a sectoral nature, for example the European Organisation for Nuclear Research (CERN)[25], the European Space Agency (ESA), the European Molecular Biology Organisation (EMBO), the European Molecular Biology Laboratory (EMBL), the European Southern Observatory (ESO)[26], the Institut Laue-Langevin (ILL), the European Synchrotron Radiation Facility (ESRF), the Reading-based European Centre for Medium-Range Weather Forecasting (ECMWF)[27], and others.

Most of these bodies collaborate, or have collaborated, with the Community, but much can still be done to set up a truly European network to establish on-going, fruitful links between all the organisations working in the field of science and technology. This is why the second sphere of activity of the Fourth Framework Programme numbers among its objectives "collaboration with other European agencies set up for the purpose of scientific and technological cooperation". There are many existing instances of collaboration between specific Community programmes and specialised research organisations, such as the CERN and the EMBL[28]. There is also regular collaboration between the Commission and the European Science Foundation. For exam-

ple, the project to develop research in the social sciences at Community level, presented by the ESF in 1992[29], has had an obvious influence on the socio-economic research programmes adopted as part of the Fourth Framework Programme, and the Foundation is helping to organise conferences connected with the Community's training and mobility programme. COST, born in a Community setting, has continued to maintain - and strengthen - its close relations with the "mother organisation". Where EUREKA is concerned, the Union takes part in many of its research projects, but in future greater emphasis will be given to the division of labour already partly realised in some sectors, with pre-competitive, pre-regulatory research carried out under the framework programme, and more market-related projects pursued in the context of EUREKA.

The European Space Agency (ESA) is one of the European organisations with which the Community has particularly close links, co-operation projects having reached an advanced stage. First and foremost, the Community is an important customer of the Agency, buying services in the fields of remote-sensing of land resources and for telecommunications. Images and data supplied by the ESA have been used by the Community for many years in such areas as agriculture, for development purposes and to prevent fraud; the environment, in aid of the Corinne project, for instance; and development aid, monitoring natural resources in some parts of the Third World. For its part, the Community has initiated a number of R&TD projects connected with remote sensing and telecommunications. In the first of these two areas, the JRC's institute for remote sensing applications has carried out research in processing and interpreting satellite data, with special reference to the marine environment and agriculture. In the second area, the Community's interest focuses on the use of satellites for pan-European communications and research, in such programmes as RACE, DELTA and HDTV, has been mostly prenormative. In 1992, at the invitation of the European Parliament, and on the basis of two studies[30] and work carried out by the DG XII unit responsible for strategy and co-ordination in the space field, the Commission brought out a document entitled "The Community and Space", eventually adopted by the Research Council on 29 April 1993. Research was only one of the many topics covered. Here, the document called for "greater complementarity and synergy between Community R&TD programmes and the programmes of the ESA and Member States, in order to render European R&TD activity more effective"[31]. In 1993, the Commission set up an *ad hoc* consultative group, consisting of representatives of the Member States, to co-ordinate space research.

The European synchrotron (ESRF), built at Grenoble on the same site as the Institut Laue-Langevin's (ILL) neutron source, is the world's most advanced electron accelerator, a machine designed for studying the atomic and molecular structure of matter, contributing to research in physics, chemistry, materials science, biology and medicine. During the long negotiations leading up to its construction, the Community played a co-ordinating role between the member countries involved in the project. The idea of building a great machine of this kind was born in 1975 in the context of the European Science Foundation (ESF), but when a detailed feasibility study was produced in 1979, the Foundation realised that the cost was way beyond its means. The ESF therefore sought to interest other European organisations and so convince governments to provide the funding. Not until 1984/1985 did the project get off the ground: on the one hand, the Council of the European Communities declared the project to be of

"Community interest" and asked the Commission to present proposals for its realisation; on the other, France and Germany demonstrated a definite willingness to get on with the job. As a result of Community mediation, in 1988 ten European countries[32], in addition to France and Germany, signed the agreement to build a European Synchrotron Radiation Facility, which was eventually inaugurated on 30 September 1994.

c) International Co-operation

The final matter we need to consider in relation to co-ordination of the member countries' research policies and activities is co-operation with non-EU countries and European participation in international bodies. In this case, scientific co-operation is an aspect of the foreign policy of the European Union, or of the so-called political co-operation between the Member States, and is therefore related to the thorny problem of co-ordinating policies that have evolved independently over decades, if not centuries, and are closely bound up with the concept of national sovereignty. In this area, the co-ordination of national policies can find support in a series of activities in which the Community has been engaged for some time. These international co-operation activities, previously conducted in different contexts and following different procedures, are now grouped together under the Fourth Framework Programme's second sphere of activity. The Community's partners in these activities are of three kinds: industrialised and developing non-European countries, and the countries of Eastern Europe.

Co-operation policies with each of these three groups differ considerably. With the non-European industrialised countries - chiefly the United States and Japan, but also Canada, Australia, Israel and the nations of South-East Asia - the Union entertains excellent relations from a general political point of view, but commercially and industrially they are Europe's direct rivals in the "globalised" economy. Consequently, co-operation tends to be centred on basic mega-projects, such as fusion, genome sequencing or the study of climatic change, where no immediate economic interests are involved and the intellectual and financial investment required tend to encourage the widest possible co-operation. In this context, clear advantages derive from the fact that Europe is able to "speak with one voice" and in recent times there has been significant progress in co-ordination between member countries.

Three large-scale scientific co-operation agreements have been signed during the 1990s. In 1990, the Community entered into a bilateral agreement with the United States to set up a scientific and technical co-operation committee and establish a Task Force in the bio-technology sector. 1991 saw the inauguration, in Beijing, of the China-EC Biotechnology Centre (CEBC), which should also contribute to co-operation between the Community and China in all other fields of scientific endeavour, while 1994 saw the first meeting, in Tokyo, of the Euro-Japanese forum, the purpose of which is to promote regular consultations and exchanges of information on science and technology, and give a further boost to existing cooperative projects, for instance the "Human Frontier" international research programme and efforts to ensure the safety of nuclear materials.

Where the Third World is concerned, Community scientific co-operation has developed through agreements with individual countries, in the context of wider development programmes, and through the specific STD programme, launched in 1982 on similar lines to the United Nations' "Vienna Programme". In putting research and development at the serv-

ice of economic and social development, a dual strategy has been adopted: on the one hand, scientific research in industrialised countries should be geared to solving the most serious economic and social problems of the Third World, from famine to endemic diseases; on the other, development aid should also seek to strengthen local capacity to engage in scientific research and technological development.

Community involvement is centred on two major areas of research, agriculture and medicine, to combat the two primary scourges of the Third World: hunger and disease. In tropical and sub-tropical regions, agricultural research is concerned with improving yields, managing natural resources, protecting the environment, and agricultural technology. The sub-programme devoted to health research in tropical regions embraces medicine, hygiene and nutrition. The research projects are jointly funded and conducted by consortia of agencies from both the Community and the developing countries concerned. They may also include training and mobility activities. Community funding for S&T in aid of development has increased significantly over the years, from 40 MECU (1982-1986), to 85 MECU (1987-1991), to 111 MECU for STD III (1991-1994). Initially intended primarily for African, Caribbean and Pacific countries adhering to the Lomé Conventions, co-operation has gradually extended to other geographical areas.

The Community also engages in scientific and technological co-operation with many countries of Latin America, Asia and the Mediterranean Basin, often on the basis of agreements concluded with local multinational associations: the Rio Group, the Andean Pact and the San José Pact, where South America is concerned; the ASEAN (Association of South-East Asian Countries), in the Far East. 1991 saw the approval of the *Avicenne* initiative, promoted by the European Parliament, for co-operation with countries of the Mediterranean Basin in matters of the environment and health. The related projects, concerned with the management of water resources, renewable energy resources and basic medicine, are intended to involve at least two research centres belonging to different Mediterranean countries and one centre in a Member State country. The programme is as yet fairly modest, but given the Union's concern for balanced relations with Eastern Europe and the South of the continent, it is likely that in the near future Community co-operation with the Mediterranean countries will develop strongly, in terms of both quantity and quality.

Scientific and technical co-operation with the countries of Eastern Europe is of special political importance, since it involves European nations which are making the difficult transition to democracy and market economy, several of which have applied to join the Union. The countries of Central and Eastern Europe, and many of the independent states born of the break-up of the Soviet Union, have a large pool of top-level scientists and engineers who cannot now be employed to good effect for lack of economic resources. The aim of early Community initiatives was therefore to avoid a general "brain drain", which would have negative effects on the future development of Eastern Europe and is perceived as a potential threat to peace, given that a great deal of research, particularly in the Soviet Union, was previously carried out for military purposes. As part of the enormous task of converting the ex-USSR's military industry to civil activities[33], the European Union, together with Japan and the United States, has helped set up in Moscow an international science and technology centre, the function of which is to redirect military research towards civil ends. Another sphere in which western con-

cerns have led to rapid development of scientific co-operation is the nuclear industry: in 1991, the Community, in conjunction with Russia, the Ukraine and Byelorussia, launched a research programme on the effects - on people and the environment - of nuclear accidents of the kind that occurred at Chernobyl in 1986.

More generally, the Union is mindful of ways in which an end to the isolation of scientists in East and West might be of great advantage to both sides, and of how science may be the field in which cultural reunification of the continent can make most rapid progress. It has therefore initiated many other projects to further co-operation with Eastern Europe. In 1990, the European Community coordinated an international programme in aid of economic reconstruction (PHARE), involving 11 Central and Eastern European countries, which included several projects devoted to science, education and vocational training. In 1992, on the initiative of the European Parliament, the Community launched a specifically scientific programme (COPERNICUS) with the countries of Central and Eastern Europe in mind. Its provisions included student bursaries, the creation of research networks, conferences, definition of joint projects, and the participation of Eastern European research centres in some aspects of the Third Framework Programme. In the last few years, some Central and Eastern European countries have also taken part in COST activities. 1993 saw the birth of the INTAS association, to promote co-operation with the scientists of the former Soviet Union, as part of a far wider programme of technical assistance known as TACIS[34].

