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I. INTRODUCTION

When the European Communities ("EC") were set up between 1950 and 1960, the founding fathers, though giving attention to science and technology in the then "classical" fields, could not have imagined that technological innovation would play such a central role by the 1990s in maintaining Europe's economic and industrial competitiveness. Indeed, the globalization of our economy and the rapidity of technological progress have led the EC to re-examine its policies and actions in light of their effect on innovation and technology transfer within the EC. The purpose of this change of emphasis is both to meet the well-known challenge for a place in the competitive world market and to prepare the economy for the 1992 Community Single Market.

The European Community, through its executive body, the Commission of the European Communities, had been active for a long time in most of the fields relating to the subject of innovation. Therefore, it already had experience on which to build, as well as considerable insight into many aspects of the problem. In many respects, what was needed was a review of priorities. This was particularly the case with research and development and the stimulation of innovation. Therefore, I will begin with some remarks on the Internal Market and then elaborate on the Commission's activities in the field of research and development and innovation stimulation, since they constitute the basis of the EC policy to develop the long term competitiveness of its economy. I shall also raise a few related aspects and then attempt to draw some personal conclusions on a subject which would require much more time and consideration than is available here.

II. THE 1992 INTERNAL MARKET OBJECTIVE

The European Communities are directing all their efforts toward achieving a real Community-wide internal market by the end of 1992. This ambitious objective was set out by the Single Act of 1986, which amended the original EC Treaties in accordance with this goal. In practical terms the Single Act requires the abolition of many barriers which still exist to free intracommunity trade, movement of people and capital

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and so forth, by harmonizing legislation in all relevant fields, from fiscal matters, norms and standards to public procurement rules and much more. To overcome the most salient of these obstacles, some 300 new EC regulations must be drafted and adopted before January 1, 1993. The Commission has done 90% of its job of elaboration, but so far only about 50% of the regulations have been approved by the Council of Ministers and the European Parliament. This is a reflection of the complexity of matters, the divergence of national interests, and the still open general question on how much of this harmonization task could be left to free enterprise instead of government action. Every sector of our economy will be affected by this event, from industry (small and large) to finance (banking, insurance) as well as transport, communications, tourism, social security and even the control of crime and fraud. It is certainly too early for an assessment of all the positive and negative consequences of the whole exercise, but experts agree that the Internal Market will lead to a considerable growth in GNP and to savings of up to 7% in the cost of products and services.[1]

The Single Market not only constitutes a challenge for entrepreneurs in general, it will stimulate technological innovation in branches aimed at satisfying the conventional needs of mankind such as food, clothing and housing. In addition, there will be a growth in the application of new technologies to fields which were not previously attractive due to market size and the obstacles mentioned above. A particularly illustrative example is communications technology with its enormous potential for new applications, including mobile telephones, electronic banking, high definition television, office organization, health care, education and the many other services to be offered once Europe has an integrated broadband communications network with common standards throughout the Community. This in turn will give a boost to semiconductor manufacturers and suppliers of equipment and software. We shall have to be careful to ensure that Europeans do not lose their autonomy in these key industrial branches — a challenging task for joint research and development.

III. Research and Technological Development

The Commission of the EC is involved in a considerable number of projects aimed at Community-wide coordination and stimulation of research, development and technology. This involvement has been built gradually, over the last thirty years, in conjunction with the EC Member States' growing commitment to support research and development at the national level. The overall expenditure for research, development and technology from the Commission budget amounts to 1.2 billion ECU per

[1] Commission of the European Community, The Cost of Non-Europe (1988)(study coordinated by P. Cecchini, available from the Office for Official Publications of the European Communities, ISBN 92-825-8605-7).

year (1 ECU = $1 U.S.), representing about 3% of the public expenditure made for civil research, development and technology by all its Member States. Since the EC only supports transnational projects, at up to 50% of their cost, and since it concentrates on basic and pre-competitive research, development and technology in those "strategic" areas which determine long-term development, the stimulation and driving effect of its actions is far greater than this percentage would suggest.

