Europe 1992: The Implications of Market Integration for R & D-Intensive Firms

Academy Industry Program and Office of International Affairs, National Research Council

ISBN: 0-309-59495-2, 180 pages, 6 x 9, (1991)

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Academy Industry Program of the National Research Council
in cooperation with the Office of International Affairs

National Academy Press
Washington, D.C. 1991

National Academy Press 2101 Constitution Avenue, N.W. Washington, DC 20418

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Support for this project was provided by the Academy Industry Program.

Library of Congress Catalog Card Number 90-62811
International Standard Book Number 0-309-04332-8

Copies of this book are available from:
Academy Industry Program
2101 Constitution Avenue, N.W.
Washington, DC 20418

Additional copies are available for sale from: National Academy Press 2101 Constitution Avenue, N.W. Washington, DC 20418

S-215
Printed in the United States of America

ACADEMY INDUSTRY PROGRAM

STEPHEN A. MERRILL, Director
LOIS PERROLLE, Associate Director
SHIRLEY E. COLE, Administrative Assistant

The Academy Industry Program was established in 1983 to enhance communication between the National Research Council and industry on issues related to science and technology. It serves as a two-way channel of communication by disseminatinhg the work of the National Research Council to industry and by providing a forum in which business leaders can bring their views on important issues in science, technology, and health to the attention of the Research Council's leadership. The program also provides support for institutionally initiated studies for which government funding may be inappropriate or unavailable.

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Preface

The economic and political relationships among the West European countries are in the process of dramatic transformation. The 12 member nations of the European Economic Community are engaged in a bold effort to overcome the enormous historical, cultural, and political barriers that have separated their economies over many centuries, with the aim of creating a Single European Market by the end of 1992. Proponents of the plan, which will create the largest integrated market in the world, argue that it will benefit businesses by allowing economies of scale, more efficient marketing, and increased demand for goods and services from outside the European Community. In non-EC countries such as the United States, however, there is some concern that the Single European Market may serve to exclude or limit the participation of non-European competition.

Undoubtedly, the changes brought about by the European market integration will have a major impact on U.S. industry. Regulations and policies adopted in Brussels by the Commission of the European Communities can influence the transfer of information and technology across borders and can affect the market position of both large multinational corporations and smaller, high-tech companies. The impact is likely to be particularly pronounced in industries with heavy involvement in research and development. U.S. R&D-intensive companies have major concerns, for example, about the policies that the EC may establish—or has already promulgated—regarding technical standards, intellectual property rights, and access to (and possible participation in) the results of EC-supported basic research, to name only a few.

Because these issues are also directly relevant to the work of the National Research Council, the Academy Industry Program, the NRC's principal channel of communication with industry, decided in 1989 to convene a major international symposium on the subject. The AIP turned to the NRC's Office of

International Affairs to organize the event, which was held on March 5-6, 1990, at the National Academy of Sciences in Washington, D.C. The Office of International Affairs consulted closely with representatives of EC member countries and the CEC in organizing the sessions and inviting speakers. (The agenda for the event is included as Appendix A.) The audience for the symposium included industry members of the AIP, other interested industry representatives, officials of the U.S. and foreign governments, and academic experts.

This report is a transcript of the speakers' remarks and of the question-and-answer sessions. It also includes as Appendix B a paper prepared by Patrice Zechman as background reading for symposium participants. The AIP wishes to express its appreciation to Mitchel B. Wallerstein and Patrice Zechman of the NRC's Office of International Affairs and Louis Blair, a consultant, for their extensive efforts in the planning and execution of this symposium.

Europe 1992 The Implications of Market Integration for R&D-Intensive Firms

Introduction

DR. PRESS: In response to the dramatic events of the past year, we are having to reassess many assumptions about international relations. Fortunately, our relationships with the countries of western Europe already have a long and strong tradition of cooperation and open dialogue. The emergence in 1992 of the European Community as the largest market in the western bloc and as a major center of science and technology has stimulated analysis and planning in governments and corporations across the world. We in the international science and technology community are interested in the implications of EC 92 for R&D-intensive industries. The interest is not an academic one, for all of the industrialized democracies realize the enormous potential of such industries to contribute to their economic growth in the years ahead. The tradition of cooperation in basic science between nations is a strong one and in all probability will continue or even be enhanced by the anticipated changes in Europe. One can envisage stronger cooperation in larger scientific projects—in special initiatives like the space station, for example, or the Human Frontiers Project, or cooperation in environmental issues.

However, when science and technology have implications for industrial competitiveness, the effect on relations between nations is not so clear. Regulations and policies of nations or communities of nations can influence the transfer of information and technology across borders. They affect the performance of multinational corporations and can be the determinants of the success or failure of small high-tech companies. How nations define and protect critical technologies is a key issue. R&D-intensive industries of national or multinational scope have a vested interest in the formation of new criteria influencing their activities, whether in technical standards, intellectual property rights, or restrictions on technology transfer. Will the current bilateral science and technology agreements adequately stimulate and regulate tech

nology flows? What role will the Commission of the European Communities play in the formulation of what have previously been national science and technology policies? All of these are issues and questions that will affect corporate strategies and will be on the political agenda in the years ahead.

This symposium reflects our need for constructive and continuing dialogue on strategic issues affecting both sides of the Atlantic. As part of the Academy Industry Program, the symposium is intended to provide enhanced communication between the National Research Council and industry leaders on issues related to the ones, for example, that we will be exploring today and tomorrow. In this regard we encourage your candor and your active participation in the discussion.

Science and Technology and European Market Integration: Changes and Continuity

DR. PRESS: Our first speaker is Vice President Pandolfi of the Commission of the European Communities. Vice President Pandolfi is responsible for science, research and development, telecommunications, information industries and innovation, and joint research—an impressive list. Mr. Pandolfi was in business before entering the full-time political world. He served in the Italian Parliament for 20 years from 1968 to 1988 as a member of the Christian Democratic Party. From 1976 until 1988, he was, in turn, minister of finance, minister of treasury, minister of industry, and minister of agriculture. And from 1979 until 1980 he was chairman of the Interim Committee of the International Monetary Fund.

In 1989 he became vice president of the CEC with the responsibilities I have described. I can think of no better person to lead off our symposium and its discussion of European market integration and what will happen than Vice President Pandolfi.

MR. PANDOLFI: Mr. Chairman, ladies and gentlemen, thank you for having invited me to this important symposium. It is actually an excellent occasion to understand and be understood. To understand and be understood is a mutual need for the European Community and the United States. This is made easier by our roots, which are common, and by our political friendship, which is strong. It is made imperative by our new responsibilities, faced with the great events in central and eastern Europe. The winds of history are blowing ever more strongly in our favor. Our model of society has come out triumphant; it is spreading. Being used to and constrained by a difficult exercise in historical patience, we were mistaken about the timing, not the result. The exciting task that now awaits us is to shape the architecture of a new era. We need to understand each other thoroughly to shape it together, understand each other in every area and on every point, including

what we are starting to discuss here—science and technology and European market integration.

The road to the Single Market in 1992 is a complex one. Like all complex processes, it tends to create events that we hope for and events that we fear. It is a typical combination of a bet and a challenge. This is true for everyone. It is true for us Europeans who are living through this process. It is true for you Americans who are wondering about this process. I would like to clear up three points straightaway.

1. European integration is first and foremost a political fact. It is a fact of historical importance that includes the economic aspect but goes beyond it. Allow me a quotation: "The European experiment has succeeded not just because it has appealed to the enlightened self-interest of European producers and consumers. This experiment has succeeded because the vision of its founders encompassed and yet transcended the material. This experiment has succeeded because it also held out the higher goal of political as well as economic barriers overcome, that is of Europe united. This was the goal of Monnet and Schuman. This was the goal supported by the United States of Marshall and Acheson. This was the goal contained in the Treaty of Rome and more recently in the Single European Act. The United States supports this goal today with the same energy that it did 40 years ago." These, you will understand, are not the words of a European. They are the words of Secretary of State James Baker in Berlin on December 12, 1989.
2. The nature of the Single Market is inseparable from the concept of liberalization. The movement toward the 1992 goal may seem like a pure process of integration and aggregation. This it is not. To use a metaphor, I think of the Single Market in terms of a parallelogram of forces. The push toward the Single Market is the result of two forces: integration and harmonization on the one hand, deregulation and liberalization on the other. Neither of these factors alone would have the strength to carry the Single Market to completion. Creating a unified market by itself does not mean that Europe will set off in the right direction. We have to combine the integration of the market with measures to liberalize it. And this is what we are doing. Then the resultant force, and the direction in which it pulls Europe, are all the more effective.
3. The economy of the 12 European states is an economy particularly open to foreign trade. The percentage of imports in our GNP is much higher than for the other two great trading blocs. In 1989 imports of goods—I'm referring to goods because the statistics are simpler—into the 12 member states ran to $1,100 billion. The corresponding figure for the United States was $480 billion and for Japan $190 billion. I repeat: 1,100 for the 12 member states of Europe, 480 for the United States, 190 for Japan. The comparison is something of an oversimplification, of course. We need to

> take intra-Community imports into account. But we also need to take into account the structural trends that can give a push to replacing intra-Community imports with imports from outside the Community. One thing is certain, though: the strengthening of Europe's economy through the Single Market will bring about increased demand to be put at the disposal of the whole world. It is difficult for me to resist the temptation to quote James Baker again: "We think that Americans will profit from access to a Single European Market just as Europeans have long profited from their access to a single American market. However, it is vital to us all—vital to us all that both these markets remain open—and indeed that both become even more open."

These first thoughts have touched on the history, nature, and reality of the Single European Market. How far we are from the idea of shutting ourselves in defensively!

It seems to me that, far from fearing the Single European Market, those who believe in free trade should welcome it, because success in trade depends on having trading partners who are wealthy enough to be able to buy one's goods. And the studies we have performed show conclusively that Europe will be all the poorer without the removal of internal barriers.

After 1992 the Single Market will help companies to recover the costs, including the spiraling costs associated with R&D. But what is true for European companies is also true for American and Japanese ones. The Single Market has been described as "a present for none but an opportunity for all." We shall all be obliged to work harder to exploit that opportunity.

And now, to concentrate on science and technology, what does 1992 mean for research activities? What does it mean, through research activities, for the industrial and economic environment? To express my views on those points, I take as a starting point the Single European Act. It represents the major update to the treaties underpinning the European Communities; signed in early 1986, it came into force in June 1987. The consequences of this act can be summarized as follows:

- An enhancement of the decision-making system of the Communities, increasing the role of the European Parliament and providing for more majority voting in the Council of Ministers.
- A major boost to integration in the political as well as economic and monetary spheres and to social and regional cohesion.
- A fixed time schedule for the completion of the internal market. This is where the magic number 1992 comes from.
- Finally and specifically, recognition of science and technology policy as an important and separate element of Community policy as a whole.

I want to be precise on this last point. The Single European Act has inserted a whole title into the Treaty of Rome, on research and technologi

cal development. The first article of this title says clearly: "The Community's aim shall be to strengthen the scientific and technological basis of European industry and to encourage it to become more competitive at [the] international level." Having in mind some controversial disputes on this subject, I want to underline that the Single European Act does not envisage an "industry policy." It does not envisage one, not in this title nor anywhere else. It simply but strongly shapes a Community R&D policy. Let me add that this policy implies support of precompetitive research only. This is not the case, as you know, of the policies implemented by some of the member states of the Community.

While we are on national and Community policies, let me say that it is now recognized that we should achieve a critical mass through combining our national strengths in cooperative efforts at the European level. Only in this way can one afford the huge investments needed to come up with competitive solutions in high-technology sectors such as telecommunications or face the need for multidisciplinary research in a subject such as the environment, to name but a few examples.

The Framework Program for Research and Technological Development is nothing more and nothing less than the main instrument of this policy of combining strengths and achieving critical mass in leading-edge technologies at the Community level. Perhaps most of you are familiar with the existence of the program and its main characteristics. It covers a period of five years, with a rolling revision. It is decided by unanimity in the Council of Ministers of the Community (unanimity is a very complicated target, as you can understand). The Framework Program is composed of a number of actions with indicative budgets; for each action there are one or more specific programs of precompetitive and prenormative, transnational, cooperative research. Each of these programs may be decided in the Council of Ministers by a qualified majority voting.

I will restrict myself to pointing out that last December we took advantage of the midterm review of the Framework Program then running, in order to face up to the new perception of priorities, both within the member states of the Community and vis-à-vis the outside world. We proposed, and had accepted by the Council of Ministers, a third Framework Program (1990–1994) with considerable streamlining of its specific programs—15 instead of 37—and a more flexible planning and budgeting cycle.

Within that new Framework Program, an important part is taken by information and communication technologies; that is, the first line. The other actions are industrial and material technologies, environment, life sciences, energy, and, finally, human resources—six actions. Some of these, especially environment, have acquired greater importance in the past few years. This is reflected in the new arrangements. In this connection I should like to stress that information and communication technologies are important not only in

a narrow sectorial sense. They pervade, in a horizontal way, many other sectors in order to make them efficient and competitive.

The overall budget for activities related to the third Framework Program, approved last December, is 5.7 billion ECUs, approximately $7 billion. Taking into account the financial resources forecast for the first two years of the period under the provisions of the second Framework Program, the two figures become, respectively, 8.8 billion ECUs and $10.5 billion—nearly $2 billion per year.

It is necessary now to consider a broad horizon, to examine other aspects of the interrelation between European market integration and R&D matters. The most important issues in this context are standards and technical regulations, intellectual property rights, and the openness of the research system itself. I will deal with these in reverse order.

First, the openness of the research system. Let me stress that the conditions for participating in EC research programs are transparent and nondiscriminatory with respect to Community-based organizations with foreign parentage. If they comply with the rules that, in essence, say the work is to be done in the Community by two or more firms that are not established in the same member state and that the work is to be exploited in Europe, they are treated exactly as firms with Community ownership. Of course, we aim to achieve a maximum benefit for Europe from the taxpayers' money invested in these projects, but benefit for Europe does not have to mean to the detriment of anybody else. In this we may take as a guideline the general framework of principles for international cooperation in science and technology, adopted in May 1988 by the OECD Council. This recognizes that the growth and development of all countries increasingly depend on advances in science and technology, which require both a sustained research effort and the widest possible circulation of ideas and information.

Looking at the particular case of the European Community and the United States, for the moment the situation is not fully satisfactory. By way of example, participation in our programs by EC-based firms with U.S. ownership or control is now as high as 1.5 percent. On the other hand, only 0.18 percent of U.S. publicly funded R&D goes to U.S.-based organizations that are not U.S.-owned or U.S. controlled.

Turning to the protection of intellectual property rights, we firmly believe that intellectual property protection rules should make a contribution to technology transfer rather than act as an impediment to it. Dissemination of knowledge should be carefully weighted against the legitimate returns due those who invest in research and development. Some problems have emerged about intellectual property rights clauses in agreements related to traditional areas of EC-U.S. cooperation, when those have come up for renewal. I am confident that in the end a mutually acceptable solution will be found for this problem.

On the third issue I mentioned, it should come as no surprise that standards and technical regulations are of such importance to completing the internal market. The absence of homogeneous standards and regulations has been the item identified by the European business community as one of the most important barriers to achieving the Single Market. In 1983 the Community adopted the "new approach" in standardization that predates the Single European Act and the drive for 1992 by several years. This can be taken as evidence of the fact that already back then we were fully aware that an effective and streamlined standardization mechanism was absolutely essential for true market integration. I think it can be said with some justification that already this approach has yielded considerable benefits for all those who operate in the European market by reducing technical barriers to trade.

This new approach has permitted considerable progress to be made in a number of areas. Among these has been the area of telecommunications, in particular terminal equipment. While we are on the subject of telecommunications, let me digress to comment on U.S. government application of certain provisions of the 1988 Omnibus Trade Act to telecommunications.

The Community is engaged in a comprehensive program of liberalization and harmonization for this sector, which was first announced in the Commission's 1987 Green Paper. Since then, we have made a lot of progress and various legislative initiatives are completed or well advanced. These include opening up the terminal equipment market to full competition, legislative work on an open network provision, and a directive on telecommunications services.

We see success in accomplishing this program as a vital element in meeting the twin challenges of 1992 and of technological development in this crucial sector of the economy. In Europe the telecommunications sector has long been excluded from competition rules and market opening measures and is only now going to be addressed in the Uruguay Round of GATT. The GATT negotiations are the logical counterpart to the Community's own liberalization drive. You may then understand our disappointment when, under the 1988 Omnibus Trade Act, the Community was put on the priority list for negotiating the elimination of barriers to U.S. exports. This was in early 1989. The U.S. trade representative has had a number of exchanges of views and information with us that were qualified by both sides as very useful.

Regrettably, the procedure under the Telecommunications Trade Act has not yet been concluded. I am glad to say, however, that a new spirit is now pervading this exercise. In a letter written to me a few days ago, Carla Hills, the U.S. trade representative, recognizes explicitly that "the European Community has made solid progress in realizing a more open and competitive telecommunications market in Europe." This seems to me very important.

I hope my presentation has served to clarify, explain, and illustrate; now

it is time to make proposals. A visit such as the one I have the pleasure of making will not amount to much unless it leaves on the ground a visible trace of its passage. I am referring to the ground of scientific and technological cooperation between the European Community and the United States. It is fertile ground, but perhaps not cultivated enough. We must do more; we must cultivate it more intensively.

I will purposely leave to one side for the moment the ambitious prospect of a new cooperation agreement or agreements on R&D between the European Community and the United States. Article 130n of the EEC Treaty, as amended by the Single European Act of 1987, provides the legal basis for such an agreement. The new Framework Program for 1990–1994 and the specific programs that will follow provide the factual basis, so there are possibilities, but we need to build the preconditions. Let's keep the main aim in sight, but start straightaway to work on well-defined points.

I propose that we concentrate on five priority areas through appropriate forms of joint work. These must be explored in depth in a sufficiently short time with a commitment aimed at decision making.

First, information technologies. Important new moves toward EC-U.S. cooperation by companies are taking place. I remind you of the IBM America-Siemens agreement on semiconductors. It is consistent with our JESSI program. On both sides, though, things are moving more slowly in the area of publicly funded programs. There is still asymmetry. There is still a shadow of diffidence. Taking as a term of reference the network of participants in the ESPRIT program on the Community side and the network of engineering research centers on the U.S. side, I propose that we study determinedly and in depth any realistic possibility of collaborating. According to many people, definite areas and specific points for possible cooperation exist. We have to identify them.

Second, prenormative research in the biotechnology sector. The areas in which public authorities are called upon to exercise their legislative or regulatory powers are becoming even wider. Health, safety, and environmental protection are among these areas. This is the case with bioengineering. We need to fix disciplines and set rules for the release of genetically modified organisms, for example. On this point the European Community is badly behind the United States. This determines a disadvantage to American industries that are deprived of the possibility of access to the European market. Fixing rules, or improving those already in existence, implies a preliminary research activity—we can call it prenormative—to have a solid and sound scientific basis. Getting together with a view to cooperating—this is our proposal. Avoiding duplication, speeding up results, increasing reliability—these are our aims.

Third, energy and environment. I am not referring to the usual subject of the constraints closely connected with the production of energy and the

need to protect the environment. I am referring to a newer and, in a certain way, more radical subject. It's a question of working on an overall cost-benefit balance sheet. It's a question of constructing models, combining scientific and economic approaches, that include larger series of variables than we have used up until now. It's a question of conceiving schemes for wider geographical areas than we have until now—continental and intercontinental, as is the case for acid rains. In this area, international cooperation is a must. Cooperation between the European Community and the United States must not be exclusive. It must be a driving force.

Fourth, research and technological development with and for the countries of eastern Europe. It would be a mistake to think of possible and welcome initiatives in this area as a simple extension of existing activities along well-known lines of research. We must identify specific emergencies, like the environmental one, and specific needs. We must develop a program whose aim is the transfer of technologies, targeted rather than advanced, capable of facilitating and speeding the recovery of productivity in a context of widespread obsolescence. We need to favor progress toward a market economy in this way. Concerted action between the two sides of the Atlantic will give more impetus to the initiatives of the Group of 24. Through this action it will be possible to better use the room for maneuver that is progressively opening up as the COCOM restrictions are eased.

Fifth, large-scale scientific projects. We propose a regular exchange of views in order to arrive at common approaches in a number of very expensive, large-scale initiatives. The initiatives include, as you know, global change, the human genome, fusion, high-energy physics and the superconducting supercollider, space stations, deep-sea research stations, and deep drilling on land. Research on the subject of global change and the human genome could be carried out through networks of many centers. The other initiatives require a highly expensive concentration of effort in large research facilities and a very long duration for this program. Within this list we need to make a selection, fix realistic targets, and establish ways of cooperating. We will take existing priorities into account. I would like to mention that among the priorities we have already agreed upon is a Global Change Program. We welcome warmly the initiative of President Bush in holding a White House Conference on Science and Economic Research Related to Global Change on April 17 and 18, 1990.

These then are five concrete examples of possible consultation and cooperation between the United States and the European Community. We propose that these should be explored and tried out. The list is neither binding nor exhaustive. We should take on board the biblical message: try everything; keep what is good. [Speaks in Greek] I have seen that there are some Greek words in the hall of this building, so I am allowed to utilize Greek words.

What is important is for us to sit around the same table, to share the same

aims, to speak the same language, and to speak to each other, for I have the impression that we have not communicated enough. Incidentally, why not set up a joint permanent task force? This is an item I have discussed with Dr. Bromley. By talking more and sharing this first exploratory work, we may be helped to face two problems that crop up and rightly worry both the authorities and the scientific community in this country. The first is an institutional problem. The second is a problem of human resources.

The institutional problem is that of the shift in Europe of the center of gravity in research activities, from the member states toward the Community and its programs. Right now only 3 percent of the total funding for research in the 12 countries is accounted for by Community funding. Right now the Community acts according to the so-called subsidiarity principle, the modern equivalent of the "jus supletivum" of medieval law: What can be done at the level of the member state is best done by the member states; what they cannot do by themselves is done by the Community.

At the moment, then, this is how it is. But what of tomorrow? How will the current structure of multibilateral relationships between the two sides of the Atlantic change? Will we succeed in understanding each other on the crucial questions? These are the important issues for our American partners and friends, for the scientific community, and for the business community itself.

The second problem touches on human capital and its mobility. This is an ever more essential factor in research activities. The whole world, and particularly we in Europe, knows what role the United States has played in preserving and increasing the human heritage in research. It has done this through good times and through bad times. We can never forget this. On this point, there is now stronger sensitivity in the countries of the European Community on the need for more intra-Community exchange, particularly at the level of young researchers. This is natural. One of the new initiatives of the 1990-1994 Framework Program deals precisely with the mobility of young researchers at the postdoctoral level. I can well understand that even on this point questions will arise in the minds of our American friends. What effect will Community initiatives have? Will there be undesirable repercussions in terms of mobility for the United States?

To sum up, what do we do? For the two problems I have raised, and for others, both known and unknown, the answer is not to stop the clock. Processes like European economic and political integration answer to the demands of history. The great merit of the United States is in recognizing and supporting them. I stress this right at the beginning. The solution is not to be found in unilateralism either. This is the way for those who succumb to the temptation of going it alone in the sure knowledge that their reasoning is right but deaf to the sound reasoning of others. We must not, we do not want to take this road.

The answer to our problems lies in the practical recognition, in word and deed, of our interdependence. We are to all intents and purposes interdependent in science and technology as well. I have come here to say this to you. I have come here to learn this from you. I have come here because we can work together better on this basis.

Science and technology are progressing. Markets are integrating. New ambitions are emerging, but the humble and great task that Thomas Jefferson gave to his fellow American citizens two centuries ago remains valid for always and for everyone, Europeans included: "Cultivate peace and commerce with all."

Views and Concerns of the U.S. Science and Technology Community

DR. PRESS: To give an American view of concerns and opportunities, we have Erich Bloch, who since 1984 has been director of our National Science Foundation. This is one of the key government agencies that supports basic science and engineering in the United States. Mr. Bloch is an electrical engineer. His entire career was spent at IBM, where he rose to the position of corporate vice president. Two years ago he received the National Medal of Technology from President Reagan for his work on the famous IBM 360 computer. He is a very important spokesman in the United States on issues of science and technology policy, both domestic and international.

MR. BLOCH: My assignment is to offer a U.S. perspective on some of the issues that are raised by European economic integration for science and engineering, from the viewpoint and concerns of the science and technology community.

This is a subject that the Committee on International Science, Engineering, and Technology in OSTP is examining in some detail. In addition, the National Science Board has established a special committee to consider the implications of European integration for our policy, and there are many more committees and task forces in place to look at the same subject.

One reason the formation of the European Community is of significant interest to the United States and to its science and technology communities is that we have a tradition of strong ties with individual European countries in these areas. We have, therefore, a natural interest in maintaining these strong bilateral cooperative links in education and basic research as well as in industry technology. The establishment of the European Community raises a question as to whether these traditional ties are being disrupted or at least changed substantially because of the EC or if, alternatively, the EC constitutes for the United States just one more actor in a complex web of

relationships. Beyond that, however, the European integration is causing us to take a close look at a series of science and technology issues that, far from being uniquely European, are becoming pervasive in the era of global technology.

Before I address any of these questions, I have a couple of more general observations. We are, as is quite obvious, living in a time of extraordinary change. The dramatic transformation of eastern European politics and economics is just one aspect of this process; EC 1992 is another. The shift from national economies to an integrated world economy is yet another. It affects a global economic arena that has become fiercely and broadly competitive for all nations. But important as these events are, they are unlikely to define the essence of our age. I suggest that this role will fall to the information and knowledge technologies that have contributed so heavily to these and other social developments.

Knowledge, in fact, has become the critical resource, as important as natural resources or access to low-cost skilled labor were in the past. It has become the engine of economic growth and change, and, in the context of the new global economy, new knowledge is the foundation of new industries such as computers, biotechnology, semiconductors, new materials, and many other things. New knowledge has revolutionized the workplace, education, and even research itself, through computers and information science, and has made it possible for us to address, on a joint basis, global issues like environmental pollution, ozone depletion, and others.

The new information and knowledge technologies, because of the effect they have on society and the competitive power they confer, have played a significant role in reshaping political and economic relations. They are responsible for the emergence of this country as a world technological and economic leader after World War II and the emergence of the Pacific power bloc. And while the reasons for European unification are complex and many, one might well ask whether the process or the rapid pace that we are witnessing today would have come about without the knowledge revolution that is occurring at the same time.

The effect of the new knowledge economy is to underscore the critical importance of investing in science and engineering research and of having a well-educated technical work force. All industrial countries, and those that aspire to join the ranks, are responding to these circumstances in similar ways. Systematic innovation and effective commercialization of new products and processes are key to economic leadership. This requires national investments in research and technical infrastructure. While total U.S. R&D spending continues to exceed the collective European total, European nations have made significant progress in narrowing the gap, based on a higher growth rate in their research investments.

This is particularly true in civilian R&D. In 1984, for example, U.S.

spending for civilian R&D exceeded that of EC nations by 40 percent. By 1988 our lead declined to 10 percent, and it would not be unreasonable to expect relative parity in civilian R&D as 1992 approaches. If the eastern European countries are included, total European spending on civilian research would exceed that of the United States for sure.

With regard to human resources, we face similar problems. In the United States science and engineering employment has grown at twice the rate of other professional employment. European countries, through their investment in the human resource base, are beginning to shorten the once substantial lead the United States enjoyed in technical personnel. The demand for a highly educated technical work force is increasing on both sides of the Atlantic, and because of demographics shortages are developing both here and there.

Cooperation and open communication across international boundaries in the sciences have always been critical to the vitality of scientific inquiry. European integration and the importance of cooperation and communication in the political arena attest to the fact that science and engineering research is no longer unique in this regard. At the same time, because of the centrality of research to the economic competitiveness of individual nations, cooperation and competition in the sciences and engineering have a different meaning today than they have had over the past 40 years. Not surprisingly, cooperation in science and technology is becoming a political question. Despite the fact that today open communication of research is more important than ever, driven in part by the pace and richness of discoveries and capabilities, and despite the fact that escalating costs make cooperation increasingly attractive on major research issues and in the use of large capital-intensive facilities like drill ships and accelerators, cooperation in science and technology is being subjected to practical, political, and economic concerns.

With these general observations then, I would now like to talk about Europe 1992 and its impact on the United States. Within this context, dominated by the growing role of research and the need for cooperation and sharing across national boundaries, European integration raises some very important issues for all of us.

The first issue I want to look at is research investment. Generally stated, the question is whether the Single Market momentum will lead European researchers and their program administrators to look inward and inadvertently disrupt the relationships that have been developed on the bilateral basis. There is no doubt that in the past the scientific relationships of some countries with the United States were stronger than with their neighbors. How or if the changes that we are seeing will change these relationships is the important question. Currently, EC R&D spending constitutes less than 4 percent of all R&D spending in Europe, and EC cooperation has been primarily in strategic technologies with commercial potential, that is, the Framework

Programs, as was pointed out before. However, the European Community will focus on basic research as a matter of necessity. Contacts with the principal investigators in our universities at the basic research level occur mostly through public research facilities supported by national governments, augmented by university researchers. This is the level of interaction that is the focus of our bilateral arrangements with the individual countries. However, budgets for basic research in most EC countries have been declining or are stable, and funding increases have been directed principally at technology development. To the extent that this trend continues, it could result in even greater pressure on basic research and potentially diminish contacts between U.S. and European researchers.

The second issue is the European community of scientists. Until recently a regular sharing of ideas and approaches among European and American scientists was assured not only by contact among senior scientists but also by the fact that many Europeans received at least a part of their training in the United States. That is changing. Among European scientists aged 45 to 54, 21 percent obtained their doctorates in the United States, compared with 12 percent of those aged 30 to 35. This change is occurring simultaneously with the emergence of a European community of scholars more oriented toward intra-European communication. This could result in greater pressure on research administrators to redirect resources—including grants, fellowships, and travel costs—to European-centered activities, to the exclusion of cooperation with scientists and engineers from other countries. In all fairness I need to add that my European colleagues have had the same concern about the alteration of the U.S. relationship to their countries when we discovered that the Pacific Rim was no longer an area that could be ignored, scientifically and otherwise.

The third issue is bilateralism. The EC process could also affect the quality and richness of these relationships. For example, will intra-European connections lessen the commitment of individual nations to interaction with the U.S. science and engineering communities over time? Another question is, what will be the role of the European Community on the research decisions of individual nations, especially since the individual countries are the locus of support for basic research? Or, a third question, will the momentum of Framework-type programs begin to affect the allocation of resources, especially human resources, and with it the access of American researchers to programs at the individual and national levels? Last, will there be a stronger tendency toward large multinational projects at the expense of more flexible research arrangements at the level of the individual investigator? By the way, a similar question is being asked here when it comes to centers and individual investigators. All in all then, is there an arrogation of power, and by power I mean funding, at the EC level at the expense of the individual country level over time?

Another issue is the tripartite relationship. The nature of government-to-government relations in science and technology is the area of concern. Our contacts today are at the bilateral level. As the European Community becomes a larger factor in research funding, what should be the nature of U.S. contacts with the integrated Community? There is some discussion already of a U.S.-EC bilateralism, and rightly so. The prospects of a fruitful relationship in this area will no doubt be strongly influenced by funding and policy choices for Europe-wide science and technology. The basic question here is, will the U.S.-EC relationship emerge in place of bilaterals or in addition to them?

Another area of concern is access to information. The competitive advantage conferred by access to the newest ideas and processes and the prospect of early commercialization give rise to pressures for limiting access to information. Current discussion of intellectual property rights is a case in point. The tougher EC position on this issue raises questions with respect to cross-licensing, protection of proprietary information, the assignment of rights in personnel exchanges, and joint research endeavors, as well as the geographic boundaries where intellectual property rights apply.

Standards have already been discussed, but let me say a word about them. The adoption of a single system of standards is an issue of obvious concern to industry, to the extent that standardization is not only a means to further the integration but could also be used to exclude some American products from European markets. However, standardization of products and services will also affect research and development activities between countries, in such areas as data processing, software, networking, telecommunications in general, environment, and biotechnology.

Technology transfer is another issue. The obvious interest of eastern European countries in the rich markets and developmental possibilities of the western European arrangement could also raise questions with respect to technology transfer. Changes in the eastern European countries and in our own relationship with them are rapid and dramatic. But the degree of openness and sharing will remain an issue, and not only a scientific one but also a political one in the foreseeable future. Stronger relations and greater sharing within a planned European context will require further examination of this topic.

To conclude, the process of European integration will undoubtedly invigorate the science and engineering research base throughout Europe. But the process also raises some important issues and could force major dislocations in established relationships dictated by the economic climate within which this integration is taking place. One thing is sure: we Americans, the U.S. science and engineering community in particular, and maybe the European Community itself and its member nations are underestimating the rapidity with which these changes will occur and the far-reaching effects they will

have. I want to expand a bit on Vice President Pandolfi's earlier remark. Maybe the timing and the results will surprise us, but I want to be clearly understood. These are positive forces at work, but they need to be understood and not ignored or understood too late. The year 1992 is not a curtain raiser; it is the end of the first or maybe even the second act of a drama of historical proportions.

I am very much encouraged about the subject that Vice President Pandolfi raised, with respect to putting actual program discussions ahead of Framework discussions or a memorandum of understanding and other arcane instruments that we normally deal with. In the interest of preserving mutually beneficial relations across the Atlantic in the sciences and engineering, however, we should bear in mind some basic principles as we discuss the details or the generalities.

Some of these principles are very clear. We must ensure reciprocal freedom of access to basic science and engineering programs and facilities for all qualified researchers. We must make provision for sharing major facilities and data bases. We must assure appropriate intellectual property protection. There must be fair terms for private sector access to publicly funded technology-based programs such as ESPRIT, EUREKA, and others. And there must be a standards-and regulation-setting process that is open, fair, and flexible without sacrificing the commonality that is so important both to us and to the Common Market. There is every reason to believe that the strong commitment to openness and cooperation that has characterized our relations in the past will continue to inform our policies in the future. It will surely help us all to deal with common concerns and to address an increasingly complex research agenda. Such a commitment will also contribute to the growth of the knowledge pool from which we all benefit.

DR. PRESS: We have 20 minutes or so for comments, discussion from the floor, or questions to be addressed to our two speakers. Our speakers may also wish to comment on each other's papers. I will start, just to begin the discussion.

Between the European countries and the United States, there are differences in style, in culture, in the way governments behave, and in their relationship with industry. It's not to say that one is right or one is wrong. They simply differ. I have the impression that in some European countries the governments could go very easily from research and development support in the civilian sector to seeing that whatever emerges in the form of new technology ends up in a commercially successful product. In other words, the governments might intrude more in the process of manufacturing investment or ownership of corporations and in that way perhaps provide some degree of advantage compared to our system where the support of basic sciences is as far as the government goes. As I said before, it isn't a question of which tradition is correct or which attitude is wrong, but it does lead to some degree of

asymmetry that might end up in perceptions of unfair competition. This may be the sort of issue that would be very difficult to resolve between western Europe and the United States. Of course, it shows the advantage of your recommendations that we cooperate in basic science in large projects to mitigate this degree of difference, of competition, but these issues will arise nevertheless. What is your picture of the future? Do you think that these differences are serious? Are they manageable? How do you think they could be reconciled?

MR. PANDOLFI: First an observation. You have mentioned the fact that in Europe we have different styles and different traditions, legislative traditions for example, in the various member states. Yes, this is clearly the present situation, but I think that the increasing role of the Community as a catalyst, beyond the small percentage of funding directly dedicated by the Communities to our programs, will produce a more homogeneous situation in the various member states. For example, one of the important policies of the Community is the competition policy. And we have more and more severe monitoring of, for example, state assistance, so I think that in the future these differences will be reduced, but in line with a higher respect for competition, free competition rules, avoiding, for example, a tendency in certain member states to use some legislative provisions to directly support competitive research, not just precompetitive research.

The future situation is probably advantageous as far as the relationship between the United States and Europe is concerned, not only for the obvious reason that it is easier to manage a bilateral relationship than a multilateral one, but also because it will be possible to negotiate and to have mutual monitoring. The United States, I think, will have a greater influence on the Community compared with its influence on the individual member states. That is why I have proposed to start immediately with this kind of joint work, because I think working together will demonstrate the advantages of direct bilateralism for removing obstacles, if they exist, ameliorating the atmosphere, and also solving some of the problems you have rightly mentioned. In any case, our policy is only to support precompetitive research, leaving to the companies the responsibility to join the market with their production. This is a clear line for the Community.

MR. BLOCH: Regarding your specific question of governments' influence on funding beyond basic research, I must point out that we are not as pure as we sometimes appear to be. For example, there is heavy funding, 50 percent, from the federal government. So we have problems on both sides, access to each other where we have a commingling of funds. But I want to elevate your question to a more general one. I think we will have asymmetries for a long time —asymmetries in our institutions, in where the funding is, and so forth. And we have lived with these asymmetries over the last decades. We have to recognize from the beginning that things will

not be that simple, that access to an activity in one country and access to one in another country mean two different things, involve two different institutions. Most of the basic research in the United States—75 percent—is done in universities. Seventy-five percent of the basic research in Europe is not done in universities; it's done in government labs. It might even be done in EC labs in the future. So I think we should be prepared to deal with that issue, recognize that differences exist and then move forward and make sure that we have access to similar kinds of activities on a similar kind of a basis. But it will never be the same, and it will never be quite as easy to determine what access means.

DR. PRESS: Those are two very good responses. Now let me turn to the audience.

MR. COONEY: Stephen Cooney, National Association of Manufacturers. My question is to Vice President Pandolfi: What are the approximate levels of funding in each of the six major areas in the revised third Frame-work Program? Can you give us those figures at this time? I know originally it was 7.7 billion ECUs. That was changed to 5.7 billion ECUs, but what's the distribution among the six program areas?

MR. PANDOLFI: In spite of the fact that I am the author of the proposal, I do not have the exact figures in mind, but my associate, Professor Fasella, does —but first a preliminary remark. The original proposal of the Commission was 7.7 billion ECUs, as you have mentioned, for the five-year period. We had a lot of problems with the Council. The final result was 5.7 billion ECUs, but with the possibility of obtaining additional money in 1992 for the last two years of the program, 1993-1994. So I am confident of ameliorating our situation and adding something to the figure already agreed to by the Council. (See Figure 1.)

Of course, there is another element of novelty. It is a certain modification inside the various actions. For example, for the first action, related to information and communication technologies, we have a new research program aimed at the interconnection of the various national networks, both of public administrations and of systems supporting industries. And this is one of the major necessities for the Community.

MR. BURLANT: Bill Burlant, GAF Chemicals. You mentioned the role of the rather profound and pervasive areas, like environmental and life sciences and biotechnology, but what impact, if any, do you project on the smaller chemical companies that are involved in a variety of research projects but not in those categories in the next five or 10 years?

MR. PANDOLFI: There is not in our programs a preliminary, a priori distinction between big companies and small enterprises. Our goal is to ameliorate the access of small and medium-size enterprises to our programs. Of course, it would be stupid to deny the driving force of big companies, but one of the characteristics of the new Framework Program,

the third one, is the utilization of some new mechanisms. One of these is a new element of our Community law: it's a new kind of European consortium whose name is European Economic Interest Grouping. Under the provisions of this new consortium, it is more possible than before to associate small laboratories, small industries—why not your small chemical industries—to big companies, with some new and very interesting and effective formulas. So we do hope that the new program will allow us to obtain much more coordination of the activities of small and medium-sized enterprises and the big companies.

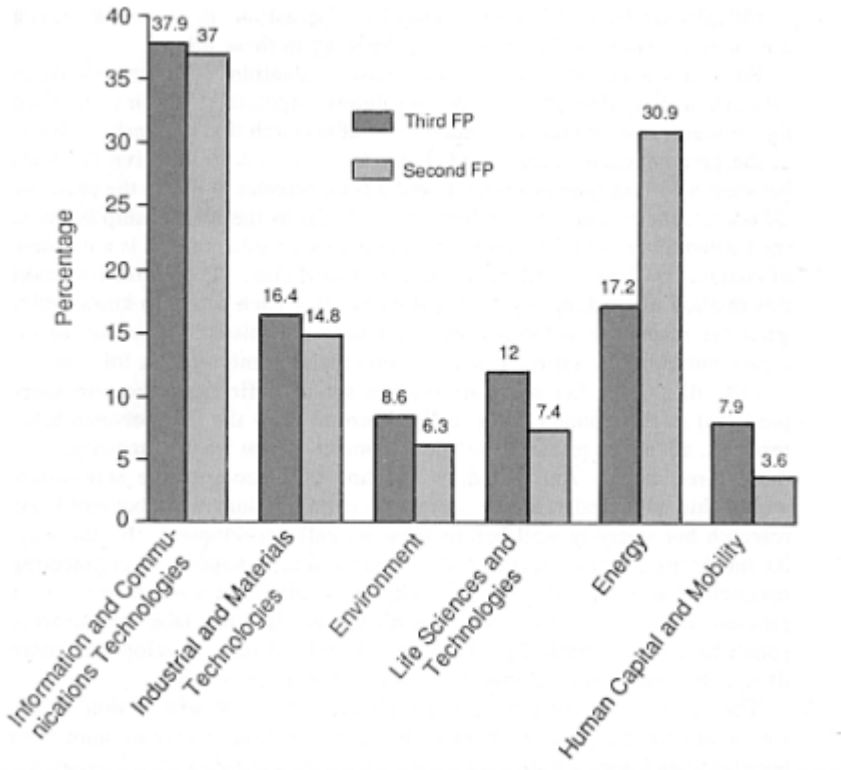

Figure 1 Distribution of Funds for the Third Framework Program.