At the end of 1994, when the Commission presided by Jacques Delors ended its term of office, co-ordination of national policies was seen as the major challenge faced by the Community in the scientific and technical field. This challenge could be faced with a degree of confidence, given the good track record and the established European importance of Community co-operation, and the great leap forward represented by the Fourth Framework Programme. According to Commissioner Ruberti, progress from co-operation to co-ordination also implied the transformation of "European Science", as it existed already, into a full-blown "Scientific Europe", still in part to be built[35]. A Scientific Europe meant, first of all, an integrated space in which every form of scientific and technological collaboration would have room to develop. But it also meant making European citizens aware of the achievements of these years and the reasons why some research objectives had been preferred to others. It also implied some deep thinking about what characterises European research and the sources from which it has sprung. Finally, it meant a rapprochement between Europe's scientific community and the decision-making bodies of the Union. To lay the foundations for this more complete Scientific Europe, the Commission launched two initiatives, the European Scientific Culture Week and the European Science and Technology Forum, and set up a European Science and Technology Assembly (ESTA).

The first European Week for Scientific Culture took place in November 1993 (followed by a second a year later), with events, exhibitions and debates in all countries of the Union, on the pattern of similar initiatives undertaken at national level. The purpose was to enhance awareness of science and technology, interest young people in the scientific disciplines, and demonstrate that science is an important and indispensable component of culture. What gave the event a European dimension was not only its geographical coverage and the participation of bodies, organi-

sations and personalities from all over Europe, but its actual content. It focused on two things: the diversity of practices and differing perceptions of science in individual countries, which represents a great asset for Europe, and, on the other hand, the unity achieved in many fields of research by Community and European co-operation initiatives. The Week should also be seen as part of a more general Commission project to give European citizens a sense of belonging to the Union. Making them aware of what the Community is doing in the economic, social and cultural spheres is a way of ensuring that the idea of European citizenship does not remain a legal form - useful and welcome as that may be - but becomes the basis of a new collective identity.

In promoting the European Science and Technology Forum, the Commission intended to reactivate debate on the social, ethical and historical aspects of science and technology in Europe, a debate initiated twenty years before under the auspices of ESIST (*European Society and its Interactions with Science and Technology*). The situation has of course changed radically since the 1970s: Europe is now a largely integrated economic space; the European Union is beginning to assume a political role at the international level; in many fields, from the environment to health, from telecommunications to competition policy, European directives are being applied in national law; the Community's R&TD policy is a consolidated reality. In this new setting, the Forum is intended to be a place of reflection on innumerable scientific and technological subjects of European importance, and also on the possibility and usefulness of redefining certain problems in a truly European dimension. Forum conferences, prepared in smaller seminars, are attended by scholars from various branches of the human and social sciences, research workers and scientists, and the directors of national and European research centres. The first five meetings to consider the European dimension of science and technology, held during 1994 in various European cities, were concerned with the following topics: scientific expertise in public debate in Europe (London); science and languages in Europe (Paris); science and power: the historical roots of science policy (Florence); problems and prospects of the education sciences (Lisbon); science, philosophy and the history of science in Europe (Paris). The results of Forum research and debate are published regularly in a special journal.

The European Science and Technology Assembly (ESTA), which was created by the Commission on 16 March 1994 and met for the first time on 6 September, is concerned with Community co-operation and European co-ordination. Its task is to work for closer links between the European scientific community and both industry and the Union. The new Assembly is made up of one hundred scientists of established reputation, including a number of Nobel prize winners. They are appointed "ad personam" by the Commission, on the recommendation of major European organisations concerned with R&TD, for instance the European Science Foundation (ESF), the Academia Europea, the All European Academies (ALLEA), the European Rectors' Conference (ERC), the European Council of Applied Sciences and Engineering (EUROCASE) and the European Industrial Research Managers Association (EIRMA). Other members are chosen directly by the Commission, and the Assembly also includes the members of CODEST, a committee which was dissolved to make way for the new body. The Assembly is representative of Scientific Europe geographically, as well as in terms of the technological sectors and disciplines it takes into account. Its members come from all countries of the Union, including newcomers Austria,

Finland and Sweden, and also from Iceland, Norway and Switzerland

On the one hand, as it brings together people performing important functions in the major European and national bodies concerned with scientific co-operation and research, the Assembly necessarily plays a role in co-ordinating the policies of the different countries, and this task has also been assigned to it formally.

On the other, as a top-level consultative committee appointed to assist the Commission in implementing the Union's research policy, it works in the interests of Community co-operation, taking over the task formerly performed by CODEST.

In accordance with its mandate from the Commission, the Assembly's first task is to offer advice on the framework programme and the specific programmes, and on all questions regarding the management of scientific and technological programmes, from criteria for assessing potential research projects to methods of selecting experts. Secondly, acting on its own initiative, the Assembly may express opinions on science and industrial research, and formulate proposals regarding new methods and spheres of research. These are to be based on the widest possible discussion within the Assembly itself of the development of science and technology in Europe and worldwide, and of their economic and social impact. The ESTA is therefore called to act as the Commission's "sensor", so that the Union's research policy can be as flexible as possible and finely tuned to the rapid and often unforeseeable changes that are occurring in science and technology, and the new demands imposed by society and the economy.

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5. TOWARDS THE INTERGOVERNMENTAL CONFERENCE

In January 1995, Jacques Delors retired from office, unanimously congratulated for his many achievements and for his contribution to the construction of Europe. A new five-year Commission was established, the first to be based on the Treaty on the European Union.

A new commissioner for research was appointed, Edith Cresson, formerly Prime Minister of France. From Antonio Ruberti she inherited the double portfolio of research and education, and the area of her responsibility was extended to cover innovation, giving her authority over that part of DG XIII in charge of the diffusion and optimisation of research results beyond DG XII, the JRC, and the newly created DG XXII for education, training and youth.

That these two fields of research and training - united under Antonio Ruberti for the first time since Ralf Dahrendorf - have been kept together has not happened by chance. In the 1990s, there has been a growing tendency all over Europe to group these concerns together. This reflects the growing awareness on the part of governments of the importance of training for the growth of competitiveness and social well-being, and of the vital role, in a society dominated by knowledge and information, of "intangible investments".

As soon as the new commissioner took up her position, she announced her intention to keep the co-ordination of research policies at the top of the European Union agenda. Her first initiatives were also explicitly inspired by a desire to increase the impact of the European Union's research on the economy and on the industrial base. During the first months of her mandate, Mrs Cresson set up a series of industrial research "Task Forces" in collaboration with two colleagues, Martin Bangemann and Neil Kinnock, respectively responsible for industrial affairs and transport. These initiatives were designed to help European research to translate its achievements into practical results, and to match Europe's technological competitors.

These Task Forces are first and foremost Commission internal structures. They work in close collaboration with industry and with users of technological products and services. The fields chosen for the first Task Forces are simultaneously of great importance to industry and of social relevance. Task Forces have been, for instance, set up in the areas of transport ("The car of the Future", "The train of the Future", "Intermodal Transport"), health ("Vaccines and Viral Diseases"), education system ("Multimedia Educational Software").

The Task Forces' mandate is threefold. Their first task is to identify, in the various fields covered, social and industrial needs, and the corresponding research priorities. The second is to prepare the launching of research actions within the specific programmes of the Fourth Framework Programme (1994-1998), and also on the basis of the European Union Treaty Articles 130 k, l, and n, which allow the Union to launch supplementary programmes, participate in national initiatives, and set up joint undertakings. The third role is that of studying the measures to be taken in order to improve the financial and regulatory environment of enterprises, so as to help them to better exploit their research results.

Following the orientations set out for the European Union research policy in the two previous years, a prime objective of the Task Forces is to improve the co-ordination of research activities between the Member States. Another aim is to make the work of European researchers more visible to European citizens.

As we reach the present day, another important item on the EU research agenda is preparation for the Intergovernmental Conference (ICG) which is due to start in 1996. The objective of the Conference is to update the European Union Treaty as agreed in Maastricht, improving the organisation of the Union's new policies in the fields of external affairs, security and justice, and preparing for the future enlargement of the Union.

The IGC will make some changes to the Union's institutional structures and legal procedures. This will not be without consequences for policies other than those set up by the Maastricht Treaty; and clearly the opportunity will be taken to re-open discussions on the way the Union operates in its traditional roles, for instance in the field of research.

One of the main changes in the area of research and technological development might be the replacement of unanimous voting for the adoption of framework programmes by a qualified majority vote in the Council. Another might be the simplification of decision-taking procedures for the implementation of specific programmes. The nature and extent of these changes will depend on decisions taken at other levels. Once again, the history of the European Union research and technological policy cannot be considered separately from - and is organically related to - the broader history of the European Union.

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NOTES

1 Altiero Spinelli, *L'idea di Europa*, Florence, 1979, quoted by Pier Virgilio Dastoli and Giancarlo Vilella in *La nuova Europa. I difficili scenari del dopo Maastricht*, il Mulino, Bologna, 1993, p.17.

2 For details of the plans for a European political community, see Mario Ferrari Aggradi, *Europa: tappe e prospettive di unificazione*, Studium, Rome, 1958; regarding the EDC, see also Raymond Aron and Daniel Lerner (eds.), *La querelle de la C.E.D.*, Armand Colin, Paris, 1956.

3 For details of the Fouchet Plan, see, for example, Charles Zorgbibe, *La construction politique de l'Europe*, PUF, Paris, 1978.

4 For details of the draft Treaty by the European Parliament, see Altiero Spinelli, *Diario europeo 1976/1986*, il Mulino, Bologna, 1992; and Bino Olivi, *L'Europa difficile. Storia politica della Comunità europea*, il Mulino, Bologna, 1993.

5 The Treaty on European Union was published in the *Official Journal of the European Communities*, 31 August 1992.

[6] The contents of this section are also based on Philippe Moreau Defarges, *Les institutions européennes*, Armand Colin, Paris 1993; Jacques Delors, *Le nouveau concert européen*, Odile Jacob, Paris 1992; and John Pinder, *European Community. The Building of a Union*, Oxford University Press, Oxford, 1991.