Starting in the 1960s with nuclear energy, coal and steel research and adding environmental and non-nuclear energy technologies in the 1970s, the concern of the 1980s became the competitiveness of European industry. Industry-oriented research and development programs such as ESPRIT (microelectronics), BRITE (basic industrial technologies) and BIOTECHNOLOGY were launched. Today about 60% of the EC research and development budget is dedicated to programs of medium and long-term relevance to industry.

This concentration on the needs of industry was given full constitutional legitimacy in 1986, when the EC Member States adopted the Single Act. It contained for the first time, a specific reference to research and development, giving it equal importance with other Community policies. In the implementation of the Single Act, the Commission developed the Community Research, Development and Technology Framework Programme, a policy and steering instrument, which was adopted in 1987, after lengthy discussions about the eight main areas of Community research and after some severe cutbacks of the proposed budget.

ESPRIT was clearly the pioneering program for EC industrially oriented research. Information technology and microelectronics, with their applications in factories and offices, were identified as a sector of strategic importance for the industrial future of the Community, which, in a rapidly growing market, had to catch up with its principal competitors. We can say that ESPRIT reversed the trend, though there are still areas for concern: software systems, advanced semiconductor components, information processing and others. Some of them suffer as much from the lack of trained personnel as from insufficient or dispersed research and development effort.

The lessons learned from ESPRIT have already been applied in other vital areas. The RACE program has pooled together all of the industrial forces within the Community in order to meet the challenges of the forthcoming revolution in communications technologies. Some "offspring" of RACE are specifically addressing electronic traffic control (DRIVE), learning technologies (DELTA) and information technology applications to health care (AIM). The markets at stake in these fields are very large and urgently require the development of equipment following common standards. Pilot research and development programs were also launched outside the communication technologies in aeronautics, marine technologies and other areas, along with a set of recently reinforced programs in the field of biosciences and in the field of new materi-

als. These programs will provide European industry with a technological base for the coming decades.

The implementation of the current Research, Development and Technology Framework Programme is almost complete and the Commission departments are already discussing the next steps. The idea is to add new dimensions and new formulae to support the transfer into application of the technologies developed by the cost-sharing contract research and development programs. Careful consideration will have to be given to aspects of free competition, and cost sharing may not be a suitable solution. The reflections on the review, or even the complete revision, of the Research, Development and Technology Framework Programme will also be influenced by a recently completed study on the state of Science and Technology in the Community.[2]

This study shows that considerable progress has already been achieved in improving Europe's position in Science and Technology. The study includes an overview of the main research needs and the identification of major science policy issues to be faced by the Community in the coming years. This report, which reflects the views of those dealing with basic research and scientific affairs rather than those of the technologists, shows that 70% of total EC research and development expenditure is spent by three Member Countries: France, Germany and the United Kingdom. There is a twelvefold difference in research and development spending between the most active and the most inactive countries. The gap is far deeper than the difference in the GNPs of these countries. This alarming fact more than justifies the recent shift in emphasis of the Community's regional policy, which now includes a number of measures to improve the infrastructure and enable the Community's lesser developed regions to start their own research and development activities or to better participate in Community research and development programs (STRIDE program). A similar goal is pursued by another program launched in 1987 which is aimed at improving the communications infrastructure in these regions (STAR program).

When reflecting on the introduction of new dimensions into the next Community Research, Development and Technology Framework Programme, we also should keep in mind that while strengthening the competitiveness of industry is important in the interim, the long-term wealth of the Community also requires the creation or maintenance of a sufficient Community-wide base of human resources through adequate stimulation of fundamental research and support to the training (and mobility) of scientists. Japanese planners are probably spending quite a bit of time thinking about this issue right now.

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[2] COMMISSION OF THE EUROPEAN COMMUNITIES, FIRST REPORT ON THE STATE OF SCIENCE AND TECHNOLOGY IN EUROPE, Report COM (88) 647 final (1988).