MR. BREMER: Mike Bremer, the Upjohn Company. Can you provide a distinction between precompetitive and competitive research? And, Dr. Bloch, would you tell us whether you would agree with that distinction?

MR. PANDOLFI: It's a very complicated question, as you know. It is a dogmatic question, and there is some theology in these affairs.

First, it's a problem of common-sense evaluation. It is impossible to establish a sharp demarcation line, absolutely impossible. But it is easy, on the contrary, to distinguish a certain body of research that is clearly included in the precompetitive area. And it is relatively easy to perceive the links between a certain type of research and a final product to put in the markets. Of course, there is an intermediate area. As far as the relationship between the United States and the European Community on this point, it is a problem of mutual confidence and better mutual knowledge. Therefore, I support this method of working together and monitoring each other, to know better what the respective activities are—just to avoid misunderstanding, to increase our common vision, especially on crucial points such as this one.

MR. BLOCH: Let me start from a set of definitions that are more prevalent in this country. It's really where to draw the line between basic research, advanced research, and development, if you want to structure it in those three areas. And I'll draw the line of precompetitive somewhere within this advanced research category—certainly somewhat beyond basic research but stopping well before what we call development. By the way, let me focus on one aspect of it. Basic research applies to engineering research as well as scientific research, and I think that's where we have a problem once in a while, that everything that has the label engineering somewhere is automatically advanced research, at best, development more likely. It's being labeled that, and I think that is erroneous.

The line is somewhere within this advanced research area. I don't think we should be that precise about it, however. I think a certain amount of nonclarity and nonprecision is to our advantage, and I think that's what you reflected on before. So let's not try to cut that particular definition so fine that we have no room to maneuver. Many things that start off in development, as you know very well, wind up in basic research and obviously vice versa. I think we should not try to draw a line that is too fine, too narrow, and too theological, by your definition.

MS. PLATZER: Michaela Platzer, U.S. Chamber of Commerce. You've talked a lot about the European Community's Framework Program. Can you talk about the connection between the EC's Framework Programs and the EUREKA programs, which were obviously aimed at competitive research?

MR. PANDOLFI: This is just the case to look at as far as this demarcation line is concerned. But this is a very important question and one of the crucial points of our activity. We have reflected and considered this problem deeply. Our final conclusion is the following. We can't afford in Europe to disperse our resources. Where we have EUREKA projects, they have a different nature than our pure precompetitive projects. But it is

possible to have a certain combination of the two, if the Community participates only in a certain part of a EUREKA project: precisely the precompetitive part of the overall project. For example, we have one of the well-known EUREKA projects, Project JESSI. Our problem has been how to identify precisely one part of this microelectronics program that is purely precompetitive research—not directly related to the final production of memories, etc. So this is our formula. Probably there is something complicated in this exercise, but it is inevitable, and now we have found, I think, a reasonable guideline with a satisfactory solution for our member states. The same thing holds true for another well-known project, HDTV. In this case, our participation is absolutely small, and it is not related to the production of the final apparatus.

Access to Precompetitive Research Programs of the European Communities

DR. STEVER: Our first speaker on this interesting subject of access to precompetitive research programs of the European Communities, is Paolo Fasella. He studied medicine and biochemistry. He started out, as so many of the leaders of all of our nations in science and technology do, in the academic world. Then his interests broadened. He is now director general of science, research, and development of the Joint Research Center of the EEC.

DR. FASELLA: Mr. Pandolfi's authoritative presentation and the excellent background material from the National Research Council provide the political framework and the basic information on the content, scope, and operational mechanisms of the European Communities' multiannual research program and its implementation. It should also be clear that, as foreseen by the Single European Act and specified in the 1990-1994 Framework Program, the Community is ready to cooperate with third countries on a basis of mutual advantage.

I shall confine myself to some considerations directly bearing on the access to EC programs of noncommunity countries, institutions, and companies. I shall first outline three key concepts that guide the EC research policy. These are: *subsidiarity*, concerning relations between EC activities and those of the member states; *precompetitiveness* , concerning relations with industry; and *prenormative research*, concerning relations with EC regulatory activities. I shall then discuss the various levels of access of EC programs and the modalities presently available for participation by non-EC countries.

On the first point, American colleagues often asked me questions such as: Will Community R&D programs progressively replace national programs? Does the existence of a Community program abolish or interfere with bilateral agreements between the United States and individual EC member states?

The answers to these and similar questions are given by the principle of "subsidiarity of Community action." According to this principle, actions are carried out at the Community level only when there is an identified advantage in doing so. For research, we have the "Riesenhuber criteria," named after the German minister for science and technology who elaborated them during Germany's presidency of the European Council.

The stringency with which the subsidiarity principle applies to research programs shows in the figures: as of now, the annual research budget of the Community is only 3 percent of the public spending for research in the 12 member states. You can find the data for 1987 in the background document prepared for this conference (Appendix B). Since then EC funding has increased and will continue to do so, at least up to 1992, but it will probably not go beyond 6 percent of total national funding. Also, the background paper reports the funds estimated to be necessary for the 1990-1994 Framework Program. To these must be added 3.1 billion ECUs carried forward from the 1987-1991 Framework Program. The total therefore amounts to 8.8 billion ECUs. Since most Community interventions cover only 50 percent of the costs, the EC is directly involved in research actions for about 17.6 billion ECUs, or $20 billion, for the 1990-1994 period. It is not a large sum, but it is significant, particularly because it is focused on relatively few key areas. As clearly indicated in the background documents, information and communication technologies are the largest single item. Environmental research and the development of human resources through postdoctoral training in networks of centers of excellence have increased considerably; so have the life sciences and technologies, whereas energy has decreased, in relative but not absolute terms.

In areas such as information and communication technologies, some member states have readjusted their own national programs in favor of Community action. In other sectors, such as controlled thermonuclear fusion, the Community program comprises practically *all* activities carried out in the member states.

Demand from industry research institutes and universities for participation in Community research programs largely exceeds present resources. While the rate of acceptance of good to very good project proposals ranges from 30 to 50 percent in most national programs, it is only 10 to 20 percent in Community programs. These figures suggest that the Community tries to satisfy widely felt needs but that the financial means available are inadequate.

What are the trends for the future? The next decision will be taken in 1992, when a fourth Framework Program partly overlapping the present third program, will be proposed for the 1993-1997 period.

The European Parliament will probably insist on substantial increases, whereas the European Council, and especially certain member states, will be more reserved. In some member states, departments that advise the

government on the Community's Framework Programs are asked by their national budgetary authorities to accept cuts in their own budgets, corresponding to the national contributions to the Framework Program. Quite an effective way of encouraging subsidiarity!

All factors considered, I expect that the Community's research budget for 1993-1997 will increase but not drastically.

The answer to the *first* question of my American colleagues is therefore straightforward: EC research programs will not replace national programs but will represent a useful and perhaps necessary complement to them, not just because they provide fresh funds but because they promote new forms of collaboration.

The answer to the *second* question is equally simple: the existence of EC programs does not abolish present or prevent future bilateral agreements and collaboration between the United States and EC member states but may add to them.

Let us now consider relations with industry and the concept of precompetitiveness. Industry is consulted, along with other social partners and the scientific community, during the preparation of the program. Industry also participates in the implementation of programs, by carrying out some of the research and/or by paying up to 50 percent of the costs. Eventually industry is expected to make use of the results and to benefit from the increased knowledge acquired.

Community support covers basic research, practical applications, general development, and demonstration, but it stops short of actual product development, industrial production, and commercialization. The term precompetitive is used to describe this situation. Several definitions have been given, referring either to the time lapse between the end of Community support and commercialization or to the financial efforts needed to develop products and take them to the market after Community support has ceased.

In practice the present system works quite well and has not resulted in complaints since the EC's precompetitive programs were launched in the early 1980s. This lack of complaints is significant, since the EC offers plenty of legal and administrative means for recourse against any violation of its Competition Rules, including state and public aids, as spelled out in articles 85 to 94 of the Treaty of Rome. The EC legislation, which assures fair competition to all, is a guarantee for *non*-EC countries as well as for EC member states.

The third key concept to which I referred is prenormative research. Though the term is not found in the Oxford or Webster dictionaries, its meaning is clear: research aimed at providing the scientific knowledge and technical know-how on which reasonable and effective regulations, norms, and standards can be based. The importance of this research is increasing as we approach 1992. The interest of non-EC countries in this Community activ

ity is also increasing. This is why I mention it here. However, I shall say no more about it, because EC research activities related to standards setting, certification, and testing will be dealt with by J. P. Contzen.

Let us now focus on the central issue for today, namely access by non-EC countries to EC programs. We do have some experience with this, particularly for what concerns the EFTA countries. They have all concluded framework agreements for science and technology collaboration with the EC.

Access can take place at various levels and through various modalities. It can include joint planning and conception of programs; "contribution to" and "access to" funding of programs; participation in the implementation of either a program or a project; and access to research results, be they published, stored in data banks, patented, or protected by copyright. The legal terms of reference for access to Community programs are to be found in the treaties establishing the Communities, the Framework Program and specific program decisions, and the harmonized research contract. The latter is of interest not only to participants in our program but also to anybody wishing to have access to the results. The harmonized contract requires users' rights and nonexclusive licenses to be granted in specified circumstances to organizations carrying out R&D in the EC or established in the EC. However, participants in the project are not prevented from granting licenses to organizations established outside the EC, provided that they do so in conformity with the interest of the EC. Moreover, third parties outside the EC may manufacture products incorporating the results of EC-funded projects.

Each specific program decision taken by the Council of Ministers in cooperation with the European Parliament on the basis of a Commission proposal specifies if and how that program can be opened to non-Community countries/agents or institutions.

Actual cooperation with non-Community countries or institutions can be established on the basis of article 130, according to the procedures spelled out in articles 228 and 130. The latter foresees a Council decision taken by qualified majority in collaboration with the European Parliament, on the basis of a proposal by the Commission. Several cooperation agreements have been established by this procedure with non-EC countries, namely with the EFTA countries. So far three modalities have been successfully used to implement these agreements: (1) Mutual information and consultation through semiannual meetings. (2) Participation on a project-by-project basis in one or more specific programs. Here the possibility of such a collaboration must be specifically foreseen in the corresponding Council decision adopting the program. Participation is through persons, institutions, or companies; participation from third countries must be proposed by at least one EC partner and accepted by the others. The country from which the non-EC participants originate does not contribute to the financing of the

program, but a small fee is generally required to cover the additional administrative expenses of the Community. Non-EC participants do not receive any contribution from the EC budget. They participate in the projects and have access to information related to or generated by the projects but *not* to that from the whole program. (3) Full participation in a program. This must be foreseen by the program decision and must be the object of a formal agreement between the EC and the third country concerned, as stipulated under article 130. This involves contributions to the funding of the program by the participating third country on the basis of its GNP. This third country is represented in the advisory committee for the program and its institutions, and firms can participate on the basis of equality with participants from EC member states. Several such agreements for full participation have been signed, with EFTA countries for example, on programs concerning the environment, medicine, advanced training, and basic research. No such agreements presently exist between the EC and the United States, but they could be envisaged for the future.

The above concerns collaboration foreseen by the treaty establishing the EEC.

Other forms of collaboration with the third countries can be implemented under the EURATOM Treaty. A joint enterprise, the Joint European Torus (construction and operation of a large reactor for controlled thermonuclear fusion), includes the full participation of Switzerland and Sweden, while the EC cooperates with the United States, Japan, and the USSR in the ITER program (joint design of a new reactor for controlled nuclear fusion). Several agreements exist between the United States and the EC for collaboration on various aspects of nuclear fission research.

Finally, the position of U.S. companies operating in the EC should be considered. There is no restriction in any EC R&D program to a subsidiary of a U.S. company or other organization participating in EC-funded projects provided that the subsidiary is established in the EC.

Subsidiaries of U.S. organizations that are located in an EFTA country must participate in the EC-funded projects on the same basis as other EFTA organizations.

The harmonized contract also permits the participation of organizations established outside the EC and EFTA in specific projects with the agreement of the Commission.

In all cases there is a general limitation on the transfer of results and information to organizations established outside the EC, including U.S. parent companies. As of now, several subsidiaries of U.S. organizations established in the EC participate in EC-funded projects.

To summarize, U.S. researchers and companies do have access to EC programs at various levels. Collaboration between the EC and the United States could be developed further. On the EC side, the legal and administrative

tools for this do exist. It is up to us to use them imaginatively and to our mutual advantage.

DR. STEVER: Our next speaker is Jean-Jacques Duby. He graduated with a degree in mathematics from the Ecole Normal Superior in Paris. He joined IBM in 1963 at the Yorktown Heights laboratory, in the research division. Since then he has spent most of his career at IBM, holding various management positions in research, development, sales, and education. He thus has all of the advantages and disadvantages of our earlier speaker, Erich Bloch, in preparation for these kinds of jobs. But in parallel with his IBM career, he has been teaching at the Ecole Polytechnique in Paris and the universities of Grenoble in Paris, France, and Geneva, Switzerland. And he has done other international work. He is also a member of the French National Scientific Research Committee and of the Research and Innovation Committee of the French Employer's Union.

DR. DUBY: I've been asked to briefly present the viewpoint of non-European-held European companies regarding access to European precompetitive programs. It's difficult for me to speak in the name of all non-European-held European companies, so they decided that I would draw a random sample, and I'm going to present the viewpoint of say, IBM.

The first question that arises is, why would a non-European-held European company want or need or be asked to participate in a European research program? I see three reasons. For IBM Europe, at least, the first reason is "Why not?" As a matter of fact, IBM has been in Europe for more than 80 years. We have 100,000 employees there, 9 research and development laboratories, 15 manufacturing locations (which, incidentally, manufacture more than 90 percent of what we sell in Europe; there are not many of our competitors, even European-held ones, that can boast the same ratio). And last but not least, we pay one and a half billion dollars a year in corporate taxes, so we believe that we have solid reasons to view ourselves as a European company.

The second reason, which sometimes is not stated loud enough, is that IBM needs a technologically and scientifically strong Europe. This may come as a surprise to you, but we have 35,000 suppliers and subcontractors in Europe, and we need them to be at the top technological level. We are the largest producer of electronic components in Europe, but we are also the largest buyer of electronic components in Europe. So we need good European components. We hire several thousand young scientists from European universities every year, so we need a top-class university and higher education and research system. To us, European technological leadership is vital to our presence in Europe.

The third reason may look a little immodest to you, but we believe that we can contribute to the European precompetitive research programs. We can contribute with our thousands of scientists who work in our European

laboratories and plants. We can also contribute, since we are a worldwide corporation, by disseminating European-originated technology through the world.

For these reasons, IBM Europe wants to participate in European programs. And, indeed, we do participate; I am very proud to state that IBM is currently involved in 11 different projects in three different European programs. But I am very ashamed to state that IBM is involved in only 11 different projects in only three European programs. Because if we compare this participation with that of some of our European competitors and other European companies, some much smaller than us, our participation is one order of magnitude below theirs. Some European Commission executives have been complaining to us about our limited participation, and rightly so.

So if everyone agrees that IBM should do more in European programs, why do we not do more? It is because there are inhibitors to the participation of non-European-held European companies in European programs. They may not be de jure inhibitors, but they are de facto inhibitors. And these inhibitors I would put in two categories. There are technical inhibitors in regulations and text, and there are also cultural inhibitors, which are probably more important and stronger.

Not all the inhibitors are from outside IBM; some come from within our own shop. We have some technical inhibitors within our own mode of operation. Our development methodology and our business decision process do not make it easy for us to include participation in European programs in our development strategy. But that is our problem, and we are working to solve it. We also have our cultural inhibitors within IBM, the main one being that sometimes it is not so easy for us to look at Europe as a source of technologies. We have been used to looking at Europe as a source of markets, but only recently have we started to look at it as a source of technology; this is a shifting paradigm that our culture has to go through. Again, that's our problem and, as a matter of fact, it is one of my principal responsibilities to help with that problem. There are other inhibitors that we cannot do anything about, and these are the inhibitors that come from the Community itself. Again, we found technical and cultural inhibitors.

Let me go over very briefly what I believe is the most important technical inhibitor. In my opinion it is the discriminatory provision in the Commission research contract that prohibits the dissemination of confidential information into affiliated companies residing outside the European Community, if the parent company is not EC based. Now this is a very complex legal term, as Dr. Fasella would put it, but let me state simply the consequences: It means that Bull can transmit confidential information to Zenith, or Philips to Signetics, but that IBM France cannot transfer confidential information to IBM in the United States, nor can IBM Germany or IBM Italy for that matter. On a case-by-case basis, I am pleased to say that IBM and the

Commission have agreed that this provision was counterproductive and have found ways to circumvent it, but nevertheless it remains in the Commission contract and probably is an inhibitor for others.

There also exist cultural inhibitors, which probably date back to the days when the first European research programs were launched. I'm alluding, for instance, to the initial ESPRIT programs in the early 1980s, where the original goal was to reestablish European computer industry competitiveness and independence from foreign "domination." At that time that meant mostly U.S. domination, and that implied IBM domination, and I recall the days when the success of European government programs to support and foster national computer industries was measured by the decrease of IBM's market share (incidentally, I must say that this measurement does not do justice to the efficiency of the European government programs, since, as you know, IBM's market share decreased more rapidly in the United States than in Europe).

Those were the days when we were told by Commission officials that maybe we could participate in European programs but on a low-profile basis and certainly not as prime contractors. Today times are changing and, as I said, we are being told that we are not participating enough. Indeed, we have been accepted as the prime contractor in one project—a small one, but it's a precedent nevertheless—and we all heard Vice President Pandolfi say that there was no difference between European-held and non-European-held companies in terms of participating in European programs.

I believe the problem today is that this new direction from the top management of the Commission has not yet rippled down to the middle and lower management layers and that the old culture has not changed. I have many examples of this; let me quote but a few. Last year in one European program, IBM took part in several proposals; all of them were rejected and, when we inquired, we found out that all the proposals of other U.S.-held companies had been rejected, too. In another case, which is even more recent, we were told that our proposal was all right but that we needed to include a European-held competitor in the consortium. Of course, it may be the case that all of our proposals were bad ones and that our other proposal was better with additional participants, but. . . .

Another case that I believe is characteristic of the difference in handling the European-held and non-European-held companies can be found in the two areas of the proposal selection work and the strategic program committee's work. The Commission asks outside experts to act as technical referees in the proposal selection process. Many of the technical referees come from European-held companies, computer companies in our case; none come from IBM. The Commission also asks outside experts to sit on strategic committees that steer its research, define future programs, or monitor existing programs. Many of these experts come from European-held companies; none come

from IBM. Now there can be different explanations for that. One is that all of the 100,000 European employees of IBM are morons or that none of them can be trusted to sound another opinion than his master's voice. Clearly, none of these explanations is reasonable. There have to be, statistically, a few smart and honest IBMers in Europe.

Indeed, if I look at individual governments in Europe, many of them call on IBMers for their expertise and I personally—although I don't list myself as necessarily smart and honest—sit on several French government advisory committees and even held for several years a government-appointed job. So I would believe that probably IBMers have been overlooked in the selection process, and I would hope the situation would change in the future, because I really believe that it's even more a problem for Europe than it is for IBM.

To summarize, I would like to say that based on IBM experience in Europe the non-European-held companies may participate in European precompetitive research programs. As Vice President Pandolfi said, they have equal rights to participate; I would submit that maybe, for the time being, they have slightly "less equal" rights than European-held companies. Now, of course, there are signs of mutual interest in relaxing the inhibitors, both within the Commission and within American-held companies—and the many representatives of such companies here today are witness to that interest. But it will certainly require time, especially for minds to change. It will also, certainly, require top management involvement. And I mean by top management, top management within the American-held corporations and also in the Commission's political and executive management.

DR. STEVER: Our next speaker is Dr. Josef Rembser. He studied physics and mathematics at the University of Mainz in Frankfurt and has a diploma in experimental neutron physics. He began his career, working as many such physicists do, on an accelerator program and then transferred into the nuclear power plant division of AEG in Frankfurt. Soon thereafter he joined government operations and has served as director of nuclear research and technology policy at the Federal Ministry of Education and Science, which was later renamed the Federal Ministry for Research and Technology. Following some years in many government positions, he is now the director general for basic research, research coordination, and international cooperation in the Federal Ministry for Research and Technology of the Federal Republic of Germany.

DR. REMBSER: The European Communities—this means the 12 member states, their societies, economies, industries, scientific communities and governments, their 300 million citizens, the potential, and the market. The EC is, as we heard, politically represented by its three institutions, the European Parliament, the European Council of Ministers, and the European Commission. Let me present here some remarks from the standpoint of a member state and its governmental administration.

The Europe of science and technology has grown constantly during the past 35 years. The starting point was the foundation of the CERN Laboratory for particle physics in Geneva in 1953. Today CERN represents 14 European member states; Finland will join next year as the fifteenth. More than a dozen other multinational European research laboratories and institutes followed, for neutron and synchrotron radiation research in Grenoble, for molecular biology in Heidelberg. They demonstrate that European states are willing and able to learn the lessons of cooperation across their borders. In the technological sector, cooperation in advanced nuclear reactors and the nuclear fuel cycle developed early and successfully. The ESA, with 13 member states, was formed in 1972 merging its two forerunners, ELDO and ESRO.

The development of European science and technology would not have been possible to this extent and with such speed without the substantial support and aid from science, industry, and the government of the United States, particularly in the first two decades after World War II.

In 1985, against the background of intensified European steps toward the Europe of technology, and in view of the technological importance of the U.S. strategic defense initiative program, the governments of 19 European states and the Commission of the EC as a twentieth partner, launched the European technology initiative EUREKA in Paris and Hanover. The best-known EUREKA project today is a JESSI program for the development of the 64-megabyte microchip, its technology, manufacturing, and applications. EC contributes to JESSI by funding selected activities out of its ESPRIT II program.

Many bilateral and multilateral relationships between European countries, on the level of individual experts, institutions, enterprises, and governments, make up the picture of intensive European networking in science and technology today. Together with the Framework Programs of the EC, all these elements, ranging from basic science in academia to industry-intensive R&D, form the large content and space of present-day Europe's science and technology. In the center of its joint and common activities, there is no doubting the growing weight of the EC Framework R&D Program, with its importance for and influence on national policies.

Both national governments and the EC Commission play a subsidiary role in European industrial technology and innovation policy. Let me, by the way, give my definition of precompetitiveness. Precompetitive research is research that competitors will do together; competitive research is research they will do alone.

The first and primary responsibility for technological research and developmental innovation is with the industrial enterprises and the managements themselves. In addition, on a second level, national governments provide a favorable climate for appropriate activities by suitable tax systems; by maintaining

scientific infrastructures in universities, institutes, and laboratories of the public sector; by stimulating the considerable number of small and medium-sized enterprises in the innovation process; by sharing large risks of technical development with industrial companies in new and emerging technologies; and by encouraging the transfer process from public sources of technology to its application in industrial products, processes, and services.

On top of the private and national responsibilities, last but not least, come EC activities and support for projects for which individual countries alone would have great difficulties in providing the required funds and staff resources. Second, the EC supports projects that strengthen the European market or the European scientific and technological community, particularly as far as uniform norms, standards, and regulations are concerned. Third, the Community supports projects that when jointly implemented are expected to bring financial rewards for all those concerned, despite the inevitable additional costs involved in international cooperation projects. Fourth, it supports projects that by the very nature of the problem to be treated—the environment, for example—call for coordinated action along the line, particularly in large geographical and global regions.

Coordination of national policies and programs in the EC is, according to article 130h of the Single Act, the task of the EC member states themselves, together with the Commission. The Commission may, in close contact with EC member states, take up every initiative that is suitable for such coordination. According to the primary role of industrial enterprises in the technological innovation process, and the stepwise subsidiary roles of national governments and the EC Commission, it is at first up to private enterprises to define and to develop their cooperation strategies with companies from abroad in R&D projects in technological sectors. We should realize that in Germany about two-thirds of all national R&D activities are performed in industry. Industry in 1987 was financing about 83 percent of its R&D work from its own private funds. Less than 1 percent of total industrial R&D in the Federal Republic of Germany is presently funded by the EC Framework Program; about 17 percent is from national, civilian and military resources.

Against this background the influence of governments and the EC Commission on access to industrial R&D work and R&D results, either from national and European multinational enterprises or from overseas companies, is very much limited—more limited, I assume, than it is in the United States, with large governmental defense R&D support for American companies. European industry R&D projects that are promoted by national governments or by the EC Commission generally imply that a project's participants are willing and prepared to share relevant existing knowledge and the new results of a project with all the project partners, on a royalty-free basis, and that they are willing to give licenses to other national or European industrial companies on a normal commercial basis, if there are no substantial arguments

against such a license, for example, when a small or medium-sized company could be overcome by a large competitor.

The openness and the sharing of results and know-how of publicly funded projects, the obligation to grant licenses, very often prevent industrial companies from taking part in such funded projects. Examples in Germany are German companies of the chemical and pharmaceutical sector; they take part in publicly funded R&D programs only on a very low scale. IBM Germany is another example as I see it of reserve and caution about national and European R&D support. The reasons in both cases are evident, from my point of view. The expected gain by participation in a joint publicly funded project might be far less than possible losses in scientific and technological advantages and leadership. At the same time, the amount of public funding would be small compared with their own, often large, financial resources invested.

Industrial companies with major shareholders from overseas can participate in German national public R&D funding, provided the know-how gained will substantially be utilized within the country, thus contributing to the national economy and to employment.

We are aware, on the national level, that a substantial part of the industrial strength of Germany and the EC depends on investments and operations of foreign business, particularly from the United States. And we are aware of the increasing engagement of European companies in North America. In the EUREKA initiative, we find several examples where Canadian and U.S. companies are partners of European industrial R&D project partners, for example, in the sectors of new materials, robotics, and biotechnology.

The rules of EUREKA—which is different from the EC, as you learned—allow participation of companies and institutes from nonmember states, if this is requested by the European project participants and if there are no general political objections from all EUREKA member states. Whenever we meet mutual advantages and benefits, when reciprocity can be assumed, it's my point of view that European national and EC rules will always find a way for opening a project to foreign partners. But in times of competition between industries of Europe, the United States, and other regions, in a difficult world market, there are innumerable ways and means for all governments to support their own industrial champions. We have to accept that there is no infinitely open world of scientific and technological cooperation. This is even true for the EC itself, where the year 1992 will not end intra-European competition between companies of EC member states on the internal and external markets. Furthermore, 1992 will not and cannot prevent or hinder entrepreneurial freedom to choose industrial partners within or outside the EC.

JESSI is an industry-led multinational and multiannual R&D program that is part of the European EUREKA framework. Particularly Dutch, French, and German companies and research institutes are involved. According to

present estimates, until 1998 it will spend about 4.5 billion U.S. dollars, of which more than 50 percent will come from companies' own resources and less than 50 percent from national governments and the EC Commission. What proportion the EC Commission will contribute to JESSI, to what program activities it will contribute, and in which way are still under negotiation. Originally, between 20 and 25 percent of total JESSI costs were expected to be covered by EC money. This will probably not be realized, as the structures of the EC and its Framework Programs hardly allow spending for such a very large project as JESSI in which only a small number of member states, companies, and institutes are participating.

Here EC policy is finding its real limits and restrictions. It is also not yet decided whether the EC will contribute to the JESSI program via a larger number of individual contracts for specific subprojects, according to article 130k of the Single Act, and out of its ESPRIT funds, or according to article 130m, which would allow global participation in this multilateral EUREKA program. The decisions about foreign participation in JESSI or in selected JESSI projects therefore lie mainly with the industrial JESSI consortium and its board. They have to consult the governments, but such foreign participation must follow the EUREKA rules I described earlier. One approach to including U.S. companies is on the basis of reciprocity for European participation in SEMATECH activities or in equivalent sharing of its results. In this context, we have heard that negotiations between the JESSI partners Siemens and IBM Germany have begun.

Cooperation in privately as well as publicly funded R&D is always a give and take. This lesson has to be observed or learned. Cooperation cannot be a one-way road. Not only the magic date of 1992 but also the recent political developments in central and eastern Europe require an intensification of information, consultations, and contact between the EC and the United States. I highly appreciate U.S. activities to strengthen its own ties with Europe, and we are aware that opportunities in the East must not weaken European links to the West across the Atlantic.

The U.S. organizers of this symposium were therefore right when they asked what would be the most productive government-to-government forums for addressing potential U.S.-European problems and whether there should be a new technology-specific forum. I also feel the necessity for such additional steps and measures. I could follow the idea of a U.S.-European technology forum or round table—perhaps a permanent task force is another word—for the 1990s, where competent personalities from the industrial and public sectors would project and exchange plans, experiences, and concerns on transatlantic scientific, and technological cooperation. Europe should in such a model contribute from the level of the EC Commission as well as from the industrial, scientific, and governmental sectors of EC member states.

Whether in the future there is a Community of 12 or more member states, Europeans are aware of our historical bindings to the United States. We will continue to treat this as the basis for an intensive partnership also in science and technology.

DR. STEVER: We have heard from biologists and chemists, a physicist, and a mathematician, and now we are going to hear from a profession that has the capability either to draw all this together or to split it apart. Dr. Holderman, our next speaker, earned his B.A. degree from Denison University and his Ph.D. in political science from Northwestern University in 1961. And he was a professor of political science. He has served at the University of Illinois at Chicago Circle as associate chancellor and vice chancellor and as executive director of the Board of Higher Education of Illinois. He progressed through various posts in the academic world and then became president of the University of South Carolina. He is an authority on international education and the role of the campus as a progressive and dynamic influence in public affairs. He has held many international jobs, chairing many different groups and participating with leaders from many countries to bring them closer together. As a member of the National Science Board of the National Science Foundation, he is now chairman of the NSF Committee on Europe in 1992: Implications for U.S. Science and Technology. So he is in a good position to bring many of these thoughts together.

DR. HOLDERMAN: I believe that what is needed more than anything else from the perspective of the United States is the courage of candor. Is the United States indeed ready for what we have been hearing about here? Is the educational system of the United States, the science and technology community, ready for 1992? I don't believe so. I feel a special obligation as a representative of both the National Science Board and higher education, and I feel quite strongly that as a nation we are not ready. I can think of no challenge greater than the fact that we are not educating people who can handle what 1992 and so many other events have thrust upon us. There is a general feeling among the populace that 1992 is truly the five-hundredth anniversary of the sailing of Christopher Columbus and not a great deal more. That is something with which we must begin to deal.

There are three major issues I want to address: the broad nature and implications of the extraordinary changes occurring around the world and how they affect us, how our universities and our entire educational system have failed to adapt, and how we can change that for the better.

Events of just the last year make the need to change obvious. One year ago the reunification of Germany seemed an impossibility; now it is inevitable. One year ago, in good conscience, South Africa and freedom could not be spoken about in the same sentence; now freedom in South Africa is on everyone's lips. And who would have imagined that Violeta Chamorro would be elected president of Nicaragua?

In fact, the world has undergone paradigm shifts in loyalties. In the Soviet Union, loyalty to obsolete political ideals moves in favor of loyalty to progress. In eastern Europe, loyalty, albeit imposed, to personality cults, is transformed by loyalty to individual freedom. In western Europe, loyalty to parochialism and loyalty to unity work together.

Such transformations in loyalty underlie the social and political upheavals around the world when we already face a world offering challenges enough—a world beset by AIDS, poverty, and family dilemmas such as divorce, abortion, and abuse; a world in which ice storms strike Tokyo, London is besieged by hurricane-force winds, and in which rain forests disappear by the equivalent of almost a football field every second. It is a world in which some of the gloomiest predictions say global warming could one day leave all but the torch of the Statue of Liberty under water. Who else but our universities with their tremendous resources of people and capital can address these matters?

In the midst of all this comes Project 1992. Elsewhere the integration of individual freedom and politics has set the pace, but in western Europe it is an economic integration and it is just as significant and just as courageous. Yet while the world has shifted toward integration, our universities remain trapped in ideas that no longer serve. We have not adapted. If Europe was suffering from Eurosclerosis, we have become prisoners of our own *United Stasis*. As a result, we are unable to provide the help that Europe and other nations seek—which leads us to a second concern.

Our distinguished guests from Europe have not come here to see Americans wash their dirty laundry, but what better place to acknowledge our problems than in the very building where scientists and engineers gathered to provide leadership on the Marshall Plan, in the very building where the American scientific community met to respond to Sputnik, and where the crucial questions of nuclear deterrence have been debated? In this special time and especially in this place, the truth demands our attention as Americans.

The American education system, the main source of talent to resolve today's greatest dilemma, is crippled. It is crippled when 50 percent of our high school students in urban areas drop out of school and when those who remain are last in math, physics, chemistry, and biology compared with other industrial nations. It is crippled when the public school compensation rewards teachers not for their contributions as educators but for their ability to survive and for their seniority. And it is crippled when universities continue to reward specialists disproportionately while the world integrates. Elementary schools are separate from secondary schools; secondary schools are separate from universities; and university departments barely speak to each other.

Akio Morita and Shintaro Ishihara in their book, *A Japan that Can Say No*, were right when they said Americans have forgotten how to change.

How strange that is for a country whose greatest strength was once its dynamism. Of course, in basic science our universities still lead the world. American basic science is why, in some fields, more foreign students get advanced degrees in the United States than our own students—an incredible irony.

Unfortunately, such specialized success has blinded us to other possibilities. How many times has someone else come along and turned our know-how into their technological advances? The Academy leadership itself has warned us that preoccupation with a single discipline is dangerous. Last spring Erich Bloch reminded us that after World War II England's computer engineering and computer science programs were among the best, but the universities and industries did not work together and now Britain's universities are endangered by the country's larger economic problems.

Frank Press himself has called for "full consideration of economic, environmental, and sociopolitical consequences." Demographics already suggest that in a few years such integrative talents will be even more important. These shifts will end a 500-year epoch in which white men in a few countries controlled the world. And in speaking of white men and integration in the same breath, surely none of us miss some critical double entendres. At this conference integration means primarily economic integration on one continent, mainly with white men in charge. But in another context the meaning of integration makes America's glib talk of helping the EC ring hollow. How can we help provide an educated core of young people from all races when 63 percent of black students drop out of college? How can we help when we have not prepared for an America where by 2001 only 15 percent of the new labor force will be white males, compared with 51 percent today? How can we help with an America that is producing a generation whose most notable quality just might be its ignorance?

With each day of inaction we leave the future in the hands of people who are unable to figure out what to do with it. But what can and must we do, ourselves, now? What can we do when change is not only in the air but is remaking the earth and the relationships among all its inhabitants? Commitments to react have been made time and time again in recent years but with little follow-through. Yet this is a rare gathering, a complex mosaic of leaders from two great continents candidly discussing mutual concerns. That one continent nearly half a century ago helped the other recover from the ravages of a terrible war tells us we can overcome great challenges. With that in mind, we can work to ensure that domestic crises don't impede America from again becoming a true scientific and technological compatriot. Such a sharing is not yet futile and it is on that note that I want to close.

Domestic chaos does not have to destroy our mutual hope. First, we know inspired young people have overcome such chaos before. Religion, athletics, poetry, finance, industry, even the chance to save this planet, can

be such an inspiration again. We must alert young people that such inspiration is very real and very important. Consider the European Community's own example, Jean Monet, the Frenchman known as the father of the Common Market, who showed us all the potential of economic integration. Or consider this Academy, which has inspired so many universities to become first-class research institutions. Or people from Berlin to Capetown, from Nelson Mandela to Vaclav Havel, turning the world on its ear. We must help our young people draw inspiration and courage from such examples. This is the first path to a solution.

Second, we must make education in grades K-12 exciting again. We must find feeder mechanisms by which the resources of our universities can modernize and recast our education system.

Third and most importantly, our universities must change their own roles in society and must begin to do so immediately. Building from their strengths in basic research, universities must develop professionals, scientists, and teachers who can recreate secondary and elementary education across all sectors of our culture. We must deal with the question of academic politics. Some say it is so vicious because the stakes are so low. That is no longer true—the stakes are very high.

The new world we have entered requires that kind of integrated training. Our young people, our love for them, our loyalty, not to yesterday but to our future and to their future, demand that we do all these things beginning now.

Everywhere the alarms have gone off, and they are loud and clear. They are ringing in Europe, the Soviet Union, Latin America, South Africa—in the skies, in our oceans, in our schools, in our factories, in our streets, in our homes; they are ringing more loudly with each passing day. They are the alarms that tell us to get up and to act. The courage to act and act decisively must come from each of us.

We must enable our education system to meet the needs of our companies, your companies, and your industries. We are not ready. We must enable the United States to work with the European Community where it is needed. We are not ready. We must enable our teachers, our researchers, and our children to appreciate the integrated world we have entered. We are not ready.

To make these things happen, to get ready, we must change the university's role in society, and we must begin now. Making all this possible is our challenge, yours and mine, and I look forward to making it a reality with you.

DR. STEVER: We have had some excellent presentations, as promised, and now it is time for questions from the floor.

MR. HADJILAMBRINOS: Constantine Hadjilambrinos, University of Delaware, also representing the Delaware Development Office. It seems to

me from the discussion we had both in the opening panel and in this panel that the big question in everybody's mind is where 1992 will lead the European Community. We have seen, from what one of the speakers talked about, that American companies or European companies that are owned by American companies face discrimination in Europe. While that might be so today, it might even be more so in the future if Europe proceeds with political integration along with economic integration. If political integration happens, Europe could entrench itself and build a wall around it and decide to become a competitor rather than a cooperator in the world scene.

We have two possible futures, it seems to me—one where European cooperation provides for world cooperation and one where European integration closes in on itself. I would like the commissioner to say how he sees the future with the possibility of political integration? Would that open up cooperation or would that be a detriment to it?

DR. FASELLA: I think that the presentation of Vice President Pandolfi made it quite clear as to which way the Community, and certainly the Commission, is going. M. Delors has always been extremely clear about it and so have the commissioners who work with him. Like all processes that involve great change, it won't be easy and, of course, there will be backlashes and forces that will try to retreat, but all indications are that this notion of fortress Europe has really been overcome; it's not there. It's not there now, and it will not be so in the future.

Pandolfi quoted the figures for international trade, and you saw how the Community trades much more than either the United States and, of course, enormously more than Japan. You saw the main points that the Community has tried to develop, which are first forming the union, but then opening up, liberalizing, and deregulating. In a way the stronger Europe becomes, the less it will need to be a fortress. In French this comes out very well; you could say, "Non, à l'Europe fortresse", no to Europe as a fortress, "Oui, à l'Europe forte." And it is fully understood that if we want to be strong we must expose our companies to competition, including competition from other world partners, and the Americans are the strongest.

Of course, when you are in the field, as Monsieur Duby made clear, there are problems such as those that IBM Europe met in participating in our programs. But he also said that this is progressively changing, that the political input from the top is in another direction and that this filters through. So I think that we are in the process of doing something new. There is a conviction that Europe must not try to build itself into a fortress because the very notion of fortresses is not a very good idea. Fortresses are needed when you feel weak and you feel you cannot defend yourself; sooner or later you will be starved in a fortress. We want to be open. The figures show that, and all the trends, including our presence here and Mr. Pandolfi's speech indicate that we want to be open. As Pandolfi said—and it is something

we repeat very often to our firms—the Common Market is an opportunity to all but a free ride to none. It will not be a free ride to European companies because they will have stiffer competition among themselves, and it will not be a free ride for weaker outsiders. But this, I think, is very much in the American spirit.

DR. DUBY: I would like to confirm Dr. Fasella's comment. The message I want to convey is that the facts do not exactly reflect Vice President Pandolfi's will and intent, but there is definitely progress in the right direction. I would also like to make a comment, this time not as an IBM executive but as a European citizen: I must say that the discrimination that American companies feel in Europe is nothing compared to the discrimination that European companies feel—and I apologize to this wonderful country which I love and where I'm a guest today—in the United States.