[7] Discussion of the supposed *technology gap* between Europe and its rivals continued during the 1980s, albeit in less dramatic terms than previously. For further information, see, for example, Andrew J. Pierre (ed.), *A High Technology Gap? Europe, America and Japan*, Europe/America, No. 6, Council on Foreign Relations, New York, 1987; and Pari Patel and Keith Pavitt, "Is Western Europe losing the technological race?", *Research Policy*, 16, 1987, pp.59-85. Whilst stressing major differences between the various sectors and nations, Patel and Pavitt in their article finally conclude that the answer is that Europe is not losing the technological race.

[8] In the Commission's document [*Research after Maastricht*], the figure for Japan is given as 3.5%, but this is clearly an error: even at its peak level, in 1990-1991, the percentage of GNP devoted to R&D by the Japanese never exceeded 3%.

[9] The expression was coined by Margaret Sharp and is discussed in her article "The single market and European technology policies" in Christopher Freeman, Margaret Sharp and William Walker (eds.), *Technology and the Future of Europe: Global Competition and the Environment in the 1990s*, Pinter, London and New York, 1991, pp.59-76.

[10] The document in question is *From the Single Act to Maastricht and Beyond: The Means to Match Our Ambitions*], COM (92) 2000 final, Brussels, 11 February 1992; but see also *The Community's Finances between Now and 1997*, COM (92) 2001, Brussels, 10 March 1992. The first "Delors package" *Making a Success of the Single Act. A New Frontier for Europe*, presented in 1987, was concerned with financial planning for the period 1987-1992.

[11] See Commission of the European Communities, [*Working document relating to the fourth framework programme of Community activities in the field of research and technological development (1994-1998)*], COM (92) 406 final, Brussels, 9 October 1992.

[12] According to many observers, the heavy emphasis placed by the European Council on pre-competitiveness is also to be interpreted as a concession to the United States, in the context of the Uruguay Round of GATT negotiations, to demonstrate that it is not EU policy to subsidise industry.

[13] See Commission of the European Communities, *Second Commission working document concerning R&TD policy in the Community and the fourth framework programme of Community research and technological development activities (1994-1998)*, COM (93) 158, Brussels, 22 April 1993.

[14] Rolf Linkohr (Rapporteur), *Draft Report on the Commission proposal for a Council Decision concerning the fourth framework programme*, European Parliament, 13 October 1993, p.32.

[15] In writing this section, we have drawn mainly on reports of meetings of CREST, the Working Party on Research, the Working Party on Nuclear Questions, the Joint Working Party and COREPER, drawn up by the Interinstitutional Relations Unit of DG XII.

[16] Only certain of Thermie's economic demonstration activities in the energy field are now being carried on outside the framework programme.

[17] For these statistics, see Eurostat, "Research and Technological development", in *Europe in Figures*, CEC, Luxembourg, 1992, pp.100-05.

[18] For figures prior to 1980, we have drawn on CEC, *Community research and technology policy: Developments up to 1984*, CEC, Brussels, 1985. For 1992, see *Twenty-sixth General Report on the activities of the European Communities - 1992*, CEC, Brussels, 1993.

[19] See Alan Maynard et al., *Evaluation of the Fourth Medical and Health Research Programme (1987-1991)*, DG XIII, Luxembourg, July 1990, p.5.

[20] Regarding the management of research programmes, the Commission has recently published a booklet of exemplary clarity; see European Commission, *Research and development activities financed by the EC. Treatment of project proposals - Introduction to contractual negotiations*, Luxembourg, January 1994 (a slightly different version, with more sober graphics, is published under the title, *Scientific research in the European Union*).

[21] Commission of the European Communities, *Competitiveness, Growth, Employment. The challenges and ways forward into the 21st century - White Paper*, COM (93) 700 final, Brussels, 5 December 1993.

[22] European Parliament and Council, "Decision n. 1110/94/EC of the European Parliament and Council, 26 April 1994, relating to the fourth framework programme of Community research, technological development and demonstration activities (1994-1998)", Annex II, *OJEC*, 18 May 1994.

[23] Commission of the European Communities, *Research and Technological Development: Achieving Coordination through Cooperation*, COM (94) 438 final, Brussels, 19 October 1994, p. 4. This document, together with the White Paper, has been our principal source in discussing the question of co-ordination.

[24] It is also worth recalling the worthy efforts of the OECD's Committee for Scientific Policy, which since the 1960s has been producing in-depth analyses of the science policies of all industrialised countries, and has also drawn up a series of categories, published in the "Frascati manual" and its supplements, for gathering coherent statistical data on research and development activities.

[25] To completely eliminate its "nuclear" connotation, the CERN has recently changed its name to European Laboratory for Particle Physics, whilst keeping the old acronym.

[26] The ESO is a scientific organisation set up in 1962 by Belgium, Denmark, France, Germany, the Netherlands and Sweden (joined in 1980 by Italy and Switzerland). Its European headquarters is in Garching and it runs an astronomical observatory in La Silla in the north of Chile.

[27] An offshoot of the COST 70 project, the ECMWF is concerned with medium-range (2-14 days) weather forecasting.

[28] To strengthen Community co-operation with these two organisations, the Commission signed administrative agreements with the CERN in October 1998, and with the EMBL in January 1995.

[29] See European Science Foundation, *The ESF and the Social Sciences*, Strasbourg, 1992.

[30] See Commission of the European Communities, *The European Community and Space: A Coherent Approach*, COM (88) 417, Brussels, July 1988; and Roy Gibson et al., *The European Community: Crossroads in Space*, CEC, Luxembourg, 1991.

[31] Commission of the European Communities, *The Community and Space: Challenges, Opportunities and New Actions*, COM (92) 360 final, Brussels, 23 September 1992, p.35.

[32] The countries were Belgium, Denmark, Finland, the U.K., Italy, Norway, the Netherlands, Spain, Sweden and Switzerland. Legally speaking, the ESRF is a company operating under French law and the scientific co-operation agreement is between national scientific organisations.

[33] The Commission has recently published an interesting study on this subject; see Marco De Andreis and Francesco Calogero, *Conversion of Military Research and Development in the Former Soviet Republics - The Future of their Nuclear Weapon Complex: An Update*, CEC-DG XII, Luxembourg, 1994.

[34] The information on co-operation with Eastern Europe is taken from European Commission, *Scientific and Technological Cooperation with Eastern Europe*, DG XII, Brussels, 1994.

[35] See Professor Antonio Ruberti's speech to the *European Technology Forum*, Bonn, 7 September 1994.

CONCLUSIONS

"I marvel each time a historian comes to ask questions about my past, and I see that he is already familiar with it, and knows about the connections between ideas and events, but wants more details. It is clear that these obscure philologists (as Croce would have called them) are those who are preparing and sorting the material that will eventually enable a historian to produce a true synthesis, from which much of the dross assembled by the philologists will have vanished."

Altiero Spinelli, Diario europeo 1970-1976

This work is intended merely as an introduction to the history of science and technology in the European Community, a first attempt to impose some order on a subject which had never been dealt with systematically. A history in the true sense remains to be written, and because a "true synthesis" is as yet to see the light, there is still much "philology" to be done. Indeed, as the reader will have noted, the selection of sources has been anything but philologically rigorous; the only method actually adopted has been that suggested by Paul K. Feyerabend: "anything goes". What we have tried to respect, with recourse to varying levels of analysis, is the complexity of the subject, a complexity deriving from the interaction of the European and national dimensions, from the number and variety of the actors involved, from the influence of political, legal and economic factors as well as the scientific and technical ones.

Our attention has been primarily focused, albeit not exclusively, on the Communities' scientific and technological *policies,* and on the underlying decision-making processes. We have therefore tried to highlight the role - as

proposer and executor - played by the Commission and its Directorates-General. We have referred to Decisions of the Council and of the Parliament, but it is perhaps worth recalling that the Council too has been composed of ministers from six, nine, ten, twelve European nations, and now fifteen. We have shown the growing importance of the work of the European Parliament in the field of science and technology. The links between the broader process of European integration and the specific RTD policies have been constantly taken into consideration, and we have turned our attention to individual European nations or political and economic events of world significance as appropriate to the historical period under discussion. As we have reviewed the many scientific and technological fields in which the Communities have intervened, we have been able to deal with free research and "big science", basic research and industrial development; occasionally we have dwelt on technical and scientific achievements which seemed to be particularly important.

In 1948, the year which we have chosen as the start of this history, "Scientific Europe" did not really exist; its growth in the nearly fifty years since then is beyond doubt, and although there is much yet to be done it can now be taken as an undeniable fact. This "Scientific Europe" is made up of universities, laboratories, public and industrial research centres in every Member State, of the organisations and international initiatives which have been developed at European level, and of the Communities' programmes and research centres. Whereas twenty years ago it was still possible to talk of a clear contraposition between national and intergovernmental initiatives on the one hand and Community endeavours on the other, today the situation is very different. The multiplication and strengthening of European research networks, representing a form of co-ordination from the bottom up; the qualitative and quantitative growth of Community programmes, with the new framework programme as an independent variable that gives the Union new ways to situate co-ordination; the possibilities of setting up supplementary programmes involving only certain Member States and those allowing Community participation in national programmes; the commitment to closer scientific and technical co-operation with countries outside the EU and the major European scientific organisations: all these are factors that help to potentiate European science, and all of them contribute to the completion of the "Scientific Europe" project.

CHRONOLOGY OF SCIENTIFIC RESEARCH IN THE EUROPEAN COMMUNITIES

1948

1.1.1948:
Customs Union between Belgium, the Netherlands and Luxembourg (BENELUX) comes into force.

17.3.1948:
signature of the Treaty of Brussels instituting the Western Union between Belgium, France, Luxembourg, the Netherlands and the United Kingdom.

16.4.1948:
16 countries set up the Organisation for European Economic Co-operation (OEEC).

7/10.5.1948:
Congress on European Unity held in The Hague.

25.10.1948:
birth of the European Movement (EM), bringing together organisations working for European unification.

1949

4.4.1949:
signature of the Treaty instituting the North Atlantic
Treaty Organisation (NATO).

5.5.1949:
signature in Paris of the statute of the Council of Europe.

8/12.12.1949:
European Conference on Culture held in Lausanne.