IV. Stimulation of Innovation and Technology Transfer

About five years ago the Commission also launched its first program to stimulate innovation and transnational technology transfer between or into industrial firms, recognizing the particular importance of such support for small and medium size enterprises ("SMEs"). Commission involvement in the exploitation of its own research and development results has led it to study the processes and the related problems by which new or improved goods, processes and services are introduced into the economy. A specific pilot program called the Strategic Programme for Innovation and Technology Transfer ("SPRINT") was started in 1987. The aim of SPRINT was not to directly support enterprises or particular technologies, but rather to create the infrastructure for transnational technology transfer and innovation. It started to set up networks of people and organizations intervening in the various stages of the process, including technology brokers, venture capitalists, licensing and patent advisors, science parks, chambers of commerce, industrial research organizations and many more. SPRINT also subsidized the organization of exhibitions, conferences, group visits and training seminars and carried out feasibility studies addressing cases of specific technology transfers into selected industry branches. Subjects such as quality, design and the development of special management skills were also considered. The SPRINT pilot phase which ended in December 1988, has generally been considered a success and a source of experience which will be necessary to prepare European SMEs for the exploitation potential of the Single Market. Some of the organizations created with its assistance, such as the European Venture Capital Association ("EVCA") and the European Association for Technology Transfer, Innovation and Industrial Information ("TII"), are now autonomous and the Commission's proposal for a substantially upgraded new SPRINT program (1989-93) was approved in March 1989. This new program will include, in addition to the reinforcement of those measures already undertaken in the pilot phase, support to concrete technology transfer projects for demonstration and training purposes. The creation of a Community-wide "innovation observatory," the aim of which will be to identify and diffuse "best practice" and to observe the effects of Community and national measures for the stimulation of innovation, is also foreseen.

Though SPRINT acts as the central focus for issues concerning innovation and technology transfer in general, the forthcoming Single Market has led to further specific action at Community level, including the creation of a Task Force for SMEs ("TFSME") and a proposal for EUROTECH CAPITAL, a program to support the creation of investment funds which reserve a part of their capital to finance transnational high-technology transfer projects. Also, it cannot be stressed enough that practically all Community policies now have a strong component intended to compensate for the possible negative effects of opening the

frontiers between the EC countries. These considerations have influenced not only Community actions for regional development, but also, for example, Community actions for Education and Training (ERASMUS and COMETT programs).

V. Diffusion and Utilization of Research and Development Results

The involvement of national governments and the EC in supporting research and development has yielded considerable results. While in past decades the transfer of these results into commercial applications or toward the general growth of the knowledge base of science and industry was left to chance and free initiative, more recent investigations tend to suggest that there should be some more effort spent on guiding and stimulating a more efficient use of these results. More efficient use means not only improving diffusion but sometimes also providing adequate protection. The recent breakthroughs achieved in superconductivity research have shown the new dimensions of knowledge handling and have indicated the sort of problems which will also be met in areas such as biotechnology, genetics, and materials research. In these fields, some results will probably have to be considered valuable commercial commodities. The Member Countries of the European Community are showing diverging attitudes in this respect, depending on the level of their national research and also on the interrelation between civil and defense research and development. In many cases, the "dual use" nature of research makes things even more complicated.

Community sponsored research and development and the handling of its results is governed by the terms laid down in a standard contract. Adaptation of the contract to the above developments and to the specific Community features (e.g. transnational collaboration, combination of industry and university laboratories in pre-competitive research projects) has taken about two years. Now that it is complete, we are starting to discuss and develop a Community Regulation which should provide guidance on questions such as the contractor's obligation to exploit, grant licenses or diffuse results and the participation of non-EC countries in Community research and development programs, which have been left open in the standard contract. Since the inclusion of new areas like aeronautics into the range of Community research and development activities, these questions have become increasingly important to the EC Member Countries, as seen in the discussions on the Commission proposal for a program named VALUE. This program is aimed at stepping up and harmonizing activities on diffusion, protection and exploitation of research and development results obtained with Community support. Included in this program, for example, are the screening of research reports, diffusion of information by printed matter and through electronic databases, patenting, prototype development, licensing and support for

the creation of Community-wide computerized networks for linking research organizations. Needless to say, this program — though basically confined to Community research and development — will enable us to create an inventory of the established measures through which our Member Countries are handling their research results. Another step of the program will coordinate and hopefully lead to more uniform management of knowledge throughout the Community. The enormous differences still existing have been investigated in a recent study dealing with the situation in almost all EC countries.[3]

The Community's attitude and rules in this field are also given much attention by our main industrial partners outside Europe, for example in GATT negotiations or when considering measures like the U.S. Trade Act. This gives the Commission's actions an importance which is much greater than the percentage of funding it provides for research and development.