DR. REMBSER: The magic date, 1992, will not change anything in a very large scale compared to 1990. The economic interests of Europe and European enterprises in having an open market, in operating in the United States, and in having competition are so large that there will be no fortress Europe. On the other hand, I think you in the United States with your big market, your big community, you have to learn a process of transboundary cooperation that Europe has learned perhaps a little better in the past 25 years. Perhaps also activating the consciousness of your people that there is a Europe where you have a historical role is also a very important necessity. This would be one element of the program James Holderman presented here.

MR. FRENCH: Larry French, North American Philips. Dr. Duby just stole some of my thunder, but I really am envious of IBM's position in Europe, and I hope sometime to have equal opportunity to talk about discrimination in the United States. In the United States, foreign-owned U.S.-based companies are not allowed to participate in research programs of any nature, such as SEMATECH or the newly formed DARPA programs. And it would seem that reciprocity of participation in U.S. R&D programs is in order. As a matter of fact, I think that it was recently announced that IBM participates in JESSI, but a company that we hold dear here in the United States such as Signetics is denied participation. So I think some of the concern here perhaps exists on this side of the ocean as well.

DR. FASELLA: We are concerned about this problem. We have a report called *An Overview of International Participation in U.S. Federally Funded R&D*, and we have a pretty thick study with a list of European companies that complain very much about the type of discrimination they find in the United States, which has just been mentioned. I did not want to raise this issue today, trying to be disciplined, which is very difficult for a person born in Italy, but now I've been tempted to go beyond this.

The topic here is access to EC programs and not access of Europeans to

American programs. We should embrace the approach of symmetry, and I must say I'm glad that this point was raised. But it is a very serious point and perhaps we should have a symmetrical meeting to discuss the type of problems just raised, what chances U.S.-based subsidiaries of European companies have to gain access to American programs.

DR. DUBY: I would like to add that the position of the IBM Corporation on this issue has always been that of total reciprocity. We believe that on each side of the ocean free access to government programs should be given to foreign-held companies on the strict basis of the research, development, and manufacturing they do in the country. I personally don't want to interfere with the legislative process in this country, but I understand that there is a bill, proposed by one of your senators, that says exactly this and includes reciprocity conditions. I guess that if similar laws were passed on both sides of the ocean, it would definitely be a very big step toward cooperation between our two entities —I was going to say our two countries.

MR. KALIL: Tom Kalil, Labor Industry Coalition for International Trade. Vice President Pandolfi kicked things off by saying that the United States and the EC ought to get specific and not just deal with Framework proposals. I'd like to ask the panelists in what specific areas they see opportunities for cooperation in information technology.

DR. DUBY: There are many areas in information technology where there is possible cooperation. My personal point of view is that we should look for areas that will materialize in the twenty-first century. Otherwise we run the risk of being nonprecompetitive; also we should not try to fix the problems of tomorrow but the problems of a couple of days after tomorrow. So in the technology area, for instance, I would see submicron electronics. Also, I would see areas like advanced methods of software engineering, based on some research breakthrough needed in logic or information theories. Probably a third area is nonclassical computer architectures, I mean non-Von Neumann architectures, such as highly parallel machines. But this is just a personal point of view. The main idea is really to shoot for 10 years ahead.

MR. CVIJANOVICH: George B. Cvijanovich, AMP, Inc. I was listening very carefully and I was missing one thing, and this is the separation between research and development as an idea-driven activity and implementation of research and development in the industry. I think that the major difficulty, from what I hear from European organizations, will come in the domain of implementation, for a very simple reason. The European Community is a very compact organization, and I think we will see some resistance, as we already have from the IBM example, where on the other hand the United States is a very loose organization.

Therefore, the question arises here: Since industry lives on the patent, the invention, the priority, what are the organizational guarantees in the

European Community that this will remain an effective way of implementing technology? What are your patent laws? What are your protection laws? You see, before it was easy. The corporations had to deal with governments, single governments and mostly through subsidiaries, whereas now there is an additional layer of inhibitors between the implementation and the discovery.

DR. REMBSER: From my experience in national R&D policy, I would say that the question of implementing R&D results is a matter for the enterprises themselves, at least in the German policy and I think also in the EC policy. There are no direct measures from the EC or from governments to intervene directly in the implementation in the last stage of the innovation process, in the building up of manufacturing systems, in going into the market. This is really a matter for the enterprises.

But there is a very important task for the public sector, to ease this process by tax systems, by advisory services, by norms and standards. I also would say it is important that the whole education process sends engineers and scientifically trained people to industry who are aware of the importance of modern technology. But what you heard here, at least from the EC side and the national government side, is their activity in the R&D phase of the innovation process, not so much in the implementation of the results. I hope I got your question right.

DR. FASELLA: I would like to confirm what Dr. Rembser has just said on the Community side. The implementation of results is indeed the business of business. It's companies that must do that. I think public authorities, both national and Community authorities, have the responsibility to create a productive environment. Specifically in the Community, we must be very careful to avoid the creation of nontariff barriers, so that indeed the large unified market we all hope for is not fragmented again through different norms, different standards, different patent laws. So we do have a responsibility, certainly not that of taking the job of industry and companies in developing products, but in norms and standards, patent laws, open regulations, and education.

On the latter point, education in the technical areas is a key aspect in Europe. Do not forget that we have nine languages, so that even to survive in Brussels, to go from your office to the toilet and from the toilet to the garage, you have to use three different languages. At the technical level this is very important, even though they say everybody speaks English or at least the Community variety of it. But it's not so widespread, and the national languages are an important heritage and must be respected.

This requires an enormous effort in education, and this is a bit of what I was saying before about the importance of our program for facilitating movement within Europe at the postdoctoral level. Even the largest of our countries, the Federal Republic of Germany, probably has the largest number of centers of excellence in Europe, but it cannot have the same number of centers

of excellence as the United States, just because it's smaller. We do have to make it so that it's not so difficult for somebody to move from Heidelberg to Cambridge and from Cambridge to Bonn. This is an enormous educational problem on which the firms are becoming very attentive, because they find that if a German firm wishes to open a subsidiary in Spain it's very useful to have somebody who has all the German approach and is very thorough but understands the Spanish system and speaks the language. This is a nontrivial aspect, and it's a problem that you in the United States do not have unless you become bilingual, too, or trilingual, if we add the Asians.

MS. TYSZKIEWICZ: Mary Tyszkiewicz, Syracuse University. Why should we be concerned about access to the European Community program? I was hoping the panel could articulate the specific benefits of cooperation. Have there been formal assessments or evaluations of the programs, especially from more than just a social aspect but also economic? What types of products have come out, and what type of money can we put to some of these benefits? Or is it too soon?

DR. DUBY: I gave three reasons why a company like IBM would want to participate. Let me try to give an example as a fourth one. IBM took part in an ESPRIT program called CIMOSA. This program produced European standards, and IBM, when it recently announced its own computer integrated manufacturing architecture, committed to support European CIMOSA standards. The benefits for both parties are obvious. For IBM the fact that we participated in that program allowed us to be aware of what was going on in its prenormative activity while taking part in its construction. For our European partners, the fact that IBM announced this new standard as part of its offering is helping their standard to be established on a worldwide basis. That's another example of the mutual gain that can be expected. I guess Dr. Fasella agrees with me.

DR. FASELLA: Absolutely. Moreover, the problem of the evaluation of programs was raised. In all our specific programs, those that implement the Framework program are generally of four to five years' duration. And for each one we must set up panels of independent experts who scrutinize the program in its various aspects, once halfway through and another time when the program is finished, not only to see if it was competently implemented but also to determine the scientific and technological results and, especially for some programs, the economic and social aspects. This is a very interesting process; it is generally painful because the experts are really independent and they are generally rather critical but very useful. I think it's an interesting approach. There is still a lot to be done to improve the technique of this evaluation, but it should not be pushed too far. I think that in Europe Germany was the first country to introduce the evaluation and also the first to become a little bit more cautious as to its value. But on this I think Dr. Rembser can say more than I can.

DR. REMBSER: I will add only one element, about the benefits. One of

the additional benefits I see in Germany is that our small and medium-sized companies learn to maneuver on the international market by participating in European projects. They learn to maneuver beyond the borders using different languages, looking into different thinking. To give you an example, in the ESPRIT I program about 13 small and medium-sized German companies participated. In ESPRIT II more than 60 small and medium-sized companies participated. So there are more and more advantages you can draw from programs of transboundary cooperation.

MR. DOYLE: Jack Doyle, Institute of Electrical and Electronic Engineers. I've been bothered by the description of the kind of R&D we're talking about here and what it really is. On the one hand, we hear that it's very basic or, a new word to me, precompetitive. Somebody said it's very difficult to draw the line as to when you're really getting into product development, and I would agree that's very true. But then again when I hear about this I also hear, well, only those who are in it are going to be allowed to hear the results. I would make a suggestion, and I would like to hear any comments, on it, that maybe the rule should be, in order to draw that line, simply that in an organizations like the EC one can do any kind of R&D as long as the results are public knowledge all over the world once it's done.

DR. FASELLA: I think we cover a fairly broad spectrum of research activities. We start with some fundamental research. We even have a program called science that has no predetermined limits but is there just to pick up new ideas that might otherwise fall between multiple chairs, programs that could be too German to be British, too British to be Danish, too much physics to be biology, etc. We do have some fundamental programs, and in them the results are generally published in accepted journals.

Then you have the whole spectrum and without ever reaching closeness to market, we do go toward the market. For these programs there are foreseen special laws that define intellectual property rights. They recognize the right of the inventor, and don't forget that for those programs companies generally pay at least 50 percent. It specifies under which conditions nonexclusive licenses may have to be given; this, I think, is altogether a reasonable approach. You handle the distribution of results differently depending on whether you are very much on the fundamental side or whether you are approaching the market.

MR. DOYLE: These latter programs that you described, are they supported in all or in part by government money?

DR. FASELLA: The latter ones are generally supported around 50 percent by Commission—

MR. DOYLE: Yes, by government money.

DR. STEVER: Thank you very much and I'd like to thank the panelists for all of us. Your unanswered questions will be answered tomorrow.

The View from Congress

DR. PRESS: Congressman Lee Hamilton has represented Indiana's 9th District for 25 years and currently serves as chairman of both the Joint Economic Committee and the Foreign Affairs Subcommittee on Europe and the Middle East. On the Joint Economic Committee, Congressman Hamilton also serves as chairman of the Task Force on Economic Goals and Intergovernmental Policy. In addition, Lee Hamilton serves on the Science, Space, and Technology Committee, where he is a member of the Subcommittee on International Scientific Cooperation, an issue of great interest to us at this symposium. He served for two years as chairman of the Intelligence Committee during the 99th Congress. Often described as, and I quote, "one of the most highly respected members of Congress on both sides of the aisle," Lee Hamilton has served on the Foreign Affairs Committee since 1965, when he was first elected to Congress. Building a favorable reputation early in his House career, Congressman Hamilton was elected president of the huge and famous Freshmen Democratic Class in the 89th Congress. He studied at Goethe University in Germany, received his law degree at Indiana University, and was a practicing attorney before being elected to Congress. Lee Hamilton has been characterized in one biographical write-up as "a man who chooses his issues carefully and times his few speeches for maximum impact." Hamilton, in the course of more than 20 years' service, has built a reservoir of respect that few members of Congress can match.

MR. HAMILTON: My task is to give you a perspective of the United States Congress on the European Community. Those of you who are familiar with the Congress know how difficult it is to try to sum up the views of that diverse and representative body, but I will do the best I can.

The long-standing position of the United States government has been that an integrated Europe is a more prosperous Europe and a stronger security

partner. With that in mind, the United States has very strongly supported the idea of European integration from the very beginning, indeed, since 1957 and the Treaty of Rome. Trade disputes such as "chicken wars" and "pasta wars" have irritated U.S.-EC relations over a period of years. But the United States and Europe have, until now, always prevented these disputes from interfering with our greater commitment to shared political and security goals.

Congress's perspective on the European Community really revolves around trade issues. The key issues for members of Congress concern U.S. exports, the trade deficit, and the future of U.S. competitiveness. Or, to put it in blunt political terms, jobs for our constituents.

When the Single European Market was agreed upon in 1986, the reaction in the U.S. Congress was a big yawn. Why? For two reasons. First, Congress pays attention to the hot spots in the world. Nicaragua and El Salvador, at that time at least, were far more important to members of Congress than Brussels, Bonn, or Madrid. European integration was simply not a question on the congressional agenda. Second, because of the enormous internal disputes in the European Community about budget and agricultural subsidies, members frankly doubted at the time whether Europe would make much progress on 1992.

The subsequent pace and intensity of the European Community integration caught everyone, including I might say the Europeans, by surprise. Beginning in 1987 members of Congress heard constituents and lower-level administration officials complain that 1992 would hurt U.S. access to European markets. This crescendo of concern grew through 1988 and early 1989 and became expressed in the term fortress Europe. The fears of our constituents that EC 92 was protectionist, exclusionary, and discriminatory came through for members loud and clear.

In 1989 the rising cry caught the attention of higher-level U.S. officials, including Secretaries Baker and Mosbacher. The United States made its view clear that the 1992 project should be an initiative to open markets and expand free trade—not to close markets. The European Community and the United States then began an intense dialogue on these questions.

Today there's an acceptance in the Congress that Europe 1992 will take place. Members' fears have been partially addressed. They no longer assume that EC 92 means protectionism. But they will want to look carefully at the development of the nearly 300 EC directives guiding the 92 process of which, of course, more than half have already been adopted. Access by American high-technology firms will be particularly important in the minds of members. For now, then, the overall attitude in Congress is one of caution and wariness.

Today congressional attention is focused on the European continent for the first time in recent memory. Members of Congress are watching developments in Europe to see how they will affect the United States in the postwar world as we have known it.

First, we realize that the European Community is becoming an increasingly important institution whose power will grow in the years ahead. The EC will play a key role in the new European order. In addition to promoting the process of economic integration, the EC will serve as an all-important anchor in the West for a new united Germany. It will be a central actor in coordinating western policies toward the newly emerging democracies in eastern Europe and toward a reforming Soviet Union.

Closer EC coordination in the political and security areas presents a challenge for the United States. Increasingly the Europeans are consulting among themselves on matters that were previously left to NATO. In many respects this process has short-circuited trans-Atlantic cooperation. The United States is being brought into key decisions now, after the Europeans have decided among themselves what course they will take. This trend away from NATO coordination is likely to be exacerbated in the current transition to a new security regime in Europe. The nature of this new regime is, of course, uncertain. It may be based on the Conference on Security and Cooperation in Europe, also known as the Helsinki Process. It is important that the United States take steps to guarantee its role in whatever new security framework emerges.

Second, we recognize that European integration can be a potentially positivesum game, with advantages for the United States and for American business. By removing existing barriers to the movement of goods, capital, technology, and labor between the 12 EC member states, EC 92 should lead to new investment, more jobs, and faster growth throughout the EC. In fact, I expect that the revenues of EC 92 have already produced an investment-led economic boom in the European Community.

As the Community's largest trading partner, the United States stands to benefit from that process. With 320 million consumers, a unified EC will have the largest single market in the world. If you include the rest of Europe, we're talking about a "European economic space" of some 500 million generally middle-income and well-educated consumers with a total economic output of $6 trillion, twice that of Japan and the four Asian tigers combined. The likely investment surge should benefit a capital goods exporter like the United States.

In addition to greater trading opportunities, European integration holds out the promise of new technology for U.S. firms to acquire. The EC is committed to a strong program of technology development and collaborative R&D. These efforts, combined with corporate R&D performed by European firms, fortified with such a strong domestic market, should enrich the international storehouse of technology on which we can all draw.

Third, there is a growing uneasiness in the Congress that the United States is being left behind in eastern Europe. The west Europeans, led by the Federal Republic of Germany, are moving aggressively to take the ini

tiative in eastern Europe. German, French, Italian, and British businessmen and bankers, building on historic ties between their countries and the East, are pursuing joint ventures and extending new credits in East Germany, Hungary, and Czechoslovakia. The perception is that U.S. firms have been slow to follow and that the United States has lagged behind its European allies in offering trade and investment incentives to companies interested in doing business in the East.

This view has been reinforced by the new French initiative to create a European Bank for Reconstruction and Development for eastern Europe, with EC majority interest. While the charter of this bank has not been finalized, there is concern that U.S. interests will not be taken into account and that the EC will control the policy.

Fourth, we are focusing attention on the impact of German reunification on the European Community and the EC 92 programs. There is some danger that Bonn's new focus on the East will slow the pace of European integration. Such a development would not be in the U.S. interest. European integration must keep pace with the process of German unification. This has become a tall order because of the accelerating pace of change in Germany. We are already beginning to see the jitters that German unity can give its neighbors. Unity within an integrated EC will be a key to future stability in Europe.

Some EC officials have expressed optimism that the decision to move toward a common currency between the two Germanys will actually boost the EC drive for the European Monetary Union, rather than slow it as many feared. EC officials hope that by displaying how it can be done, German monetary integration will silence the critics of the European Monetary Union.

Fifth, we note the issue of the future depth and breadth of the European Community and the importance to the United States of how this question is resolved. As the major economic force on the continent, Brussels will serve as a magnet for other countries on the continent interested in trade. The neutral countries, EFTA, and the emerging democracies in the East are already setting their domestic economic agendas to the tune of Brussels. Austria and Turkey have applications for EC membership pending, and Hungary, Czechoslovakia, and Poland are likely to be close behind.

The European Community has not yet decided how it will proceed on these applications. For the time being, Brussels has said that there will be no expansion until after 1992. But the pressure to open its doors to new members will only build in the coming years. How the EC acts will determine the future nature of the Community. Further enlargement is likely to limit political integration and security cooperation within the Community.

Sixth, we are aware in the Congress that the new developments in Europe are shifting U.S. relationships with our European allies. There's a growing recognition within the administration of the need to work more closely with Brussels on political as well as economic matters. In addition, the pace of developments in Germany has increased the urgency of U.S.

cooperation with Bonn. In contrast, Prime Minister Thatcher's opposition to the European Monetary Union and her more reticent position on German unification have set her apart from her European allies. It is too early to predict what the implications of this trend will be for the future of the Anglo-American "special relationship."

While knowledge of the EC and opinions about it vary, most of us on Capitol Hill have genuine concerns about the impact that Europe 92 will have on American firms. Specifically, what are those concerns? Let me give you a flavor:

- The EC standards-setting process does not allow sufficient participation by U.S. exporters. For example, the EC mandated a battery cable standard for forklift trucks to which only European-manufactured cables were able to conform.
- Government procurement rules favor EC products and services in certain sectors. As a result, U.S. exporters of telecommunications and electrical equipment cannot sell to European governments.
- Local content requirements may result in American movies and television programs being taken off the air to reserve programming for "European works."
- Approval to market biotechnology products may involve a "fourth hurdle," in addition to the normal criteria of safety, efficacy, and quality. This fourth hurdle would take into account whether the product would cause economic harm to segments of European society, such as small farmers, that have received special concessions from national governments.
- The EC has recently tightened its guidelines for suspending tariffs on pharmaceuticals and electronic products. The guidelines appear to discriminate against a U.S.-made product if the firm's EC subsidiary could produce it.

To many members of Congress these practices appear to add up to fairly strong encouragement that U.S. firms manufacture in Europe. Congress is less worried about American multinationals. Most members believe that the giants of American industry are well positioned to benefit from a single market. But we are concerned that American exporters, particularly small and medium-sized firms, could be hurt by a change in the rules. Until their access to EC markets and technology is assured, Congress will remain skeptical.

Let me focus on one particular industry, one I'm sure is familiar to you—semiconductors—to illustrate our apprehension.* I'm no expert in electronics, but here's my understanding of what's happened.

* For more detail, see Kenneth Flamm's chapter on semiconductors in *Europe 1992: An American Perspective* by G.C. Hufbauer, ed., Washington, D.C.: Brookings Institution, 1990.

In February 1989 the EC approved a regulation that drastically altered the rules for determining the origin of semiconductors. That change, combined with the EC's implementation of recent antidumping settlements against Japanese electronics producers, means the following. Chips fabricated in the United States but tested and assembled in Europe no longer receive favorable treatment. As a result, EC-based firms are pressuring their U.S. chip suppliers to manufacture in Europe or, worse, are switching to European suppliers altogether.

Electronics industry representatives tell me that the use of antidumping regulations will become increasingly important as the 1992 deadline approaches for abolishing national quotas and voluntary export restraints. There are other problems for semiconductors as well. A 1989 change in the rules that will reduce the ability of member countries to suspend tariffs on semiconductors promises to leave higher walls around the market for semiconductors after 1992.

Finally, let me mention the flow of public subsidies into joint research and development activities in information technology in electronics, including semiconductors. Projects such as ESPRIT and JESSI are highly commendable as a way to overcome the inability of private firms to capture the full benefits of R&D. I believe the United States should itself be doing more to promote cooperative R&D in civilian technology. But subsidies to R&D can be problematic when used as a means of selectively helping national firms in world markets, that is, as an alternative to production subsidies, which are illegal under GATT.

One way to avoid that problem is through reciprocal access to R&D, that is, by permitting firms from other countries to join one's own subsidized R&D programs in exchange for comparable access by the other country. This represents a departure from current practice in both the EC and the United States, and there are obstacles to implementing it. Nevertheless, it's an idea worth exploring in the name of creating a more open international trading system, from which we all would gain.

Congress is also concerned about U.S. policy toward the EC. Sweeping changes in eastern Europe as well as the EC have underscored the need to update our own government's policies and priorities for a world in which economic strength is increasingly more important to our nation's security than military strength.

First, we are concerned about the inadequacy of U.S. resources assigned to EC 92. The U.S. trade representative has only one person assigned to the U.S. mission to the EC in Brussels. The Treasury and Commerce departments have no one. Last spring the Commerce Department asked permission to assign three foreign commercial service officers to the mission in Brussels, but it took many months for the mission, which is dominated by the State Department, to agree, and the three officers are still not in place.

Because of this staff structure, we rely heavily on U.S. multinational companies for economic intelligence and information. Their information is obviously important to us, but the private interests of U.S. multinationals may on occasion diverge from the U.S. national economic interests, including the interests of U.S.-based exporters. IBM Europe is arguably as much a European company as an American one, which is as it should be.

Insufficient resources are not the only problem with U.S. policy toward EC 92. We suffer from a common Washington problem: On any given issue, it's often not clear who's in charge. Fragmentation of executive authority leads to turf battles. Different agencies, each with its own valid interest, invariably clash, and the internal conflicts sap our strength for the trade fight going on outside. Why did it take the Commerce Department six months to get approval to place three foreign commercial service officers in Brussels? I suspect that the State Department resisted sharing its authority toward the EC. As industry's watchdog, the Commerce Department clearly has a different view—and a more critical view—of EC 92 than does the State Department.

This tension between departments may be unavoidable and even healthy, but it reflects the lack of overall direction concerning Europe 92. U.S. government actions to promote trade and investment in the EC have proceeded on one track, led by the U.S. trade representative, while our government's political dealings with the EC have proceeded on another track, led by the State Department. Various interagency groups are at work to coordinate one track with the other, but no single Cabinet member has responsibility for both.

Among other problems, this results in a lack of accountability, and those of us in Congress don't know whom to call on EC policy. Industry officials, perhaps more than members of Congress, have been frustrated by the same problem.

Finally, we are concerned with the dominance of military interests over economic interests. In the case of EC 92, many members of Congress are concerned that the United States is not getting the leverage it should from the memoranda of understanding that the Department of Defense maintains with European nations. Although these memoranda are the major bargaining chip we have in EC 92 negotiations, the Defense Department has been unwilling to let our U.S. trade representative use them as a bargaining tool.

Military interests often dominate economic interests. Federal support for advanced technology development goes largely for defense technology. That approach, which relies on defense spinoffs to civilian technology, worked well during the 1950s and 1960s, but I question whether it does any longer. Military technologies have steadily grown more specialized and the defense sector more isolated from the rest of the economy. The direction of influence has even been reversed in many areas, where military applications now

depend on advances in civilian technologies. Despite that the United States continues to spend a far smaller percentage of its GNP on civilian R&D than West Germany or Japan. Historically, the U.S. ratio of defense to civilian R&D was 50/50. In the 1980s that ratio became 70 percent defense and 30 percent civilian.

In Europe the ESPRIT and EUREKA programs provide support for civilian technology development. In this country there is enormous debate over such support. Under the policy of the Bush administration, we do not support advanced civilian technology development unless there is a clear national security rationale. But what constitutes national security is not entirely clear. The Department of Defense, for example, recently funded R&D efforts on food processing and apparel.

In conclusion, Congress is watching EC 92 developments carefully, and members are, in a word, concerned. Despite assurances from the administration that negotiations are moving in the right direction, members are frustrated about specific developments.

My own view is that, on the whole, the United States has benefited from the past expansion of the European Community. These benefits have not been automatic. We were vigilant in the mid-1970s and again in 1981, and our vigilance was met with success in the form of trade barriers that were lower than they otherwise would have been. We need to approach Europe 92 with the same kind of vigilance.

DR. PRESS: We wanted the views of Congress and we got it straight from the shoulder. Thank you, Lee. We have time for three or four questions, and Congressman Hamilton has consented to respond.

DR. REMBSER: Do you in the U.S. Congress have contact with the European Parliament?

MR. HAMILTON: Yes, we do on a number of occasions during the year, and different members have a variety of contacts. We also have contacts with other European organizations of parliamentarians. For example, this afternoon I met with 15 members of the Council of Europe. I think those contacts are improving. After a kind of dry spell, they're becoming more substantive and vigorous and I hope more useful.

PARTICIPANT: At times we are our own worst enemy. What can be done to give a more unified U.S. government approach to negotiations with the EC?

MR. HAMILTON: My own sense of that is that we're improving on it. The real key is raising the level of visibility of the European Community problem in the government. We're moving in that direction. Secretaries are beginning to pay more attention to it now. And I think the president is. If that happens, you'll see some of these areas that I referred to as being problems beginning to be ironed out.

We had better get it through our heads that we're in for the economic fight of our lives. The competition is going to be very tough and keen for

American businesses, and we're going to have to reorder our house and become more aggressive in asserting the American national interest in these economic matters. So I am pleased to see the moves that I think are now under way to raise the priority and the visibility of these matters within the government and to assert that interest more directly and strongly.

PARTICIPANT: Isn't the best way to improve our competitive position to get the budget down and thereby, of course, increase our savings?

MR. HAMILTON: I thoroughly agree with you. I'm not sure all of my colleagues do. The question is what are the prospects for that, and the answer is not very good, I'm afraid. We are temporizing with the problem of the deficit. We are dealing with it on the margins. We are not hitting it foursquare. We had a disappointing year in 1989. We are headed for a disappointing year in 1990, unless things change, so I don't think we have yet gotten the message that the deficit has to come down.

As you all know, the Gramm-Rudman targets require a reduction each year, not in the deficit but in the projections for the deficit. We have become so skillful in this town at game playing and accounting tricks that we persuade ourselves that the deficit is in fact coming down, when it is not. The deficit has for the last three years been at the $150 billion level; if you include the Social Security surplus funds, it's $220 billion. You're going to hear an announcement in a few days increasing the deficit projections for this fiscal year in a very substantial way. So, while we fool ourselves—and maybe that's not so bad—about getting the deficit down, what is happening is we're eroding the economic strength of the country and that's serious.

PARTICIPANT: I wonder if you could tell us about the views of the Congress about the kind of research in SEMATECH?

MR. HAMILTON: I guess the views in the Congress with regard to that are very much split. You would have, I think, very solid support for it across the ideological divides of the Congress, if it has a national security rationale. If it doesn't, then I think you very quickly move away from consensus and you get a very divided view within the Congress.

As you know, we've backed away from using the term industrial policy, but there's enormous concern in the Congress on the whole question of U.S. competitiveness. Like others, we look intently at the trade deficit figures month by month and year by year. We recognize that U.S. competitiveness is not a matter that is going to be solved by the United States government and certainly not by the United States Congress, but I think we also recognize that our responsibility is to provide an environment in which our American business community can compete. Many of us think we are not really doing that as well as we ought to be doing it.

DR. PRESS: Please join me in thanking Congressman Hamilton. Thank you all for being here this evening.

The 1992 European Market Integration: Bush Administration Policies

DR. PRESS: Today we are dealing with important issues such as standards setting, certification, testing, and the implications for our industries, then strategies for the European market, and, finally, strategies for U.S.-EC cooperation—as well as competition—in the years ahead. It is very appropriate that we open the day with a talk by Dr. Allan Bromley.

Dr. Bromley is assistant to the president for science and technology and director of the Office of Science and Technology Policy. He was formerly professor of physics at Yale University, where he was founder and director of the A. W. Wright Nuclear Structures Laboratory. Dr. Bromley has published some 450 papers in science and technology and has edited 18 books. He has received numerous honors and awards, including the National Medal of Science. In more than two decades he has been a leader in the national and international science policy communities. In the early 1970s he chaired the National Academy of Sciences' Physics Survey, which contributed in a central way to charting the future of that science in the subsequent decade.

He was president of the American Association for the Advancement of Science, the world's largest scientific society, and also was president of the International Union of Pure and Applied Physics, a world-coordinating body for physics. Prior to his present appointment, Dr. Bromley served as a member of the White House Science Council throughout the Reagan administration and as a member of the National Science Board. He has been awarded 10 honorary degrees from universities in the United States and abroad, honors richly deserved. It is a pleasure to introduce Allan Bromley.

DR. BROMLEY: It is a great pleasure for me to be here this morning to talk to you about the Bush administration's view of this important subject. As I think all of you will recall, back in the 1920s quantum mechanics taught us that it was very frequently necessary to view a single phenomenon

from at least two different points of view—which frequently seem contradictory—waves and particles. The state of world affairs today seems to me to be characterized in many ways by similarly contradictory viewpoints.

On the one hand, the world is becoming, as is quite obvious, increasingly diverse. A simple division of the world into East-West or North-South is losing relevance as new centers of economic strength continue to develop. Countries and formerly autonomous parts of countries are exerting their rights to independence and self-determination, and a strong resurgence of democracy around the world is enabling countries to express their national aspirations free of external oppression.

At the same time, the forces of unification around the world have never been stronger. East and West Germany are rushing toward unification with an irresistible momentum. The European Community is moving toward a single integrated market that will make it an economic superpower that is certainly comparable to, if not larger than, the United States or Japan. Throughout the world countries are embracing the promise of economic modernization despite the social changes that such modernization will inevitably cause.

I firmly believe that science and technology are among the strongest unifying forces in our world today. Science and technology have always constituted perhaps the most truly international of all our human activities. It is frequently the case that scientists and engineers have much more in common with colleagues on the other side of the globe than with those on the other side of the hall. Furthermore, science has always been public knowledge, because its results, before they truly become science, are freely available to all.

But science is even more than public knowledge; it is international knowledge and an international resource. Today, most research results from the United States or Germany or the Soviet Union are available almost immediately. The fax machine works with remarkable effectiveness, and the international language of science, which is frequently a combination of mathematics, jargon, and badly distorted English, ensures that anybody with proper training is able to read and understand the results almost as soon as they become available.

We in the United States have derived much of our scientific and technical tradition from Europe, and for that reason our scientific and technological ties with Europe remain stronger than those with any other part of the world. Indeed, until World War II our contacts in science and technology were almost exclusively with western Europe, particularly in the years before the war when, because of the great strength of European science and technology, the flow of scientists and engineers was almost entirely from America to western Europe.

After World War II, with particular impetus from the Marshall and Fulbright programs, and with the burgeoning growth of American science and technology,

this flow to a large extent reversed, and it became traditional for young European scientists and engineers to feel that their education had not been complete until they had spent at least some period in the United States.

In recent years, however, we have tended to lose focus on this very important exchange, as we have become more and more preoccupied in this country with the technological prowess of the Pacific Rim nations and with our role in working with the nations of the Third World. Although the absolute number of European students studying science and engineering in the United States has not generally declined, their fraction of the total has diminished as more students from non-European countries have chosen to come here to take advantage of our universities and our research opportunities.

With the unification of the European Community, many in this country feel that there is at least the possibility of substantial weakening of U.S.-European ties in science and technology as European researchers, for very obvious reasons, look inward to new challenges and new opportunities closer to home.

I believe very strongly that any weakening of the linkages between the United States and Europe in science and technology would be a tremendous mistake. Both the United States and Europe, in my opinion, have much to gain from a greater rather than a lesser degree of contact between our scientists and engineers. Even in aspects of research and development that are closely related to commercialization, I feel that cooperation in science and technology can pay handsome dividends to all participants.

I noticed that Filippo Pandolfi and Erich Bloch spoke with you yesterday, so you may have already discussed many of the detailed issues in science and technology that surround EC 92. I had the pleasure of speaking with Dr. Pandolfi myself yesterday.

I thought that perhaps it might be useful if I were to address some of these issues from a slightly broader viewpoint—the viewpoint of the Bush administration—and tell you something about our policies toward the Single Market plan and our overall approach to international science and technology.

There are several broad principles that underlie this administration's approach to these matters. First of all, let me say that our support for a free market of ideas and researchers as they flow back and forth across the Atlantic is strong and sure. The vast majority of science and technology interchanges take place without any government sponsorship, recognition, interference, or even knowledge, and that is precisely as it should be. The backbone of cooperation rests in the individual-to-individual and institution-to-institution bonds that are created over long periods of joint work, cooperation, and general friendship.

For those interactions that do occur under formal government-to-government agreements, a somewhat more rigid and formal set of criteria will always be required. We believe very strongly, for example, that there should be shared

responsibilities for both basic and applied research; access to foreign research and development processes and facilities that is comparable to the access granted foreign researchers in the United States; and adequate protection of intellectual property rights (this becomes an ever more important issue as the world becomes smaller in the commercial sense). We also need effective protection for truly sensitive knowledge. We have to recognize that perhaps for too long we have tried to protect too much in the way of knowledge. What we must do instead is to decide upon those specific technologies or areas of system integration that are truly sensitive, focus upon whatever protection we deem appropriate for them, and make everything else freely available worldwide.

The United States will continue to pursue these overall goals in both our bilateral and multilateral agreements with international science and technology partners. These goals will be made part of all of our specific R&D endeavors.

I want to talk about three particular categories—basic science, precompetitive research and development, and competitive product development—and then mention a few general issues.

Let me talk first about basic research. The United States has always been and remains firmly committed to the free and open international flow of basic scientific knowledge. Open communication eliminates duplication of effort, increases the pace of scientific advance, and ultimately benefits all countries. Protectionism in my view is just as damaging in science as it is in trade.

This philosophy also underlies the U.S. approach to a very important subset of our scientific effort today, namely the large, or "mega," projects in science, particularly in the basic sciences. These projects—which include such things as the Superconducting Supercollider, Space Station Freedom, the mapping of the human genome, the compact ignition tokamak, global change research . . . I could go on at some length—are all expensive and of great international interest. The results they produce, once they are completed, will be additions to the international reservoir of fundamental knowledge. Consequently, in my view it is not only desirable but necessary to coordinate the planning and support of these projects.

The outline of international cooperation is at least partly in place for a number of these projects. For example, ESA, Japan, and Canada are contributing laboratory modules and other hardware valued at more than $7 billion to Space Station Freedom. The total initial U.S. investment in the space station is about $16 billion. This so far is the largest international research and development project that has ever been undertaken.

On the other hand, the largest basic research project that has even been conceived is the Superconducting Supercollider, the 54-mile ring planned for Waxahachie, Texas. The Department of State and my office have been working closely with the Department of Energy and other agencies to develop

a plan so that we can involve other countries in the planning, building, use, and management of the Superconducting Supercollider.

Similarly, the importance, complexity, and cost of the effort to map and sequence the human genome make international cooperation essential. Cooperation already exists on this project between the United States and the EC and between the United States and the United Kingdom. Many other developed and developing countries are already involved or are working to become involved because of the tremendous interest that all have in the future use of this very fundamental knowledge.

In the past—in part because of the great differences in funding mechanisms between the United States and many of our collaborating countries—there have been misunderstandings about levels of support. Indeed, the United States has in some cases come to be known as an unreliable partner. In significant measure this reflects the fact that in most other countries, once a large project is approved, the funding for the entire project, whatever duration its construction may be, is also approved. In this country, of course, we have an annual congressional budget cycle and in that cycle priorities can change.

My office is now undertaking a study, in collaboration with a number of other agencies and countries, of ways in which we can put the support of megaprojects on a more formal, reliable, and steady base. It seems desirable to us that we should consider megaprojects not as individual projects but as an international opportunity, if you will, spanning a large range of projects. If we do this, it will be easier to develop equitable funding arrangements and a satisfactory geographical distribution for these one-of-a-kind facilities. On our side the United States needs to develop more stable and credible agreements to cover our participation in these international programs.

At some point we may wish to consider agreements that ensure multiyear commitments. These agreements obviously will have many—if not all—of the features of treaties. We are not yet ready to make a specific recommendation, but we are working both within the administration and with the Congress on these topics.

Important as these major facilities and devices are, however, they are nowhere near as important as the people who use them. It is very important for us to keep a firm focus on the training, and particularly in this context the international exchange, of scientists and engineers. These are the kinds of exchanges that build the person-to-person bonds that I have already mentioned. International cooperation is a habit-forming activity. Once a young scientist has experience in international cooperation, he or she finds it very easy to do it again and again. It is important that we make this exposure part of the career experience of as many of our young people as we possibly can.

We in the United States believe, and have always believed, in open and equitable access to our educational institutions, not only for students from

our own country but for students from any country. Many countries have taken advantage of this access, and indeed there are many who would argue, I think correctly, that graduate education may well be our most important export.

More than 50 percent of the advanced degrees in engineering in this country are now being awarded to people who have foreign citizenship. This certainly does not mean that there are too many foreign engineering students in the United States. It means that there are far too few Americans. This is a problem that we in this country have to address.

We already face shortages numbering in the hundreds of thousands in field after field of engineering and science in the 1990s, and there is not a thing we can do about it within our own boundaries. In fact, the situation is getting worse. Over the past two decades the population of 18 to 24 year olds in the United States has declined by 19 percent. Even more disturbing are the results of a recent survey of freshmen interests that asked young people entering the nation's universities and colleges what fields they had chosen for their major. It shows very disturbing trends. In the last two decades interest in majoring in science or engineering has dropped by a third. Interest in engineering dropped by a quarter in the last seven years, and interest in computer science dropped by two-thirds in the last four years.

Without a very large flow of foreign students into our educational institutions who remain here to pursue their careers, we would face devastating shortages. The U.S. economy depends critically on the influx of bright young people from abroad for its health and vitality.

Regarding exchanges with Europe, we have not yet begun to see a decrease in students studying abroad that many predicted would be a consequence of European unification. But there is a very widespread perception throughout the scientific community that this will happen, and unhappily this is the kind of perception that can be self-fulfilling. If we are to maintain the strong bonds that arise from exchanges between Europe and the United States, then we in the United States must give greater encouragement than we have to Americans going abroad and European scientists spending time in this country. For example, in the case for which I have the best statistics, in the exchange between West Germany and the United States, for the past two decades, Germany has borne more than 70 percent of the total cost of the exchange, both for Americans going to Germany and for German scientists coming to the United States. It is essential that we develop new sources of support for this kind of exchange, so that something more approaching reciprocity can be put in place. We are working toward that goal.

Let me turn to the question of competitive research and development. The question always arises: At what point does one draw the line between what is freely open and available and what requires protection of some

kind, either for economic competitiveness reasons or for national security reasons? It seems to me that there is a reasonably clear line of demarcation that can be drawn. We all understand what we mean by basic research, by the discovery of new knowledge, and we all know what we mean by production of attractive goods and services. It is in that interface where we move from the basic discovery to the production phase that much of our difficulty arises, and I believe that this is an area where cooperation can yield handsome dividends to all concerned. It can reduce the risk, cost, and time required in the development of generic technologies. These are technologies that may underlie a great many aspects of our national life, civilian economy, and national security, but by their very nature it is difficult for any single industrial organization to reap sufficient benefit to justify their support.

We in the federal government have an important role to play in helping to arrange, support, and seed this kind of cooperation. We have a rather peculiar problem in this country regarding cooperation. It has been recognized for many years in the Congress, and not only in this but in prior administrations, that it was very important for us to change our antitrust legislation, and as a result the legislation has been changed in many ways to make such cooperation possible. What we have not succeeded in doing, perhaps for obvious reasons, is making our industrial leaders trust either the administration or the Congress in these matters. There is an understandable feeling: "You say that you encourage cooperation, but what will the people who replace you say, and what will happen two congresses from now?"

It is terribly important in this country to make it increasingly evident that this administration and this Congress believe that it is important, that it is worthy of federal support, to have competition and collaboration. They are not antithetical in the development of generic technologies.