1950

9.5.1950:
speaking in Paris, Robert Schuman proposes that Franco-German coal and steel production be placed under a single authority, to which other European countries may adhere.

7.6.1950:
fifth General Assembly of UNESCO held in Florence; proposals that the European nations should work together in the scientific field.

25.6.1950:
beginning of the Korean War.

1951

15.2.1951:
opening in Paris of a conference to draft a Treaty instituting a European Defence Community (EDC).

18.4.1951:
signature, in Paris, of the Treaty instituting the European Coal and Steel Community (ECSC).

1952

25.7.1952:
Treaty instituting the ECSC comes into force.

10.8.1952:
the High Authority of the ECSC begins its work, in Luxembourg, under the presidency of Jean Monnet.

10.9.1952:
first meeting of the European Assembly in Strasbourg, during which the creation of a European Political Community (EPC) is mooted.

10.12.1952:
inaugural session, in Luxembourg, of the Court of Justice of the ECSC.

1953

10.2.1953:
institution of a common market in coal, iron ore and scrap metal.

29.4.1953:
institution, at the High Authority of the ECSC, of a committee for technical research in the steel industry, and two technical committees for the coal industry.

1.5.1953:
institution of a common market in steel.

1.7.1953:
signature of the Paris Convention setting up the European Nuclear Research Organisation (CERN).

September 1953:
the High Authority appoints a committee of producers, consumers and technical experts to draw up a joint glossary of terms for steel products (Euronorm).

3.9.1953:
the European Convention on Human Rights comes into force.

8.12.1953:
Eisenhower delivers his "Atoms for Peace" speech.

1954

6.6.1954:
first Eurovision broadcasts, in Lille.

1.8.1954:
institution of a common market in special steels.

30.8.1954:
the French National Assembly fails to ratify the Treaty setting up the European Defence Community (EDC).

4.10.1954:
first session of the Council of the European Nuclear Research Organisation (CERN).

23.10.1954:
the Western Union becomes the Western European Union (WEU), taking in Italy and the Federal Republic of Germany.

9.11.1954:
Jean Monnet resigns from the presidency of the High Authority of the ECSC.

16.12.1954:
European Foundation for Culture established in Geneva.

1955

1/3.6.1955:
Messina Conference: the foreign ministers of the ECSC member states propose to extend the common market to the whole economy and to set up an atomic energy community.

8/20.8.1955:
first international conference on the peaceful use of atomic energy held in Geneva.

13.10.1955:
Jean Monnet founds an Action Committee for the United States of Europe.

1956

21.4.1956:
the Inter-governmental Committee set up by the Messina Conference presents a report on the Common Market, EURATOM, and sectors requiring urgent intervention (Spaak Report).

29.5.1956:
at the inter-governmental conference in Venice, the governments of the Six adopt the Spaak report as a basis for economic integration and the creation of EURATOM.

September 1956:
conference on safety in mines.

5.11.1956:
France and the United Kingdom intervene in Egypt, following Nasser's decision to nationalise the Suez Canal.

1957

20.3.1957:
birth of the European Nuclear Energy Agency (ENEA), under the auspices of the OEEC.

25.3.1957:
signature in Rome of the treaties instituting the European Atomic Energy Community (EAEC or EURATOM) and the European Economic Community (EEC).

4.5.1957:
"three wise men" (Louis Armand, Franz Etzel and Francesco Giordani) present their report on nuclear energy production within the Community.

4.10.1957:
the Soviet Union puts its first artificial satellite (Sputnik 1) into orbit.

20.12.1957:
foundation of Eurochemic (European Company for the Chemical Treatment of Irradiated Fuels), with head office at Mol (Belgium), as part of the European Nuclear Energy Agency (ENEA).

1958

1958:
NATO Science Committee set up.

1958:
foundation of the Institute of Advanced Scientific Studies (IHES), as a European centre of excellence in mathematics and theoretical physics.

1.1.1958:
the Rome treaties instituting EURATOM and the EEC come into effect.

10.1.1958:
the EURATOM Commission takes office under the leadership of Louis Armand. Enrico Medi

and Paul De Groote appointed Commissioners for Research and Training.

16.1.1958:
first meeting of the EEC Commission.

25/26.1.1958:
meeting to constitute the Council of the EEC.

28.2.1958:
dissolution of the ECSC Assembly.

19/21.3.1958:
inaugural session of the joint Assembly of the ECSC, EEC and EURATOM in Strasbourg. Robert Schuman elected President.

20.4.1958:
publication of the first issue of the Official Journal of the European Communities.

1.6.1958:
General de Gaulle called to form a government in France.

23.6.1958:
the United States sign a collaboration agreement with EURATOM.

27.6.1958:
following contacts with EURATOM, the CERN sets up a group to study thermonuclear fusion.

1.7.1958:
EURATOM begins collaborating with the ENEA on the heavy-water reactor at Halden (Norway).

3/12.7.1958:
conference of agriculture ministers at Stresa marking the beginning of the Community's agriculture policy.

7.7.1958:
the Scientific and Technical Committee of EURATOM approves the organisation's first research and training programme (1958-1962).

1/13.9.1958:
second international conference on the peaceful use of atomic energy, held in Geneva.

1.11.1958:
the EURATOM Commission sets up a Central Bureau for Nuclear Measurements, provisionally accommodated at the Mol research centre (Belgium).

1959

1959:
founding of the European Conference of Postal and Telecommunications Administrations (CEPT).

1.1.1959:
common market in nuclear products comes into effect.

2.2.1959:
Etienne Hirsch becomes President of the EURATOM Commission.

4.2.1959:
framework agreement between EURATOM and the United Kingdom regarding nuclear research.

4.2.1959:
EURATOM decides to take part in the ENEA's Dragon project to build a high-temperature gas-cooled reactor.

20/21.7.1959:
seven of the OEEC countries - Austria, Denmark, Norway, Portugal, the United Kingdom, Sweden and Switzerland - decide to create a European Free Trade Association (EFTA).

22.7.1959:
EURATOM negotiates an agreement with the Italian government to establish the first Joint Research Centre site (JRC) at Ispra.

6.10.1959:
EURATOM signs two agreements with Canada

to co-ordinate research and development of heavy-water-moderated reactors (CANDU).

1960

early 1960:
preparatory work at Ispra for the ORGEL project, to study the problem of organic-liquid cooling.

early 1960:
European Scientific Information Processing Centre (CETIS) set up at the Ispra facility.

March 1960:
applications invited for first EURATOM traineeships (1 to 6 months).

1.6.1960:
EURATOM Supply Agency comes into operation.

20.6.1960:
association agreement between the EURATOM Commission and the Belgian Nuclear Energy Study Centre (CEN) for joint management of the BR2 fast-neutron high-flux reactor at Mol.

1.12.1960:
inter-governmental conference at the CERN decides to set up a European committee to prepare for space research.

14.12.1960:
signature of the Paris Convention instituting the Organisation for Economic Co-operation and Development (OECD, to replace the OEEC).

21.12.1960:
agreement relating to the JRC's Institute for Transuranium Elements at Karlsruhe comes into effect.

1961

1961:
European Committee for Standardisation (CEN) set up in Brussels.

10/11.2.1961:
first European summit held in Paris, with political co-operation on the agenda.

12.4.1961:
Yuri Gagarin completes the first manned space flight.

May 1961:
the EURATOM Commission sets up an Information and Documentation Centre.

June 1961:
the EURATOM Commission signs an agreement with the Belgian government to establish the JRC's Central Bureau for Nuclear Measurements permanently at Geel.

9.6.1961:
co-operation agreement between EURATOM and Brazil.

July 1961:
agreement signed between EURATOM and the Dutch government to set up a Joint Research Centre (JRC) facility in Petten.

1.9.1961:
first regulations governing the free movement within the European Community of workers from Member States come into force.

November 1961:
the EURATOM Commission sets up a radio-isotope information office (Eurisotop).

2.11.1961:
presentation of the "Fouchet Plan" for European political union.

1962

1962:
birth of the ESO (European Southern Observatory) with an observatory in the North of Chile and a research centre in Garching, near Munich (Germany).

1962:
Franco-British agreement to build a supersonic passenger aircraft: Concorde.

10.1.1962:
EURATOM Commission chaired by Pierre Châtenet takes office. Enrico Medi and Paul De Groote confirmed as Commissioners for Research and Education.

14.1.1962:
first regulations of the Common Agricultural Policy adopted; European Agricultural Guidance and Guarantee Fund instituted.

February 1962:
first issue of the "EURATOM Bulletin".

29.3.1962:
European Launcher Development Organisation (ELDO) Convention signed in London.

30.3.1962:
the European Assembly decides to assume the name of European Parliament.

14.6.1962:
European Space Research Organisation (ESRO) Convention signed in Paris.

23.7.1962:
the Council of Ministers approves Euratom's second five-year research and education plan (1963-1967).

1.11.1962:
Petten high-flux reactor (HFR) officially transferred to EURATOM.

27.12.1962:
Latina power reactor goes critical.

1963

14.1.1963:
General De Gaulle blocks the United Kingdom's bid to join the European Common Market.

22.1.1963:
Franco-German co-operation Treaty.

1.3.1963:
on completion of the transition period, the Ispra 1 experimental reactor is transferred to EURATOM management.

2.4.1963:
the Council adopts a decision regarding vocational training within the Community.

9.4.1963:
the BARN reactor (Biological and Agricultural Reactor Netherlands) goes critical.

20.7.1963:
signature of the Yaoundé Convention instituting an association of 18 African countries and the European Community.

25.7.1963:
in its recommendation to the Council on economic policy in the medium term, the EEC Commission advocates the creation of a body to promote the development of scientific and technological research.

September 1963:
European Molecular Biology Organisation (EMBO) set up in the form of a private association.

October 1963:
first ministerial conference on science organised by the OECD.

14.10.1963:
the EEC and Iran sign a trade agreement in Brussels, the first such agreement with a non-EEC country.

21.12.1963:
co-operation agreement between EURATOM and Argentina.

1964

21.4.1964:
the Council of Ministers of the ECSC decide on a common energy policy.

25.5.1964:
agreement between EURATOM and the United States (USAEC) on fast reactors.