VI. Intellectual Property and Innovation

Experts tell us that there is a strong link between the innovation climate and the way intellectual property is handled. This is probably true. However, without additional knowledge or details, this observation is quite theoretical. The Commission therefore expends some effort within the SPRINT program to obtain more guidance for future actions. One of the investigations[4] concluded in December 1988 identified considerable differences in the cost of patent infringement suits, depending on the country. Work is presently underway investigating the usefulness of limitations on consulting patent indicators, as well as the value of patent information to SMEs.

In order to gain more insight into this whole matter, the Commission intends to hold a conference, called "Patinnova 90," in May 1990 (probably in Madrid). This conference should lead to the identification of the patent problems and requirements arising specifically in light of the creation of the Single Market. It is our intention to call not only upon those who are already specialists, but also upon those who might be able to help surmount barriers which have thus far prevented many scientists and engineers from exploiting the possibilities offered by patent and licensing specialists.

Of course, harmonization in the field of intellectual property presents the European Community with a very difficult task, since technological progress sometimes makes national or Community legislation obsolete before the harmonization exercise is terminated. But these rapid

[3] J. McMullan, Publicly Funded Research and Development in the European Community: Improving the Utilization of Results (1988) (available from Office for Official Publications of the European Communities, ISBN 92-825-8269-8).

[4] Patent Infringement Litigation Costs — A Practical Worldwide Survey (1988) (edited by A. Bouju).

changes, for example in the field of protection of computer software, of microchip layouts, of plant specialties or animal and other "like forms" are also opportunities for the Commission to come forward with proposals before national legislation has taken the lead. My colleagues from the specialized departments dealing with these questions are under great time pressures, since the direction of investment in the "next generation" by the Community's high-tech industries depends on them and their colleagues in the Member Countries.

VII. Financing and Innovation

Another very important factor influencing the innovation climate in a country or a region is the availability of seed, risk and venture capital. We all know that in most EC countries the "bank mentality" of financial institutions is rather widespread. Venture capital is not yet available as abundantly as in the United States, though the effects of the activities of the EVCA are beginning to appear. The Commission's Venture Consort scheme has led to the syndication of venture capital for quite a number of projects. It is now being considered to further encourage the venture capital financing of high-technology projects between industries in different EC countries, through a scheme called EUROTECH CAPITAL. This is probably an opportunity for a number of results of the EC precompetitive research and development programs to obtain that part of the financial support required for a successful commercialization, but which the EC budget could not provide without distorting free competition.

It should not be forgotten that it is only by application of the new, simplified decision procedures laid down by the Single Act that it becomes possible to open frontiers between the EC countries for the movement of capital. The recent agreements reached by the EC in this matter will have a considerable impact on innovation by adding to transnational technology transfer. The next obstacle to be removed lies in the considerable differences with respect to taxation, for example, capital gains.[5] Harmonization in this field will take a long time, since it will require in some Member Countries a profound reconsideration of political and even ideological issues.

VIII. Conclusions

What are the main elements determining the context for innovation in Europe? There is no single or reproducible reply to this question, but everybody will agree that a certain number of ingredients have to be considered and carefully measured in order to get the right mixture. These include basic and applied research, education, fiscal matters, intellectual

[5] *See, e.g.*, Deloitte Haskins & Sells, Fiscal Environment of, and Corporate Vehicles for Venture Capital in the European Communities (1988)(study carried out on behalf of the EC SPRINT program).

property, availability of risk capital, labor cost, communications and transport infrastructure, and access to information. The Commission of the European Communities is addressing these questions and attempting to come forth with solutions that are acceptable to its Member Countries. In most cases the Commission's task is confined to harmonization and the creation of appropriate boundary conditions. The rest depends on human initiative.

Real entrepreneurship normally grows either out of a threat or an opportunity. Both of these types of challenges are abundantly provided for by the perspectives of the Community Internal Market. I therefore firmly believe that the twelve countries of the European Community will become, in the next decades, a very interesting playground for innovators. Our task in Brussels will be to ensure that a good share of the players are European, without unduly preventing other competitive players from joining the game if they come from a country applying the same rules as we do.