When you move into the production phase, of course, this administration believes that none of us is wise enough to make better decisions than is the private sector. For that reason we do not wish to be in a position of picking winners and losers at the production level. We do believe, however, that it is important for us to level the playing field where the technology development that underlies production takes place. This applies not only nationally but internationally.

One of the key areas in achieving this international cooperation is arriving at agreements on intellectual property rights. This becomes increasingly important as we move into new areas like biotechnology, software development, or other areas where the results of research and development are very easily moved from one country to another. One of the problems we faced in the past was that Congress quite understandably—and I believe rightly—required a few years ago that in all of our science and technology agreements we incorporate specific language on intellectual property rights. The intent was excellent, but unfortunately specific language makes it very difficult

for some collaborating countries to adjust that language to their laws, and it is not reasonable for us to expect them to do so in some cases. As a result, my office is arranging a more flexible set of criteria that will ensure the appropriate protection of intellectual property rights and yet leave flexibility for negotiations, within the conditions unique to specific countries with which we are negotiating.

At some point in the continuum from basic research through product development, we cross the obvious line that separates competition from the precompetitive phase. It is my experience thus far that not only we but most other countries as well are overly cautious in defining where that line should be. I am convinced that the results of fundamental research are clearly public knowledge, and as I said before I am convinced that much more than we now make publicly available should be publicly available. We must decide carefully and thoughtfully what is truly important to us and important for us to protect, limit it strictly, and then protect it as thoroughly as we know how.

The basic position of the U.S. government toward European unification is that we commend the EC's effort to increase competition and stimulate economic growth within Europe by removing internal barriers. However, as an administration and as a nation, we want to be sure that the unification of the European market does not decrease competition between Europe and the rest of the world. In other words, we want to be sure that when trade barriers are removed within Europe, new barriers are not erected between Europe and the rest of the world. This concern touches upon the first of two general issues I want to discuss that extend across the entire spectrum of our international science and technology agreements.

By harmonizing the standards and regulations required of goods and services, the European Community could make it much easier for all industrial organizations to compete in the formerly fragmented European economy. However, if standards and regulations are used to delay, inhibit, or otherwise obstruct competition from outside the EC, it would have a most deleterious effect, not only on U.S. sales and marketing but also on the R&D activities necessary to compete effectively in quality and in innovation.

In the past the European process of creating and adopting standards in some cases was not particularly open, and we congratulate the EC for taking steps within the past year to increase the transparency of the standards-setting process. For example, the Commission has encouraged European standards' bodies to work with outsiders in developing standards. Some problems, of course, still remain, as in the case of biotechnology, where the issue of social need as a determining factor in the regulation of biotechnology is one that is still a matter of debate between the EC and the United States. What we have to ensure is that the standards are applied fairly to all participants in the market and that the testing and certification requirements are applied uniformly.

Of course, the process of European integration looks much different today than it did even a year ago because of the astonishing changes that have taken place in eastern Europe. As Vaclav Havel said just a week ago, speaking before a joint session of Congress, "We live in very extraordinary times. The human face of the world is changing so rapidly that none of the familiar political speedometers are adequate."

Certainly, the changes going on in eastern Europe have already had a dramatic impact on my own office. Delegations from Czechoslovakia, East Germany, the Soviet Union, and Hungary have all visited OSTP within the past few weeks to explore the possibility of upgrading our existing scientific and technology agreements or initiating new ones. The East Germans and the Czechoslovakians in particular were very quick to point out at the opening of our discussions that their new science ministers were not communists but rather respected scientists who will be putting together their national policies.

The countries of eastern Europe have a marked need for western science and western technology. The challenge facing both the United States and western Europe is to transform and adapt existing arrangements and multilateral institutions so that they can accommodate the new relationships that are required with eastern Europe. We in the United States will be looking for opportunities to integrate science and technology cooperation with the president's broad foreign policy goals of encouraging the independence and democratization of eastern Europe. We look forward to working with our colleagues in the EC in making this happen.

As the walls between East and West come tumbling down, both figuratively and literally, an old chasm takes on new importance. The different levels of development between North and South have become ever more apparent. More and more, science and technology in the United States, Europe, and Japan will be called upon to solve problems that are not local or national but rather truly global. Increasingly, the axis of these global problems is not East-West but rather North-South. These problems will raise additional issues; they will have to be taken into account in all of our bilateral and multilateral agreements. At the same time, they offer unparalleled opportunities for increased worldwide cooperation in science and technology.

Global environmental change offers perhaps the most stark example of these new and truly global problems. There are a great many changes about which we must be concerned—the destruction of the ozone layer, acid rain, pollution of the earth's ocean—I could go on at great length, as could anyone in this room. The prospect of environmental change on a global scale is going to force all nations to examine a wide range of policies in the light of new scientific and economic understanding of the earth's system and of human influence on that system.

Next month the president will host the White House Conference on Science and Economics Research Related to Global Change. The intent will be

to bring together leading scientists, economists, and environmentalists from a representative cross section of the world's nations to focus on how, by working together, we can improve our understanding and use of the analytic tools and data available to us. We can make at least a start on developing the framework for an international research program that will draw on the expertise, the data, and the resources of all the participant nations.

The results of this meeting will feed into the United Nations-sponsored Intergovernmental Panel on Climate Change, a panel in which all of us have played an important role. This is truly an international process involving some 60 nations, hundreds of scientists, and nongovernmental as well as governmental organizations. Its charge is to form an international consensus on science-based climate change so that agreements can be forged on these issues before legal and regulatory actions are taken. In turn, the IPCC process feeds into an International Framework Convention. President Bush has issued an invitation to the world's nations to hold the first negotiating session for that convention here in Washington.

This is a situation typical of what will be a rapidly growing class of problems that can no longer be addressed on any national or regional basis but that truly demand the best of us acting on a global basis. Such problems will pose a major challenge, not only to science and technology but also to international diplomacy. The important thing is that channels that are open for science and technology have a long history of opening wider with the passing years, to encompass all sorts of topics that are important to the nations on either end of the agreement.

I would close simply by quoting Louis Pasteur, who said, "Science knows no country, because knowledge belongs to humanity and is the torch that illuminates our world."

MS. HOLDEN: Constance Holden, *Science* magazine. I am glad to hear you talk so much about global environmental problems, but I have not heard any mention of the underlying cause, rapid population growth. Does this mean you do not think science and technology have any contribution to make to this?

DR. BROMLEY: Not at all, and I agree with you that population growth worldwide is clearly a very important part of the problem that we all share, of keeping this planet habitable. However, science and technology, while they have a great deal to contribute to this problem, are no longer in any sense the dominant issue involved in population control. It has become a political problem. We scientists and technologists will certainly be expected to continue to contribute. I think there are real opportunities in some of the new discoveries and developments, in molecular biology, for example, but fundamentally the major problem areas in this whole question of population control remain social, political, and cultural, not scientific or technological.

DR. DUBY: Jean-Jacques Duby, IBM Europe. Yesterday we spent some

time discussing the participation of non-European-held companies in European research programs. I would like to ask you, what is your administration's view on the reciprocal, the participation of non-U.S.-held companies in research programs that are partially supported by the federal government?

DR. BROMLEY: I think that we would take exactly the same point of view that was taken in the case, for example, of IBM's participation in European activities. We treat them on a case-by-case basis, and we are quite prepared to do so.

DR. INGRAM: John Ingram, Schlumberger, Ltd. American universities have long been bastions of basic research and, as such, our communication with Europe and the rest of the world. We do a certain amount of basic research ourselves in conjunction with American universities. I see a trend—and perhaps I only see a very small part—a trend toward sensitivity in American universities to the commercial importance of basic research and toward the locking up of the intellectual property rights on that, which to some extent is interfering with the publication of that research and its dissemination, at least in some of our projects. What I would like to ask you, is that a general trend, are we worried about it, and are we doing anything about it?

DR. BROMLEY: Let me take the questions in order. Yes, we are worried about it. Yes, we are trying to do something about it. Yes, the problem is real, but it is not in any sense a generic problem. It occurs in specific cases and it should be stamped out wherever it occurs, and I think that it really is the responsibility of the individual university, in the first order, to take appropriate action. I was involved before coming here, for example, as chairman of committee in my own university at Yale considering these topics. What we discovered was that as we began to rebuild bridges between the universities and the private sector, it was a new concept for both sides, so there was a period of jousting as the lawyers on both sides tried out the system to see what they could obtain.

I well remember our first encounter with a very distinguished private sector organization whose lawyers came in with a set of requirements that would have tied up the university thoroughly and forever. We spent about a week looking in horror at this document, saying, "My God, is this what university–industry relations are going to be like?" Then we had a meeting and said, "You know, this is ridiculous." The lawyers on the other side said, "Well, if you feel that way," and took out most of the stuff. It was a trial balloon; it was shot down and we then proceeded.

I think what it requires is an understanding that both sides are in unknown and uncharted territory, as well as a lot of goodwill. I do believe that the kind of secrecy or proprietary control, whatever you want to call it, is antithetical to the spirit of American universities. It should not be there any more than classified research for the military should be in universities. It is

one of the things that would most quickly destroy the most precious aspects of our academic community, a community that we more than any other developed nation make enormous demands on, not only for new knowledge but for the young minds trained to use it in a creative fashion.

DR. REMBSER: Josef Rembser, Federal Republic of Germany. The philosophy of the U.S. government toward megaprojects seems to be to decide upon a megaproject and then invite others to participate. Do you also think that in the future there could be a joint discussion about the decisions for such projects?

DR. BROMLEY: That is precisely the point that I am making. I think that we have tended to view these projects as originating in this country, particularly because science policy relating to those projects typically comes from the bottom up in the United States: A large community of scholars decide that they must have something, and it rises higher and higher on our view screens until something happens. That being the case, there is an unhappy tendency for us to think about international cooperation only after the program has gone a considerable way beyond initial conception, toward planning, funding, design, and so on. I do not think that this situation is viable anymore. In fact, I think in the case of some of our existing megaprojects that we have failed in a very important way to communicate effectively with our international partners, who understandably are upset if they feel that they are engaged with us in a joint research program and find out about major changes in the scope or character of that program only after we have made them. That is not what we mean by cooperation, and I think that a major cultural readjustment is required in our science and technology community. Perhaps some adjustment will be required in others, but I do believe that we, again with goodwill, can work toward a situation where the international aspects are considered right at the beginning.

MR. ANDERSON: Chris Anderson, *Nature* magazine. Yesterday, Vice President Pandolfi said that he had talked to you about the possibility of a joint international task force on cooperation. What do you think about that proposal, and what are the prospects of seeing such a task force?

DR. BROMLEY: We talked about the general question of cooperation in a number of areas. The idea of a specific task force is one that we agreed to look into. I think that we will very probably end up with slightly different mechanisms on both sides of the Atlantic. For example, on our part, we have two mechanisms. One is FCCSET, which with strong cabinet support I am in the process of revitalizing and restructuring to deal with intragovernmental coordination and integration of U.S. participation in research activities. In addition, as you noted, a few weeks ago the president announced his appointment of PCAST. That was designed in part to take care of one of the fundamental weaknesses of the FCCSET mechanism, namely that it had no provision for bringing private sector, industrial, academic, foundation, or other input

into its deliberations. Since I have the privilege of chairing both PACAST and FCCSET, if they do not talk to one another it is my responsibility and my fault. I would certainly look upon the PCAST-FCCSET axis as playing a very important role as we establish our end of what I hope to build with Dr. Pandolfi and his associates: a very real and effective bridge between this country's science and technology enterprise and that in the EC.

DR. PRESS: The next speaker on this morning's session is W. Arthur Porter. It is his job to be a respondent. I am not sure what a respondent is supposed to do, but I guess we will soon find out. Dr. Porter received his Ph.D. in interdisciplinary engineering from Texas A&M University. Since 1985 he has been president and chief executive officer of the Houston Advanced Research Center, a nonprofit research consortium that includes such fields as materials science, lasers, high-energy physics, supercomputing, geotechnology, space, and policy studies. Located in the greater Houston area, its membership consists of some nine institutions, universities, and research centers. Previous to that, Dr. Porter was professor of electrical engineering at Texas A&M University. He was a member of the technical staff of Texas Instruments in the semiconductor R&D labs, and there he developed the first fully automated system used in manufacturing integrated circuits. He currently serves on the Governor's Business Development and Jobs Creation Task Force and is a member of the U.S. Department of Commerce's Semiconductor Technical Advisory Committee.

DR. PORTER: I am pleased to have the opportunity to respond to Dr. Bromley's comments and to try to incorporate the questions and answers that followed his presentation on the EC 92 integration and the Bush policies. When asked to be a respondent, Frank, I asked the same question. I was asked to bring a perspective from American industry, but bringing a perspective from American industry is like trying to bring a perspective from Congress: It will always be mixed. But let me proceed.

Dr. Bromley, I think, has done an excellent job of reviewing the historical relationships between Europe and America and the importance that science and technology have and are playing to unify people from different cultures as well as to drive the world economy into a single marketplace. Europe and America can benefit together by seeking newly formed win-win partnerships, as opposed to the more historically traditional win-lose games that we have often tried to play. It is critically important that we define these new win-win partnerships in a world that is changing at absolutely breathtaking speeds.

It is my thesis today that industry must take the lead and that governments must support that action. Let me repeat that. Industry must take the lead and governments must support that action.

I make this point for two reasons. One, which Dr. Bromley has already made, is that science and technology are public knowledge and the results

are freely available worldwide. Second, only companies within R&D-intensive industries are capable of rapidly responding to the type of change that is occurring in today's global marketplace. I will return to this point of industry leadership in a moment.

American industries, to remain competitive, must form partnerships with European industries to leverage off of the R&D that is utilized to manufacture products in order to take advantage of new market opportunities, particularly as EC 92 approaches. Value added from existing technologies and new R&D results must be pursued through these win-win European-American partnerships. To do this will require that we pay attention, as has been mentioned, to international versus national laws, to intellectual property rights, and that we take advantage of events such as are occurring today in eastern Europe, to develop these emerging markets through creative multigovernment support that encourages collaboration between industries, particularly between America and Europe.

Now, in response, I concur and I applaud the point made about protectionist policies not working. I firmly believe that in our changing world, given the economic importance and mobility of intellectual products, nationalist protectionist measures will be no more effective than trying to legislatively regulate the migration of wild geese. A good idea or a valuable solution to an important problem is as mobile and as fast as a satellite communication, which we all know can be instantaneously transmitted anywhere in the world. Intellectual products, the basis for future wealth, are much more mobile at any stage of development—whether we are speaking of basic, precompetitive, or competitive—than a shipload of spices or silks ever was.

I want to pause here and talk about two cultures, not cultures of nations but the culture of scientific and technological knowledge and the culture of business. The differences pose a challenge for all of us in this global village. These two cultures have basic, fundamental differences that have been spoken of particularly here today. Science and technology are a culture of openness. Those of us in this room from this country and our neighbors in Europe have communicated openly. In this country we have always had communications with our colleagues in Russia, even when America and Russia were in the most stressed relationship politically. But the business community, which must take this new set of intellectual products and get value added from them, has a culture of proprietariness, of secrecy. There is a big gap between the scientific and technology community, with a culture of openness, and the business community, with a culture of proprietariness. We must address that gap within nations and across nations.

What does this all mean? It means that human talent is the critical factor for any nation that will remain competitive. Dr. Bromley has already pointed to the importance and value of European-American student exchange programs, as well as collegial scientific person-to-person relationships. I suggest,

however, that we must do more, and I fully support the proposal of Mr. Pandolfi for creating a joint task force to help us learn how. Any competitive region of our new world will discover new mechanisms for networking intellectual talent from industry, academia, and government laboratories, crossing traditional political boundaries to meet new challenges. Being able to mix and match existing technologies to meet new needs as well as collaborating to develop new technologies through R&D are important in meeting opportunities in our changing world. Together, we will have to make long-term commitments to investments in the future, coupled with a balanced emphasis on near-term exploitation of our present capabilities.

In spite of the differences and complexities such as were mentioned yesterday by Mr. Duby of IBM and again this morning in the questions, we have to learn to form cooperative alliances and partnerships, to lower the risk of investments and share the benefits. We have to do a much better job of collecting and distributing high-technology information, and we must create a new culture of shared interest and understanding of management, business, and technology. We must lower the barriers to the flow of knowledge and encourage people to learn about entirely new fields and apply their knowledge to solutions of economically important problems.

Science and technology, as well as scientists and engineers, are becoming commodities—commodities that will be pursued as never before. Europe and America have an opportunity today to build upon our common cultural history and to celebrate the differences that can be taken advantage of to help our partnerships compete in the global marketplace. I can tell you that in President Bush's hometown of Houston we are seeking to do just that.

This point, of talented people, leads to what I believe is the most important role for any government and that is education. Above all, every nation's government must work to see that its citizens have access to quality, competitive education. America faces its greatest challenge on that single topic today. Support of R&D and the process of getting value added by encouraging and endorsing university/industry/government collaborations are also vital government roles. We must pursue these collaborations by every means.

As EC 92 approaches, it seems to me that one of the greatest longer-range impacts on American R&D-intensive industries will be determined by the European cooperative educational and R&D programs that develop and support EC 92 as well as a technology learning environment. We know of many newly created programs in the EC: DELTA, AIM, DRIVE, BRITE, ERASMUS, COMETT, plus others known even better, such as those mentioned often here, ESPRIT and JESSI. These programs collectively could dwarf American efforts and again point to the value of collaboration between America and Europe.

Let me give a specific example, from an industry point of view, of many of the discussions that have already come out in our deliberations. One of the

other hats I wear is chairman of the board of a company called Electro-Scientific Industries in Portland, Oregon. Fifteen years ago as a professor at Texas A&M, I was consulting for this company as we developed a laser system that today holds market share throughout the world as a critical device for building DRAM chips. As I sit as chairman of the board of this $100 million company, selling systems built in Portland, Oregon, and marketed throughout the world, I look at these new technologies that are emerging—precompetitive, competitive, or basic—and think about how they will drive future companies and what impact that may have on this company's ability to market throughout the world. It brings very close to home the importance of this collaborative research, how it will impact new competitive technologies, and how Europe 92 and the regulatory issues of manufacturing in one country and selling in another will impact the profitability of companies such as ESI. I am very much interested in discovering and better understanding that issue.

In summary, America must act, not just react. We must reach out to suggest new partnerships that embrace the objectives of our partners, respecting the complexities of different cultures but building upon our commonalities. The economic wind that is blowing across our globe is clearly headed to America. The wind may not be tropical, as we are used to seeing, but it packs forces that destroy structures like the Berlin Wall. If we do not see it coming in this country, or simply do not act to prepare for it, the damage will be tremendous.

We all know that European-American collaborative opportunities will be influenced and shaped by Asian Rim competition. Collaboration among Europe, America, and Asia must also be a focus and a consideration for all R&D-intensive industries. In any event, we must position ourselves to use the force of these new winds that are blowing and to put them to work to build a stronger economy, not simply let them destroy one that refuses to adapt. Partnerships will need new organizations to help overcome critical barriers that traditionally inhibit industry/university/government collaborations, and these organizations are being developed. To follow up on the question after Dr. Bromley's presentation, that cultures coming together from academia and industry must have a place in which they can develop a focused effort, to bring together the cultures of openness and proprietariness for the common benefit of a nation and a market—in my own organization in Houston, we are doing this. We are working in projects and technologies such as magnetic resonance imaging, superconducting magnetic energy storage, MAG-LEV trains—all new technologies that have spun out of magnets that we designed for the Superconducting Supercollider. And we are working collaboratively with university, industry, and government entities to bring these technologies to the fore. We are also working through our European liaison to develop new microwave remote-sensing capabilities for holographic imaging, working with Europe and developing a new company in Spain.

Those of us at this conference must lead. Otherwise, who will? This conference helps America focus on EC 92 and its importance, and I hope it encourages Europe to proceed with its worthy objective. We must discover how to proceed together, and I suggest early task forces can help.

Now I will return to my point about industry leading. Recognizing that industries and companies are not of nations but of markets is critically important to our collaboration. Let me restate that. I suggest that industries and companies are not of nations but of markets. Markets may be of nations or certain regions of the global single marketplace, but industries track and respond to those markets. Companies that are capable of anticipating and responding to market changes will lead, and nations that adapt to the change and encourage responsive companies to collaborate will create economic advantage for the people of their nation.

Finally, in response to the major global issues that Dr. Bromley so appropriately pointed to, I remind us that industries have as much responsibility as nations to pay attention to how science and technology can be applied to help address such problems as climatic change, acid rain, pollution of our oceans, the ozone hole, and so forth. Here again, collaboration between Europe and America in a united approach to the solution of these problems will far more effectively influence our own populations as well as our Third World neighbors who share this globe with us.

In conclusion, Europe and America have every reason to pursue this collaborative opportunity together. To reuse Dr. Bromely's quote from Louis Pasteur, "Science knows no country, because knowledge belongs to humanity and is the torch which illuminates the world." I would only add that it is our opportunity now to work together to get mutual benefit from this product of humanity that has never before in the history of man been so valuable and so important to the health of our world.

DR. PRESS: While you are thinking of questions, let me start off with an issue that I raised yesterday that reappeared in the two talks today, the issue of asymmetries between European attitudes, for example, toward economic development, industrial development, and American ones. These asymmetries have their bases in different traditions, different cultures, and different political attitudes about the roles of governments. A good example is the number of EC projects that have been mentioned—ESPRIT, JESSI, and the others, half a dozen or perhaps even more, whereas in the United States one or two counterparts come to mind. Certainly SEMATECH derived its rationale of government support not in terms of a critical economic need but in terms of a strategic military need, and that is why it is being supported by the Defense Department.

This is an example of a European initiative that makes good sense in Europe, whereas in this country we do not have that kind of a model. It is interesting to talk about foreign-held companies participating in each other's

programs, but we do not have very many, whereas Europe does. How do you see our own policy evolving, Dr. Porter? Do you think that we will have such things as a civilian DARPA, being driven by what we see happening in Europe, where the criticality will not be in terms of defense needs but in terms of the needs of economic competition?

DR. PORTER: I think we are not likely to see an industry policy, as Dr. Bromley alluded to earlier. I think that we can certainly be guided by the experience of our European neighbors' programs. On the issue of how this country has been able to leverage off of research for national security purposes, it is well known that the aerospace industry has had strong R&D support for development of products that otherwise had military requirements but that the technology developed there could be applied in the private sector. I think that has effectively been done.

Our opportunity is to look collaboratively for these types of science and technology programs that serve the economic health of a global marketplace and to work collaboratively to find and discover the ways in which we can do this together.

MR. KAPLAN: Gadi Kaplan, *IAAA Spectrum* magazine. Do you have any cooperation with Germany, for example, on such advanced things as MAG-LEV? As I understand, Germany and Japan are leading in terms of applications.

DR. PORTER: We have been in conversation with the Germans, the French, and the Japanese on those three separate technologies for MAG-LEV. It is only very recently that we have pursued the potential of our superferric magnets that are self-shielding in this new technological application, so we are in the very early stages of identifying with those potential partners. On the other hand, in magnetic resonance imaging we have already worked closely with Siemens and Brucker, both German companies, and with others from around the world.

DR. NICHOLSON: Geoff Nicholson, 3M. Several remarks have been made about the openness and availability of basic science, and I think we all agree and support that. I think one of the concerns that we may have about Europe, about Japan, is that whereas U.S. industry is very comfortable with working in the basic science area with universities, there seems to be more and more basic science being done in other countries that is outside of the university environment and therefore not as readily available, such as in consortia. I wonder if anyone has any comments or views on that subject.

DR. BARKER: Richard Barker, McKinsey and Company. This is an issue that I have also been thinking about recently, and I do not think it is one-sided. You have a number of U.S. companies that not only have collaborated very closely with U.S. universities but have overtaken U.S. universities in their basic science programs. I was visiting a West Coast biotechnology company the other day, and I said, which of the academic centers do you

need to collaborate with to make sure you are at the leading edge? Their response was, we have overtaken them, we are way ahead.

So I think on both sides of the Atlantic we have the issue of the disappearance, if you will, of precompetitive R&D into companies and the only mechanism I can see is the international collaboration and consortia between companies rather than an expectation of freely available, precompetitive R&D.

DR. PRESS: Where that works, that is fine, but recent trends show that, with an exception perhaps for the pharmaceutical industry, the trends are down for the support of basic science within companies. The issue is an important one, and I have been involved in some discussions with the Japanese on this. In Japan they do not have the research university system that we have here. Perhaps that is changing, but they still do not have it, and much of the kind of research that takes place at Stanford or MIT or the University of California can be found in Japan in government laboratories or in the central research laboratories of industry. So if one wants symmetrical access to the American research university in Japan, one has to find it, in many cases, within industry or within government laboratories.

The Japanese understand that case, and they are trying to open up these centers and these central research facilities where the basic science gets done. They accept the principle, but the progress is very small. In Europe I think it is a mixture of the American and the Japanese system. Of course, it varies from country to country, but I think it is a real issue that has to be explored as well.

DR. REMBSER: I would like to give a comment from the German side. In Germany about half of the R&D capacity in the public sector comes from universities and half from what we call the extrauniversity sector. The extrauniversity sector includes the Max Planck Institute and the national laboratories. In the 1960s and 1970s the science went more to extrauniversity institutes. Now there is a trend to include and integrate science more in universities. This is also due to a gradually decreasing number of students, so universities will have more capacity for research in the 1990s. In all extrauniversity institutes that are funded by federal and state governments, there is compulsory publication, so all results are published; they are open.

When Professor Bromley talked about the exchange of scientists, a very large part of the American scientists coming to Germany are going to this part of the German research landscape, the Max Planck Institute and national laboratories, so at least from the standpoint of secrecy and proprietariness, there is no problem and no difference between universities in Germany and the extrauniversity institutes.

DR. PRESS: That is a good example of the way somewhat different systems can be made to match and link up between our two countries.

MR. EISELE: Albert Eisele, Cornerstone Associates. Dr. Porter, you mentioned very briefly toward the end of your remarks that European-American

collaboration opportunities will be influenced and shaped by Asian Rim competition. It seems to me that is a fairly important and perhaps critical point in the subject we are addressing here, and I wonder if you could expand on that and tell us whether you think that we can build on the common heritage and celebrate our differences with Asian competitors as well as European.

DR. PORTER: Obviously we could have a whole other conference on that topic, but certainly I made the point about celebrating the heritage of commonality and taking advantage of our differences. That cultural link between this country and the Asian Rim is not really as historically common as it is between America and Europe, although as we look at this global marketplace, it is clear that there are three major centers of economic force. I know from my own experience in the microelectronics world—from Texas Instruments to doing research in publicly funded universities to being involved with a company marketing a system that is critically important in the manufacture of DRAM—that we have to pay attention to what is happening, particularly in Japan. The R&D efforts that are forthcoming there will generate technologies that will be competitive with what we produce. So the question from the corporate perspective—being of a market—is where do you find the partnership? Which one does it make the most sense to make the alignment with, as you try to maintain your opportunity to participate in a viable economic way and still be profitable?

I think in all of these leading-edge technologies, the companies that serve the future global markets will be looking for partnerships where they can find them, where they are the most responsive to their need to effectively compete and the partnership can bring the most rewards. I suggest that we will find ever-increasing opportunities in the strengthening of the Asian Rim market and the competitive intellect that is driving that market and that capability.

All I was trying to suggest today, following the theme of this conference, is that America and the EC have a cultural and historical base for becoming partners at this time, if we seize the moment today and this nation embraces EC 92 and encourages Europe. I know that the formation of such partnerships is not easily done from within Europe; there is still much debate about how it will happen, exactly what will it mean. I think by America coming forth to encourage that to happen, and by us building upon these historical commonalities, we may be able to develop today partnerships that even a short period from now we may not have as much flexibility to develop, as they will be influenced. My point was and is that all partnerships will be influenced by a strengthening technological base that comes from the Asian Rim, and no one will be able to ignore that.

EC Standards Setting, Certification, and Testing Processes: Roles and Implications for U.S. R&D-Intensive Industries

DR. AMBLER: The subject of this session has been referred to a number of times already. Mr. Pandolfi stated that he thought standards and technical regulations were among the most important factors to achieving the Common Market, and in fact he said that he and others had believed that for a long time and had already made quite a lot of progress, particularly in telecommunications, with respect to standards for terminal equipment.

Of course, those of us who have been connected with standards-setting and testing procedures have known for a long time that they are essential for market integration and an efficient marketplace, but we have also known that they could be used as selective barriers to integration. That point was emphasized by Professor Bromley.

The speakers on the panel today are going to discuss topics such as the importance of transparency and openness, the avoidance of costly duplicative testing for conformance, timely notification of proposed regulations and standards, and various other issues of concern to those interested in standards and similar regulations. We have two speakers from the EC and two speakers from the United States.

The first speaker is Jean-Pierre Contzen, who is director general of the Joint Research Center of the European Community. Mr. Contzen is by training a mechanical and electrical engineer and had postgraduate studies in nuclear physics at the University of Brussels. Past positions include, first, the Ministry of Defense at the Belgian Nuclear Research Center at Meaux, then as engineer in reactive studies, head of the reactor dynamics group, and head of the section for advanced projects. In 1964 he became senior engineer for future programs directorate of the European Launch and Development Organization and worked on many applications of nuclear power in space.

At the same time, he was also consultant to the Nuclear Energy Agency of the OECD in Paris. He transferred to the ESRO in Paris and was a successful mission manager for telecommunications satellites, assistant director for space applications, and director for telecommunications. In 1974 he joined the CEC as director for prospective studies for the Joint Research Center of the ESPRIT establishment. Subsequently he was director of programs of the Joint Research Center at Brussels. In 1981 he became director of science and technology policy coordination with third countries for the Directorate General for Science, Research, and Development, and in 1986 he assumed his present position.

DR. CONTZEN: In the present session, dealing with standards-setting, certification, and testing processes, I intend to concentrate my remarks on the upstream part of the entire process, that is, on the interaction between research and standards. I will focus more specifically on the case of new materials, which represent in my view a very good example of how this interaction can be organized, and I will examine its international implications.

Research and standards: Distant neighbors or good partners? Replying to this question a decade ago I would have been inclined to choose the first—distant neighbors. For a long time, standards makers had a limited awareness of what was going on in the research world and what might be of relevance to them. For many decades, standardization could be efficiently achieved by ensuring that good practices were progressively agreed to and codified, the standardization occurring after market penetration and being in many cases aimed at demarcating market shares. With the notable exception of basic metrological standards of time, mass, electricity, etc., the academic world displayed little or no interest in descriptive standards-related work. It was considered an indignity for a true scientist, and only a few research managers in traditional industries were aware of the potential benefits of such work.

That situation is changing radically. The acceleration of the technological innovation process, the subsequent requirement for shortened innovation cycles, the increased cost of developing new products and processes, the growing importance of high-technology products to ensure industrial competitiveness, the prospect of the European Single Market, the need for eliminating nontariff barriers at the international level—all have brought new requirements for standards during the premarket phase, particularly in high-tech areas. This in turn necessitates early linkage between research and standards-making activities.

No fixed list of such areas could be established in view of the evolving character of the technological scene and the movements of the market. Nevertheless, one may indicate a stronger need in fields such as biotechnologies, telecommunications, advanced materials, lasers, membranes, and advanced production techniques as well as in more conventional sectors such as food and construction.

An agreement ex ante on standards avoids the implementation of diverging solutions that would have little chance of converging at a later stage. This is particularly true for complex systems, which require at least some convention for the organization of such systems. Furthermore, standardization during the premarket phase creates a momentum for new products and processes, by promoting the right degree of consensus for wider use of innovative concepts; it ensures quicker and wider development of new technologies, accelerates market penetrations, and gives more assurance of end-use performance.

One should note at this juncture the advent of a new element in the technological innovation process, in the penetration of new processes or products into the market—that is, the element of societal acceptance, beyond strictly technical and economic factors. Compatibility with the environment is beyond any doubt a growing factor in determining this social acceptance. Product safety is rapidly becoming a sensitive public issue. This requires assurance of protection by rigid, credible standards. Hence, standards that take into account societal constraints such as respect for the environment at the premarket stage could greatly accelerate market introduction.

The evolution of the situation I have just described must bring distant neighbors together and transform them into close partners. Proposals for standards should in the future involve more research work; conversely, an enhanced transfer of the results of research to the standardization process should be organized. Hence, the advent of a new class of research—prestandardization, now known as prenormative, research, which can be defined as research aimed at providing the scientific, technological, and metrological bases for the preparation of agreed standards on products or processes, in general born of advanced technologies. Prenormative research is not an area of research in itself. It is more a new dimension in research, horizontal in nature, having a bearing on several areas.

The importance of this prenormative dimension has been stressed in the new Framework Program of Community activities in the field of research and technological development for 1990-1994: ". . . in order to guarantee the scientific and technical basis to establish adequate norms and standards, this approach being likely to facilitate the completion of the Single Market and to provide a response to the Community's increased responsibility in the fields of environment, health and safety."

The Industrial R&D Advisory Committee of the CEC has constantly drawn attention to the need for further action in the area of prenormative research. During 1990 IRDAC is organizing a number of workshops to discuss the concept of prenormative research in three selected fields: construction, food processing, and adhesives. These workshops, bringing together representatives from the private and public sectors and from European standards organizations, are aimed at demonstrating the importance of prenormative

research for European industry and encouraging the Commission to take, if appropriate, further action in this field.

Many research programs already include this dimension; ESPRIT, RACE, the nuclear fission safety research program, and the environmental research program constitute good examples. I would nevertheless use the example of advanced materials, and more especially advanced ceramics, to illustrate how an efficient interaction between research and standards-setting work can be organized.

More than in many other areas, the design engineer accustomed to traditional practices will not shift to the use of new material until he has received some assurance that the new materials will bring some functional or economic advantage. He needs, in particular, the assurance of consistent performance and service before he will have the confidence to switch from the traditional materials. This assurance can be built through the provision of advanced specifications on the performance of the new material. Therefore, there is clearly a strong connection between the rapid introduction of new materials on the market and the early existence of standards of performance.

In advanced ceramics at the European level prenormative work has been organized since 1987 and involves four components: pressure from alert industries in close conjunction with Commission services, in this case the Joint Research Center; organizations concerned with the definition and agreements on standards, regrouped in CEN; laboratories and test houses providing testing, calibration, and analytical services, verification of conformity to standards, validation, and certification; and, finally, public and private research organizations and research laboratories from industry.

Figure 2 shows how this prenormative work can be organized. It starts with a state-of-the-art analysis of developments in advanced ceramics, carried out by research organizations and industries. This leads to an inventory of standards requirements, which in turn leads to a request for action by the CEN. In this case the CEN responded by setting up a technical committee (TC-184—Advanced Technical Ceramics), which through various subgroups has formulated a standards work program to be implemented within the CEN framework. Meanwhile, in close consultation with this CEN technical committee, on the initiative of the Commission's Joint Research Center, actions were initiated by BCR. BCR is run by the Commission of the EC, in close association with national testing laboratories, such as the National Physical Laboratory in the United Kingdom or the Physikalisch-Technische Bundesanstalt in Germany.

These BCR actions are aimed at investigating requirements and procedures for testing various types of ceramics, leading through round-robin exercises to the elaboration of testing methodologies. Such actions, together with the needs arising from the standards work program, would lead to the formulation of new research requirements of a prenormative type, to be

implemented by the public and private sectors and, finally, to the formulation of agreed published standards.

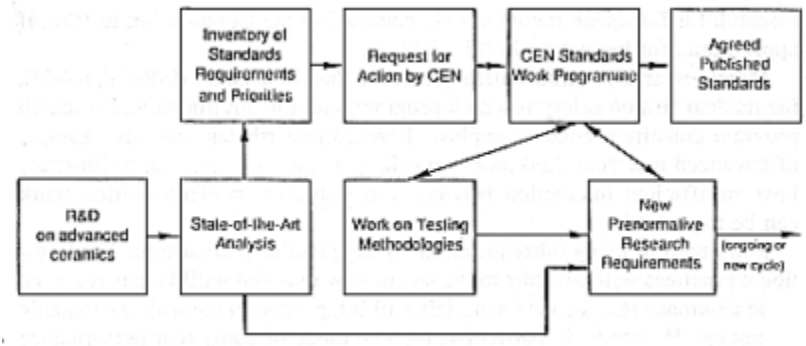

Figure 2 Standards Setting in Prenormative Research: Advanced Ceramics.

After three years of effort and adjustment, one might claim that the system works in a coherent fashion and that collaboration has been achieved between researchers and standards makers. At least in this particular case, distant neighbors are becoming good partners.

Could such a scheme, experimented with at the European level, be applied at the international level, particularly in the framework of U.S.-EC relations? The answer is yes, as far as the research is concerned. Because of its prenormative character and the desirability of internationally accepted norms and standards, its output should be made widely accessible to all firms as well as to all institutions that are involved in standards-setting work.

Recognition of this fact has been the basis for the launching and subsequent very efficient operation of an international project called VAMAS. At the 1982 meeting of the Economic Summit powers at Versailles—as Dr. Rembser will certainly remember—a working group on technology growth and employment was set up to consider the problems presented by technologies in relation to economic growth and employment. It was also to submit ideas on how to explore the many opportunities presented by the new technologies, noting in particular the requirement to remove barriers and promote the development of trade in such new technologies.

The United Kingdom, in the person of Sir Robin Nicholson, then chief scientist at the Cabinet Office, together with the United States, in the person of Dr. George Keyworth, then science advisor to the president, spearheaded a proposal for multilateral collaborative research on advanced materials and standards, which was subsequently selected and implemented. This was the origin of VAMAS, which after seven years of operation is still very active.

The Versailles mechanism as a whole has faded away; some projects achieved their short-term aims, but some projects among the 18 initially selected are still going on, not for the sake of bureaucratic self-perpetuation but because they respond to an effective need.

All G7 countries are involved in this effort, as well as the Commission of the EC. The VAMAS organization is a very light one, with practically no bureaucracy. The alternating chairmanship and the secretariat are assumed for the time being by the U.K. National Physical Laboratory. The U.S. member of the organization is NIST. The work is conducted on a flexible basis, with each participating member using existing resources. In other words, the work-sharing principle has been adopted for this type of collaboration.

VAMAS aims at stimulating, by means of international collaborative projects, the generation of agreed standards and codes of practice for advanced materials. VAMAS is not intended as a standards-drafting body. It is essentially a supportive body aimed at providing the enabling technical base and sophisticated information that will accelerate the production of internationally agreed standards.

The technical working areas of VAMAS are listed below:

TABLE 1

Wear test methods
Surface chemical analysis
Ceramics
Polymer blends
Polymer composites
Superconducting and cryogenic structural materials
Hot salt corrosion
Weld characteristics
Materials data banks
Creep-crack growth
Efficient test procedures for polymer properties
Low-cycle fatigue
Technical basis for an unified classification system for advanced ceramics

As one can see, the scope of the collaboration embraces all agreed aspects of enabling science and technology—data bases, test methods, design methods, and materials technology—which are required as precursors to the

drafting of standards for advanced material. Collaboration is emphasized in prestandards measurement research, intercomparison of test results (mostly by round-robin exercises), and consolidation of existing views and priorities for standardization action.

To get a view on who participates in VAMAS, Tables 2 and 3 give as examples the participants in round-robin tests on superconducting materials and cryogenic structural materials. You see that if academic institutions, research organizations, and testing laboratories predominate, industry is nevertheless present—rather strongly in the case of Japan, much more timidly in the case of Europe and the United States.

To conclude, I would like to submit for your consideration the following reflections. There is an objective need for closer links between researchers and standards organizations; industry should be part of this rapprochement. Progress has already been made in this direction, but further efforts are needed. The distant neighbors should gradually become good partners. Particular attention should be given to the prenormative dimension of research activities. Finally, experience in specific cases such as VAMAS has shown that international collaboration in the field of prenormative research is not only feasible but also beneficial, if it relies on interested, strongly motivated partners, and if it is focused on very well specified technical areas—hence the suggestion that we might, in selected areas, consider the implementation in common of new VAMAS-type projects.

DR. AMBLER: The next speaker is Dr. Ivan Dunstan, president of the European Committee for Standardization. Dr. Dunstan had been director general of the British Standards Institute since 1986, having joined that organization as director of standards in 1983. His scientific training is in materials and quality assurance. He has been director of the Department of the Environments Building Research Establishment and is currently involved in standardization, testing, and quality assurance over a wide range of technologies, including mechanical and electrical engineering as well as building and construction.

DR. DUNSTAN: There is no shortage of information, but I believe there is still a good deal of misunderstanding, and perhaps even misinformation, about what is going on in Europe and the reasons for it. My remarks will concentrate rather more on the practicalities of what is happening, how far we have got, where we are going, and particularly how important we feel it is that all of you and other interested countries around the world do participate as fully as possible in the activity.