June 1964:
nuclear research ship "Otto Hahn" launched in Kiel.

August 1964:
the experimental reactor at Winfrith Heath (UK), part of the Dragon project, goes critical.

31.8.1964:
third UN conference on peaceful uses of atomic energy opens in Geneva.

1965

5.3.1965:
Committee for Medium-term Economic Policy sets up a working party to consider Scientific and Technological Research Policy (PREST).

8.4.1965:
Treaty amalgamating the executives of the three European Communities signed in Brussels.

13.5.1965:
the Council of Ministers of EURATOM decides to review the second five-year research and education programme (1963-1967).

1.7.1965:
the French government recalls its permanent representative to the European Communities in Brussels, and for seven months France is not represented at Council meetings (empty chair policy).

11.12.1965:
the ECO reactor (Orgel Critical Experiment) at the Ispra facility goes critical.

1966

1966:
metallographic atlas published by the ECSC.

29.1.1966:
compromise agreement reached in Luxembourg giving governments the right of veto at Council meetings, as requested by France.

12/13.1.1966:
at the Ministerial Conference on Science, held in Paris under the auspices of the OECD, the Communities are represented by a single delegation, led by the president of the inter-executive working party for "Scientific and Technical Research".

6.3.1966:
France announces its intention to withdraw from the military structure of NATO.

September 1966:
the Italian government, represented by Prime Minister Amintore Fanfani, presents to the Atlantic Council a document on "Europe's technological backwardness and the need for international co-operation".

15.12.1966:
Sneak and Masurca, the fast-neutron facilities at Karlsruhe and Cadarache, go critical.

1967

19.1.1967:
following an agreement between the French and German governments, the Institut Laue Langevin (ILL) is set up in Grenoble to carry out neutron research in physics, chemistry and biology.

27.1.1967:
international Treaty on the demilitarisation of space.

28.1.1967:
the experimental Rapsodie reactor, fruit of collaboration between EURATOM and the CEA, goes critical.

February 1967:
the Commission transmits to the Council a document entitled "Future Activities of EURATOM", opening discussions on the third research programme due to begin in 1968.

19.3.1967:
the ESSOR project heavy-water reactor ("réacteur d'ESSai ORgel") at Ispra goes critical.

1.7.1967:
Treaty amalgamating the executives of the three European Communities (ECSC, EEC, EURATOM), setting up a single Council and Commission, comes into force.

July 1967:
the PREST working party presents a report entitled "For a research and innovation policy in the Community".

6.7.1967:
The Commission of the European Communities, consisting of 14 members and chaired by Jean Rey, takes office. Fritz Hellwig becomes Commissioner for General Research and Technology, Dissemination of Knowledge and the Joint Research Centre (JRC); Guido Colonna di Paliano is the Commissioner responsible for industrial affairs.

10/11.7.1967:
ministers responsible for scientific research meet in Rome to discuss space research.

September 1967:
Directorate-General for Industrial Affairs (DG III) set up.

October 1967:
Jean-Jacques Servan-Schreiber's book, "Le défi américain" [The American Challenge], published.

31.10.1967:
first meeting of the Council of Ministers responsible for scientific research held in Luxembourg.

27.11/1.12.1967:
debate in the European Parliament on the problems facing scientific research.

1968

1.7.1968:
complete abolition of customs tariffs between the six EEC member countries.

1.7.1968:
international nuclear non-proliferation Treaty.

August 1968:
third international conference on thermonuclear fusion held in Novosibirsk; the Soviets present the results of their Tokamak reactor.

20.8.1968:
invasion of Czechoslovakia by Warsaw Pact forces.

18.12.1968:
Sicco Mansholt, Vice-President of the Commission, launches a plan to modernise European agriculture.

20.12.1968:
the Council approves a EURATOM research and education programme for 1969.

1969

29.5.1969:
signature of Franco-German agreement to build the Airbus.

30.6.1969:
the Council decides to abandon the Orgel project.

16.7.1969:
success of the Apollo XI mission: two American astronauts land on the moon.

28.10.1969:
the Council approves 30 projects proposed by PREST in seven areas of research: information technology, telecommunications, new means of transport, metallurgy, oceanography, the environment and meteorology.

1/2.12.1969:
Heads of State and Government meeting in The Hague relaunch the process of European integration and approve the enlargement of the Community to include other countries.

6.12.1969:
the Council decides to extend the 1969 EURATOM research and education programme for one year.

1970

18.3.1970:
the Commission transmits to the Council a document on "Community Industrial Policy" (Colonna Memorandum).

20.3.1970:
within the Council, the French government presents a memorandum on "Ways of strengthening European co-operation in industrial and scientific development".

2.4.1970:
twelve European governments officially found the European Conference for Molecular Biology to finance the activities of the European Molecular Biology Organisation.

21.4.1970:
signature of the Treaty granting the Communities their own resources.

30.6.1970:
negotiations begin to enlarge the European Common Market.

2.7.1970:
Commission led by Franco Maria Malfatti takes office, with Altiero Spinelli as Commissioner for Industrial Affairs, General Research and Technology and the Joint Research Centre (JRC).

7/8.10.1970:
presentation of the "Werner Plan" for economic and monetary union.

13.10.1970:
the Council decides to extend the 1970 EURATOM research and education programme for 1971.

27.10.1970:
foreign ministers of the Community Member States initiate European political co-operation, on the basis of the "Davignon Report".

10.11.1970:
the Centre for Information and Documentation (CID) officially enters the millionth document in its automated nuclear documentation system.

17.11.1970:
the German government submits a memorandum proposing that technological co-operation should be extended to further sectors.

16/17.12.1970:
the Council decides to restructure the Joint Research Centre (JRC) and to adopt a common policy for scientific and technological research.

1971

13.1.1971:
the Commission undertakes a restructuring of the Directorates-General and the JRC.

11.2.1971:
international Treaty making the sea-bed a nuclear-free zone.

24.6.1971:
Commission sets up the Committee for Scientific and Technical Information and Documentation (CIDST).

19.7.1971:
agreement between Germany, the United Kingdom and the Netherlands to develop ultracentrifugation for the enrichment of uranium (URENCO) comes into force.

15.8.1971:
US President Nixon announces an end to the convertibility of the dollar.

16.11.1971:
first meeting of education ministers of the EEC member countries.

22/23.11.1971:
meeting in Brussels, ministers responsible for science and technology from 19 European countries initiate European Co-operation in the field of Scientific and Technical Research (COST).

20.12.1971:
the Council fails to approve the three-year EURATOM programme proposed by the Commission and decides instead on a one-year transition programme for 1972.

1972

1972:
neutron source at the Institut Laue Langevin (ILL) in Grenoble comes on stream.

1972:
publication of "The Limits to Growth", a report commissioned by the Club of Rome.

February 1972:
first meeting of the Joint European Torus (JET) working party.

March 1972:
agreement between Germany, Belgium and the Netherlands (DEBENE) to build a prototype fast-breeder nuclear power station.

19.4.1972:
convention setting up the European University Institute (EUI) signed in Florence.

25.4.1972:
the Council adopts a five-year research and education programme for information technology.

June 1972:
United Nations Conference on the Environment held in Stockholm.

14.6.1972:
Commission transmits to the Council a document on "Objectives and instruments for a common scientific research and technological development policy".

19/21.10.1972:
Paris summit of Heads of State and Government approves a "Community Development Charter" and announces the creation of a European Union by the end of the decade.

1973

1.1.1973:
the United Kingdom, Denmark and Ireland accede to the European Economic Community, the ECSC and EURATOM.

1.1.1973:
European Committee for Electrotechnical Standardisation (CENELEC) set up in Brussels.

1973:
the Commission creates a separate Directorate-General for "Research, Science and Education" (DG XII); the new director-general is Günter Schuster.

1973:
Belgium, France, Italy, Spain and Sweden decide to initiate a project to built an isotopic separation facility based on gaseous diffusion (EURODIF).

6.1.1973:
Commission led by François-Xavier Ortoli takes office. Ralf Dahrendorf becomes Commissioner for Research, Science and Education, the Joint Research Centre (JRC), the Statistics Office, and Scientific and Technical Information and Information Management.

5.2.1973:
Council approves the reform of the JRC and its first long-term plan (since the end, in 1967, of the second five-year plan) for the years 1973-1976.

5.4.1973:
first meeting of the European Research and Development Committee (CERD).

May 1973:
decision to set up the European Centre for Medium-range Weather Forecasting (ECMWF), but the operating agreement is not signed until 1985.

22.5.1973:
Council sets up the Standing Committee on Uranium Enrichment (COPENUR).

18.6.1973:
Council adopts a series of research programmes in non-nuclear fields: the environment, samples and reference substances, solar energy and the recycling of raw materials.

August 1973:
on the basis of Commissioner Dahrendorf's work programme, the Commission transmits to the Council an "Action Programme for Scientific and Technological Policy".

6/27.10.1973:
Yom Kippur War.

24.10.1973:
Commission submits to the Council the first action programme relating to industrial and technological policy.

22.11.1973:
the Council adopts the European Community's first action programme for the environment.

December 1973:
the Commission supports the setting up of the Federation of European Industrial Cooperative Research Organisations (FEICRO).

December 1973:
Belgium, France, Germany, Italy and the Netherlands sign a convention for the building of two fast-breeder nuclear power stations: Superphenix in France, and SNR 2 in Germany.

1974

14.1.1974:
the Council sets up a Committee on Scientific and Technical Research (CREST), to replace PREST, with the purpose of co-ordinating national science policies; approves an action programme in the field of forecasting, assessment and methodology ("Europe +30"); decides that the Communities will be involved in the European Science Foundation (ESF); and formally initiates Community non-nuclear research activities.

15.7.1974:
the Council adopts a resolution authorising the planning of a medium-term Community programme to promote research, industrial development and the application of information technology.

17.7.1974:
presentation of a communication entitled "Energy for Europe: research and development", which identifies five strategic sectors: energy conservation, production and use of hydrogen, solar energy, geo-thermal energy and systems analysis.

11.11.1974:
Guido Brunner becomes Commissioner for Scientific Research.

13.11.1974:
headquarters of the Joint Research Centre (JRC) moved from Ispra to Brussels.

18/19.11.1974:
the European Science Foundation (ESF) holds its inaugural meeting in Strasbourg;

9/10.12.1974:
official birth of the European Council, made up of Community Heads of State and Government.

1975

1975:
creation of European Foundation for the Improvement of Living and Working Conditions, with headquarters in Dublin.

28.2.1975:
in Lomé (Togo), 46 African, Caribbean, Pacific and European Community states sign a convention covering the period 1975-1980 (Lomé I).

20.3.1975:
inauguration of the European University Institute (EUI), in Florence.

April 1975:
the Council approves a programme of technological research in the textiles sector.

15.4.1975:
European Space Agency (ESA) created, with headquarters in Paris.

26.6.1975:
the Council approves a five-year plan relating to the management and storage of radioactive waste.

15.7.1975:
the Council approves a four-year research and development programme in the energy sector.

1.8.1975:
Conference on Security and Co-operation in Europe (CSCE) held in Helsinki.

September 1975:
the group of experts responsible for the "Europe +30" study submits its final report to the Commission.

10.12.1975:
education ministers' meeting in Council adopt an action programme relating to their field.

29.12.1975:
presentation of the "Tindemans Report" on European Union.

1976

May 1976:
the Commission organises a symposium, in Milan, to define guidelines for a common research and development policy.

May 1976:
the CERD sets up a sub-committee concerned with European society and its interaction with science and technology (ESIST).

10.5.1976:
the EAEC and Sweden sign a co-operation agreement relating to controlled thermonuclear fusion and plasma physics.

6.7.1976:
the Community and the International Energy Agency (IEA) sign a general co-operation agreement relating to energy research.

21.10.1976:
the Council adopts new regulations for JRC research workers.

1977

1977:
the European Telecommunications Satellite Organisation (EUTELSAT) set up, with headquarters in Paris.

6.1.1977:
Commission chaired by Roy Jenkins takes office. Guido Brunner is confirmed as Commissioner and takes responsibility for energy, research, science and education, the EURATOM Supply Agency, scientific and technical information and information management, and the Joint Research Centre. Etienne Davignon made responsible for the Internal Market and industrial affairs.

18.7.1977:
the Council adopts a research programme for the JRC covering the period 1977-1980, the key sectors of which are nuclear safety, new sources of energy and the environment.

September 1977:
first conference on photovoltaic solar energy held in Luxembourg.

October 1977:
publication of a report on science and European public opinion, based on an Euro-barometer opinion survey.

25.10.1977:
the Council chooses the Culham laboratory (UK) as the site for JET, a major facility for experimentation on controlled thermonuclear fusion.

1978

1978:
European Molecular Biology Laboratory (EMBL) inaugurated in Heidelberg; foundation of the European Federation of Biotechnology (EFB).

1978:
publication of report by S. Nora and A. Minc: "L'informatisation de la société" [the computerisation of society].

February 1978:
the Council adopts the first concerted action programme on medicine and public health.

17.4.1978:
the Council adopts a three-year research programme (1978-1980) concerned with recycling paper and cardboard.

June 1978:
the Commission organises a seminar, in Copenhagen, on the assessment of scientific research.

25.7.1978:
the Council adopts a five-year programme (1979-1983) of indirect research activities regarding long-term forecasting and assessment (FAST: Forecasting and Assessment in the field of Science and Technology).

14.9.1978:
EURATOM signs a co-operation agreement with Switzerland relating to controlled thermonuclear fusion and plasma physics.

5.12.1978:
the Commission proposes for the Council's consideration a draft directive governing certain genetic manipulation activities.

1979

1979:
the Council decides not to adopt the aeronautical research programme put forward by the Commission in 1977.

20.2.1979:
the European Court of Justice hands down its ruling on the "Cassis de Dijon" case.

13.3.1979:
European Monetary System (EMS) comes into operation.

7/10.6.1979:
first elections to the European Parliament based on direct universal suffrage.

26.7.1979:
signature of first agreement on concerted action between the Community and COST.

16.8.1979:
the Council approves an agreement between the EEC and the Swiss Confederation to extend the Community's data transmission network (Euronet) to cover Switzerland.

20/31.8.1979:
the Community takes part in the UN conference on science and technology in the service of development (Vienna).

11.9.1979:
the Council adopts a four-year programme (1979-1983) to promote the development of information technology.

29.10.1979:
the Council decides on support measures for 24 technological development projects in the hydrocarbons sector.

31.10.1979:
signature of second Lomé Convention, covering the period 1981-1985.

12.11.1979:
the Council adopts a four-year research programme concerned with recycling of urban and industrial wastes.

29.11.1979:
the Commission proposes to the European Council a series of initiatives in the new information technologies sector ("Telematics").

December 1979:
first launch of the Ariane rocket from the Kourou base in French Guyana.

18.12.1979:
the Council adopts a programme for the period 1980-1984 concerned with climatological research.

1980

1980:
The European Patents Office grants the Community European patent no.1 for a heat pump invented at the JRC facility at Ispra.

13.2.1980:
inauguration of Euronet-Diane, a Community on-line data access network.

13.3.1980:
the Council adopts a new Joint Research Centre (JRC) programme covering the period 1980-1983.

16.9.1980:
Eurydice, an information network for educational purposes, comes into operation.

1.1.1981:
Greece joins the European Economic Community.

1981

1.1.1981:
The European Solar Test Installation (ESTI), the biggest European facility of its kind, becomes operational at Ispra.

6.1.1981:
the Commission chaired by Gaston Thorn takes office. Etienne Davignon becomes Commissioner for Industrial Affairs, Energy, the EURATOM Supply Agency, Research and Science, and the Joint Research Centre (JRC).

19.5.1981:
the Council approves continuation of the Super-SARA project at the JRC's Ispra facility (started in 1980, following the Three Mile Island accident).

25.5.1981:
inauguration of the Eurelios solar power station.

August 1981:
Paolo Fasella appointed Director-General of DG XII.

10/21.8.1981:
United Nations conference on new and renewable sources of energy (Nairobi).

15.10.1981:
the Commission submits to the Council a communication on the Community's research and development strategy for the 1980s, proposing that all research activities should be included in an overall framework programme.

7.12.1981:
the Council adopts an initial four-year R&D programme (1982-1985) in the biomolecular engineering sector (BEP).

1982

4/6.6.1982:
Western summit (the world's seven most industrialised countries and the European Community) in Versailles; working party for technology, growth and employment set up.

4.11.1982:
the Council adopts the Eurotra programme, concerned with creating a machine translation system.

3.12.1982:
the Council adopts a research and development programme in the field of science and technology for development (STD) covering the period 1983-1986.

6.12.1982:
European Development Committee for Science and Technology (CODEST) set up, replacing the CERD.

21.12.1982:
the Council adopts a pilot programme (for 1983) in the field of information technology (ESPRIT).

1983

1983:
European Centre for Vocational Training (CEDEFOP) set up, with headquarters in Berlin.

January 1983:
the "Technology, Growth and Employment" working party publishes the report commissioned by the Western summit held at Versailles.

1.3.1983:
EURATOM sets up the NET (Next European Torus) group.

March 1983:
twelve European companies working in the field of information technology set up the Standards Promotion and Application Group (SPAG).

March 1983:
the JRC's Super-SARA project abandoned.

23.3.1983:
speech by US President Ronald Reagan on the Strategic Defence Initiative (SDI).

25.6.1983:
the JET (Joint European Torus) becomes operational.

28.6.1983:
the Council adopts an experimental initiative to stimulate effective exploitation of the Community's scientific and technical potential (Stimulation), and an action plan relating to assessment of the Community's research and development programmes.

17/19.6.1983:
solemn declaration on European Union signed at the European Council meeting in Stuttgart.

25.7.1983:
the Council adopts the First Framework Programme for research and development (1984-1987), which includes such new Community programmes as ESPRIT, BRITE, Race and BEP.

12.9.1983:
the Commission's services organise a meeting of experts on the subject of Acquired Immune Deficiency Syndrome (AIDS).

November 1983:
European Venture Capital Association (EVCA) founded with Commission support.

25.11.1983:
the Council adopts a decision to create infrastructures to assist in technological innovation and transfer (SPRINT)

16.12.1983:
a current of 3 mega-amperes is generated in the JET, with a confinement time of a third of a second and a maximum temperature of approximately 17 million degrees centigrade.

1984

1984:
European Academic Research Network Association (EARN) founded, with headquarters in Montpelier.

20.1.1984:
the Parliament asks the Commission to present an urgent research programme with a view to combating AIDS.

14.2.1984:
the Parliament approves the Spinelli Project for European Union.

28.2.1984:
the Council adopts a decision relating to a strategic European R&D programme in the information technology sector (ESPRIT) for the period 1984-1988.

29.2.1984:
the Commission sets up an advisory committee on industrial research and development (IRDAC).

9.4.1984:
official inauguration of the JET at Culham.

14/17.6.1984:
second election to the European Parliament on the basis of direct universal suffrage.

29.6.1984:
the Council sets up twelve advisory committees concerned with the management and coordination (CGC) of research and development.

November 1984:
scientists at the JRC's Ispra facility invent a method of removing sulphur from the combustion gases of thermal power stations, known as "Ispra Mark XIII A".

8.12.1984:
signature of the third Lomé Convention, for the years 1986-1990.

1985

7.1.1985:
the Commission chaired by Jacques Delors takes office. Karl Heinz Narjes is Commissioner for Industrial Affairs, Information Technologies, Research and Science, and the Joint Research Centre (JRC).

12.3.1985:
the Council gives final approval to the BRITE research programme (Basic Research in Industrial Technologies for Europe) for the period 1985-1988.

14.6.1985:
the Commission presents a White Paper on the completion of the Internal Market by the end of 1992.

25.6.1985:
the Commission presents a memorandum entitled "Towards a Technological Community".

27.6.1985:
the Council approves the experimental phase of a programme for the co-ordination of information on the environment (CORINE).

28/29.6.1985:
meeting in Milan, the European Council reaches an agreement to harmonise EUREKA with the Community's R&D programmes, and adopts the Commission's memorandum "Towards a Technological Community".