There is no doubt about the level of interest. Only two weeks ago there was a major conference in Brussels for non-Community countries. Over 50 countries from around the world were represented. The level of interest was quite remarkable. The common theme, of course, was to ensure that

TABLE 2 Participants in the Round Robin Tests on Superconducting Materials

I_c Measurement	AC Loss Measurement
Europe	
Atominstitut der Osterreichischen Universitaten (Austria)	Atominstitut der Osterreichischen Imoversotatem (Austria)
Institute for Experimental Physics, Osterreichischen Universitaten (Austria)	Alsthom DEA (France)
SCK/CEN (Belgium)	KfK (Federal Republic of Germany)
SNCI, CNRS (France)	Siemens (Federal Republic of Germany)
KfK (Federal Republic of Germany)	Universitat Twente (the Netherlands)
Siemens (Federal Republic of Germany)	Clarendon Laboratory (UK)
Vakuumschmelze (Federal Republic of Germany)	
ENEA, Centro di Frascati (Italy)	
Universitat Nijmegen (the Netherlands)	
Clarendon Laboratory (United Kingdom)	
Rutherford Appleton Laboratory (United Kingdom)	
United States	
Brookhaven National Laboratory	Battelle Memorial Institute
Francis Bitter National Magnetic Laboratory	Brookhaven National Laboratory
Lawrence Livermore National Laboratory	NIST
NIST	
University of Wisconsin	
Japan	
Electrotechnical Laboratory	Center Research Institute for the Electric Power Industry
Furukawa Electric Company	Electrotechnical Laboratory
JAERI	JAERI
Hitachi	Jyushu University
Kobe Steel	Nihon University
NRIM	NRIM
Osaka University	Tohoku University
Tohoku University	
Toshiba	

what was happening was a contribution to global trade and did not lead to any kind of fortress Europe.

TABLE 3 Participants in the Round Robin Tests on Cryogenic Structural Materials

Tensile Measurement	Fracture Toughness Measurement
Europe	
Technische Universitat Wien (Austria)	KfK (Federal Republic of Germany)
KfK (Federal Republic of Germany)	
EMPA (Switzerland)	
Rutherford Appleton Laboratory (United Kingdom)	
United States	
Lawrence Livermore National Laboratory	NIST
Materials Research Engineering, Inc.	
NIST	
Teledyne Engineering Service	
Japan	
Hitachi	Hitachi
JAERI	Kobe Steel
Kawasaki Steel	NRIM
Kobe Steel	Tohoku University
Nippon Kokan	Toshiba
Nippon Steel	University of Tokyo
NRIM	
Tohoku University	
Toshiba	
University of Tokyo	

In this conference we have just crossed a bridge from research and development into standardization. As you heard from the chairman, I have worked on both ends of that bridge, and I crossed from research to standardization about seven years ago. To set the scene for this session on standardization, I would like to go back to the fundamental statement in the Treaty of Rome that started a good deal of what we are talking about today: "The European single market is 'an area without internal frontiers in which the free movement of goods, persons and capital is ensured.'"

That is the very simple objective set down in the Treaty of Rome a number of years ago. It was not addressed forcefully until about the mid-1980s, when it really began to receive attention. Of course, the achievement of that objective should be of great benefit to all the different nations

of Europe, but there has been great concern from other countries, that achieving it would, in fact, tend to isolate Europe from other trading partners around the world. Much of that concern has focused on the subject I have been asked to talk about: standards, testing, and certification.

Standards traditionally have been drawn up to help communication, to help reach technical agreement about design and production and delivery, but it is also a fact that countries around the world, including European countries, have used them as quite effective barriers to trade. The idea has been to harmonize standards and to reach arrangements for mutual recognition of testing and certification, so that those barriers would disappear between European countries. There was certainly no wish to create new barriers between European countries and other trading partners around the world. In fact, what is happening in Europe with regard to standardization, testing, and certification is aimed at breaking down national barriers and at moving increasingly toward international agreements.

European work starts with international agreements and adopts them whenever possible. If they are not in place, then we have to do some new work, and as soon as possible, that new work is fed into the international arena. All the time we are trying to break down national frontiers for the purposes of free and fair trade. It says nothing about competition. The more efficient company will still get the business; the higher-quality product is more likely to achieve its place in the market. But at least the common standards and the methods of testing and the arrangements for certification will, we hope, be harmonized as far as the European market is concerned. That is the target.

Two major policy declarations have sent us down this road, starting in 1985 with a "New Approach to Standardization and Technical Harmonization" and more recently with the 1989 policy declaration called a "Global Approach to Testing and Certification." This is very new and I will spend some time on it later; the policy is going to be developing quite rapidly during the current year.

The New Approach directives set out what are called essential requirements, written in general terms, relating to health, safety, or environmental matters, consumer protection, and so on—fundamental safety requirements where government has a legitimate interest. Those essential requirements are described in the New Approach directives in a very general way. There is no attempt, as happened in the past, to write all the technical requirements into the directives. It is fairly easy to change a technical standard, but it is quite difficult to change a legal instrument like a directive, so the New Approach directives set down very simple requirements, and the details are filled out with European standards.

Those European standards are voluntary documents, drawn up essentially by European industry and by their customers in the marketplace, through

the process of voluntary standardization. They provide guidance on the best way to meet the essential requirements. Anyone can choose other ways if they wish, but the best defense if you get into trouble is to show that you followed the European standards. Products that meet those requirements, as described in the European standards, will carry the CE mark, which simply means that the product meets the essential requirements, usually for safety, health, environment, consumer protection, set down in the directives. The CE mark enables the product to enter all the countries of the Community and indeed all the countries of EFTA. That is the simple basis on which the New Approach to directives has been designed.

I want to answer a question I am often asked and that is: We have national standards, we have international standards. Why do we need another level between, of European standards? Why is it necessary? Why should we have this regional standardization? The answer is perhaps the most important feature of what is going on. It is simply that by reaching certain agreements, which I will mention in a moment, the 12 countries of the Community and six countries of EFTA—a total of 18 countries in western Europe—have agreed to accept those standards as their national standards. Every country will withdraw its existing technical material and put those standards in place. If that document is already an international standard, we have 18 countries that accept it as a working document to support their trade. If the work is not in place internationally, then we shall have a new document that is in use in 18 countries and that will immediately be offered for international adoption. What we are doing here is really a very supportive action in relation to international standardization.

What is driving the approach to European standardization? The first driving force is the directives that result in what are called Commission mandates to the European standards organizations. A mandate is a Brussels' word for a work order. The Commission asks for a program of standardization to support each directive, and these come to the European standards bodies, are approved by the technical boards, and go into the program.

Second, there is an instrument called the Information Directive 1983, which is a way of capturing and recording all the national standards work that starts in Europe. The idea here is to intercept national work, and, if it is appropriate, see that it is done at the European level. It is another way of swinging the emphasis away from national technical activity into European or international technical activity. It is a declaration of national work with the possibility that it may be challenged and it may become European or even international.

We have heard a great deal about the need for new technologies to have their standardization support in place at an early stage. There was a good example yesterday of computer integrated manufacturing, where development could not proceed until there was agreement on standards. We heard

from another speaker today about how this is also applicable to new materials, so I will not go into that.

Another lever that is driving standardization is public procurement policy. Governments throughout Europe wish to make tendering public building and supplies more open. One way to make it more open is to base requirements for purchasing on European standards. This is creating a need for more standards, particularly in major utility areas and in transportation, telecommunications, and so on.

Finally, European industry itself is beginning to realize that there are benefits in having standards that are common throughout the Community and EFTA and is coming up with initiatives for standards work that industries would like to see undertaken. So there is quite a driving force behind the original catalytic action of the Community.

That is the scene at the moment—a high level of standardization in traditional sectors that are affected by the directives, by industry initiatives, and by public procurement and a small but growing involvement in the new technology areas, as this bridge from R&D into standards begins to become more significant and the deliverable standards from R&D begin to increase in number.

How does it all work? There are three major European standards bodies, CEN, CENELEC, and ETSI, a new body, created only a year or so ago, to bring together the national PTT organizations and their suppliers into a new European standards institute. The membership of CEN and CENELEC consists of the 12 Community countries and the six EFTA countries. Each national standards body belongs to CEN and each national electrotechnical committee belongs CENELEC. We have 18 national standards bodies forming CEN, and 18 national electrotechnical committees forming CENELEC; they correspond to ISO and IEC in the international arena.

I should explain the way these bodies work together in CEN and in CENELEC. There is a small central office in Brussels where permanent staff coordinate the work, but most of the work is done by the member bodies, which act as hosts for the various technical committees. BSI may take some committees, DIN in Germany, AFNOR in France, and so on. The principles are very important. First, we use international standards whenever possible; if we are unable to do that, as I have said before, the results of new work are fed immediately into the international arena. We accept standstill, which means that as soon as the European work starts, all national work must cease. That is a tough discipline, but it means all 18 countries have agreed to stop their own national work and give priority to the European work.

Next, the standards are agreed by weighted voting. The votes are weighted in the same way as votes taken on political matters, directives, and other decisions by the Council of Ministers, and there are rules about how many positive votes are needed to succeed and how many negative votes you need

to think again. There is no opportunity for any one country to exercise a veto, so you really do have to join in. If you are not in there playing the game, something might happen that you might disagree with, and the weighted voting makes it impossible to do very much about it until the amendment of the standard is due. The final obligation is that once the European document is agreed, all 18 countries must adopt it as a national standard.

These are tough disciplines, which do not apply generally to international work, but they do apply to this particular international work, and, as I said earlier, it does give very powerful support to the implementation of international standards.

Before I leave standardization, I would like to give you an indication of how the sheer volume of work has escalated following adoption of the New Approach. The number of technical committees in CEN, for example, has trebled since 1985. That number, approaching 200, is about the same number of technical committees that exist in ISO. European standardization has become a major activity, and, of course, those technical committees have many working groups and subcommittees. The number of staff in Brussels has doubled over the last couple of years. The number of work items has also increased dramatically: About 1,000 European standards have been published, and the target to meet the essential requirements part of the program is probably about 2,000 standards. There is a lot of work to be done in the next three years.

Now I turn to testing and certification, and here I must be very careful. This morning someone used the phrase "unknown and uncharted territory." That is certainly true of this area. It is a very recent decision of the Council of Ministers that we should have a global approach at the European level to testing and certification. We aim for a transparent, visible, and coherent approach to conformity assessment. Reaching agreement on standards is only one element of harmonization. However, if we all have different testing arrangements and different certification arrangements, we still have just as many barriers as before. There has to be a coherent approach.

That coherence will be based on some important documents. The EN 29000 series of standards describe the quality management systems that companies would normally expect to demonstrate to achieve acceptance; the EN 45000 series indicate the criteria that testing laboratories and certification bodies would normally aspire to. You can take it from me that any good company, any good testing laboratory, any good certification body will meet those criteria without any difficulty.

There is a proposal to establish a European Organization for Testing and Certification. That will happen later this year. The aim is to make it nonbureaucratic, a very light framework that brings together interested parties who have reached agreements or wish to reach agreements about mutual recognition in testing and certification. It is not a European governmental

body. It is a body that is there essentially to serve trade and industry. Of course, on the regulatory side a good deal will depend upon mutual recognition between the Community and non-Community countries.

How will non-Community countries have access to this framework? Everyone will face the same requirements whether they are European countries or non-European countries. In the regulated sectors, where directives apply—about 15 percent of the products used in the Community will be affected here—products will have to meet the essential requirements described in the European standards, and conformity assessment procedures will be geared to the particular product. In some cases the product may involve a very high safety requirement like a pressure vessel, in which case the conformity assessment procedure will be tougher. All products coming under directives will need to acquire the CE mark, and that will ensure mutual recognition across the Community.

In the unregulated sector the whole market should be much more open and accessible. Instead of each European country setting its own testing and certification requirements, there will be a clear understanding about what is required and what is acceptable in areas where the marketplace normally expects some demonstration of conformance, not for regulatory reasons but purely for market reasons. There will be mutual recognition of certification bodies that work to the same criteria, and, of course, certification gives access to the whole European economic space. I believe that represents good news for non-Community countries; our main concern is to avoid it becoming bureaucratic, to keep it simple, and to keep it open.

Before concluding, one final point about access to the standardization work. I know this is cause for concern. It has been discussed extensively over the past year, and we have agreed that non-Community countries that have legitimate interests in the European standardization work can have access at a number of points. Information is provided about new work items through a regular monthly document from CEN-CENELEC and also in the journals of each national standards body so that some intervention, some expression of interest, can be made by a non-Community country like America as soon as the new work item is announced. When the document reaches the first draft and is ready for public comment, comments are welcome from our trading partners, and, if it is appropriate, ad hoc meetings can be arranged with the technical committee to thrash out particular issues that present problems for international trade.

Of course, when the document is published, there is always an opportunity to suggest amendments or to take it through to the international work and assure that it comes out as a truly international document. That is the way we handle the new work. If the work is already available as an international standard, there are no difficulties. We all work together in ISO and IEC.

To conclude, we have reached a point where the program of directives is well under way. The program of standardization is up and running, although there is still some way to go, and the arrangements for mutual acceptance, testing, and certification are in their very early stages.

This meeting is very timely. There is still a great deal to be done and a great deal of experience we can share together. Behind it all, though, is the idea that industry should be driving this activity. The Commission has been the catalyst, the procedures I have described provide the mechanism, but the driving force should be industry in Europe and globally.

We believe that we can do it best on an international basis, and I join all the expressions of hope that this particular meeting can be repeated on some future occasion. We need effective liaison, some regular overseeing of how it is going, whether there are difficulties in implementation, whether there are actions we should be taking to make it better. It is a very open, international exercise. I am delighted to have had this opportunity to talk about it.

DR. AMBLER: Our next speaker, Joe Bhatia, is vice president for government affairs with the Underwriters' Laboratories. He has been with Underwriters' for the past 19 years. His background is in electrical engineering and industrial management. His responsibilities include working with Congress, government agencies, trade associations, and other organizations regarding Underwriters' programs, policies, and procedures. In his tenure at Underwriters' Laboratories, Mr. Bhatia has served in various capacities, including positions in the engineering department, assignments in research and technology development, and leading teams that conducted the feasibility studies of Underwriters' involvement in electromagnetic interference, telecommunications, fiber optics, and satellite, microwave, and cable transmission. He is a registered safety engineer and serves on various committees for ANSI, IEEE, and many others. He is a member of the Standards Engineering Society, the National Fire Protection Association, and the American Management Association.

MR. BHATIA: As I was listening to Dr. Dunstan's talk, I recognized that I do not have too much left to say. You covered the issue very nicely, and I felt that what I had hoped to cover, at least from the American perspective, was on target. I will try to address the impact of these developments in the EC on American industry, U.S. exporters and U.S. manufacturers. As you can guess, the entire issue of product design, standards, testing, certification, and approval mechanisms relative to the EC is full of technical and procedural complexities. I will try to clarify some of these.

For us, here in the United States, one thing is clear. Because of the EC activities, products will have to be researched, developed, designed, and manufactured in a certain way. They will have to be tested in a certain way; they will have to be certified in a certain way. And there is a new concept: Quality in the manufacturing site or plant will have to be demon

strated. What is decided by the EC is going to have a serious impact on U.S. industry, and for those of you who like statistics, let us take a look at some of them from our perspective.

The EC has 323 million consumers, about 50 percent larger than the U.S. market. The EC is the greatest bilateral trading partner of the United States, and has a combined output of goods and services of $4.5 trillion. I am sure that is more now than when I put the statistics together and that does not include the EFTA countries and the countries whose applications are pending. It does not include East Germany either. So we do have a major economic force to deal with.

What are the objectives of the EC? Obviously, the broader objectives are two: elimination of trade barriers so we have free movement of goods, services, and products and development of a single market, perhaps somewhat similar to the one that exists in the 50 U.S. states.

Focusing on our panel's interest, what are the objectives in the standards, testing, and certification area? Standards, testing, and certification are often described as technical barriers to trade, or nontariff barriers to trade, and the single most important EC objective in this area is elimination of these barriers by 1992, internally at least.

What is the situation at the present time? Right now, and of course in years past, exporters find it difficult to meet the requirements in each of the 12 member countries. There is no guarantee that products tested, certified, and imported in one nation will be accepted in the remaining 11, even if the standard is the same or similar. What are the advantages from the U.S. point of view? Certainly there are many; this has been said before, and I would like to echo the sentiment. It is much easier to produce to, design to, and manufacture to one set of standards. It is also much easier to get certification and approval to one set of certification criteria. Everyone gains by this process, not only the EC member manufacturers but also U.S. and other exporters.

I am sure you recognize that the impact of the EC in the economic sense is broader than the EC because CEN-CENELEC includes EFTA countries, as we saw. Of course, membership is restricted to those nations that are members of EFTA or the EC; others are not permitted to participate directly. What is the concern here? We already heard about ETSI; the same situation applies here. The concerns are openness of the process and transparency.

Transparency can be described in many ways. One definition is that all those who are materially affected by the process should have at least an opportunity to influence the process that will influence them. The concern of U.S. industry has been for a long time that there is no specific way for the United States to participate in the EC standards process. A lot of that concern has been overcome. The process is designed so that international

standards—IEC and ISO standards—are going to be the basis for European norm standards. The United States can and does participate in that process through the EC connections of those two groups, so the opportunity is there for us to influence the process indirectly and get our opinions considered.

Let us move on to the certification area. One basic goal of the EC is mutual acceptance of certification within the Community. Now, does that mean that acceptance will apply to the Americans who get certification in EC systems on the same basis as it applies for the Europeans? The answer, I think, is yes. Realistically it is not necessary, not practical, to have identical systems in the EC and the United States. What is perhaps more important is that we have access on the same basis and that we go through the same requirements and same conformity assessment procedures as those applied to the European manufacturers. So the major area of concern for the United States has been access, and I think we are moving in the right direction in that, and with the development of the EOTC, perhaps we will get further clarifications.

The key to all the certification procedures is contained in the directives; since Dr. Dunstan covered that, I will not spend too much time on it. I will tell you basically that since the Single European Act became effective in July of 1987 about 150 directives have been adopted and about another 130 are under consideration. Directives have been issued in some of the key areas where I know we have a lot of exporting activity from the United States, and there are many, many more.

Taking the issue of directives a step further, it is important to understand the distinction between essential requirements and standards. It is the key here, especially from your perspective. Directives, as they are designed, contain general requirements relating to health, safety, and environmental concerns and consumer protection. They are to be used in a way that allows more innovation, more introduction of new technology, because they do not hold a manufacturing community or an industry or a private individual to a specific way of designing the product. You do not have specific criteria that you must live with, you have either the option of going for the broad requirements and meeting the essential necessities or of going for specific standards that are developed through CEN and CENELEC, which operate under contract from the EC. This, I think, will introduce innovative practices and new technologies in an easier way. Obviously the burden of demonstrating equivalency rests with the industry or the manufacturer, but the opportunity is there, and that is a good development.

The most critical factor is determining compliance with the requirements, be they essential requirements contained in directives or specific standards issued by CEN and CENELEC. How does an American manufacturer do that? There are several ways of doing it, and a real innovative concept that perhaps is going to be more helpful than not is a process called declaration

of conformity. Under this process, permitted by several directives, manufacturers can declare conformity on their own.

How do they do that? They can use either the CEN or CENELEC standards, make sure that the performance criteria are met, do testing to evaluate that. Make sure the construction requirements are met, make sure the labeling and other general requirements are met, document that, and if everything proves to be acceptable, you can, on your own, declare conformity. Or you can use the essential requirements out of the directives, and use not only European norm standards but perhaps other standards—U.S. standards, other national standards—and demonstrate equivalency.

So you do have that declaration of conformity option, but before exercising that option, you must do one additional thing. The testing laboratory in which the data are created must be accredited to the EN 45000 series norms. These are basically good laboratory practice requirements, and they are used to assess the operations of testing laboratories and to accredit the laboratories, be they of notified bodies or of the manufacturer. The same criteria apply to both sectors. Additionally, the manufacturing plant must go through the quality assessment process, following the EN 29000 series norms adopted by the EC. So the manufacturer will have to demonstrate quality conformance in addition to complying with the EN 45000 good laboratory practice guide.

After that has been done, the individual company is able to apply the CE mark. A key point to note here is that for many product sectors the CE mark may not be adequate by itself. True, it is a passport to the European Community countries, but for those products for which third-party certification has traditionally been required, and where it has been mandated by the directive, the mark of the notified body or the other body involved in the testing and certification of that product may have to be applied.

What does it mean, than, this declaration of conformity path? Does it mean that the third parties will be bypassed? Does it mean that the notified body situation is going to deteriorate and NBs (notified bodies) will not be used? A logical answer is perhaps no, because there are many reasons that the third party or notified-body process will have to come into play. Certainly, manufacturers will be on safer grounds going through a third-party unbiased opinion and declaration based on that. There are certification procedures that exist right now, because until directives are adopted by the member states, you must live with the certification policies of the countries and, at least in the interim period, those procedures must be complied with.

Lastly, the CE mark may not be acceptable in all cases, as we mentioned. Some directives require involvement of notified bodies, quality assessment procedures, and factory inspections. Some validation of that has to take place, so use of NBs will still continue, at least in some capacity. I understand, and perhaps you can verify, that a separate directive on marks is

coming; I suspect it will be here before the year is out, but I am not sure. That would give us some further guidance on the labeling and marking of products.

Let me switch to another area of interest that is critical to United States industry. Here I use Underwriters' Laboratories as an example, but certainly we are not the only method by which this is done. If U.S.-based certifiers and testing agencies are not to be notified bodies—and it appears that way right now—another option is available—reciprocal agreements or subcontracting agreements with European-based testing labs and certifiers. It is understood, at least at this time, that the EC thinking right now is that these will be continued to be accepted. In regulated areas there will be requirements and criteria that will have to be met, and EC approval will be needed. But in nonregulated areas the subcontracting and bilateral agreements that exist or do get developed in the future will be accepted without EC review and control, and I think that is good news.

As developments go forward and the EOTC is developed and we understand what the participation criteria are for U.S. industry, both in regulated and nonregulated product sectors, I think we will have a much clearer picture. Hopefully, we will gain some of that understanding via our delegation that is planning to go there next week, so we will come back more educated.

Finally, I would like to conclude by saying that EC 1992 is a positive development, positive for Europeans and certainly positive for U.S. manufacturers if the guidelines and rules are properly developed and do not discriminate. Under the GATT agreements, certainly the opportunity is there for the process to be open to U.S. entities. For us it is an opportunity and a challenge. I hope we meet it.

DR. AMBLER: Our last speaker is Manuel Peralta. On January 1, 1989, Mr. Peralta was named president of the American National Standards Institute, a very central body in that it coordinates the voluntary standards system in the United States. Through that system, standards developers, users, and other interested parties come to a consensus resulting in the status of an American national standard. ANSI is the U.S. representative to the ISO and the IEC.

Previously, Mr. Peralta served as a senior executive in both government and industry, with the National Aeronautics and Space Administration and with Exxon. He has been a member of a number of boards of directors of several private organizations and has had extended assignments in the Netherlands, Spain, and England.

MR. PERALTA: I am certainly pleased to have the opportunity to talk about ANSI, EC 92, and the activities that are going on because they have tremendous significance to the United States and to the whole global marketplace. What I am going to try to focus on are (1) successes to date in the United States achieving access to the EC standards process, through the

vehicles of ISO and IEC, and (2) the work that still needs to be done in connection with standards, particularly with testing and certification. Finally, I will discuss the need for increased U.S. government and industry cooperation to strengthen our global competitiveness.

Before I expand on those three points, what I would like to do is set a backdrop, covering global economic developments, the changing role of standardization technology, particularly its increasing significance in a global economy, and, finally, the global challenges that face the international standardization community. I think that provides a very important perspective as we look at what is going on in connection with EC 92.

For a number of decades the United States produced about 40 percent of the world's worth with 5 percent of the world's population. Our products were the most technologically advanced and were accepted as being of the highest quality. The enormous technological and economic advantages that the United States enjoyed have changed with the emergence of the global economy. In 1987 the U.S. share of the world GNP was 26 percent; it has been at that level since the 1970s. The EC is at 22 percent, Japan at 9 percent, and Russia at 14 percent. Significantly, the U.S. position in today's global economy is best characterized as the first among equals.

Today, the imperatives that we face include expanding global markets, increasing worldwide competition, and rapid technological changes. Underscoring these imperatives is Europe's rapid movement to integrate its markets by 1992. The Community's efforts to remove its many internal barriers that impede the movement of goods and services is a positive development that will present both opportunities and challenges.

In a global marketplace, standardization technology represents a key link between products and services and the customer in the marketplace. Standards set the minimum acceptable criteria for goods and services and capital flow into the marketplace. Standards impact productivity, economies of scale, and pace of product development. Standards represent a technological asset that can facilitate or hinder marketplace competitiveness.

At one time standards lagged significantly behind R&D, but this has changed, particularly in the area of high technology. One example is in the joint ISO and IEC technical committee regarding information technology, JTC-1. The experience with JTC-1 has become the model for the development of international standards. It is able to produce standards in about half the time of the typical ISO and IEC committees.

Let me now turn to the challenges we face in the international standards community; there are four. The first is managing change effectively. The rapid pace of technological development, intense competition, and increased global markets, which I discussed earlier, are causing unparalleled change within the international standards community. Managing this change effectively will require creative leadership and a tolerance for complexity.

The second item is maintaining system balance. This requires managing expectations and perceptions at a strategic level, to ensure that transition into the future occurs in a way that does not result in any one political entity dominating the system to its own advantage. I will come back and say more about that with regard to ISO and IEC voting.

The third item is achieving technological transfer. This means timely development of standards to meet the needs of the global marketplace. Overall, development and application of global standards need to be accelerated through the use of more modern management approaches.

The fourth item is pursuing innovation. It is innovation that minimized the inertia to change and the inclination toward risk-avoiding status quo, and it is up to the leadership of the standards community to cultivate an environment of innovation and a collective sense of purpose. Dealing with these challenges successfully means a bottom line of contributing to a global market that is expanding; everyone is gaining from the prosperity that is associated with it.

Let us now talk about the points I wanted to get into from a specific perspective, starting with access to the European standardization activities. There are really three approaches by which the United States has access to the activities in Europe. The first approach is that of using the vehicle of ISO and IEC—the international forum. The second is by commenting directly on CEN and CENELEC work plans, drafts, and so on. The third is having ad hoc meetings where there is a mutual interest.

Participation in ISO and IEC is a key to U.S. interest and influence in EC standards activities. The EC has charged the European private sector standards bodies, CEN and CENELEC, with coordinating standards within the European Community itself. In turn, CEN and CENELEC are looking to ISO and IEC standards, except in areas where they cannot be made available on a timely basis. Thus, through ANSI's membership in ISO and IEC, the United States has a significant opportunity to influence standards development in the EC.

The ANSI federation's membership in ISO and IEC provides the umbrella for the United States to play an effective role in international standards development. Through the efforts of the institute's members, the United States holds some of the most important ISO and IEC standards secretariats. Since the 1970s the U.S. leadership position in terms of administration of secretariats has increased significantly in both the ISO and the IEC. In addition, the United States holds secretariats in many of the most economically significant sectors, as well as having some of the most productive secretariats.

Certainly, with the growing significance of international standards it is increasingly important that the United States maintain a high level of interest and involvement in the activities of the ISO and the IEC. It is important

that ANSI communicate the needs to the private sector to become active participants in that process. Over the past year, improved access for U.S. industry to European standards activities has been achieved following U.S. and EC government contacts and through direct private sector meetings between CEN and CENELEC and a U.S. delegation under the auspices of ANSI. The meeting took place in July 1989 and was a major step in improving communication between the private sectors and in resolving some of the areas of mutual concern.

In addition, liaison agreements between ISO and CEN and IEC and CENELEC were established in 1989, incorporating a proposal advanced through ANSI and forwarded to ISO and IEC for increased transparency. The agreements established served to strengthen the flow of information between the European standardization organizations and ISO-IEC as well as the non-European member bodies such as ANSI. The agreements covered the mechanisms for monitoring and coordinating technical activities; for providing effective information flow, including details on work plans, future projects, target dates, and work in progress; and, finally, drafts on standards for voting. The ANSI federation is actively working to inform U.S. groups with a material interest about the access agreements and is seeking to test the effectiveness of the implementation.

As a long-time player in international standards activities, ANSI feels that the EC 92 efforts of the Community should not be viewed as fortress Europe, but neither should the will of the European Community be underestimated. We advise active involvement and monitoring in the ongoing standards and certification work; to quote some other people, it is not a spectator sport. During 1989 ANSI launched a special EC 92 information campaign to provide U.S. interests with the background necessary to effectively compete in a changing global marketplace and to ensure greater access to timely information and improved coordination with the EC. A cornerstone of that effort was the establishment in August 1989 of the ANSI Brussels office, the center of the European Commission's activities.

ANSI provides updates and special bulletins from the Brussels office on recent standardization activities of CEN and CENELEC. Special bulletins were issued in September 1989 and January 1990 to ANSI members, bulletins that are very important for anyone interested in EC 92 standardization issues; they are available through ANSI offices. For those of you who have not seen it, the January bulletin provides information on how to use the existing mechanisms, defines the existing mechanisms, and provides examples of case studies that have occurred over the past several years in dealing with the standardization issues. I think it is a very informative document.

As I already noted, ANSI is working to keep the U.S. voluntary standards community better informed on access agreements that have been ne

gotiated between ISO and CEN and between IEC and CENELEC. In addition, to convey the latest EC information to the American standards community, the theme of this year's ANSI public conference is Standardization in the 1990s: Success in the Global Market; it will feature presentations by several European and American standardization leaders and trade experts. The focus of the meeting will be on challenges, seizing and creating opportunities and overcoming obstacles facing U.S. industry in light of EC 92 developments.

Now that we have achieved a mechanism for access to European standardization developments, we must inform and encourage U.S. industry to fully participate in the process and ensure its further development. To advance U.S. comments on European and regional standardization activities, our current focus is on communicating the CEN and CENELEC agreements to the private sector and monitoring the agreements to be sure that their intended purpose is being achieved. In addition, ANSI is also advancing a proposal within ISO and IEC to examine voting and funding relevancy, to ensure that ISO and IEC activities remain a viable forum for the expression of U.S. interests in light of global and EC 92 developments.

Another area continuing to be pursued is testing and certification. The Institute's board has undertaken a special effort to develop mechanisms through which the United States can achieve mutual recognition and gain equal access to European certification and testing activities. To that end a special ANSI board committee on testing and certification was established last year, and at the private sector meeting in Brussels in July, CEN and CENELEC clarified Europe's global approach to certification and testing. While the specifics are still evolving, there was no indication that imported products would be structurally prevented from equal access to European markets.

Moreover, we are very pleased that in the Council of Ministers' resolution dated January 21, 1989, the EC appears to modify a hard-line position taken earlier regarding testing and certification. We are hopeful of a Council decision that would have the effect of allowing non-European private sector organizations to negotiate the acceptance of their testing and certification by European notified bodies, as long as the European notified body maintained the legal responsibility for that certification.

Also, to build on the progress achieved at the July 1989 meeting in Brussels, follow-up meetings between CEN and CENELEC and the U.S. delegation under the auspices of ANSI will be held on March 12. 1990, in Brussels and on March 27, 1990, in Washington, D.C. The United States has the opportunity to more effectively influence the outcome of Europe's decisions on standards, testing, and certification if the government and private sector work more closely together. In fact, a 1988 Harvard Business School study noted that one phenomenon that marked the global economy

of the 1980s was the extraordinary performance by countries whose national strategies are characterized by business and government cooperation.

Along these lines, ANSI's board has proposed to the U.S. Department of Commerce the establishment of a national partnership. The proposal calls for a private-public sector partnership that would foster better coordination and communication between government and the private sector in addressing the international challenges confronting the United States. As envisioned, the partnership would be based on maintaining existing roles and responsibilities and would be driven by the recognition that better cooperation is essential to the overall competitiveness of the U.S. efforts, for example, in dealing with the standardization issues related to EC 92.

Certainly, the United States does not need a new structure, as suggested by a recently floated NIST proposal to establish the Standards Council of the United States of America. For 70 years the private sector administration of the voluntary standards system has effectively served U.S. needs and it continues to do so. To quote James Pearse, chairman of ANSI and group vice president for engineering at Leviton, "We are advocating more cooperation rather than more government." We are advocating a partnership rather than intervention. We seek a public-private sector partnership built on the strengths of the free enterprise system and not driven by government subsidies or market distortions.

At this point, let me briefly summarize three points. First, the United States has achieved much over the past year, including better access to the European regional standardization activities. We must now test the access and follow up to ensure the intended objectives are being achieved. Second, there is more work that needs to be done with regard to voting and funding relevancy in ISO and IEC and with regard to equal access and mutual recognition in testing and certification. These represent areas of specific focus for the ANSI federation in 1990. Finally, the ANSI federation stands ready to work in a productive, cooperative partnership with the Commerce Department and other government bodies to enhance the global competitive position of the United States through standardization technology.

In closing, I would like to parallel some other comments I have made in similar talks. We are in a period of profound change and opportunity. The ANSI federation has a major task and challenge in front of it. The U.S. voluntary system has demonstrated in the past its ability to successfully respond to the challenge, and it will continue to do so in the future.

MR. BYRD: Gary Byrd, consulting engineer. I have spent most of my career in the field of transportation. In our field it has been the observation in the recent past that industry's investment in R&D has diminished rapidly over the years as standards and specifications have become more rigid. One alternative that has been looked at and holds promise, we believe, is the use of performance standards rather than specific identification of materials and

processes. I am simply interested in whether our panel members are looking at that as a future opportunity as well.

DR. DUNSTAN: Yes, performance standards are certainly an ideal solution for the sort of problem you have described. The normal description of a product in terms of prescriptive requirements does tie down design, especially with regard to dimensions and similar parameters. But it is very difficult to write performance standards. The building industry, which I know well, does quite a good job on things like fire testing and so on, but it is always difficult to simulate real-life performance in the laboratory. It is very difficult to write that into a test schedule that can be followed cheaply and economically and in a reasonable time. I agree with you; ideally we should be aiming for performance criteria; practically, it is quite difficult to achieve them, and we have not enjoyed too much success so far. Maybe it is another topic for R&D in its support of standardization.

DR. BHATIA: I would like to echo Dr. Dunstan's view. Underwriters' Laboratories, like many other organizations, writes standards that contain both performance criteria and what we call construction criteria. It is almost impossible to write strictly a performance document, because the real issue, whenever a standard is used, is a minimum and consistent level of performance, be it quality, safety, or whatever, and you cannot very easily achieve a comparable level of equivalency demonstration strictly on performance criteria. The tendency for us is to go more and more toward performance standards because they do allow better, more innovative design to be introduced. Certainly if you do not have the limitations placed on your design by construction or materials requirements, it would be easier to create and introduce into commerce new types of products, but the limitations have to be practically considered. You have to be fair in your assessment of different systems so that certain minimum criteria are met consistently.

MR. DOYLE: Jack Doyle, IEEE. It has been stated several times here that the Europeans are going to—"wherever possible" I think is the line that was used—settle on the international standard if there is one. Yet in one area that I am familiar with, the telecommunications area, we are already seeing some European Community standards being set up that differ from the CCITT standards, which have normally been the international standards. My question is, is there or should there not be some kind of an appeals process where the Europeans are choosing to or wish to select a standard different from the international community standard, so that the rest of the world has some opportunity to negotiate and try to get a world standard?

DR. AMBLER: Are you speaking specifically about telecommunications standards?

MR. DOYLE: No, I am using that merely as an example, where already it appears that they are adopting standards different from the world standard. But this would apply, I think, to almost any standard.

DR. DUNSTAN: I believe the questioner is right. If there is a departure from the international standard in the regional work, then at the very least there should be an explanation, and that should be given by the regional committee to the international committee. The channels that Manny Peralta talked about make provision for that. There are very close technical cooperation links between CEN and ISO, CENELEC and IEC, and of course between ETSI and CCITT. So if they go in different directions for some reason, those channels are the right ways to exchange views and find out why.

There is usually some reason, and the reason is not fortress Europe. There are many reasons why there may be some slight departure or some narrowing of options and so on. But always there should be, I believe, explanation and discussion, which I think you could class as an appeal.

MR. PERALTA: The only thing I would add to Ivan's comment, is that ANSI is not involved in the CCITT aspect of international standards; that is a treaty organization. But certainly from the viewpoint of the nontreaty organization relationships, the mechanisms that are in place we see working, and in fact there are several examples where issues have been identified at the technical levels, in terms of the activities that either CEN and CENELEC was involved in or planning to be involved in. Meetings to arrange communications with U.S. counterparts were arranged, and I think a productive resolution resulted on those issues.

What we are interested in is not only those issues but also whether there are any other examples of issues that need work. That is part of the system that is in place. As I tried to indicate, while we feel we have a reasonable access mechanism through ISO and IEC, there may be a need to modify the system if it is not working properly. We are looking for as much input and information as we can from the U.S. standards community and activities, so that we can follow up and, if appropriate, change the system and strengthen it.

DR. AMBLER: Was there any implication in your question that, for example, with respect to telecommunications standards, U.S. interests did not get a chance to participate?

MR. DOYLE: Well, sometimes in these areas, paranoia comes early and easily. I think the answer has to be, at least in my case, yes.

DR. AMBLER: The open systems interconnect, for example.

MR. DOYLE: Yes. In other words, it is sometimes very difficult to say that a standard is being adopted merely because it is the best for the EC and not at the same time saying that it discriminates against the rest of the world. These are simple things that can occur on both sides, so I am only saying that where we differ or where they differ from the world standard, you would hope that at least there would be a chance for everybody to have their say and agree.

MR. MEYER: Jim Meyer, Eastman Kodak. Several of the speakers have spoken of indirect pathways into influencing the European standards-setting process. Do U.S.-owned European subsidiaries have a more direct link into CEN and CENELEC?

DR. DUNSTAN: That is a very important point. Certainly, U.S.-owned companies with subsidiaries or partners working in European countries have a very direct link into the various national committees where opinions are formed, and it is those opinions that come together at the European level. Multinational companies can be among the most active constituents in European standardization. Their views can influence the national delegations, which come together to agree on European standards. So they do have a rather direct route, and both Manny and I forgot to mention that in our presentations. Thank you for raising it.

Strategic Implications of European Market Integration for U.S. R&D-Intensive Industry and the Science and Technology Base

MR. NILES: I am the ambassador to the U.S. mission to the European Communities in Brussels. I am basically here as the introducer. I will not have separate remarks on the substantive issues since I am not an expert on science and technology. Also, I have been in Brussels for only eight months, and I still have much to learn there.

Our first speaker is John McTague, vice president of technical affairs for Ford Motor Company. Born in Jersey City in 1938, Mr. McTague is a graduate of Brown University. He worked with North American Rockwell in Los Angeles from 1964 to 1970, was on the faculty of University of California at Los Angeles, and is a member of the Institute of Geophysics and Planetary Physics. John joined Ford in 1986 and was elected vice president effective the first of March 1990. So John has been on the job now for five days, and we expect him to be a great expert in all things having to do with Ford and automobiles.

DR. MCTAGUE: Many of us here are in the business of the future. Certainly our researchers in microelectronics will confidently predict to you that the density of memories will increase by a certain fraction or certain multiple over the next five years and that the speed of devices will go up by an order of magnitude in 2.5 years or 2.3 years or whatever it is, and the cost per unit computation will drop by an order of magnitude in x years. What they say is almost certainly correct. Politicians will predict that the laws of physics and chemistry will allow unknown technology to increase the effectiveness of automotive catalysts from about 96 percent to 99 percent in a few years, and I hope they are correct. If the present laws of physics and chemistry will not do the trick, why, politicians can always amend them.

The complex political, economic, and technical environment that we are

discussing today I think normally should lead us to a little humility about predicting the future. Probably a year or so ago I would have stated something to that effect. However, some other more monumental things have introduced a new scale of humility. At the beginning of this year, I happened to be away on vacation with my family in a remote area of the world where we did not have access to radio or telephone or television. For the period of 10 days that we were out of contact, there was a revolution in Rumania, Nicolai Ceaucescu literally lost his head, and Manuel Noriega was turned over to the U.S. forces in Panama.

Things are changing extremely rapidly. Most recently, of course, there was an election in Nicaragua for which, to my knowledge, only a single expert predicted the proper result, at least in public. We are all watching with absolute amazement what is going on in the eastern part of Europe right now, and I am sure a lot of people in the government in the Soviet Union are wondering what is happening in the elections, particularly in Moscow and Leningrad.