17.7.1985:
meeting in Paris: representatives of 17 European countries hold a conference on European technology (EUREKA).

25.7.1985:
the Council decides to go ahead with defining a Community initiative in the telecommunications technologies sector (RACE).

25.7.1985:
the Council adopts a resolution to build a laboratory for handling tritium at Ispra.

1.10.1985:
convention instituting the European Centre for Medium-range Weather Forecasting (ECMWF), based in Reading (UK), comes into force.

8/9.10.1985:
the Parliament adopts nine resolutions on the theme of "Europe and the challenge of modern technology".

15.10.1985:
the ESPRIT Review Board (ERB) presents the Commission with a report assessing the initial results of the ESPRIT programme.

5/6.11.1985:
in conference in Hanover, the ministers of eighteen European countries and the Commission adopt a programme document defining the aims of EUREKA.

1986

1.1.1986:
Spain and Portugal join the European Economic Community.

1986:
as a result of restructuring, DG XIII absorbs the Information Technologies Task Force (ITTF) to become the Directorate-General for Telecommunications, Information Industry and Innovation, with Michel Carpentier as Director-General.

15.1.1986:
meeting in Munich, the Community, the United States and Japan sign a co-operation agreement in the field of controlled thermonuclear fusion.

28.2.1986:
signature of the Single European Act.

21.3.1986:
the Commission transmits to the Council a communication on the thrust of the forthcoming framework programme (1987-1991).

April 1986:
as part of the reactor safety programme, the Commission initiates an analysis of the accident at the Chernobyl nuclear power station in the Soviet Union.

June 1986:
presentation of an entirely optical logic circuit prototype developed by the European Joint Research Project on Optical Bistability

(EJOB), a sub-project of the Science programme.

10.6.1986:
the Council adopts a research programme concerned with advanced materials (EURAM), for the period 1986-1989.

24.7.1986:
the Council adopts a decision to set up a cooperation programme between universities and industry concerned with technology training (COMETT).

27.10.1986:
the Council adopts a Community programme to assist the development of certain disadvantaged regions by giving them improved access to advanced telecommunications services (STAR).

24.11.1986:
the Commission transmits to the Council a communication on EUREKA and the European technology community.

17.12.1986:
the Commission submits to the Council its "Europe against Cancer" programme.

22.12.1986:
the Council adopts a decision regarding standardisation in the field of information and telecommunications technologies.

1987

1987:
the member states of the European Southern Observatory (ESO) approve plans to build a Very Large Telescope (VLT).

1987:
in the wake of the Chernobyl disaster, the JRC sets up a data bank (REM) to store measurements of environmental radioactivity.

1987:
the JRC publishes the "European Inventory of Existing Chemical Substances" (EINECS), which lists 100,116 different substances.

18.2.1987:
the President of the Commission, Jacques Delors, presents to the Parliament a document entitled "Making a Success of the Single Act: a New Frontier for Europe" (first Delors package).

March 1987:
the European Parliament's Scientific and Technological Options Assessment programme (STOA) is born.

15.6.1987:
the Council adopts a programme to encourage the mobility of university students (ERASMUS).

30.6.1987:
the Commission presents a Green Paper on developing a common market in telecommunications services and equipment.

1.7.1987:
the Single European Act comes into force.

28.9.1987:
the Council adopts the Second Framework Programme for research and technological development (1987-1991).

5.10.1987:
the Council adopts a Community programme relating to the electronic transfer of commercial data over the communications networks (TEDIS).

29.10.1987:
the Commission transmits to the Council a proposal to reform the JRC.

November 1987:
official start of the BRAIN research project (Basic Research in Adaptive Intelligence and

Neurocomputing), a sub-project of the Science programme.

18/19.11.1987:
the European Parliament and the Economic and Social Committee give their opinion of the Commission's document "Making Success of the Single Act : a New Frontier for Europe".

14.12.1987:
the Council adopts the main phase (1987-1992) of the research programme concerned with advanced telecommunications technologies (RACE).

21.12.1987:
the Council adopts a revision to the radiation protection programme (1985-1989), to allow for research on the short and long-term effects of the Chernobyl nuclear accident.

1988

1988:
establishment of the Academia Europaea, based in London, which brings together individual members of European universities.

11/13.2.1988:
the European Council, meeting in Brussels, reaches agreement on the Commission's document "Making a Success of the Single Act : a New Frontier for Europe".

26.2.1988:
the Commission signs a commitment on the part of the Community (EURATOM) to take part, with Japan, the Soviet Union and the United States, in a preliminary project for an international thermonuclear experimental reactor (ITER).

March 1988:
European Telecommunications Standardisation Institute (ETSI) set up.

29.3.1988:
the Commission publishes the results of a study of the advantages of the Single Market: "The Cost of non-Europe" (Cecchini report).

April 1988:
the Tore-Supra Tokamak reactor at Cadarache (France) comes into operation.

11.4.1988:
the Council adopts the second phase of the ESPRIT programme, covering the years 1987-1991.

18.4.1988:
the Commission submits to the Council a communication on COST and the European technology community (Roland Report).

16.6.1988:
presentation of the EUREKA project for high-definition television (HDTV).

29.6.1988:
the Council adopts the DELTA (Development of European Learning through Technological Advance) and DRIVE (Dedicated Road Infrastructure for Vehicle Safety in Europe) initiatives.

29.6.1988:
the Council approves the proposal to reform the JRC.

29.7.1988:
the Commission transmits to the Council a communication analysing the contribution the Community could make to European space activities, in collaboration with the European Space Agency (ESA).

October 1988:
the Wendelstein VII modular stellarator comes into operation at Garching (FRG).

October 1988:
the Commission submits to the Council a proposal regarding patents to protect inventions in the field of biotechnology.

14.10.1988:
the Council adopts a decision on new specific programmes for the JRC (1988-1991).

17.10.1988:
the Community ratifies the Vienna Convention on protection of the ozone layer.

4.11.1988:
the Council adopts a decision relating to the AIM programme (Advanced Informatics in Medicine).

15.11.1988:
presentation of first "Report on the state of science and technology in Europe" (Narjes Report).

December 1988:
signature, in Paris, of the conventions and regulations governing construction of the European Synchrotron Radiation Facility (ESRF) in Grenoble.

1989

1989:
European year for information about cancer.

1989:
the FTU Tokamak reactor at Frascati (Italy) and the Compass Tokamak at Culham (UK) come into operation.

6.1.1989:
within the Commission chaired by Jacques Delors, Filippo Maria Pandolfi becomes Commissioner for Science, Research and Development, Telecommunications, Information Industry and Innovation, and the Joint Research Centre (JRC).

February 1989:
the executive phase of the EUREKA JESSI project (Joint European Submicron Silicon Initiative) gets underway.

13.2.1989:
the Council adopts a Community plan (1989-1992) to stimulate economic research (SPES).

23.2.1989:
the Council approves a programme of research and development in the agro-industrial sector (1988-1993), based on biotechnologies (ECLAIR).

14.3.1989:
the Council adopts a four-year programme (1989-1992) relating to industrial, production and materials applications technologies (BRITE-EURAM).

14.3.1989:
the Council approves a specific research and technological development programme concerned with non-nuclear energy and rational energy use (JOULE)..

14.3.1989:
the Council adopts a Community plan for funding access to the major scientific facilities (1988-1992).

April 1989:
the Council adopts a decision defining a strategic framework for the rapid introduction (1992-1995) of high-definition television (HDTV) throughout Europe.

15/18.6.1989:
third elections to the European Parliament on the basis of direct universal suffrage.

20.6.1989:
the Council adopts a five-year programme (1989-1993) of research and development in the food science and technology sector (FLAIR).

20.6.1989:
the Council adopts a four-year programme (1989-1992) of research in the marine science and technology sector (MAST).

20.6.1989:
the Council adopts a specific programme concerned with disseminating and exploiting the results of research (VALUE).

27.6.1989:
the Council approves the Community MONITOR programme (1989-1992) concerned with strategic analysis (SAST), forecasting (FAST) and evaluation (SPEAR) in the field of research and technology.

28.6.1989:
to achieve a single market in telecommunications, the Commission adopts three texts concerning competition in the areas of services, providing an open network and terminal equipment.

18.7.1989:
the Council adopts a new research and education programme (1989-1993) concerned with remote handling in nuclear hazardous and disordered environments (TELEMAN).

25.8.1989:
the Commission adopts a proposal for a framework programme to cover research and technological development for the period 1990-1994.

30.9/2.10.1989:
following their conference in Paris, 26 European countries and the Commission issue a joint declaration relating to the creation of EUREKA in the audiovisual field.

3/4.10.1989:
European conference in Waterford (Ireland), as part of the STRIDE programme, on the relationship between science and technology policy and economic and social cohesion.

9.11.1989:
fall of the Berlin Wall.

20.11.1989:
the Council adopts research programmes (1989-1992) in the areas of the environment (STEP) and climatology (EPOCH).

20.11.1989:
the Council adopts a research and technological development programme (1990-1992) concerned with raw materials and recycling. It covers minerals, the recycling of metals (REWARD) and forestry (FOREST).

21.11.1989:
the Commission adopts a draft decision for a specific research and technological development programme (1990-1993) in the transport sector (EURET - European Research for Transport).

28/29.11.1989:
the Council reaches an agreement in principle on the Commission's proposal to set up a European Environment Agency (EEA) and a pan-European information and observation network for the environment (EIONET).

1990

1990:
thirteen European countries initiate the EUCLID programme of military research (European Co-operation for the Long-term in Defence).

January 1990:
European Environmental Research Organisation (EERO) set up, with headquarters in Wageningen (NL).

March 1990:
constitution of a European economic interest grouping, Vision 1250, for the rapid introduction of HDTV services throughout Europe.

23.4.1990:
the Council formally adopts the Third Framework Programme for research and technological development (1990-1994).

7.5.1990:
the Council adopts regulations governing the proposed European Environment Agency and environmental monitoring and information network.

29.5.1990:
the Council adopts an action programme for the development of continuing vocational training (FORCE).

13.6.1990:
the Commission adopts a communication on scientific co-operation with Central and Eastern Europe.

19.6.1990:
signature of the Schengen agreement, which sanctions the principle of free movement of persons between member countries.