What this should tell us is that we should be rather humble about trying to predict the future a few years from now. It also tells us that we cannot look at any one event in isolation. They are all connected. That also goes for the Single Market in the EC. The environment elsewhere in the world—the most obvious example being eastern Europe—may change any predictions that we might make. It is clear that one thing is true though: Events are changing faster than institutions, in particular large institutions like governments, can anticipate or respond. The institutions are trying to catch up, as opposed to trying to lead. I think that is also true in the case of a European Single Market. That being as it may, however, if you look at the situation of the Single Market, compared to the scale of some of these other things that are happening today, it looks a little more tractable with regard to predicting the future, and the rate of change seems relatively tame all of a sudden.

What I am going to talk about today is the experience of large U.S.-based companies. It may not apply universally to smaller companies. Most very large U.S.-based companies certainly have been solid components of Europe for a rather long time. Obvious examples are Ford—which has been in Europe since 1903 and is the company I happen to know best, so I will talk a fair amount about it—and IBM. What we will be talking about relative to what is going on today and in the near future has to do with the change of pace, not a revolution. It is not primarily motivated by the European structural change that is occurring; rather, from our perspective, both our change and the structural change in Europe are driven by common forces.

Let me step back a few years to 1903. Ford was founded in 1903 with 10 people and made its first sale in Europe, actually in Britain, in the same year. Since then it has evolved rather substantially. In 1911 the first

assembly plant was opened in Europe, assembling kits of cars whose components had been put together in the United States and that were U.S.-designed cars, the same cars that were sold here. In 1921 we established our first R&D facility in Europe; it was in Britain. In the late 1920s we had factories not only in Britain but also in Ireland, Germany, and, by the way, Japan. However, they were building U.S.-designed cars. It was not until the late 1920s that Ford made its first design for Europe, but it was designed in Dearborn, specifically for Europe and built in Europe. In the 1930s, however, despite regulations coming from headquarters, a group in Europe bootlegged a design of a European car, and in 1936, I believe it was, the first completely European Ford was manufactured in Europe.

In those days, because of the difficulties of transportation of goods and of communication, Ford of Britain and Ford of Germany—which had become quite large by them—basically operated as stand-alone units, each separate from the other and separate from the United States, designing and building different cars and communicating as little as possible with corporate headquarters.

However, as times have changed, as the ease of communication has increased, and as the cost of transportation has dropped to historic lows, there has naturally been an increase in the scale of the coherent unit. In Europe that started for us in 1967, when Henry Ford II decreed that there would no longer be a Ford of Britain, a Ford of Germany, a Ford of France, etc.; instead there would be one Ford of Europe. It would have a common design team, common engineering, and completely integrated manufacturing. That has occurred over time. In fact, now on the design of a vehicle in Europe, the design team, the engineering team might come half from Cologne, half from England; they literally fly back and forth on a day-to-day basis, work together, and then go home at night in their own respective countries. Ford Europe is completely integrated, and it has been a large part of the market for some time. For example, in Britain we are by a substantial amount the largest producer of automobiles.

Since that time, of course, communication has increased even more rapidly, and we are now, have been for about five years, in a completely globalized phase. Engineering teams from around the world work together on common cars; most of the vehicles that will start coming out in the next few years will be globally based in design, although they will be differentiated for local markets. So we are essentially a global company now. We are global not only in the sense of our own situation, but also because the pace of change is so rapid nowadays, and the knowledge and resource base are too much to be self-contained. Even in a company as large as Ford, which is the second largest industrial company in the world, we have had to take other actions, and those include very close associations with people who in fact are our competitors.

In Japan we have very close associations with Mazda and Nissan. We

own 25 percent of Mazda, for example, and jointly develop vehicles with them, sometimes them manufacturing them and sometimes us manufacturing them. In Korea we have an association and a partial ownership with Kia; in South America the manufacturing and development operations of Volkswagen and Ford have been completely combined in a joint venture called Auto Latina, which has 56 percent of the Brazilian market. We do joint development and joint production but sell our own vehicles. In Europe for several years we have had a joint venture with Ivecco, which is a Fiat entity, where we jointly design and produce heavy trucks. And we are forming closer associations in Europe with Volkswagen.

These integrations are being done, as I said, because the scales have changed: The natural size of the unit to be competitive in this business has changed, and the amount of knowledge and the resource base that one needs have changed, and the ease of moving things around globally has changed. So we are essentially completely integrated. What we see occurring in Europe is a natural evolution. I think you can get an idea of that evolution from Figure 3.

If you look at the population of the world on the left side, the population of the United States is rather small; add to it the population of the EC, you get something like 11 percent of the world's population, then the population of Japan, and then there is everybody else. These three entities are rather small in terms of population, but if you look at them in terms of gross national products, or what I call world products, you see a different picture. The GNP of the United States and the GNP of the EC are reasonably similar; the GNP of Japan is smaller. What is more important for most industrial corporations, and indeed for R&D, because civilian R&D is closely tied to it, is manufacturing production. If you look at manufacturing, in fact the world looks like it is naturally divided up into three supercountries, the United States with about a third of the manufacturing, the European Community with almost an identical amount, and Japan with a slightly lesser but rapidly growing amount.

It looks like the natural scale for manufacturing has basically resulted in an evolution of the European Community, in order that there be essentially equivalent competition. Now this looks similar, and you might say, well, the European Community is the European Community. However, if you look internally there are some very significant differences. In the United States, for example, about 22.5 percent of GNP is manufacturing and it has been forever. That is also true of almost all the major EC countries, with the exception of Germany, where manufacturing is more than a third of GNP. That means exports; manufacturing exports much more easily than services. Likewise, in Japan, manufacturing is about a third of GNP.

So even though an integration of the European market is coming, the different emphases on manufacturing in the various EC countries will probably

continue. However, from the point of view of a large corporation, the Single Market is just a natural evolution that we have been responding to due to the greatly changed environment relative to communications and the cost of transportation.

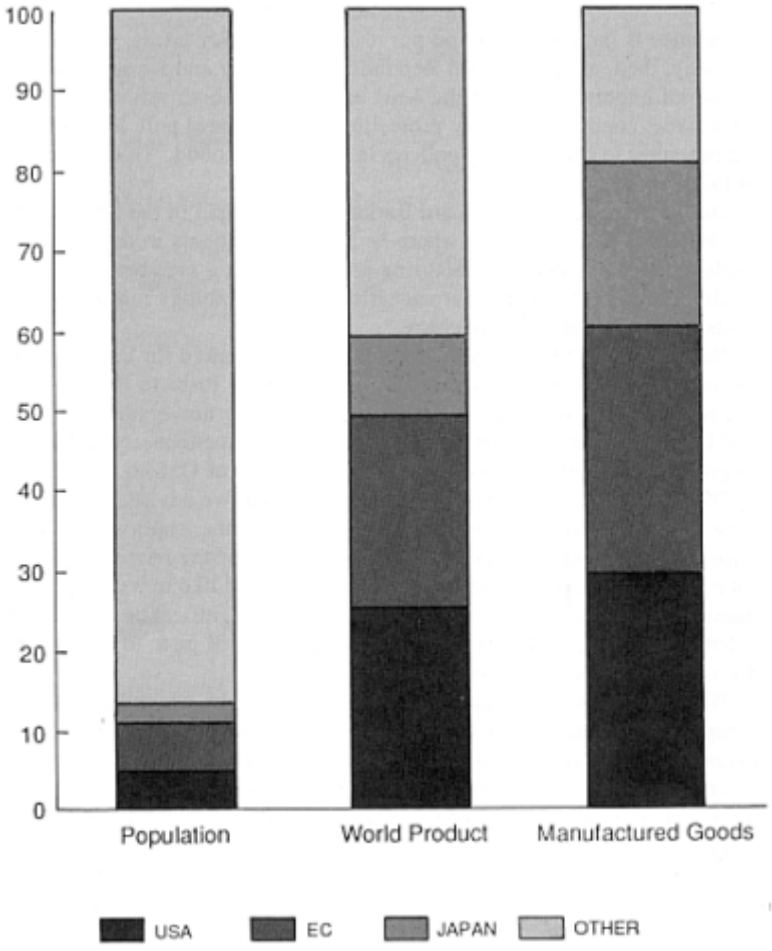

Figure 3 U.S., EC, and Japanese Share of World Population, World Product, and World Manufactured Goods (in percent).

MR. NILES: The point Mr. McTague made about the Federal Republic of Germany and Japan and the role of manufactured goods in those two

economies is interesting. If you put it in public policy terms, you ask yourself why, then, are the Federal Republic of Germany and Japan, those major industrial exporters, among the least enthusiastic about reforming agricultural trade, conducting highly protectionist agricultural policies, and resisting pressures to change those policies in the GATT Round. That is something to think about.

Our next speaker, Dr. Richard Barker, is a principal in the London office of McKinsey and Company, where he focuses on clients in the pharmaceuticals, chemicals, and manufacturing sectors. He is a member of the firm's worldwide core groups in pharmaceuticals and technology management and leads its practice in biotechnology.

Before joining McKinsey in 1980, Dr. Barker worked for Esso Petroleum in supply, planning, and operations management. Prior to this he carried our research in biochemistry and biophysics at the universities of Munich and Leeds, having received his bachelor's degree in chemistry and a doctor of philosophy in biochemistry from the University of Oxford.

DR. BARKER: Our clients, the companies that we advise, force us from time to time to think the unthinkable, to project the implications of very imponderable trends and events. The emergence of the new Europe is just such a trend—and 1992 just such an event. I would like to try to tackle two questions about the new Europe: What is its significance strategically? What are the major challenges that these events will pose to companies in research-intensive industries?

We work with many companies in industries in which the long-term competitive position of a company is clearly hinged upon high up-front investments in R&D to maintain this dynamic of innovation. Let me first review the past European realities for such businesses. The pattern is very familiar to most of you: a past that is characterized by national protectionism to some extent, market fragmentation certainly, and a vital erosion, I believe, of global competitiveness of European high-technology companies.

The motivations behind this explicit and implicit protectionism are in many ways laudable: the enhancement of national research and innovational power, the requirements for national sovereignty or autonomy, protection of employment, prestige, and so forth. Of course, what it led to was the dominance in each European country of a small number of national suppliers, to uncompetitively high prices for some products compared with truly international competitors, and reduced innovation flow. The industries in which this pattern has been most prevalent are a function of how much capability and desire there is to protect them nationally and how much R&D investment there is to protect. The aerospace industry is clearly one that has figured prominently, particularly as it relates to defense. We see it also in telecommunications (e.g., public switches), pharmaceuticals, and so on.

The mechanisms for achieving it, consciously or unconsciously, include

public procurement policies, legislation, technical standards, and public funding of research. Each in different ways has been used in the industries that we are thinking about here, but we have learned already in this conference of major changes on each of these fronts.

The consequence of protectionism, of course, has been the domination of national markets by leading national competitors, in public switches, pharmaceuticals, and clearly also some of the aerospace markets. This, of course, causes those European companies and industries to be technologically uncompetitive only if the critical mass of R&D investment internationally cannot be supported by their national markets. But clearly—for even the largest European countries—we are well past that stage in aerospace and, increasingly, as we read in the press, we are past that stage in pharmaceutical, as the R&D "competitive mass" increases.

Cost competitiveness of those industries is also seriously affected. In telecommunications, for example, if we draw an experience curve (meaning economies of scale) by plotting price per line versus the number of lines produced per year, we see that those operating within only a small national market cannot be as competitive as a Northern Telecom or any supplier that is serving a large international market.

It has also led to some lag in the development of innovative products. In PBXs, we see an increasing lag between the major European competitors and their U.S. counterparts in developing new generations of equipment. This clearly cannot be allowed to continue. It results in an uneven set of unnecessarily high prices for some of these products across the European countries. Many of you will have been struck by the variation in price, for example, in leading pharmaceutical products across European markets.

So what about the 1992 proposals? I will skip very quickly through this because it is now familiar ground. The technology-intensive industries have been fairly intensive targets for EC regulations and directives. Those measures will tackle the policies on procurement, registration, and technical standards that have given us the pattern of the past. What we will see, as in the particular case of telecommunications equipment, is a phased process that frees up large chunks of the market, which will be available not only for a wider range of European competitors but for people in this room also.

There has been much analysis along these lines of the "cost of non-Europe," which some of you will have seen in the very voluminous documents produced at the time of the original 1992 legislation. But in addition to the cost of non-Europe, there will also be a "cost of Europe," because clearly we cannot achieve a more concentrated and consolidated European industry without a certain amount of pain. We already have reached the phase of "work sharing" between national aerospace companies, the formation of consortia in much the same way as in Mr. McTague's references to international alliances in the automobile industry. We will continue to see

the formation of such alliances, and some of those are bound to cross the Atlantic as well as be European based. We will see them most where there is the greatest pressure on contribution margins of the industry and the greatest scope for consolidation. We have already seen quite a flurry of consolidation in pharmaceuticals so far in the United States; I believe it will extend into Europe in a much more significant way, as pressures on margins intensify.

So one then has to consider how large an industry structure the new Single European Market will support. If we think here of public telecom switches, you can do calculations that persuade you there is only room for three or perhaps four major public switch manufacturers in Europe.

As U.S. companies such as yourselves think about your European counterparts, obviously you have to consider whether they are going to be future leaders of the global industry, potential partners that could provide you with European infrastructure or specific valuable sources of technology. Overall, there are many hundreds of companies, even in fairly technology-intensive and traditionally profitable industries, that have to worry about their future a great deal. So this is something of the "cost of Europe," to consider alongside the cost of non-Europe.

We have spoken so far of "Europe" without defining it. I would assert that you have to distinguish at least three Europes coming into being at different speeds: Europe as a technology source, Europe as a competitive arena, and Europe as a group of customers. It is always a mistake, of course, to think about it as a single place. I believe we will see technology concentrating in certain centers, centers that get funds from the EC, centers that companies themselves set up to be the European focus. We will see consolidated competitors: ABB Asea Brown Boveri is simply the first major *European* (as opposed to nationally rooted) company. However, we may not see Euro-consumers emerging at anything like the rate that some people imagine. Certainly, companies in industrial markets, because of the economic pressure on them, will soon become less nationalistic in their purchasing policies, but I do not think there is any EC directive that can deal with the psychological barriers that you see between different groups of European consumers.

At this point I want to stress that when we think about Europe in the late 1990s, the 1992 event and everything associated with it must be considered alongside the opening of the eastern European frontiers. This second major discontinuity is bound to some extent to distract the German companies to look eastward for markets and partners, and many other European companies will do the same. A major redeployment of defense resources, with its implications for the R&D infrastructure of the defense industry, is bound to take place progressively over the 1990s. We already see people changing

their defense procurement policies and funding decisions in a matter of weeks and months following the events we all marveled at last year.

The globalization of Far East competitors is another factor. You have to project what the Japanese companies are planning to do; many of them have made some European moves in these industries already. Environmental pressures will also be at least as important for many chemical companies in the 1990s as will 1992, so will health care cost containment for companies based on pharmaceuticals or biotechnology. One could go on; I just want to encourage us all to think about how these trends may interact before launching into a 1992 strategy that simply adds up *today's* European markets and European competitors and treats them as a measure of the future Single Market.

What are the challenges that Europe in the 1990s will represent for companies, and how should they think about responding? Making alliances is one widely canvassed response. Companies that have, for example, only a foothold in Europe and need to extend across it and American companies that want to establish a stronger network there are obvious candidates for such alliances. As Mr. McTague reminded us, neither transatlantic nor transpacific alliances are new. Neither is easy to forge because of the different business psychologies as well as technical specifications that the prospective partners may have. They are certainly difficult to manage, and arguably one has to plan how to exit such an alliance, if it proves unmanageable, just as deliberately and rigorously as how to enter it.

A second challenge in responding to the new Europe is designing and phasing in European company *structures*. It is not going to be possible in a single bound to form a Euro-company structure. In many cases it will take a matter of decades to put this in place. Indeed, more important than formal structures are informal networks—networks between technical people, between manufacturing people, between marketing people. Such networks may have no line authority but can be very effective in coordinating policy and action and, of course, in developing Euro-managers.

What I want to close on are some of these broad organizational consequences of future European companies. This thinking is often uncomfortable for us, since many of us are technologists in background and so would rather think about future technology or the strategy that might follow from this technology. However, because they can constrain technology, strategy, and operations, the organizations of future European companies have to be examined from first principles. You cannot transplant a successful structure, or even an empirical model, of how to run a company from U.S. experience across Europe—at least not yet; maybe you never can. You certainly will not be able to over the 1990s, so you have to work on a whole range of different levers and characteristics of the organization in order to make the future European company work. You certainly need to develop Euro-managers, and I believe many American companies will find this to be the most constraining

feature of their moves into Europe—developing a cadre of Euro-managers who speak the languages, who know the people, who appreciate both the differences and the similarities, and who can thus operate right across Europe. Today such people are truly rare.

In conclusion I want to emphasize that although technology is becoming increasingly global and markets and businesses are converging, developing effective European organization may be the rate-limiting step. As usual, it is the soft stuff that is going to be the hardest to manage.

MR. NILES: The point you make about the difficulties of merging across national borders in Europe is an interesting one—at least I think that is one you were making. I am reminded of the recent unsuccessful effort to merge a big bank in Belgium with a big bank in the Netherlands. You would think that might not be too difficult, particularly since they fit rather well in financial terms and in terms of the way their operations were structured in each country. But after about six months they abandoned the effort because they could not get together culturally. We have seen quite a few experiences such as that in Europe.

One of the things that has struck me in my eight months in Brussels is the fact that the real European companies in Europe are the American companies—or non-European companies; they could very well be from other parts of the world—companies such as the Ford Motor Company. Ford has been in Europe since 1903 and does not think of itself as being a national champion of the United Kingdom, Germany, Spain, or any other market. It has structured its operations with the European market in mind. Other American companies and non-European companies have done the same thing, and I think by and large they are better prepared to deal with the uncertainties and the tremendous changes ahead than many of the national champions in Europe such as the Siemens or the Fiats, which have thought of themselves primarily as German, Italian, or French companies.

There is a shakeout ahead in Europe, I think, particularly in the area of manufacturing, that one hopes occurs at a time when the European economies are sufficiently buoyant to absorb the workers who will no longer be making automobiles, for example, and not just because of the penetration of the Japanese companies.

Our next speaker is Mr. Winston Wade, president of U.S. West Advanced Technologies, also a vice president of U.S. West. Mr. Wade was born in Nebraska. He earned a master's degree in business administration and electrical engineering from the University of Nebraska and has worked with the Bell System in Omaha and in other parts of the Midwest. He became president of U.S. West Advanced Technologies in August 1985.

MR. WADE: As some of you know, and maybe a lot of you do not know, U.S. West is one of the "Baby Bells." I say baby even though we have revenues of $10 billion. We are very active in Europe and around the

world, though we have been there only a couple of years, in contrast to the story you heard about Ford. Our projects include cellular phone service, radio technology, fiber optics, and cable television. Much of the technical consulting and detailed planning work for these projects is provided by one of the organizations I lead, U.S. West Advanced Technologies.

The background paper that we all received for this conference really captures the essence of my remarks. The question was raised: Are U.S. government and industry setting appropriate priorities for the country's science and technology base? For my industry, the answer is no. At U.S. West we see ourselves as strategic partners in bringing the benefits of the information age to Europe. By benefits I mean access to the widest possible range of information sources and the freedom to choose from a variety of communication technologies to help manage both the speed of your business life and the quality of your personal time.

A few years ago U.S. West had virtually no foreign investments; let me briefly describe to you what we have done in the last couple of years. In the United Kingdom we are involved in cable TV and we are a partner in 10 franchises. You might say, "Why cable?" Well, it is close to our base businesses: telecommunications, switching, transport, and installation. The timing is just right for us there, and the opportunity looks very good. It will also help us learn more about that industry in the United States, so we could potentially, if allowed, be a carrier for the cable companies in the United States. Perhaps even more important, the U.K. cable franchises give us the right to provide telecom facilities in the United Kingdom.

Another major U.K. opportunity is in PCNs, personal communication networks. This technology differs from cellular technology a bit: a higher frequency range, more cell sites, and a greater volume of calls. It is really ideal for densely populated areas, using very small portable handsets, we can link a person to the telephone infrastructure. U.S. West is a partner in one of the three PCN licenses in the United Kingdom.

We are also involved with cellular technology in Hungary. We have a joint venture with the Hungarian PTT to build and operate nationwide cellular services. There is a huge pent-up demand in Hungary, in all of eastern Europe for telephone service, and of course we can implement cellular services much faster than we can land line services.

In the Soviet Union, U.S. West is part of a consortium proposing one of the longest fiber-optic cables in the world, 6,000 miles. It would cross the Soviet Union, linking Europe with the Far East, including Japan. It is not a done deal yet, but we are hoping to get approvals to move forward in this area. In Hong Kong we are a partner in a consortium that is building the largest single cable TV franchise in the world, potentially serving a million and a half customers. We will offer high-speed fiber-optic networks for telecommunications as well as for cable TV.

For U.S. West, being a strategic partner in the international marketplace means bringing our research and development activities close to the customer to support our international investments. We have to keep up, like you do, with the customer's needs and with what the potential is in the marketplace. I do not mean just keeping up our knowledge of telecommunications. I also mean maintaining our expertise in voice recognition, expert systems, advanced software development, user interface technology, network architecture, and a lot of the standards development that we heard about this morning. User interface, for example, means user friendliness. Can we make the products and services of the information age as easy and friendly to use as possible, especially worldwide? Can we create the common standards we need so a service in London responds just like the same service in Paris, Hong Kong, or Seattle?

Despite everything we are doing in Europe and worldwide, I have to return to the opening part of my report: that the U.S. government is not setting appropriate priorities for its science and technology base in my industry. The handcuffs we find on ourselves—on the regional telephone companies, on telecommunications R&D, and on our ability to offer information services in the United States—are hurting us not only domestically but internationally as well. My point is, strength begins at home. We could do a better job for America overseas if we are permitted to do all we are capable of doing here at home. The problem is what we call the MFJ—the modified final judgment—the court order that broke up the Bell System and created U.S. West, Southwestern Bell, Bell South, Ameritech, Nynex, Bell Atlantic, and Pacific Telecom. This court order significantly affects the R&D we can do. It makes us work very inefficiently, and in some cases it stops us from pursuing innovative ideas completely.

The decree's language is vague about what is or is not permitted. The result is that we use extreme caution in developing new products; there are lawyers on all our development teams. With all due respect to the legal profession, and I believe there are a few here today, this slows our R&D process and leads to extremely conservative thinking. It really leads us to the status quo, which is the antithesis of innovation, and it casts a chill over the R&D work that we can do.

For U.S. West there have been several instances of R&D stopped or curtailed because of the decree's foggy language and its prohibition on our providing information services. No industry, especially one facing international competition, can survive for long with legal constraints on the speed at which new products are brought to the marketplace. If they are brought to the market at all, success depends on R&D to fill time-limited market windows.

Foreign competitors and other manufacturers in the United States do not have to go through this process. They can sell in the U.S. domestic markets,

unhampered by U.S. legal restrictions, committing big investments to R&D. Nippon Telephone and British Telephone have very large laboratories, but they do not have the constraints that we have. I read the other day that Nippon Telephone is building a data processing center in New Jersey. We cannot do that; we are prohibited from doing that.

Modifying a decree through the existing waiver and petition process is not adequate, and, of course, we are arguing for congressional action and are working very hard to convince Congress of the need. In Europe and around the world, U.S. West has more freedom to pursue R&D and explore new markets than in the United States. We are seriously considering basing researchers in the United Kingdom and may establish a communications laboratory at some point in Hong Kong. If we go ahead, these research efforts would support our investments in cable and telecommunications systems in Europe and Asia and bring our researchers closer to the customers. They would be able to do R&D work on information-age services that should be available to our customers in the United States but are not because of the legal constraints that we now have.

I am not talking about designing new customer equipment for manufacturing. We would research the next generation of information services, like broadcast messaging, which would allow police or fire officials to alert entire neighborhoods of an emergency situation; or advanced electronic mail and fax services, local area networks, and metropolitan area services; or electronic vaulting of critical data for businesses that need to protect themselves against disasters; and inexpensive smart office and home capabilities that use the facilities of the telecommunications network to control temperature and computer systems.

We think these ideas are part of the next generation of telecommunications services. We believe they deserve to be researched and developed to the point where market trials will prove their viability and market demand. As I've indicated, this research is difficult for us to do in the United States, not because it represents a major threat to any existing business or unfairly leverages any monopoly we might have, but because of the law.

So far the courts have turned a deaf ear to our case. Recently, I told the U.S. House Committee on Telecommunications and Finance that the decree forces us to try and define black-and-white technical boundaries where there are really, as you know, only shifting shades of gray. In the absence of relief from Congress, as I said, we are considering deploying those areas of research and development overseas. The first customers to benefit from this research might be in the European Community and in Hong Kong and potentially even in eastern Europe. Thanks to the modified final judgment, American businesses and consumers could be denied access to the next generation of advanced services.

We believe it is critical that Congress act swiftly to modify the decree.

As I said earlier, strength begins at home. It is now easier for American telecommunications companies to deliver the information age to Europe. With more freedom at home, we think we could do a better job serving our customers, contribute more to the growth of the U.S. economy, and potentially help the trade balance. As we look forward to 1992 in Europe and even now, we see great opportunities and, as you heard me say earlier, we are moving on those opportunities.

But my bottom-line message is that we really should look at the roadblocks we have here at home that prevent us from taking better advantage of the international opportunities that present themselves. If we don't examine those roadblocks, we could potentially put the United States further behind Europe in the development and exploitation of information-age capabilities.

MR. NILES: Mr. Wade raises a very interesting, important question for any company, whether high tech or not, and that is the relationship between domestic antitrust and competition policy and foreign trade. We certainly are aware of cases in the past where well-intended efforts to enhance domestic competition resulted in creating foreign competition for us. One example is the creation of Aluminum of Canada Ltd. out of Alcoa, making the world a little more difficult for U.S. industry in the interest of competition policy.

Our last speaker is Professor Richard Cooper of Harvard University, professor of international economics. He has a distinguished career in academia and in government. He served in the Department of State most recently from 1977 to 1981 as under secretary for economic affairs. In that capacity he also worked on the planning and implementation of the economic summits.

DR. COOPER: My assignment was to think about the impact of EC 92 on the priorities of U.S. R&D-intensive firms. As I thought about that issue, I concluded—with a few exceptions that I will note in a moment—that for the alert, well-managed, forward-looking firm, there should be no impact of EC 92 on its priorities. That is not to say that many changes are not taking place, but those changes by and large were taking place independently of EC 92.

The European Common Market has existed in a meaningful sense since 1958. Trade is not completely free within Europe, but merchandise trade is largely free. Most firms that have the possibility of trading successfully with Europe, either by exporting from the United States of producing successfully abroad, have already noticed Europe, have seen the opportunities there, and have taken advantage of them. They would be well established already.

The EC 92 program is extremely important for certain aspects of internal trade, much more for trade in services than for merchandise trade, but its impact on outsiders, on balance, will be neutral to positive. And as I said, most alert firms would have already seen the opportunities and taken advantage of them.

But, of course, most firms are not alert, well managed, and forward

looking about all things that are going on all of the time. Like individuals, firms fall into patterns of behavior. They develop formulas and rules of thumb that have been successful, and they tend to discard those formulas or rules of thumb reluctantly. In this sense, EC 92 plays an extremely important role, but it is a psychological rather than a tangible one. It serves to remind firms that Europe exists, that there is a huge market there, that it has been open. But after 1992, assuming the Europeans succeed—and every indication is that they will succeed with at least 90 percent of their program—the market will be even easier to deal with than in the past.

So the great value of the EC 92 program for outsiders is to disrupt our habitual patterns of thought, our rules of thumb, to force us to think again, as we should have been doing all along, about the opportunities there. Decisions that were made five or 10 or even 15 years ago may no longer be optimal today and should be rethought and reexamined, not because of a program called EC 92 but because of all the other developments that have taken place since previous decisions were made but that we have not yet integrated into our thinking in a systematic way.

Certainly, that is what is happening in Europe. It is odd to recall today that as recently as five years ago the general theme on both sides of the Atlantic was one of Euro-pessimism, Euro-sclerosis, and Euro-stagnation. The Brookings Institution, one of better public policy research institutions in the United States, undertook a study in the mid-1980s, with European encouragement, called *Barriers to European Growth*. It is characteristic of the scholarly and publication lags that the book came out in 1987, just as Europe was beginning to recover from nearly a decade of stagnation. But in the last few years Europe has become a much more vibrant economy, and it has become vibrant not least because EC 92 has induced European firms to shed their habitual patterns of thought and to think about new possibilities. One manifestation of that change is the accelerating number of mergers and acquisitions in Europe since the 1985 White Paper, *Completing the Internal Market*.

European firms are taking EC 92 seriously. Shrewd American and other third-country firms will also take seriously the new possibilities in Europe, not just because of the EC 92 program but also because of the many other changes.

One of the consequences of the developments within Europe is that at least some European firms will become more formidable competitors on the world market, as a result of the consolidations and rationalizations that are taking place within European industry. Extensive economic studies were done on the consequences of completing the European internal market, and it was concluded that there would be substantial cost-cutting advantages arising from economies of scale and perhaps more importantly from the increased pressures of competition, which would be more acute after completion

of the Common Market. The Emerson Commission estimated that on average costs would drop about 6 percent compared with what they would otherwise be. One can argue about the magnitude of the drop, but the pressures are clearly there, and that will have consequences outside Europe as well as inside Europe for American, Canadian, Japanese, and other firms that are in competition with European firms.

I said there were a few exceptions to my generalization that EC 92 narrowly considered should not have any implications for the priorities of the alert and well-managed firm. The first concerns standards, to which a session has been devoted, so I can be brief about it. The first point to note is that the harmonization of standards in Europe should offer tremendous opportunity to American firms. American firms above all others are accustomed to producing for a large market to a common standard. One of the problems in Europe for any firm, European or non-European, has been producing for moderate-sized markets that do not operate to a common standard. That will change. The change might not be completed by the end of 1992, although that is the target date for common standards or sometimes only common minimum standards for the whole range of industrial products and services throughout Europe. Americans have learned how to take advantage of large scale in marketing, and common standards will provide new opportunities in Europe.

In setting the standards where third countries other than the EFTA countries are not actually present in the process, there is some danger that outsiders operating to different standards may be put at some disadvantage. That risk is certainly present. It has already materialized in a few cases. The response to it is vigilance and constant awareness of what is happening in the standards-setting process. Brussels is as leaky as Washington when it comes to policymaking, so it should not be difficult to find out where the arguments are, where the disagreements are, and where the consensus is tending.

If those tendencies look as though they are going to be disadvantageous from the point of view of American firms, the proper response is to make representations before the standards are set definitively. These should take place first at the level at which the standards are being set. If that approach does not seem to be working, you can always complain to Ambassador Niles, whose job it is, among other things, as our chief delegate to the European Community, to represent the interests of Americans there. But this activity is not something that American business should sit back and wait for the U.S. government to take care of. With a few possible exceptions, the U.S. government does not have the technical knowledge to be able to identify when the evolution of a particular standard was going to be disadvantageous or not. That is the responsibility of those who have the knowledge. The U.S. government can come in at a later stage and make representations as necessary. But on balance in the area of standards the opportunities

outweigh the risks and the risks are manageable with proper vigilance to the standards-setting process.

The second area where my opening proposition is incorrect concerns those sectors of the European economies where government procurement has played an important role. Unlike most merchandise trade, Europe has not had a common market in government procurement. It is not just that outsiders have been excluded; other Europeans have been defined for these purposes as outsiders. The Commission estimate is that only 2 percent of total government procurement within Europe has been across European boundaries. Government procurement has been overwhelmingly national in its orientation. That, the Europeans are agreed in principle, must cease if Europe is to complete the Common Market.

A major effort is now afoot to generalize government procurement. There is a lengthy list, including power generation and pharmaceutical where national health authorities are involved, but telecommunications is perhaps the most significant area. In these areas the market will change dramatically after 1992, and the open question is how it will change. There will be tremendous resistance to this change because some firms' survival today depends on having a cozy relationship with government purchasers; those firms may be in serious jeopardy. So there will be tremendous resistance.

The open question is whether government procurement will be opened up just for other Europeans—that is to say, will this be a Common Marketwide procurement alone—or whether it will be opened up for third parties as well? That is to say, will Americans, Canadians, Japanese, and others be able to participate in what inevitably will become a more transparent process of government procurement?

That issue has not been settled. European officials in Brussels say the right thing, which is that it should be opened up in general. One of the economic purposes of EC 92 is to get more competition into these industries, and that competition can come from outside Europe as well as from within. Whether that view is sufficiently attractive to overcome the political resistance to its execution is still open. In this area the U.S. government can play an important role. A code that covers some government procurement dates from 1979, negotiated in the Tokyo Round of GATT, under which Americans should exercise their rights.

The current Uruguay Round of trade negotiations provides an opportunity to broaden the coverage of government procurement open to international competition. It is already on the agenda. To nudge the Europeans in the direction of allowing third countries to participate in their opening, the United States, Japan, and others should reduce the barriers to foreign bidders in their own procurement. So in selected industries there are potentially important new developments, especially those where government procurement is significant.

The final issue I would like to address, since it is on the list of questions circulated to all of us for this session, has to do with export controls by the United States. It will be difficult, and in the end impossible, to sustain the current U.S. government position on export controls of high-technology products to eastern European countries, which one by one are developing democratic forms of government. We are in transition at the present time. The Hungarian election is later this month, and non-Communists are expected to win handily. The Poles have locked themselves temporarily into a particular government that involves a coalition between Communists and Solidarity, but that will change over time. Czechoslovakia now has a democratic government, but it presides over an apparatus that has been there for over 20 years.

Nonetheless, the possibility of sustaining a high degree of control on exports of dual-use but militarily significant exports to countries such as Poland, Hungary, and Czechoslovakia, not to mention an East Germany that is integrated with West Germany, becomes nil. It becomes unsustainable even if the U.S. government were to stick by its historical position in this regard, because the Europeans will not agree to it, and the United States no longer has even a near monopoly on high technology. It will be impossible to separate East Germany from West Germany for trade control purposes once Germany is reunified, for example, and the logic of relaxing controls to countries such as Czechoslovakia, Hungary, and Poland is too compelling.

At the same time, one has to recognize that strong ties have developed between those countries and the Soviet Union, not only institutionally but also, and more importantly, between individuals. We must assume that high-technology exports to those countries, or the technological content of them, will occasionally find their way to the Soviet Union. Take the case of East Germany. Many individuals, whether or not they are personally upset by the reunification of Germany under a capitalist regime, have personal ties with Russian officials, and no doubt many will go into private enterprise as spies, basically, for the Soviet Union after reunification of Germany.

A new set of issues arises for managing the control of militarily significant technology to the Soviet Union. At a minimum, however, the situation implies that the United States must back off from the position that it has taken in practice so far, that anything that is militarily useful—not militarily significant but militarily useful—should be denied to the Soviet Union and its east European allies, and we should establish an apparatus that attempts, however imperfectly, to accomplish that end. That position is untenable given the recent developments in eastern Europe.

I would hope therefore that the U.S. government shows more flexibility and more suppleness than it normally does in adapting its policies to rapidly changing circumstances in this area. It has an important bearing, I do not have to remind this audience, on the practical possibilities for U.S. exports.

MR. NILES: I would like to make a few comments. As Dick pointed out, I am your representative in Brussels to the extent that you run into problems or have questions involving activities by the European Community. While we have talked a little bit about EC 92, basically there are lots of other things going on in Europe today as well. Some of them have potentially greater implications for us than the Single Market program, which, as Dick Cooper points out, is something that has been under way in one form or another since 1958. Economic and monetary union is on the agenda, and I think European political union is very much on the agenda, too. The relationship between the European Community and the countries of eastern Europe is on the agenda and will be discussed at a summit on April 28; I think there will be some important decisions taken there.

The European Community and the EFTA countries are moving into a relationship that will be something more than association and less than membership, difficult to define; whether they will actually find something that works for both sides remains to be seen. It may well be that some of the EFTA members, particularly as neutrality in Europe becomes less significant, will continue to opt for membership, as Austria says it will. You could see other members of EFTA applying for membership in the European Community.

The psychological changes in Europe, to my way of thinking, are almost more important than the negotiations that are under way and the changes within the European Community as far as regulations, unification of rules, etc. There is a sense of optimism. There is a certain sense of unease right now because of what is going on in eastern Europe, particularly in Germany, but there is a very optimistic, dynamic spirit. These developments represent a response, as Dick Cooper suggested, in part to fear, as a result of the period of stagnation of Europe from 1975 to 1985, of falling behind the United States, and, to an even greater extent, a fear of Japan, which is as present in Europe as it is in the United States. This has led to much more emphasis in Europe on cooperation across European boundaries, and this is where I think the questions of future U.S.-EC scientific technical cooperation are particularly raised.

There is today in Europe, in the private sector as well as in the public sector —and the two, of course, work very closely together—a sense of preference for the European solution, a preference to work together in Europe, between European companies, perhaps excluding U.S. companies. The same thing is true to a degree on the part of European governments, which look in the first instance to these programs under the EUREKA program (which was, in a sense, the scientific/technical counterpart of the 1985 White Paper, *Completing the Internal Market* , that led to the Single Market exercise), and the strictly EC scientific programs such as ESPRIT, BRITE, RACE, and so forth.

There is a preference for doing things within Europe, and that is not something

I think we should be overly alarmed about, provided we manage our side of the relationship wisely. However, we have contributed to this European attitude in part by the mistakes we made in the past. The image of the United States, in the eyes of many Europeans, particularly in the area of scientific-technical cooperation, is of a country that is incoherent, inconsistent, and arbitrary, a country that changes its direction frequently, adopts programs, as Professor Bromley mentioned this morning, and then tries to sell them to other countries and is surprised sometimes when other people are not prepared to jump on board with great enthusiasm. Then after having signed everybody up, we decide, well we won't do it quite that way, we will do it this way, and we will let you know about it when we have decided how we want to do it.

This will not work anymore. There needs to be a cultural change in the United States in the way we look at western Europe and the rest of the world for that matter. It involves a sense of the proportionality between the United States and western Europe, and in no area, I think, is it more important that we do this than in the area of scientific-technical cooperation.

Dick Cooper talked about the need for a partnership between government and the private sector. I think it is a very good point. We feel, in the U.S. mission to the Community, that we have to work very closely with the private sector if we are going to do our job properly. We want to hear from you, from the private sector, about problems. Dick mentioned standards. That is certainly an area where we need to work closely together, and I think the previous panel made clear that a lot of progress has been made in that area. Government procurement is something that we have very much on the agenda between now and the end of the year, parallel with the Uruguay Round talks, the talks on extending the government procurement code to these four famous excluded sectors: telecommunications, water supply, transportation, and power generation. The European Community has now made an offer, in a sense, by adopting a directive that unifies the European market in these areas. We think we have the possibility at least for a deal in the procurement code negotiations.

Finally, we will be adding, in April 1990, a scientific counselor at the mission to the European Communities—Bud Rock, who currently works in the Oceans, Environment, and Science Bureau of the Department of State.

MR. LEIGHT: Walter Leight, NIST. We heard Dr. Contzen applaud the partnership in prenormative research. We heard Dr. Dunstan say that Americans or other third parties could make comments on draft CEN-CENELEC standards. We heard that we can participate in ISO after the standards are forwarded to ISO. In response to a question, we heard Dr. Dunstan say that those American companies or non-European companies with European subsidiaries could participate in the development of CEN-CENELEC standards, and now we have heard Professor Cooper suggest that Ambassador Niles can raise protests with the European Commission if something goes wrong.

The simple question is, would it not help short-circuit the whole process if we could participate directly in the development of European standards in the first place, in exactly the same sense as most of the major standards-developing organizations in this country are completely open to participation by anybody from any part of the world.

DR. COOPER: The answer to your question is yes. We put it to the Europeans and they rejected it. Tom Niles probably knows the story. He can perhaps elaborate.

MR. NILES: I would not say we put it to them in quite that way, but the answer to your question is yes, it would be simpler. Is that possible today? The answer, realistically, is no. What we have done, I think, is to construct a network of contacts that to a large degree make up for the fact that we are not at the table in CEN or CENELEC or ETSI—unless, of course, we go back to the question raised by the Eastman Kodak representative. U.S. companies in Europe have every opportunity through the national standards organizations to participate in the establishment of CEN-CENELEC-ETSI standards.

The key for the United States is to get more actively engaged in the international standards process through IEC and ISO. I really believe that. The United States is missing a great opportunity here, it seems to me, by not being more engaged than it has been traditionally in the international standards-setting operation because, as was made clear earlier by the panelists in the previous session, to the extent there is an international standard, CEN, CENELEC, and ETSI adopt it. I must look into this case about ETSI perhaps departing from some international standards. I had not heard about that, but we want to protect our interest in the international standards area, not just in the case of Europe. The key is through ANSI into ISO and IEC.

DR. DUBY: Jean-Jacques Duby, IBM Europe. I have one question for Professor Cooper. You said that you do not see any impact of the European programs on the American companies' research and development strategy, and I am perfectly willing to believe you on this point. My question is, do you see the same zero impact on American companies' research and development localization on the one hand and R&D alliances strategy on the other hand?

DR. COOPER: The question is a general one, and both industrial activity and R&D activity are series of specific cases. I guess I would not want to answer the general question in the negative, but my basic view that I tried to suggest is that Europe has been there for some time. It has been a great opportunity for some time, and most of the firms that have opportunities there, apart from those areas where government procurement has confined the market very sharply, should already have been doing the things that they now might think of doing as a result of EC 92. I am not sure that is responsive to your question. It is not that changes are not taking place; it is

that I do not see EC 92 per se, apart from the areas that I mentioned, as generating those changes. If there are reasons to promote the EC 92 program, they are generated because really interesting work is going on in Europe, and, in order to tap into it, you have to locate your research facilities there. That by and large would have been true without EC 92.

MR. KALIL: Tom Kalil, Labor-Industry Coalition for International Trade. It seems to me that part of the message of the European Community is that if you want to participate in Europe's market you at least ought to have the decency to make your stuff in Europe. They have been very effective at using antidumping duties and anticircumvention orders and rules of origin to encourage U.S. and Japanese manufacturers to increase their manufacturing presence in the Community, particularly in areas like consumer electronics. My question for the panel is whether the Community is not shooting itself in the foot by creating overcapacity in certain sectors.

MR. NILES: I will try to respond to that, at least for me; I do not know whether I can respond for the panel. The problem that we have encountered, and to which you allude, is a rather restricted one. It involves antidumping cases arising from Japanese market success in Europe, and anticircumvention arrangements designed to ensure that so-called screwdriver plants set up by the Japanese elsewhere—in one case the Ricoh Company moving into California—do not have the effect of getting around the antidumping requirements. So they established a requirement that in order to avoid the dumping duties at least 40 percent of the product has to be from a country other than the country of the dumping company. The Japanese company must acquire at least 40 percent of the value of the product somewhere else.

Where does that 40 percent come from? There were some indications the Europeans had said to the Japanese companies in a couple of cases that they would be a lot better off if they acquired that 40 percent in Europe. That would of course encourage the Japanese to buy European and would encourage United States companies, in order to sell to the Japanese, to invest in Europe when they would not otherwise have invested there. We have now secured from the Commission an explanation that indeed that is not the policy, that if the Japanese company wishes to buy that 40 percent from other parts of the world, that is fine and it does not have to be acquired in Europe.

A problem remains on the matter of defining the origin of a printed circuit board, which is an important part of many consumer and industrial electronics items. It is a mind-numbing problem if you have ever tried to get into it. I will not even try to describe the complexity of it, but that is the one very limited case where we have an ongoing discussion with the European Commission. The problem has been narrowed down to the point where we are discussing what sort of a rule to use in determining the origin of a printed circuit board.

Whether this could result in the creation of excess capacity, the answer to your question is yes, if rules of origin were misused in order to force investment in Europe. We believe the Commission has made clear to companies that this is not its intention, that it is not trying to force investment in Europe. To the extent that companies are investing in Europe, they welcome it, but this is not a result of manipulation of the rules of origin.

DR. BARKER: It seems to me that, picking up Dick's view about progressive thinking, global manufacturers should be beyond some of this already. This may be an idealistic point of view, but the optimum location of your manufacturing facilities globally should be regarded as very much an open question. There are European countries such as my own that have pretty low labor costs and pretty high skill levels. You see the same elsewhere; you see the Japanese companies, for example, setting up many of their manufacturing facilities offshore in Singapore, Malaysia, and so on. I would have thought it was worth our while thinking beyond whether we can export U.S. manufactured goods to asking where in the world does it make economic sense to carry out research, development, manufacturing, and so forth.

Suggested Strategies for U.S.-EC Cooperation and Competition

MR. HOWARD: We have saved the best for last. Thus far we have heard a description of where the science and technology policies of the European market are headed; the views and concerns of the U.S. science community; access to precompetitive programs in the European Community; and standards and the strategic implications today. Our last session is going to answer all the questions that arose in previous sessions.

Our first speaker is Michel Carpentier, who is the director general of DG-XIII, the directorate general that covers telecommunications, information industries, and information. He began his career in government after a brief private service at the Commissariat à l'Energie Atomique. He worked in the nuclear industry both in France and within EURATOM. He has held a variety of positions in the European Community in both the nuclear and environmental areas. In his present position he has been heavily involved in the creation of a number of programs that have been discussed in the last day and a half, specifically the ESPRIT program and RACE and others in the telecommunications area, generally in the area of policy and action programs concerning telecommunications, information industry services, and standardization in these sectors.

Mr. CARPENTIER: We have, as Vice President Pandolfi indicated in his opening address, looked into the conjunction of several important and exciting developments that concern Europe. It has been said repeatedly that the EC is nearing the conclusion of a largely integrated market that will allow the free movement of people, goods, money, and services. What has not been said as often is that the Single Act also gives the EC the means to ensure the economic and the social cohesion of all member states, including the less privileged; to take environmental and training issues into account; and to start negotiating the creation of a European economic and monetary

union. I say this because Mr. Barker mentioned that there were a few topics that may have not been underlined enough.

At the same time, the world is faced with very fast-moving events in central and eastern Europe, where the restoration of both democracy and a market economy will undoubtedly have an impact on all of these issues in the future.

What consequence is this conjunction of events going to have for R&D transatlantic cooperation, at a time when science and technology are becoming more and more important in shaping the industry of tomorrow and its ability to compete in the world market? How can we make the best of the changes that are occurring and that will occur? We have heard many answers to these questions, ranging from concerns to more optimistic analyses, from pressure to cooperation.

From the recent statements and initiatives of President Bush, and from the discussions we had with various departments and establishments over the past few days, we know for sure that the importance of the role of science and technology is fully recognized in this country. On the EC side, the inclusion in the Single Act of one chapter devoted to R&D as well as the expected early approval of the next five-year R&D Framework Program provide the EC with the legal basis and the financial means to launch or consolidate cooperative R&D programs. European governments, universities, and industries are also engaged unilaterally or collectively in cooperative R&D programs.

For this closing session, the panel has been asked to make suggestions on how the United States and Europe could use the opportunities that are opening up to cooperate in the R&D fields, reconciling cooperation with competition. Although competition and cooperation may at first glance seem mutually exclusive, I do think that each of these concepts is a prerequisite for the existence and realization of fair competition, on the one hand, and balanced cooperation on the other. There must be, therefore, a fair and delicate balance between competition and cooperation to cope with the interests of the various actors concerning R&D—and there are many, namely public authorities, governments and parliaments, economic actors, scientists, and also taxpayers.

This balance, and the part in the decisions taken by these different actors, must be found within each country or group of countries, such as the EC. It must also be found at the international level. It may be of interest of quickly examine how the EC has proceeded to reconcile R&D cooperation with industrial competition, in order to consider to what extent one can draw upon this experience to improve U.S.-EC R&D cooperation and competition.

First, EC R&D cooperative programs are focused on basic research and on precompetitive and prenormative R&D, as opposed to competitive industrial development whose funding must originate from industry alone.

Second, the EC is involved in R&D sectors where the European dimension appears to be useful or necessary. This is referred to as the so-called subsidiarity principle. The selected sectors are, for example, those where economies of scale are needed or those that are by nature of common interest for member states, for example, environmental research or skill improvement schemes.

Third, where industry is involved, one should never forget that it is requested to bring a large proportion of matching funds.

Fourth, the intellectual property rights' conditions are prenegotiated, in order to find, before any contract signature, an appropriate balance of interest, including the background and the foreground information dissemination regime.

Fifth, the return for the countries and companies involved is not calculated in a narrow sense but on a global basis, including advantages of varied nature: improved knowledge, participation in centers of excellence networks, financial return. Financial return is one aspect; it may not be the most important.

Sixth, there is no relation whatsoever between trade problems and R&D cooperation.

Seventh, both member states' administrations and industry are tightly associated with the implementation of the programs, through different types of joint committees.

Moreover, and I think this was said yesterday by my friend, Paolo Fasella, the Commission does strictly apply the competition rules provided in the Treaty of Rome on abuse of dominant position and on public aid. These may be conditions that, mutatis mutandis, might be applied to U.S.-EC R&D cooperation.

Turning to these relations as they stand now, one must first state that there already exists an impressive record of cooperation bilaterally with the member states, with the European Community in the nuclear and environmental areas embodied in the Framework Program, with other European organizations such as ESA in space research. We are certainly aware of the European commitment to cooperate with the National Aeronautics and Space Administration in Space Station Freedom. European efforts in this domain will amount to about $3 billion.

Besides this already impressive list of cooperative initiatives, I strongly believe that as arrangements for the Single Market in Europe are completed, making this market more open, more integrated, and more transparent, the balance of new developments having a positive impact on science and technology will serve to strengthen transatlantic cooperation. Naturally, there will be changes, and adaptation to a changing situation always requires efforts; this will require efforts from both sides of the Atlantic. We have carefully listened to your concerns, and we must take them into consideration. Let me, in turn, recall a few of our concerns. I will focus on three of them.

The first one relates to the reciprocity and retaliation concepts used by U.S. authorities in sectorial and bilateral trade negotiations, as opposed to the more positive concept of mutual access to opportunities negotiated through multilateral agreements on a multisectorial basis, which EC favors. We feel that continuing to put the EC on the priority list of the Telecommunications Trade Act can hardly contribute to creating the atmosphere of mutual confidence necessary to embark on a most desirable transatlantic cooperation in the field of telecommunications.

A second concern, but it seems that it is going to be relieved, relates to intellectual property rights and to export control rules on technologies and technology-based products. The third concern relates to the fact that on balance European firms have less access to the U.S. R&D bases, which we feel have become more restricted in recent years as defense outlays for R&D have grown.

In the ESPRIT II program for instance, more than a dozen American EC-based firms are involved in 25 projects, which represent 16 percent in number and 17 percent in value of the total program. It has been said already that the R&D EC money going to EC-based U.S. firms is now as high as 1.5 to 2 percent, compared with only 0.18 percent of U.S. publicly funded R&D going to U.S.-based EC organizations. Both figures naturally are small, too small, in absolute terms, but the proportions are clearly asymmetrical. Moreover, EC firms are excluded from SEMATECH, VHSIC, and SBIR, and they participate in a very limited way in industrial cooperative U.S. programs such as RPI, MCC, and so on.

I would like to stress, however, that for us these obstacles do not make cooperation any less desirable. Of course, it provides a challenge for our industries and universities as well as for yours to find the common ground, the right topics, and the right occasions. I am very optimistic on that score. We are opening up our markets and extending the possibilities of cooperation. At the same time, it was with great satisfaction that we learned about significant progress and an expression of willingness by the United States to streamline the COCOM list.

Within a framework of gradually retreating obstacles, how can our cooperation grow and at the same time enhance fair competition? Starting with fair competition in high technology, we have heard the role played by standardization. It has been explained to you that the European process will eventually be a single one and that legislative actions will be restricted to the essential requirements. Compared to the current situation of a multitude of national standards and sometimes very detailed legislative provisions, there can be no doubt that the new situation will be much easier for companies outside the EC to work with. I am not only talking about the results of the process that you will be confronted with. I am sure that once everyone is accustomed to it a single process will also be found much easier regarding

opportunities for comment or actual technical contributions in an earlier stage. Of course, things would go even smoother, as has been said many times here, if the United States in its domestic standardization process would give preference to the adoption of implementation of international standards to the same degree as we do.

Our approaches to standards are not yet the same, and differences do still arise, but we can also come closer by attacking our future differences at their root—at the level of prenormative research. Jean-Pierre Contzen gave some examples earlier. Collaboration in prenormative research can bring us closer to planning in advance for the same standard rather than each trying to impose our own. There are many areas for cooperation in prenormative research, from software for computer-integrated manufacturing to office document architectures; from testing tools for speech recognition systems to tools for electronic verification; and from CAD framework standards to home systems, whose economic importance is growing rapidly. A good example of prenormative research can be found in the area where we are investing many researcher-years in rationalizing the communication taking place between the different production processes. CIMOSA and CNMA are typical examples.

Another interesting example is the area of speech recognition. U.S. research in this area is more oriented toward recognizing different accents of the English language, whereas European research is more oriented to recognizing the accents of different European languages. Prenormative research can result in standards for testing systems that will accommodate both approaches.

Besides cooperation in standards, there are also technology areas in which the exploitation of combined efforts can bear significant results. What we call HDTV or what you call high-resolution image systems, is one such area. Semiconductors are another.

As you know from our activities in the field of HDTV, the Community considers, as you do, the creation of a compatible high-quality image system to be of great importance economically as well as culturally. In a very successful European cooperative project, our industry has come up with a fully qualified technical solution, including HDTV production standards. It seems to me that without going into detail there is ample scope for identifying possibilities of cooperation in this area.

In a similar vein it has been recognized for several years that semiconductors are a key element in the whole of the modern economy. Two years ago relations between the United States and Europe were quite difficult in this sector, but the situation has now improved significantly. In the first place, there is a growing recognition that it is essential for the major industrialized regions to have access to competitive and alternative sources of supply of the key technologies. Second, policies aimed exclusively at complete domestic

self-sufficiency are going to fail, both economically and politically, given the global characteristics of high-technology markets and the need for competition.

Consequently, there will have to be a degree of cooperation. It will not be exclusive really in one direction or another, but it does seem to us in the Community that there is currently a window of opportunity to raise cooperation between the United States and Europe in the area of semiconductors to a rather higher plane. The agreements between companies such as Siemens and IBM for the development of 64-megabyte DRAMs show that such cooperations make sense and can produce mutual benefits.

I am sure we can find the topics on which both sides can make complementary contributions and where the exchange of expertise involved in the cooperation is not conditioned other than by the legitimate property interests of those providing the contribution. In fact, some topics have already been explored tentatively between both sides. Vice President Pandolfi mentioned in his opening address five domains of potential cooperation. I will therefore limit myself to a very short round of elaborating on basic research and information technology.

This is an area where transatlantic cooperation has a long tradition and where progress will still hold the key for major future breakthroughs. Again there are many areas for cooperation, and the following are but three examples. There are important issues to be resolved in the field of computer vision and even more important ones in integrating the knowledge acquired from that research into the applied realities of robotics. A lot can be gained also through cooperation in the foundations of software tools that deal with concurrence, parallelism, and distributed systems generally. These are difficult areas, and unification of the conflicting backgrounds and solution of the problems in them can have long-term implications in the marketplace.

Neurocomputing, according to many, holds enormous promise for the future. It is recognized, however, that unless a lot more research goes into the foundations of this new technology the current industrial experiments will be disappointing and may deprive us of real progress for some time to come. Considerable benefits can result from cooperation in a challenging area where resources are particularly scarce.

Cooperation between well-recognized teams in the United States and the EC could bring together the best and the brightest in the world in an effort to cross the present thresholds. I think that on both sides we would like to encourage the dialogue for cooperation in basic research, which, if it focuses on the areas where balanced benefits can be achieved by optimizing our use of scarce human resources, will find our joint and full support.

Cooperation has met with problems in the past, and some of these problems have inevitably been reflected in my remarks. But we are all subject to the discipline of membership in the global system, and finding solutions

to problems is what cooperation is all about. On the whole, the opportunities that present themselves far exceed, in my view, the problems that have to be overcome, and the will to overcome them is there. If consistency is pursued and the support for competitiveness does not impede the success of cooperation, more cross-border technological and scientific alliances will emerge.

That brings me to the end of my statement about cooperation. You have noticed, of course, that I have avoided a too-precise choice of subjects and approaches. One thing seems clear to me. If one wants to proceed rapidly, any agreement to be concluded will have to be fairly specific about the topics to be treated and will have to deal with the aspects of property rights, exploitation, etc., on a case-by-case basis. What is, of course, of paramount importance is that in these specific cases where cooperation is deemed advantageous by both sides, all obstacles to the flow of knowledge and reserves are removed. Once the desirability of cooperative work in a certain area has been established by identifying our mutual interest, workshops of experts can be set up on both sides of the Atlantic to identify or even to set up the teams that can start cooperation and to elaborate on the methods of cooperation most suitable for each area.

I should like to thank the organizers for the opportunity to give our views on developments toward the European integrated market and the prospects for cooperation and competition. Throughout the years the Community has become better equipped to face these challenges. This has no doubt contributed to the interest of others to cooperate with us. I wish to point out in closing that there is a wider implication.

The political and economic presence of the European Community as a whole acts as a stabilizing factor, especially with the current situation in the eastern European countries. Balanced, mutually beneficial cooperation with the United States will reinforce this stability and help with peaceful transition to democracy in those countries. That seems to me an additional incentive to continue and actively explore all possible forms of cooperation.

MR. HOWARD: We move on now to our second speaker. Dr. Hans Van Doesburg is a vice president with Booz, Allen and Hamilton, based in the firm's headquarters in The Hague. His management consulting expertise and experience over the past 10 years have concentrated on business strategy and technology management issues, primarily for companies in the energy industries and chemical and pharmaceutical industries; he refers to these as the molecular industries. His clients are in industry, government, and various European countries as well as the United States. Prior to starting his consulting career, he had a career with Shell Oil and has a series of degrees in chemical engineering.

DR. VAN DOESBURG: I would like to step away from the main theme of today, which has largely been policy-related issues and standardization.

I would like to bring somewhat more of a businessman's perspective into the discussion, to try to address a couple of questions such as what really are the strategic implications for companies that want to compete in Europe as part of the global competition. I would also like to address the question of what competitive restructuring in Europe and around the world really means for actually managing research and development resources.

I think this is a somewhat different theme and brings in the corporate and company management perspective. I think it is certainly interesting for those of you who are from corporations; for those of you who are not, it is interesting to get a sense of the other aspects that government or policymakers should worry about, to try to facilitate companies who want to compete in Europe and help them actually do that.

I would like to break Europe 1992 into three different phases. One could look at this event as kind of a sound barrier, called 1992. I certainly do not want to see it as a discrete event; it is something that stimulates a lot of change, but it is certainly not a major cause of the change that we are seeing at the moment. The first phase is regulatory harmonization. This has been addressed to quite an extent already today; it is certainly the area of harmonization that has progressed quite well. The areas I would like to spend more time on are industry restructuring and resource reallocation.

Industry restructuring is already occurring in and around Europe. At the moment, to a very large extent, it means mainly a change of ownership of companies. There has certainly been a wave of mergers and acquisitions within the EC, and companies from outside the Community are trying to buy companies in the EC.

What follows after a lot of companies have been bought and sold—and that is the essence of the restructuring—is a phase that I call resource reallocation. Then the corporate manager owning a lot of companies in many countries needs to somehow try to manage that group of companies in a way that ultimately uses the resources throughout Europe or the world in an optimal way.

I want to leave you with the message that the industrial restructuring going on is absolutely not the result of the harmonization of 1992. Certainly there are things that are being triggered by the harmonization, but by and large a lot of the changes are driven more by the need to compete on a global basis in a number of industries. I think that means that Europe is not only a battleground for European companies to try to compete with each other. Europe is one of the three major markets in the world where European, U.S., and Japanese companies are competing with each other as part of a global game.

To think about what drives restructuring, we should look at the effects of deregulation. A lot of European companies have been protected within their national borders. Because of protectionism, there really was no need

to compete internationally. To look for growth many of those companies have diversified in their home markets, in Germany, France, or Belgium, or wherever. That has led to a scale that is actually not quite optimal to get the right level of production costs, particularly in those industries where scale really counts. It is very clear that a company that has Holland as its home market does not have the advantage in terms of tapping economies of scale as a company doing business in, say, Germany does.

What is actually happening with harmonization is that this vicious circle is being broken by doing one very simple thing—removing the "no" in "no need to compete internationally." That brings us to a totally different situation, where companies now really have to compete internationally. As a result, companies are focusing much more on core businesses, and they try to grow these at an international level. There is also a process I call dediversification. Before, companies diversified to achieve growth in other businesses within their home country. It is fair to say now that many companies are spinning off businesses that they no longer consider part of their core business. They really focus on core businesses across many different countries, trying to seek the scale economies they need to compete in global markets.

That brings us to a more competitive industrial structure for most companies throughout Europe, which in turn brings more desire for deregulation. I think the 1992 process and the more international attitude within Europe certainly stimulate the drive to compete internationally. This stimulates some of the industrial restructuring, but certainly not all of it.

We have already seen quite a bit of restructuring, but we have not seen the end of it yet. Figure 4 shows a number of industries; two of them are technology intensive, but the argument applies just as well to other industries. It shows the concentration levels of the industries in number of countries, giving the market share of the top five companies in each country in the various industries. What it indicates is that in passenger cars the concentration level in most European countries is very high. You could conclude that we have therefore achieved economies of scale that make us competitive, but I think that would be the wrong interpretation. The right-hand side shows the 1992 scenario. If you take the economic borders away and make a very simple calculation of the market share of the top five competitors in Europe, you see that the concentration levels are quite a bit less.

Well, so what? I think that is a fair question. Consider this: We are now competing at a European scale, but to really be competitive at a world level companies will probably have to become even bigger. Therefore, there will be a lot more consolidation and concentration in most of these industry sectors. As a means of comparison, we have added the top five competitors in Japan and the United States in similar industries to the chart (Figure 5). You see that the automotive sector and also the other two sectors in Japan

and the United States have much higher concentration levels. From that it can be concluded that those companies are probably better positioned to compete in the world scale, at least in the industries where scale counts and where world markets are needed to be competitive.

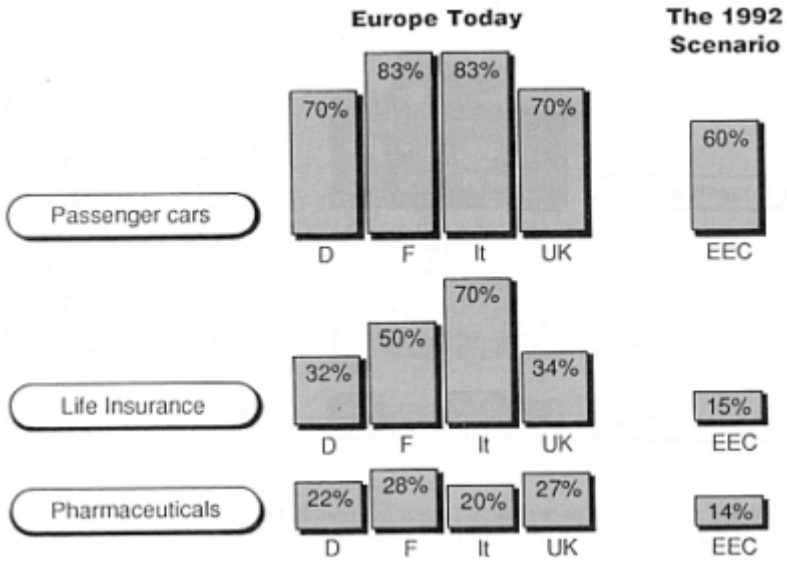

Figure 4 Industry Concentration Levels in Three Industrial Sectors: Market Share of the Top Five Competitors in the EC (D = Denmark, F = France, It = Italy, UK = United Kingdom).

Analyzing this for many industry sectors, you see a similar picture. I think the restructuring, the consolidation, of industries in Europe is by no means at an end. What we have seen so far is just a start. If industries really want to become competitive, a lot more consolidation will happen over the next several years. Even in an industry such as pharmaceuticals, which is one of the more fragmented industries, European companies are by no means large enough to compete on a global scale. Some of the moves of major pharmaceutical companies in the past year are a reflection of this situation.

Not only are European companies consolidating and becoming more powerful competitors in Europe, but there is a whole new category of competitors becoming extremely powerful; these competitions are a variety of Japanese companies coming to Europe at a very rapid rate. There are large numbers of Japanese businesses based in Europe, and most of these locations have

been set up in the past five to eight years. In the model for the European competitive arena, this is a major component: Not only will the much more powerful and larger European companies be more forceful in competing with U.S. companies doing business there, but there are also a fair number of very powerful Japanese companies that have come into the picture.

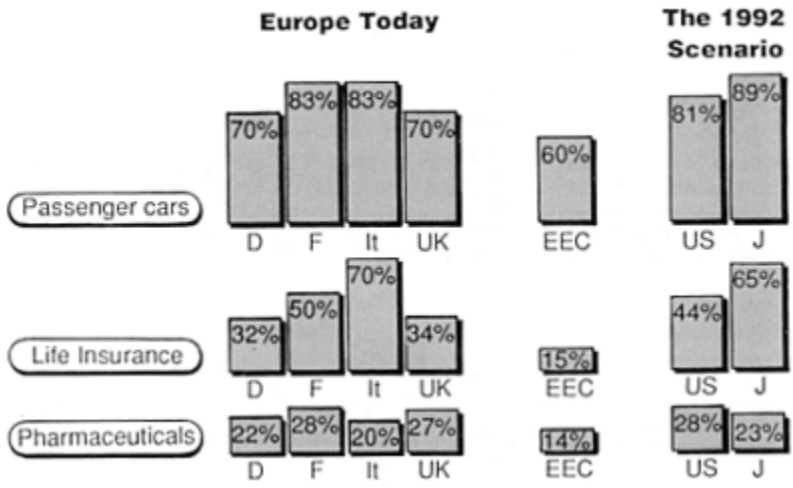

Figure 5 Industry Concentration Levels in Three Industrial Sectors: Market Share of the Top Five Competitors in the EC, United States, and Japan (D = Denmark, F = France, It = Italy, UK = United Kingdom).

Companies will have to change; they will have to become more international or global in their R&D orientation to support their international position in doing business. We can compare leading companies in Japan, the United States, and Europe to try to understand how international they are at the moment. What you see is interesting: Japanese companies, despite their world success, are actually not yet very internationally oriented when it comes to doing a significant portion of R&D outside Japan. This is changing rapidly, however. There are major changes going on in the automotive industry, in the direction of the United States and Europe, where Japanese companies are becoming much more active in doing R&D overseas.

European companies have usually been much more international in their operations. Certainly, the amount of R&D they do outside their home continent has been impressive. Among U.S. companies, there is quite a range. There are companies that hardly do any R&D outside the United States and work mainly on an export basis; there are also a fair number of companies that have kept their international research presence reasonably

well balanced with their international business activities. The example heard earlier about Ford is one that falls in that category—a company that has moved to keep its international R&D management very much in line with the needs of the business and the dynamics of the industry.

This picture will change quite a bit in the sense that Japanese companies will become a lot more international in their R&D activities. They will, therefore, also be competing for valuable R&D resources in Europe and the United States. There will be competition of a completely different nature: not necessarily competition for the consumer but competition for the top scientist. There is a very limited supply of scientists, and it is again the proactor, the company that is there first with a good R&D facility, that will have the ability to attract the top talent. This topic has not been covered much today, but I would like to stress it as a key issue for success in research and development in overseas markets.

If the world is changing as much as I have said, where does a company put its R&D resources? It depends on how mature the technology is and on how close to the consumer or to the end market a company must be to develop a product technology. If a company is working in embryonic or new technology areas that require much adaptation and customer specificity, the most logical location for R&D resources is close to key customers. The emphasis is on key—the leading customers—because one can do sophisticated development only if it is done for customers who are leaders in their industries. Or one must be very close to what we have called innovative technology sources, the basic centers of excellence in the academic world.

At the other extreme, in dealing with mature technologies that do not require much closeness to the customer, it is obviously more logical to have an R&D facility close to a plant, because the emphasis is optimizing the process rather than improving the product. This is one way of thinking about where to put R&D facilities. That is easier said than done. How does one look at European markets with this concept, and where does one put R&D resources? I think then there is the problem of the very heterogeneous, homogenized markets that will dominate in Europe.

The notion is that 1992 will bring homogenization. My thesis is that we will be less heterogenous in many respects than we are today. I do not think 1992 will do much about the fact that we already have about 100 centers of excellence. There is no one Silicon Valley. There is no one Route 28. There is no one energy center such as the one around Houston. Each country has quite a laundry list of its own centers of excellence. Therefore, if I wanted to put an R&D facility anywhere close to the source of talent, I have quite a variety of choices, and in many cases quality of living becomes an important selection criterion. Companies tend to pick nice areas, like the southern part of France.

It is an interesting situation to have a lot of good talent spread around the

market, but to get an R&D facility that has a certain amount of economy of scale, it may be a drawback to be this fragmented. Also, many people are not willing to move from one country to another. We will also have many different cultures, many more than languages. In a small country such as Holland, there are three to four different cultural regions that are very different. A country such as Belgium, even smaller, has two very different cultural regions. The number of cultures is well above 12. This is a barrier to homogenizing a science and technology and R&D community in Europe.

There is still very much a heterogeneous market despite the economic harmonization. If a U.S. company is considering deploying more R&D resources in Europe, the choice will still be extremely difficult. There is no one recipe for, say, an electronics company to go to southern Germany or if you are a pharmaceutical company to go to Ireland. There is no simple general rule, and the question of location has to be looked at for each company's specific situation. It is a very difficult choice but an important one.

The last question is, how do you think about what kind of resources to move around? Many businesses move from being strictly export based to being geographically customized global businesses. The simplest kind of company makes a standard product and ships it around the world. I guess in the early days of Ford, as we heard earlier, that was exactly what happened. Ford, however, has changed completely, because it has gotten to a situation of a global network of technology centers, acting very much as one network—a real global business.

It certainly has an impact on what kind of foreign laboratory or foreign R&D center you need, depending on where the business brings you. It is probably not necessary to move a major part of the R&D resources to Europe. It will depend on the dynamics of the business, and it is useful to think in these terms, where moving from a simple standard product shipped around the world to one that recognizes the centers of excellence in the various continents is a progression that your industry goes through. In that case the right kind of R&D deployment scheme is very much dependent on the state of the business and the needs of the market.

In summary, the industrial restructuring in Europe is driven only in part by 1992, but it is a definite change that brings a very different competitive arena. It is part of a global competition. It is a European-specific competition with linkages to the rest of the world, very global and changing rapidly. Also, you cannot really participate in that kind of a competitive game in the R&D sense if you sit in the United States and watch what happens in Europe; the name of the game is to participate in the appropriate way. My sense from a lot of the discussion today is that there seems to be somewhat of a fear that U.S. companies or U.S. institutions will be locked out, which is probably justified if you talk about it while you sit here.

My message is, if you want to be in the game, participate and do not only talk about it. We have to invite most of you over to Europe, because it is quite an exciting place to be right now.

MR. HOWARD: We have now had a chance to hear an EC government perspective on the possibilities for cooperation and competition, and we have had a business overview that essentially says that where you are going and what your strategy is depend upon specifics of the business. That is a good lesson.

We will now hear from a couple of company perspectives. First, a large company that is well established in Europe, has been for quite some time. We will hear from Jim Hubbard. Jim is the general manager of TI Europe and also the European semiconductor operations of Texas Instruments in Nice. He has 30 years of experience with TI semiconductor operations as general manager of engineering. He was manager of TI's U.S. computer industry operations and was previously in Japan and in charge of TI's Far East sales activities and opportunities as well.

MR. HUBBARD: I will address from a semiconductor viewpoint how we can look at Europe for the opportunities and the challenges as we see things evolving. It is a worldwide battlefield. Most of my remarks will relate to U.S. and European potentials and the economic and political changes that we have talked about and heard comments on today. Certainly, integration of the market will offer opportunities and challenges. The question is, how do we tackle this?

We are accustomed in the semiconductor business, for those of you who don't follow this industry, to ups and downs. We are more or less always looking at uncertain things; if we could ever forecast a certainty, I am sure we would all find a good reason to retire. Certainty is not in our mode of operation. As we look at the uncertainties that we can project in the total European scenario, related to such things as eastern Europe, we know there are going to be some opportunities. Of course, there is potentially higher economic growth there in Europe and certainly reduced business costs from such things as common standards, and there is a large potential reduction in costs from the freer movement of goods, from things like savings in paperwork and transportation costs. The prospects of more rapid technological innovations, are of course, very attractive.

On the other hand, we can look forward to some changes that will be a big challenge. The competitive pressures in some cases that have not been faced before and the intensity we will see will be quite significant, because governments will be asked to tolerate the possible loss of industries that they had considered indispensable in the past, because there will be tremendous pressure to protect certain markets for European companies.

To understand the competitive battleground, a few numbers from the semiconductor industry are helpful. Semiconductors are the driving force

for a worldwide electronics industry that is expected to be $2 trillion by the turn of the century; the semiconductor content of that $2 trillion will be about $200 billion. Looking at the market as recently as 1989, the market shares of the major players in the semiconductor business around the world are very interesting. Japanese companies now have about 50 percent of the total world semiconductor markets. U.S. companies have 34 percent. European companies have 11 percent, and the rest of the world companies have the 5 percent that remains.

There are some noteworthy differences by regions of the world in the composition of the semiconductor markets. For example, the computer segment in the United States is strongest. In Japan it is the consumer segment, and in Europe it is the telecommunications segment where you see the leadership in terms of equipment developments and the demand for leading-edge semiconductors. An even more revealing insight is possible when you examine the market shares of the companies in regional markets. For example, Japanese companies in Japan hold 90 percent of their own home market. They hold 24 percent of the U.S. market, and the Japanese hold 19 percent of the European market.

Looking at U.S. companies in these three regions, the U.S. companies own 66 percent of their home market, 40 percent of the European market, and only 10 percent of the Japanese market. European semiconductor companies have 37 percent of the market at home, 6 percent in the U.S., and 1 percent in Japan. The absolute level of market share coupled with the penetration in other than home markets gives a rough feel for the state of global competitiveness and regional differences in the semiconductor industry.

The 1990s can certainly hold some potential areas for conflict, and they are contained heavily within these regional market share numbers I have just quoted. The question is, will European companies, in an attempt to gain a larger share of their domestic market as well as a larger share of worldwide markets, put increasing pressure on the European Commission for special local content regulations and other trade barriers, thereby slowing or restricting access to the European market by non-European companies? This is an oft-asked question. Of course, it can be debated for a long time; it is something that we keep looking at, but this is somewhat self-defeating in itself.

Let's look at areas of potential cooperation, which I think we need to continue to focus on. What are some of the areas between the U.S. and European companies that might make sense? Of course, it has been mentioned many times that in order to compete or even to survive you have to think about global competitiveness, not competitiveness in any particular region of the world. U.S. semiconductor companies, for example, put between 10 to 12 percent of their annual revenues into research and development, and this is almost a minimum in our industry to stay in the race. The capital

cost of building a state-of-the-art wafer fabrication facility these days now exceeds $250 million and with each new generation of technology is moving up very rapidly. So the capital requirements for R&D say the scale of the cooperation has to be on the very high side.

These considerations obviously drive the cooperative potential between U.S. and European companies. For example, the possibilities for joint research and development may evolve from organizations such as SEMATECH and JESSI, if the proper support and push from industry trade groups such as the Semiconductor Industry Association and its counterpart in Europe continue to develop. Second, there are accelerating opportunities for strategic partnerships between U.S. and European customers, suppliers, and these days even competitors; because more and more if you make semiconductors, your customers are quite often your competitors as well. The combination can be a partner with your customer who may also be one of your key competitors. These alliances are increasingly mandatory to offset the very high cost of capital and R&D investments.

A third potential area of cooperation could, again, be in the definition of product standards, which has been discussed. How do we get European standards in areas such as high-definition television and telecommunications to the level that they are important on a global scale and enhance the cost-effectiveness and competitiveness potential?

How then can an electronics company prepare to compete effectively in this dynamic and certainly yet-to-be-determined scenario? At TI we think globalization of the electronics industry in total, and the semiconductor market in particular, drives the need for leading companies to be successful in that arena. Borrowing the often used global localization comment, it just states what is required. How can you meet local customer requirements for product differentiation and cycle time and still be able to leverage a global potential to serve customers to the best advantage?

Putting resources in Europe makes sense, not from a local content or regulatory point of view but so that one can be able to support local customers. The potential for competitive leverage, advantage, and differentiation is increasingly based on one thing: speed. Time-based strategies are the key to being successful in the 1990s. The best competitors in our industry these days are about equal on quality, on reliability, and on the ability to deliver products in a certain window. The game that is yet to be fought among the Japanese, European, U.S., and other competitors is in the area of time-based strategy execution. This drives logistics considerations all the way from R&D to manufacturing to the types of marketing plans that are developed.

Texas Instruments has been a part of the European market and economy for 30 years. We built our first factory in England about 30 years ago, and our resources in Europe put us among the top 150 high-technology firms in the region, with eight manufacturing locations, 32 sales and marketing offices

in 15 countries, six regional technology centers, around 7,000 employees, and more than $1 billion in annual revenues. We have experienced local managers in all our European locations, and they are a significant resource to us as we move into the post-1992 era, continuing to execute the essential transitions in our global and local networking of organizations. Our operations began in Europe with semiconductors. Today that is about 60 percent of our total revenue. In addition, we have industrial automation and control systems, business computer systems, consumer electronics products, defense electronics, metallurgical materials, and electrical control products in Europe.

All of our worldwide operations are connected with real-time communication networks, and if we use this properly it is a key asset in this time-based competitive need we have for the future. We intend to bring this capability to our customers in Europe at the point of use, in whatever village the customer is located in, and try to leverage our worldwide capability to do this.

In summary, I think the task at hand for all parties in the process of a European integration is to take full advantage of the opportunities we have heard about. They are going to continue to evolve for the next several years, and firm positions must be taken to meet the challenges because they certainly will appear also. There are a few points that I might offer to consider.

First, the European Commission must ensure that guidelines on such issues as local content, product standards, rules of origin, competition policy, and procurement are written and enforced in a manner that is nondiscriminatory to U.S. companies and others doing business in Europe.

Second, the U.S. government must counter unfair foreign trade practices and ensure improved access to worldwide markets through aggressive enforcement of U.S. trade laws. This is the best recipe for avoiding enactment of protectionist legislation. The U.S. government must also be prepared to work closely with the European Commission on safeguarding things such as intellectual property rights and on bringing the present round of GATT negotiations to a successful conclusion.

Third, European electronics companies will continue to consolidate and merge operations as necessary to get scale, to get technology leadership positions, to take advantage of shared investments and common standards, and so forth. Still, European companies will be looking outside Europe to acquire some of the technological, manufacturing, and marketing expertise that will be required to compete in the international marketplace. This will obviously be a move when you look at the market shares I mentioned earlier.

Finally, U.S. electronics companies must develop European strategies that allow increased emphasis on the localization of marketing and flexible production to accommodate customer demands. The European push to achieve technological parity with the United States and the Asia/Pacific region means that U.S. firms competing in Europe can afford nothing less than state-of-the-art technology and R&D, coupled with top-class customer support.

We at Texas Instruments consider ourselves to be a global company and an operator in the worldwide free enterprise system as well as a good European citizen. The recent watershed events in eastern Europe have demonstrated that the desire for free markets will eventually overwhelm those who seek to curtail them. The best competition policy we can request is equal access to all markets and the opportunity to compete fairly for all business, government or commercial. With this policy we can continue to contribute to the development of world-class technologies across Europe and around the world.

MR. HOWARD: We have now heard from a representative of a large established company in Europe in an industry that at one time was a newcomer but is now beginning to mature in its worldwide and global respects. We will now hear from Jim Wavle, who is with a new company in a new industry—the integrated biopharmaceuticals industry. Jim is president and chief operating officer of Centocor. He comes to this technical responsibility with a background as an attorney, working his way up through Warner-Lambert in the law department. He broke out of the law department, becoming senior vice president of Warner-Lambert and then president of Parke Davis, Warner-Lambert's pharmaceutical division. He oversaw major expansion activities within Parke Davis, including new research facilities in the United States and Europe. He joined Centocor as president and chief operating officer in November 1987 and is working on building this new company into a major biopharmaceuticals firm.

DR. WAVLE: Thank you. In preparing my remarks it was suggested that I consider the issue of cooperation and competition in Europe, 1992, from the unique perspective of my own particular company, Centocor. Unlike most of the corporations represented here, Centocor is not as yet a household word. In addition, the challenges faced by the highly regulated biotechnology and pharmaceuticals industries in which Centocor participates are somewhat different from those associated with semiconductors, telecommunications, or various heavy industries.

Therefore, it seems essential that I preface my comments by sharing with you a little background about who we are and what we do. Monoclonal antibodies were first produced in 1975, an achievement that subsequently earned a Nobel prize for Kohler and Milstein. Four years later, in 1979, Centocor was founded for the explicit purpose of utilizing this powerful new technology to create novel health care products targeted at unmet medical needs. To us it is axiomatic that the pursuit of a new technology with substantial commercial potential must be conducted on a global basis, in order to maximize the chances of receiving an adequate return on the research investment. Europe and America are of equal and paramount importance to global success, whether in research or in the commercialization process, and the significance of Japan is now apparent to all.