28.6.1990:
the Council adopts a directive relating to the provision of an open telecommunications network (ONP).

28.6.1990:
the Council formally adopts the THERMIE programme concerned with the promotion of energy technologies.

29.6.1900:
the Council adopts a new research programme concerned with analysis of the human genome (1990-1992).

July 1990:
a committee of independent experts publishes an evaluation report on the fusion programme.

2.8.1990:
Iraq invades Kuwait; the Community condemns the invasion and decides to impose an embargo.

September 1990:
the Community sets up a scientific and technological consultation committee in conjunction with the United States.

September 1990:
the Commission decides to take part in the pilot phase of the international research programme - "Human Frontier - proposed by Japan.

25.9.1990:
the Council decides to extend the JET project until 1996.

3.10.1990:
reunification of Germany.

November 1990:
the Commission adopts a Green Paper on satellite telecommunications.

November 1990:
the Community and the United States set up a joint task force in the field of biotechnology.

November 1990:
Community Research and Development Information Service (CORDIS) set up in experimental form.

1991

1991:
European Information Service on Biotechnology established.

31.1.1991:
the Commission adopts draft regulations instituting a financial instrument for the environment (LIFE).

14.4.1991:
European Bank for Reconstruction and Development (EBRD) inaugurated to assist Eastern Europe.

4.6.1991:
health ministers' meeting in Council adopt the "Europe against AIDS" action plan.

7.9.1991:
opening of The Hague Conference on peace in Yugoslavia.

9.9.1991:
the Council formally adopts the CRAFT programme for small and medium-sized enterprises (SMEs).

14.10.1991:
launch, on the initiative of the European Parliament, of the Avicenne programme, concerned with scientific and technological co-operation with the Maghreb countries and other countries of the Mediterranean Basin.

29.10.1991:
the Council adopts the SAVE programme concerned with efficient use of energy.

1.11.1991:
China-EC Biotechnology Centre inaugurated in Beijing.

9.11.1991:
the JET produces a substantial amount of energy.

17.12.1991:
signature of the European Energy Charter.

1992

1992:
the Commission takes part in an experimental campaign in the Arctic, in the context of the EASOE project (European Arctic Stratospheric Ozone Experiment).

7.2.1992:
signature of the Maastricht Treaty on European Union.

11.2.1992:
the Commission presents a document entitled "From the Single Act to Maastricht and beyond: the means to match our ambitions" (second Delors package).

16.3.1992:
the Council adopts a programme concerned with human capital and mobility for the period 1990-1994.

7.4.1992:
the Commission presents a document entitled "Research after Maastricht: an assessment and a strategy".

2.5.1992:
signature of Treaty on the European Economic Space (EES) with the countries belonging to EFTA.

7.5.1992:
a group of scientists taking part in the BAP programme makes the first complete sequential analysis of the chromosome of an organism. The results are published in the journal "Nature" under the title "The complete DNA sequence of yeast chromosome III".

22.5.1992:
Hungary joins EUREKA.

2.6.1992:
in a referendum, the Danes vote against ratifying the Maastricht Treaty.

3/14.6.1992:
the Community takes part in the Rio Conference on the Environment and Development organised by the United Nations, and signs the international conventions on global climate change and biodiversity.

18.6.1992:
COST co-operation is extended to Slovenia and Croatia.

23.6.1992:
the Commission signs an international co-operation agreement with Russia, Byelorussia and the Ukraine, with a view to a research programme on the consequences of the Chernobyl nuclear disaster.

3.7.1992:
the Commission decides to set up an international association to promote co-operation with scientists in the independent states of the former Soviet Union (founded in 1993 under the name of INTAS).

22.9.1992:
an information day on health, pollution and safety in the steel industries of the ECSC is organised in Tharendt (Germany), to disseminate the results of Community experience in these fields in the new German Länder.

23.9.1992:
the Commission adopts a communication on the Community and space.

9.10.1992:
the Commission presents a working document on the Fourth Framework Programme for research and technological development (1994-1998).

27.10.1992:
the Commission adopts a communication on how to implement the principle of subsidiarity.

11/12.12.1992:
meeting in Edinburgh, the European Council approves the second Delors package.

31.12.1992:
the Council agrees on providing additional funding for the Third Framework Programme (1990-1994).

1993

1.1.1993:
the Single Market comes into force.

1.1.1993:
the VALUE programme's Relay-Centre Network comes into operation, with the purpose of disseminating and encouraging full use of the results of Community R&D.

1993:
the Commission sets up a European Science and Technology Forum to promote consideration and debate on the historical, social, ethical and cultural aspects of science and technology.

6.1.1993:
within the Commission chaired by Jacques Delors, Antonio Ruberti becomes Commissioner for Science, Research and Development, the Joint Research Centre (JRC), Human Resources, Education, Training and Youth. Martin Bangemann is responsible for industry, and information and telecommunications technologies.

15.1.1993:
ministers from the EC and Japan meet in Brussels to institute the Forum on Science and Technology (FST).

19.1.1993:
the Committee on Energy, Research and Technology (CERT) of the European Parliament comes out in favour of additional funding for the Third Framework Programme (1990-1994).

1.2.1993:
negotiations regarding the applications of Austria, Finland and Sweden to join the European Union open in Brussels.

8.2.1993:
on the initiative of the European Parliament, the COPERNICUS programme is initiated, to encourage scientific and technological co-operation with the countries of Central and Eastern Europe.

15.3.1993:
the Council finally agrees to provide additional funding of 900 million ECUs for the Third Framework Programme (1990-1994).

16.3.1993:
the Council approves the principle of introducing new technology to monitor the common fisheries policy.

1.4.1993:
COST co-operation is extended to the Czech and Slovak Republics.

5.4.1993:
negotiations regarding Norway's accession to the European Union open in Luxembourg.

22.4.1993:
the Commission presents a second working document on the Fourth Framework Programme for research and technological development (1994-1998).

5.5.1993:
the Commission adopts a document on education and training policy.

19/21.5.1993:
Commissioner Ruberti visits Washington to discuss bilateral EC/US relations in the field of research and technological development.

16.6.1993:
the Commission presents a draft decision of the Fourth Framework Programme for research and technological development (1994-1998).

24.6.1993:
Russia joins the EUREKA programme.

29.6.1993:
first assembly, in Luxembourg, of the International Association for Co-operation with Scientists of the former Soviet Union (INTAS)

22.7.1993:
the Council adopts a resolution on developing technologies and standards in the advanced television services sector.

29.9.1993:
the Commission presents a Green Paper on the European dimension of education.

14/15.10.1993:
the Committee on Energy, Research and Technology (CERT) of the European Parliament organises the first "European Science Summit" in Brussels.

25.10.1993:
the Council, the Commission and the European Parliament adopt a draft inter-institutional agreement on implementing the principle of subsidiarity.

30.10.1993:
the regulations governing the European Environment Agency come into force.

1.11.1993:
the Treaty on European Union comes into force.

22/27.11.1993:
first "European Week for Scientific Culture".

December 1993:
Israel joins the EUREKA programme.

5.12.1993:
the Commission presents the White Paper on Growth, Competitiveness and Employment.

10/11.12.1993:
the European Council, meeting in Brussels, adopts the White Paper on Growth, Competitiveness and Employment.

22.12.1993:
the Council approves a common position on the Fourth Framework Programme for research and technological development (1994-1998).

1994

2.2.1994:
the Commission approves the regulations for a European Training Foundation, to be based in Turin.

10.2.1994:
at its "second reading", the European Parliament proposes an increase in the budget of the Fourth Framework Programme for research and technological development (1994-1998).

21.2.1994:
the European Union and Australia sign an agreement on scientific and technological co-operation.

15.3.1994:
the Commission decides to set up a European Science and Technology Assembly (ESTA).

21.3.1994:
Council and Parliament reach agreement on the Fourth Framework Programme for research and development (1994-1998).

15.4.1994:
signature of the final act of the Uruguay Round of GATT negotiations.

26.4.1994:
formal approval of the Fourth Framework Programme for research and technological development (1994-1998).

8.6.1994:
first meeting, in Tokyo, of the Euro-Japanese Forum on Science and Technology.

9/12.6.1994:
fourth elections to the European Parliament based on direct universal suffrage.

24/25.6.1994:
the European Council, meeting in Corfu, discusses the perspectives opened up by the White Paper on Growth, Competitiveness and Employment.

27.7.1994:
informal meeting in Schwerin (Germany) of the Council of Ministers responsible for research and education.

6/7.9.1994:
first meeting of the European Science and Technology Assembly (ESTA).

14/15.9.1994:
first symposium, in London, of the European Science and Technology Forum.

30.9.1994:
inauguration, in Grenoble, of the European synchrotron (ESRF).

10.10.1994:
the CERN and the European Commission sign a co-operation agreement.

19.10.1994:
the Commission presents a document concerned with co-ordinating national and Community research and technological development activities.

31.10.1994:
European Environment Agency (EEA) inaugurated in Copenhagen.

21/25.11.1994:
second "European Week for Scientific Culture".

15.12.1994:
the Council completes its approval of the specific programmes of the Fourth Framework Programme (1994-1998).

1995

1.1.1995:
Austria, Finland and Sweden join the European Union.

1995:
officially starting of activities of the new technological Observatory of the Institute for Prospective Technologies of the Joint Research Centre (JRC) in Seville.

20.1.1995
installation of the new Commission under Jacques Santer. The new Commissioner Édith Cresson took up responsibility for Science, Research and Development, the Joint Re-

search Centre (JRC), Human Resources, Education, Training and Youth, and Innovation. Martin Bangemann kept his position as Commissioner responsible for Industry, Information Technology and Telecommunications.

10.3.1995

meeting of the Council of research ministers, including discussion of modifications to the budget for the Fourth Framework Programme to allow for the new requirements caused by the accession of the three new Member States of the Union.

1.6.1995

Édith Cresson, in collaboration with her fellow Commissioners Martin Bangemann (Industry) and Neil Kinnock (Transport) announced the setting up of several Task Forces for industrial research.

INDEX OF NAMES

INDEX OF PROGRAMMES AND ORGANISATIONS

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CHAPTER 1

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