This global perspective is particularly critical for any company that wishes

to participate in the highly fragmented pharmaceuticals industry, where many large, well-financed, multinational players aggressively compete across a wide spectrum of research while strong national firms often hold predominant positions in local markets. By the end of the 1980s, more than 1,000 new biotechnology companies had been established, and the vast majority had deliberately chosen to place themselves at the service of the pharmaceutical giants to act, in effect, as contract research houses. We have taken the opposite approach. We seek to compete with the biggest companies in the industry by establishing an independent, fully integrated biopharmaceuticals company with our own research, manufacturing, and sales organizations in Europe and the United States.

We are convinced that we can successfully challenge the large drug companies provided we do two things very well. First, we must remain tightly focused on our specific technology and, second, we must maintain a keen awareness of the key factors for success in the pharmaceuticals industry. Thus, Centocor is a technology-driven rather than a market-driven company. Our goal is to establish a preeminent position in monoclonal antibody technology by placing ourselves at the forefront in the creation of tangible products from every important scientific advance in this field. Large pharmaceutical companies often begin a drug development effort by selecting a disease category and then choosing from the gamut of potentially applicable technologies. We, in contrast, start with monoclonal antibody technology and then pick the disease targets this technology can most effectively address.

This approach allows us many synergies, and yet it does not restrict our ability to have a potentially major impact on public health. We have a wide range of antibodies with utility in diseases for which current therapies are inadequate, including cardiovascular, autoimmune, inflammatory, and infectious diseases. Because our objective is to build an independent pharmaceuticals company, we study the strengths of the industry leaders in every facet of the business, and we look for competitive advantage wherever we can discern weakness, whether in product opportunities or in industry structure. These analyses are essential to strategy formulation for key areas such as basic research, product and process development, clinical development, regulatory affairs, manufacturing, marketing, sales, and finance.

In our view, management is of crucial importance in all of these endeavors. Our management team is highly experienced in every aspect of the pharmaceuticals industry, with veterans of most of the multinational pharmaceutical companies, whether American or European. At least 15 nationalities are represented among our senior managers in the United States and perhaps a dozen in Europe. Nearly half of the members of our board of directors and senior management team are Europeans. The vast majority of our senior management team has extensive international business experience. We believe this experience is critical to success in the global marketplace and to

the formulation of global strategies addressing every key success factor for the pharmaceuticals industry.

In terms of basic research, our strategy is rather straightforward, whether in Europe or in the United States: Cooperate with academia and compete with industry. In biotechnology, research is conducted on a global basis. We maintain an extensive network of collaborations with academia, the source from which so many of the advances first emerged. In fact, Centocor has arrangements with researchers at more than 50 different institutions. We strive to work with the world's leaders in every field of antibody research; thus, not surprisingly, we have dozens of collaborators in Europe. To date, our research efforts have not been significantly encumbered by government research policies in either Europe or the United States. It is essential that the research environment remain open if we wish to allow people to benefit from the latest advances in biotechnology.

In this regard we hope the EC will not see fit to condone or expand upon the policies of some member states, which have sought to favor local research by allowing more generous price reimbursement for those pharmaceutical companies that conduct research within their national borders. Such policies clearly have the potential to distort research and could be prejudicial to small, young, research-intensive companies such as ours.

If government is to enhance the research process, it is essential that strong patent protection be expeditiously provided to inventors. We believe that the so-called patent restoration efforts in Europe, as in the United States, are appropriate and necessary for pharmaceutical products. Governments need to reward inventors who develop new pharmaceuticals that both enhance the quality of health care and address the concerns of public and private payers who wish to improve the cost-effectiveness of the health care systems in the United States and Europe.

We believe that the European patent office is working very effectively and that patent offices on both sides of the ocean are performing in an evenhanded manner without national bias. Our hope would be that the U.S. government might follow Europe's lead and provide our patent office with the resources necessary to expeditiously handle the burgeoning load of biotechnology cases.

Clinical development, like basic research, cannot be limited by national borders. One of the key factors for success in the pharmaceuticals industry is the ability to conduct well-designed and well-controlled clinical trials. This is crucial in the development of antibody pharmaceuticals because in vitro studies and animal models have proven to be of limited utility in assessing the activity of antibodies. Thus, often, meaningful data can only be gathered in humans. Our collaborators in Europe and the United States have been of enormous assistance to us in rapidly exploring the clinical activity of new antibodies.

Our research and clinical development activities have been greatly assisted by the very high level of scientific knowledge within both the FDA'S center for biologics and the regulatory agencies of the EC member states. The regulatory standards are likewise uniformly high. Importantly, we have not detected significant favoritism or national bias in any of these agencies. We trust this will always remain so and are unaware of any proposals that would make us doubt that this would be the case.

In regard to regulatory policy, our most fervent wish would be that the administration and the Congress might come to recognize the urgent need to provide the FDA with a very substantial increase in the resources needed to carry out its broad mandate to promote and protect public health. In Europe, Centocor is the beneficiary of an enlightened regulatory environment. All of our products are biopharmaceuticals and thus are governed by the new high-technology concentration procedure. The 12-nation CPMP and its biotech working party are working very effectively. The CPMP has established comprehensive guidelines for biotechnology products such as ours, and its members are driving themselves hard to ensure that marketing approval applications are reviewed expeditiously.

Thus, Centocor is fortunate to have its European destiny governed by one of the most forward-thinking multinational groups to have emerged within the EC. While we do very deliberately praise the high-technology concentration procedure with respect to the CPMP review process, the time taken by some member states to issue the national licenses required for marketing has been disappointing. In this regard we view very favorably proposals by the Commission to establish a European agency for evaluation of medicinal products, with the power to directly issue EC marketing authorizations. We will continue to see competitive advantage in our ability to deal rapidly and flexibly with the evolving European systems.

In building the organization needed to develop and commercialize our technology, we have taken a somewhat novel approach. From the outset we have been attempting to build a European-American company or an American-European company. The order is irrelevant. We conduct our operations from two major sites, one near Philadelphia, the other in Leyden, Holland, where we built a major mammalian cell culture development and manufacturing facility five years ago. We consider both to be part of corporate headquarters and have linked them together through a heavy investment in information systems. We tell our employees that the geographical center of our corporate headquarters is located somewhere in the middle of the Atlantic. Psychologically, there is a very big difference between a headquarters group and a subsidiary group. We are trying to cut through the internecine warfare that consumes so many large companies and instead focus everyone on the external objectives that must be achieved as research, manufacturing, and marketing activities are carried out at both of these locations.

For Centocor, 1992 arrived in 1989, when we launched our first pharmaceuticals product in Europe. For Centocor, Europe is already a single market. We recognize that many of the liberalizations scheduled for 1992 have not as yet come to fruition and that certain important barriers are unlikely to fall for many years after 1992. Nonetheless, as a young company in the biotechnology industry, we believe it would be foolhardy to wait for the calendar. The possibilities that other companies anticipate in 1992 we see as today's realities.

Thus, while some companies continue to plan for 1992, Centocor has already begun implementing actions designed to take advantage of the benefits of a single European market. To a large extent, this is a function of our youth. Well-established pharmaceutical companies are saddled with unwieldy and inefficient infrastructures. They have networks of companies, personnel, and facilities born in an age of major trade barriers and regulatory constraints. It will be years before they can sort out the social, fiscal, and operational problems associated with the restructurings that will be essential before they can fully avail themselves of the relaxation of trade barriers scheduled for 1992.

This fact offers Centocor an enormous competitive advantage, and we are rapidly capitalizing on it. At Centocor we manage Europe as if it were a market to the maximum extent possible. To comply with current legal and fiscal requirements, we have subsidiaries in each of the major countries; however, all operate under the Centocor name. While these Centocor companies give us a local presence and employ the sales representatives who call upon physicians and hospitals, all of their activities are supported from a single location in Leyden, Holland. If a physician or another customer has a question about a Centocor product, he or she calls a local number in their own country, but the call is answered by our multilingual staff in Leyden, who speak in the appropriate language depending upon the color of the phone that is ringing.

Likewise, warehousing, shipping, billing, and other services are all handled by a single support group on behalf of the appropriate subsidiary. Although these may seem to be mere details, when added together they become quite important. Furthermore, they are indicative of a management philosophy that seeks to reduce operating costs while optimizing efficiencies and emphasizing customer friendliness wherever possible. To operate in this fashion, we have had to make substantial investments in information systems. We believe that these investments give us the ability to compete very effectively with the large companies without duplicating their enormous infrastructures in each of the European countries.

Many issues that impinge upon our ability to function effectively are still to be fully addressed in Europe. We have a very high level of computer literacy within Centocor, with more than 80 percent of our 600 employees

in Europe, Japan, and the United States as registered users of information systems, including electronic mail and sales force automation systems. Yet the degree to which telecommunication standards and regulations on cross-border data transmission will restrict their utilization remains to be seen.

Unlike some new companies that are attempting to match the organization structure of the established pharmaceutical companies in Europe, we are seeking every opportunity to operate in a far more efficient manner. Yet there are pricing and reimbursement formulas in some countries that are keyed to work done within their borders and thus may reward those with costly and inefficient structures while punishing those who attempt to eliminate or, in our case, avoid the creation of duplicate infrastructures in their countries. We trust that the correct answers to these and other similar questions will be forthcoming over the years ahead.

Last night at dinner I could not help but notice the words over the door in the Great Hall of this Academy: "Hearken to the miseries that beset mankind. And if ever a man fell ill, there was no defense but for lack of medicine they wasted away until I showed them how to fix soothing remedies wherewith they now ward off all their disorders." It is one of the joys of biotechnology and pharmaceuticals research that we labor in this tradition. By providing a nourishing environment, government can greatly facilitate these efforts. This is of critical social importance, for I believe that biotechnology and pharmaceuticals technology in general offer the most cost-effective weapons in the entire health care armamentarium.

I myself am convinced that the free enterprise system, democratic capitalism, call it what you will, has a far greater capability of bringing more and different new pharmaceuticals to the market than we would ever see if a few centrally controlled research laboratories were responsible for all new drug development. Government policies that enhance this independent and creative process should be encouraged everywhere but most certainly among the countries of the European Community and the United States of America.

MR. HOWARD: I would like to open the floor now to questions. We are limited to two or three questions in the interest of time, and then we will close this symposium.

MR. AISENBERG: Michael Aisenberg, Digital Equipment Corporation. I am struck that Michel Carpentier has taken the opportunity to leave, because my question was going to be the most difficult one for him to answer. I was struck that all three of the subsequent speakers were very focused on the ability of public policy to address concerns that U.S. businesses may have with the EC 92 changes. Mr. Carpentier seemed to gloss over the importance of trade-based concerns and focus on the limited area of research cooperation. There is an ongoing effort within the office of the U.S. Trade Representative right now to develop a bilateral dialogue with the EC on a range of trade issues. I would like the gentlemen on the podium who seemed to touch on

some of these to address what they think might happen at the political level as we look at EC 92 and whether Mr. Carpentier was indeed sidestepping the question of some fundamental concerns on areas such as tariffs, rules of origin, standards, and intellectual property rights.

MR. HOWARD: Can I make one comment, before I answer—that is that Mr. Carpentier had to apologize. He did have a previous appointment, and we are running a bit late. That was not an attempt to sidestep any of the issues. Can I ask if our panelists have comments?

DR. VAN DOESBURG: I do not think I have a lot to add in terms of the political aspects around research at the European scale. I think in my presentation I focused mainly on the need for R&D organizations to be properly deployed across borders, where that makes sense from a business perspective. I do not think I am in a situation to comment on what then the requirements are for policymakers to prearrange things so that all that can happen. I guess the key thing that I would want to leave on the table is that rather than intensifying the debate over a lot of technicalities about policies and the political issues around them, my sense is that the whole policy debate could probably be a lot more productive if it focused on the real needs of businesses rather than on trying to get political equality on all scores. My sense is that not all issues that are being debated are equally important for companies to really establish a European network. I think the last speech is probably one of the better ones to address that point. What are the things that really need to be addressed to make companies like Centocor and others really succeed in a very international way as they are obviously operating?

In summary, my plea would be to try to take a hard look at all the issues that are being debated in the political arena and make sure that they do indeed have a direct relevance to the key problems that industries are facing when they are trying to operate in a very international way.

MR. HUBBARD: I think it is very important, as we have said many times, that business take the leadership with the governments and that in the United States or Europe we have to be very careful that we do not allow these artificial things to develop, the trade barrier issues. We must keep highlighting this and pointing out the real competitive nature of businesses and whether you are doing harm or gain by these types of things, like local content issues. I think the question was asked earlier today, when you set up an artificial barrier, the real competitor gets inside the barrier very fast anyway, so what have you accomplished? You have to always keep this type of thing in mind and then you kind of come to the right conclusions.

DR. WAVLE: I think it is always a question of, is the cup half full or is it half empty? There are those who can look at Europe 1992 and see a threat. I think it should be viewed, as many speakers have said before, as an enormous opportunity. While there will always be individual cases and

particular circumstances where governments will have an interest that they are seeking to protect, I think what we see on the part of the European Community and the member states is a good-faith effort to proceed in a far more open fashion. Those who feel they are being disadvantaged had better spend some time in Brussels and visiting with the particular member states and working with the many trade associations that are represented here. There obviously is not one overall solution, but I think there is a willingness on both sides to accommodate each other and obviously this forum is a good indication that we are well along in that process.

MR. SIMON: Greg Simon, House Science Committee. One issue that I did not hear discussed this afternoon was the impact of the eastern bloc changes. There are two or three premises to my question. First, the premise that for some time now the question of whether the EFTA nations should be allowed to join the EC has been complicated by the fact that a lot of civilian research in the EC had connections with NATO, because of the increasing connection between military research and civilian research. So that there was a complication there, and the COCOM restrictions fed into that. Now that NATO really has no one to play against and will take a lesser role in the European sphere, the question arises about the relationship of the eastern bloc countries to the European Community—which may now be a misnomer; it is now the European semi-Community if we open up Czechoslovakia, Poland, Hungary, Bulgaria, and Rumania to western or at least neutral status. What is a U.S. business, what is a European-based business, to make of the fact that as the trade barriers fall in the European Community nations, similar barriers of the past that were in the European Community may now be rising in the eastern bloc countries? Given the inequality that already exists among European Community nations economically, and the need to bring regions up to some level of equality, and the difficulty in doing that and bringing up the eastern bloc countries at the same time, should there be a new alliance of the eastern bloc and the EFTA countries, possibly centered in Vienna? How would that group relate to the concerns you raised today about how U.S. companies should address trade in Europe, since it seems that trade in Europe now also implies that a lot of capital will be fleeing to Prague and Warsaw that earlier was intended for Amsterdam or Brussels?

MR. HOWARD: I think you may have defined the subject of our next symposium! Any comments on the eastern European developments?

DR. WAVLE: My comment would be that when we look at eastern Europe this is a situation where government has a major role to play. While I personally am delighted, and I think we all are, with the political changes, we also have to recognize that the economies there are in such desperate shape that chaos could result unless there is concerted international action. That is my view. Until they have a basic economy, I do not think that many

business opportunities will blossom. Unless we see concerted action by the European Community, the United States, and probably Japan as well, to assist in a far more major way than anyone is talking about, I really am concerned about the course of events in the next few years.

DR. VAN DOESBURG: You are talking about free trade or trade barriers. I think if you look at it a bit more in the context of today's symposium, which really deals with research and development, my opinion is that all of the eastern European countries are in desperate need of economic repair. That is nothing more than getting basic productivity up to a level where they can compete. If you take some very simple numbers and you look at, say, East Germany, which has the best economy in eastern Europe, productivity is exactly half of what it is in West Germany. So if you want to bring that up to a competitive level, you could basically do away with half the work force overnight, provided you could then make products that can stand the test of quality.

To get the rest of the work force productively employed, you would have to sustain an economic growth rate that is well into the double-digit numbers. As far as I remember, there have been very few countries that have sustained double-digit growth rates for any length of time. That puts the challenge of getting the economies in any kind of shape into somewhat of a perspective. It is a humongous task, not only to repair the economies but to get the environmental situations up to snuff. If you look at the enormous problems in virtually all these countries, there are environmental conditions that did not even exist anywhere else in the world many years ago.

It really is a very bad situation. Before those nations can play any role in terms of a research and development opportunity or base or source, I think you are probably talking well into the next century. Trade flows to a limited extent will really be from those countries into western Europe. You can probably only do that with groups that can stand the test of quality. I do not think there is any western European consumer prepared to pay for goods that are inferior in quality. First you have to get beyond the whole problem of barter trade and things of that sort; those things need to be ironed out first. Get the economies in decent shape, and solve the environmental problems; that is the sequence of support to eastern European economies.

I do not think that at this stage of the game it is fair to even worry about what all the developments in eastern Europe will mean for the R&D community. Not even in situations where—and you are right, those things are going on—European companies are at the moment not investing, say, in Spain or Portugal but are starting to invest in East Germany. A lot of that is strictly manufacturing investment, because they are trying to get access to the low labor costs and see that in a way as economic support for East Germany. I do not think that is necessarily a leadership type of investment in new

technological developments. It is strictly accessing a temporarily cheaper source.

MR. HOWARD: With the recognition that there are more questions and an apology because of a lack of time, I would like to close this symposium and briefly draw together a couple of the threads that we have heard in the last several days.

We have listened to the background and mechanics of the formation of the EC and the formation of its R&D policy and strategy. I have particularly appreciated the candor and openness of the discussion. It made it a fascinating symposium. In listening to the responses on each side, it is clear that both the United States and the EC desire closer cooperation. In order for that to happen, we have to look at the basis on which we do business and redo a lot of the bilateral agreements and a lot of the multilateral agreements that govern our relationships. We have to move forward to ensure that these relationships remain intact and that we revitalize them.

We certainly face many challenges in this area. The definitions of research and development are undergoing all sorts of changes as we uncover what really is precompetitive and what really is generic technology. As we begin the search for solutions, hopefully the opportunities for cooperation and the possibility for effective competition will be strengthened on a worldwide basis for both communities.

U.S. and European industry must lead the way in this process, because I believe that we both have a better attitude toward cooperating than some of the other competitors we sometimes meet in the world. To do so, our system must be bolstered by improved education systems in the sciences, increased flexibility in regulations, and fair terms for cooperation and competition. We must realize the fact that in many cases, as one of our speakers stated in this last session, nothing beats starting to work, seeing where the problems arise, and then working to solve those problems.

I want to thank everybody involved in this symposium for their interest and their participation and you, the remaining audience, for your patience. In particular, I wish to recognize the National Research Council's Office of International Affairs, especially Patrice Zechman and Mitch Wallerstein, for their close collaboration with the Academy Industry Program in establishing the program that is behind this symposium. I would also like to thank the Academy Industry Program staff, particularly Deborah Faison, who provided most of the logistic support for this program.

APPENDIXES

Appendix A

Agenda

MARCH 5, 1990

12:00 p.m.	Registration	
2:00 p.m.	Welcome	Frank Press, President, National Academy of Sciences
2:10 p.m.	Science and Technology and European Market Integration: Changes and Continuity	Filippo Pandolfi, Vice President, Commission of the EC and Commissioner for Science, Research and Development, Telecommunications, Information Industries and Innovation, Joint Research Center
	Views and Concerns of the U.S. Science and Technology Community	Erich Bloch, Director, National Science Foundation
	Open Discussion	

3:30-5:00 p.m.	Access to Precompetitive Research Programs of the European Communities	H. Guyford Stever, Chair, Corporate Director and Science Consultant Paolo Fasella, Directorate General XII, Science, Research and Development, Joint Research Center, EC Research and Development, Joint Research Center Jean-Jacques Duby, Group Director of Science and Technology, IBM Europe Josef Rembser, Director General for Research, Federal Ministry for Research and Technology, Federal Republic of Germany James Holderman, President, University of South Carolina, and Chairman, National Science Board Task Force on EC 92
	Open Discussion	
6:00 p.m.	Reception	
6:30 p.m.	Dinner	
7:30 p.m.	After-Dinner Speaker	Lee Hamilton, Chairman, Joint Economic Committee, U.S. Congress, and Chairman, Subcommittee on Europe and the Middle East, Committee on Foreign Affairs, U.S. House of Representatives
	Open Discussion	

MARCH 6, 1990

8:30 a.m.	Continental Breakfast	
9:00 a.m.	The 1992 European Market Integration: Bush Administration Policies	D. Allan Bromley, Assistant to the President for Science and Technology, and Director, Office of Science and Technology Policy
	Respondent	W. Arthur Porter, President, Houston Area Research Center
10:30 a.m.	Break	
10:45 a.m.	EC Standards Setting, Certification, and Testing Processes: Roles and Implications for U.S. R&D-Intensive Industries	Ernest Ambler, Chair, Director Emeritus, National Institute of Standards and Technology
		Jean-Pierre Contzen, Director General, Joint Research Center, EC
		Ivan Dunstan, President, European Committee for Standardization
		Joe Bhatia, Vice President for Government Affairs, Underwriters' Laboratories
		Manuel Peralta, President, American National Standards Institute
	Open Discussion	
12:15 p.m.	Lunch	

1:15 p.m.	Strategic Implications of European Market Integration for U.S. R&D-Intensive Industry and the Science and Technology Base	Thomas Niles, Chair, Ambassador to the U.S. Mission to the European Communities
		John McTague, Vice President Research, Ford Motor Company
		Richard Barker, Partner, McKinsey and Company
		Winston Wade, President, Information Technologies Group, U.S. West, Inc.
		Richard Cooper, Department of Economics, Harvard University
	Open Discussion	
2:45 p.m.	Suggested Strategies for U.S.-EC Cooperation and Competition	William Howard, Chair, Senior Fellow, National Academy of Engineering
		Michel Carpentier, Director General, Directorate General XIII, Telecommunications, Information Industries and Innovation, EC
		Hans van Doesburg, Vice President for European Operations, Booz Allen and Hamilton
		James Hubbard, Senior Vice President, Semiconductor Group, and Manager, Semiconductor Europe, Texas Instruments, Incorporated

		James E. Wavle, Jr., President and Chief Operating Officer, Centocor, Inc.
	Open Discussion	
4:15 p.m.	Closing Remarks	
4:30 p.m.	Adjournment	

Appendix B

Science and Technology and the 1992 European Market Integration: Implications for R&D-Intenstive Industries

*Patrice Zechman**

PART I. OVERVIEW OF THE EUROPEAN COMMUNITY AND ITS ROLE IN SHAPING EUROPEAN R&D PROGRAMS

Background

For observers of the rapid changes in Europe today, there is little doubt that the drive and momentum of the 1992 activities are creating a climate of increased competition in many areas, including research and development. The role that the Commission of the European Communities plays in the stimulation of this climate is under continuing discussion in the international science and technology community. There appears to be a consensus within the CEC that its role be to facilitate, coordinate, and disseminate R&D activities, thereby representing a positive addition to science and technology resources available in the 12 member countries.[1]

The Cockfield White Paper of 1985,[2] the Single European Act of 1986,[3] and expenditures committed to the Framework Program[4] are fundamental to the CEC's mandate to strengthen the scientific and technological basis of European industry and encourage it to become more competitive at the international level. To ensure economic growth through industrial development, the CEC acts as a mechanism to accelerate the tendencies toward cooperation and collaboration among industry, research centers, and universities. Governed by the overriding principle of "subsidiarity,"[5] CEC projects and programs must demonstrate value added from a Community perspective over and above what could be achieved at the purely national level.

* Patrice Zechman, Office of International Affairs, National Research Council, January 1990.

Table A-1 shows R&D funded by the CEC in 1987 as well as levels of funding in each of the 12 member countries. The percentage of funding by objective is the most revealing. The two areas receiving the most emphasis by the CEC are energy and industrial productivity and technology. Although total CEC R&D funding is small, the contribution is enhanced by identifying priorities where no single nation can afford to pursue forefront research. Research quality judged from a wider perspective strengthens the science base of each participant by concentrating available resources within the Community structure.

Programs

The challenges of an expanding role for the European Community in R&D are well illustrated in the emphasis and growth in the Framework Program. This umbrella program (see Annex 1) is directed by legislation to provide overall principles and objectives for the improvement of industrial competitiveness. On December 15, 1989, political agreement was reached (with final agreement expected in early in 1990) for funding the next phase (1990-1994) of the program as outlined below:

Enabling technologies:	ECUs	$U.S.
Information and communication technologies	2,221	2,532
Industrial and material technologies	888	1,012
Management of natural resources:		
Environment	518	590
Life sciences and technologies	741	845
Energy	814	928
Management of intellectual resources:		
Human capital and mobility	518	590
Total (million)	5,700	6,497

Under the first heading, information and communication technologies receive the largest portion of total funding, followed by industrial and material technologies, together equaling approximately 55 percent of the total 5.7 billion ECUs. The "industry-led" nature of the Framework Program is very clear. Research is tied directly to the goals of the Single Market, both to necessitate improved trans-European capacity and international competitiveness.

Examples of R&D at the Community level can be found in the enabling

TABLE A-1 Breakdown of Provisional 1987 R&D Budgets of the CEC and 12 Member Countries

		EC	B/L	DK	D	GR	E	F	IRL	I	NL	P	UK
	Total Financing in 100,000 ECU*	7.77	6.73	5.77	107.86	1.13	8.91	106.05	1.12	47.55	17.86	1.15	65.86
	Percentage by Objective %												
1.	Exploration and exploitation of the earth	0.7	3.1	1.5	1.9	7.1	7.7	1.4	0.6	1.4	0.6	9.0	1.7
2.	Infrastructures and general land-use planning	0.6	0.7	2.3	1.9	0.3	0.2	3.2	4.2	0.8	4.6	10.5	1.6
3.	Control of environmental pollution	5.3	2.2	1.3	3.3	2.1	2.0	0.4	1.0	0.9	3.1	3.4	1.5
4.	Protection and improvement of human health	2.8	3.0	4.8	3.2	7.4	8.6	3.6	3.9	4.5	2.5	0.2	3.3
5.	Production, distribution and rational utilization	51.6	9.5	4.4	8.7	3.6	3.1	6.7	1.1	11.1	4.0	4.7	3.6
6.	Agricultural productivity and technology	1.5	7.6	8.5	2.0	26.0	6.7	3.6	24.2	3.5	4.3	14.2	4.3

TABLE A-1 Breakdown of Provisional 1987 R&D Budgets of the CEC and 12 Member Countries

		EC	B/L	DK	D	GR	E	F	IRL	I	NL	P	UK
7.	Industrial productivity and technology	33.2	12.8	16.2	15.3	11.2	21.5	10.6	27.2	19.1	17.6	6.2	9.9
8.	Social structures and relationships	1.1	0.5	3.6	2.3	7.3	0.9	2.7	10.0	1.2	2.4	1.3	1.2
9.	Exploration and exploitation of space	1.5	9.8	2.6	4.9	0.4	8.8	5.9	2.3	9.3	2.8		2.6
10.	Research financed from general university funds		22.3	32.1	31.5	25.3	19.8	12.0	23.0	31.9	40.7	30.5	15.3
11.	Non-oriented research	1.8	23.6	22.3	12.3	6.7	8.5	14.7	2.4	6.6	10.3	0.5	3.3
12.	Other research		3.8		0.1	0.2	3.4	1.0		1.9	4.4	19.5	0.3
	Total financing of civil R&D	100.0	98.9	99.6	87.5	97.7	91.1	65.9	100.0	92.2	97.2	100.0	48.8
13.	Defence	0.0	1.1	0.4	12.5	2.3	8.9	34.1		7.8	2.8		51.2
	Total Financing	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* European currency unit (1 ECU = U.S. $1.14 as of 12/1/89).
** EC = European Communities, B/L = Belguim/Luxembourg, DK = Denmark, D = Federal Republic of Germany, GR = Greece, E = Spain, F = France, IRL = Ireland, I = Italy, NL = the Netherlands, P = Portugal, UK = United Kingdom).
Source: Office for Official Publications of the European Communities, *Government Financing of R&D 1980-87*, Luxembourg, 1989.

technologies category, which is part of ESPRIT. The goals of ESPRIT are (1) to help the European information technology industry with the technology base it needs to meet competitive requirements, (2) to promote European industrial cooperation in information technology, and (3) to contribute to the development of internationally accepted standards. As part of the ESPRIT program, the Community has launched ENS, a program that will link all the electronic networks of Europe into a single supranational structure. The idea for ENS evolved from the need for collaborative research in information technology between industry and academia. The free movement of information is viewed as critical to the realization of the free movement of goods, services, and people.

The supernode "fifth-generation" computer is considered one of ESPRIT's most important successes. Capable of handling concepts and ideas instead of numbers, the supernode has been developed by groups in Britain and France. The parallel architecture of this supercomputer has already been exploited as a commercial product and, in the view of some, has given Europe a lead over Japan and the United States.

Some have also suggested that European information technology will be the largest economic sector in Europe by 1993, and almost two-thirds of other industrial and service sectors will depend on it for their efficiency and competitiveness. Although the budget for ESPRIT is comparatively small (approximately 5 percent of the R&D expenditure of the information technology industry), it has measurably increased information technology activity by persuading European industrialists to tackle R&D projects they would not otherwise have attempted. Evidence of this can be seen in the microelectronics and software sectors, which have responded by creating highly competitive multinational firms.

The second category set out under the Framework Program is the management of natural resources, representing approximately 36 percent of the total funding under the next phase. Environment, life sciences, and energy are all transborder issues. The CEC has responded to increased pressure from growing national environmental interests by forming a European Environment Agency. In addition, the CEC has taken on issues of auto pollution, water quality standards, and "polluter pays" legislation, to name only a few. Whether CEC's role will be scientific or operational is yet to be determined, but the challenge of enforcing environmental legislation will be the proving ground for its effectiveness.

Projects in the life sciences include quality of life categories in medical and health issues, radiation protection, and human genome analysis, as well as biological resource areas of biotechnology and agroindustrial technologies. As an example of CEC legislation, directives for genetic release by the 12 member countries were approved in the fall of 1989. It provides for national authorities to assess the environmental effect of releasing genetically altered organisms.

Though receiving slightly less emphasis in the new phase of the Framework Program, energy research is identified for development. Examples of programs in this category are radioactive waste management, decommissioning of nuclear installations, remote handling in hazardous environments, controlled thermonuclear fusion, and nonnuclear energy.

Under the last category of management of intellectual resources, human capital and mobility make up the final 9 percent of the total funding of the 1990–1994 phase of the Framework Program. Concerns for the quality, mobility, and concentration of scientific personnel play an integral part in the future of the Single Market. The long history of collaboration and cross-fertilization in the scientific community may well aid this effort, although national disputes remain on the protection of human resource capital.

The *Communication from the Commission* dated June 1989 entitled "A Framework for Community RTD[6] Actions in the 90's" balances observations of the European Community's activity in R&D against the backdrop of national and international priorities:

> The strengthening of the European R&D efforts in the 1990s does not at all imply a greater centralization of planning and support. Individual regional and national actions will fully retain their importance; and a number of different mechanisms for coordination and support will continue to evolve. The diversity of national expertise and specialisation in Europe is one of the Community's assets. But not only are there national benefits from giving a European dimension to nationally planned and managed R&D efforts. In many cases it will be much more cost-efficient to pursue a specific R&D objective in the Community framework, rather than develop separate and competing sub-critical national efforts. There are also areas where R&D is needed specifically in support of other Community policies (for example, standards and environment in particular). In these areas Community-level R&D will be a more natural and appropriate frame of reference than either national or bilateral efforts.

PART II. SELECT U.S. INDUSTRY AND GOVERNMENT RESPONSES TO EUROPEAN MARKET INTEGRATION

Overview

In a survey done by KPMG Peat Marwick in the fall of 1989, U.S. executives expressed mixed concern about European market integration. Of the 872 responses from senior executives of U.S. manufacturing high-technology, merchandising, and transportation firms, only 17 percent had actually implemented plans to strengthen their position in the European Community. In his article "Strategies for Survival in Europe in 1993," Peter Drucker summarizes one of the main concerns for those who have yet to implement plans:

> Altogether the most important decision a European company has to make—but also an American multinational operating in Europe—is whether the Common Market will be primarily a market of competing national economies or of competing European businesses. (*Wall Street Journal* , July 12, 1988, p. 32)

Realizing their stake in the outcome of Single Market initiatives, many U.S. companies are becoming more active (if only in response to the uncertainty) in the European Community through various investment mechanisms. The fact that North American and European Community companies accounted for more than 95 percent of all cross-border acquisitions (in the 12 months ending September 30, 1989), according to another Peat Marwick survey, is evidence of this trend. As U.S. industry examines its strategy, the question of ownership may not be as critical an issue as where the know-how or design capability resides for determination of successful investment.

U.S. and European alliances in the high-technology sector have been under discussion as a mechanism to bolster market strength to compete better against Japan. These alliances would be difficult for a number of reasons. For example, considering U.S. government and European-funded R&D projects, would public funding by either party underwrite technology advances by other governments? Will "technonationalism" be a barrier to strategic cross-border alliances? Problems with reciprocal access, intellectual property rights, restrictions on technology transfer, antitrust, and product liability are only a few of the major corporate concerns. In the case of the U.S. SEMATECH[7] and European JESSI[8] programs, cooperation in semiconductor technology has not provided full reciprocal membership, as many had hoped. Instead, cooperation on select projects and development of technical standards have been the allowable extent of participation.

Select U.S. Government Responses

In November 1989 the Senate Task Force on the European Community 1992 made the following 10-point policy recommendation concerning U.S. interest in the emerging directives and rules of the European Community:

1. Promote the positive evolution of EC 1992 through U.S. objectives in the GATT Uruguay Round.[9]
2. Recommend that the EC not adopt policies that force firms to abandon sales to Europe in favor of investment in Europe.
3. Address concerns of small and medium-sized businesses.
4. Pay careful attention to standard setting.
5. Increase burden sharing of western security by the EC.
6. Increase cooperation by U.S. and Europe on environmental issues.
7. Increase staff commitment in the U.S. mission in Brussels.

8. Improve the administration's internal coordination of the U.S. response to EC 1992.
9. Establish an intergovernmental group to represent U.S. concerns regarding EC 1992 developments.
10. Begin to look at implications of European economic and monetary union.

Other U.S. government agencies and advisory boards have identified sectors and specific areas of concern. For example, the International Trade Commission report, *The Effects of Greater Integration Within the European Community on the United States* (July 1989), identified machinery, automotive, computers, banking, insurance, chemicals, telecommunications, and medical equipment as sectors most likely to be affected by market integration. The Advisory Committee for Trade Policy and Negotiations report entitled *Europe 1992* flags rules of origin, public procurement, product standards, testing and certification, technology transfer, local content, and reciprocity as significant issues in which the United States has substantial interest. The report further points out that "public focus in the United States on 'Fortress Europe' impedes understanding of actual developments in Europe and is therefore counterproductive." Suggesting the United States should support and encourage the successful promarket constituency of the 1992 activities, the Advisory Committee recommends the U.S. government should

- keep pressing the EC to make its rules clear, predictable, and free of local content clauses;
- use renegotiations of defense agreements as leverage to ensure that U.S. industries can compete for government projects;
- formalize and clarify agreements that ensure the EC will not set standards that discriminate against U.S. products; and
- give the highest priority to streamlining the list of products and technologies that are subject to special export controls.

These recommendations only begin to identify the issues as they emerge in a climate of rapid political change. How the United States acts to respond constructively to European market integration and its effect on R&D-intensive industry is one of the many challenges for the 1990s.

PART III. QUESTIONS TO CONSIDER: U.S. STRATEGY AND U.S.-EC RELATIONS

This section is intended to provide preliminary questions for consideration based on the agenda of the meeting. Fuller discussion of these and other important issues will undoubtedly take place in response to the presentations.

Plenary Session I: Access to Precompetitive Research Programs of the European Community

1. There are significant differences between SEMATECH and JESSI (objectives, shares of funding provided by government, linkages between universities and member companies, technology transfer arrangements between firms, etc.). How does the EC define precompetitive R&D and how do these definitions fit those used in the United States?
2. If equal access to precompetitive research results from government-industry consortia like SEMATECH and JESSI is made possible in critical areas of technology, what controls are there on the extent to which U.S. and EC companies can pass information back to their respective parent companies?
3. Is there a need to formalize the structure/process through which the EC and United States make decisions on access to R&D programs? Which government agencies/advisory groups should take the lead in these: U.S. trade representative, Department of Commerce, or Department of State, in the United States? What group would take the lead in the EC?
4. Will the United States and the EC provide the incentive, legislation, and regulatory environment that would allow reciprocal access to precompetitive research?
5. Bilateral science and technology agreements, like the move toward bilateral trade pacts, are often mentioned as a way of starting a process toward regulating technology flows. How far will the EC go in taking responsibility for deciding whether or not U.S. firms can participate in joint programs in Europe? Aside from the programs directly under its control, can the EC hope to dictate what are essentially national science and technology policies?
6. Does formal access to these programs really matter? Are the informal linkages between U.S. and European firms, like a SEMATECH member company in the United States and a JESSI member firm in the EC, the avenue through which technology generated in joint R&D programs ultimately flows out of consortia? In essence, are multinational corporations and strategic alliances the primary force in international technology transfer?
7. Successful resolution of intellectual property rights, national treatment, and subsidies issues would have an important impact on EC 1992, as it relates to U.S. industry. How will the GATT round completion affect U.S.-EC science and technology relations?

Plenary Session II: EC Standards-Setting, Certification, and Testing Processes: Roles and Implications for U.S. R&D-Intensive Industries

1. Will the technology used in commercial products be advanced through proposed standards-setting policies and what concerns exist about the use of standards to gain "unfair" competitive advantage?
2. In the absence of mandatory mutual recognition of testing and certification procedures, what standards will U.S. products be subject to in order to gain acceptance in the EC?
3. In developing standard systems for conformity assessment, can the existing or proposed international organizations represent all interests equally?

Plenary Session III: Strategic Implications of European Market Integration for U.S. R&D-Intensive Industry and the Science and Technology Base

1. With the increase in R&D activity and investment in Europe, are U.S. government and industry setting appropriate priorities for the country's science and technology base?
2. Are small and medium-sized enterprises being excluded by the strategic maneuvering of multinational enterprises based on both sides of the Atlantic?
3. Are issues of local content and rules of origin fully addressed and unambiguous?
4. With U.S., European, and Asian companies looking at the market potential in eastern Europe, can issues of technology transfer and export controls be resolved quickly enough to take advantage of the expanded market without deteriorating into economic anarchy?

Plenary Session IV: Suggested Strategies for U.S.-EC Cooperation and Competition

1. What are the most important avenues through which private sector actors will influence U.S.-EC cooperation and competition?
2. Are current intellectual property laws adequate for future cooperation between the United States and the EC?
3. Do the various current science and technology agreements and informal memoranda of understanding adequately reflect the U.S. position with the 12 European Community members?
4. What are the most productive government-to-government forums for addressing potential problems? Are these mainline trade forums, GATT, U.S.-EC bilateral working groups in sector-specific talks, WIPO, or others? Should a new technology-specific forum be devised? The Technology Ad

ministration was given the lead (nominally) in representing U.S. commercial interests in science and technology agreements/forums (P.L. 110-519). What role will it play as events unfold in the EC?

NOTES

1. The European Community's 12 member countries are B, Belgium; DK, Denmark; D, Federal Republic of Germany; GR, Greece; E, Spain; F, France; IRL, Ireland; I, Italy; L, Luxembourg; NL, the Netherlands; P, Portugal; and U.K., United Kingdom.

2. The CEC's Cockfield White Paper of 1985 was a study listing approximately 300 directives that were seen as necessary to achieve a true European common market, along with a timetable to dismantle all physical, technical, and fiscal barriers within the Community by the end of 1992.

3. The Single European Act of 1986-1987 is the act amending the Treaty of Rome, the EC founding document. It gives the European Parliament wider powers, eliminates the unanimous voting requirement in the Council of Ministers, and provides a basis for Community action in the field of R&D. (Title VI of Third Part of the EC Treaty as introduced by the Single European Act, Article 130 I)

4. Through legislative directives in the Single European Act, the Framework Program (1983-1987, 1987-1990, 1990-1994) defines priorities, sets out criteria, and establishes a financial structure for Community research and development.

5. The principle of subsidiarity states that what can be done by the private sector should not be done by national or regional authorities; what can be done better at the national level should not be done at the Community level, provided that Community law, including provisions relating to competition policy, is fully respected. (Communication from the Commission, SEC(89)675 final)

6. RTD is European nomenclature for research and technology development.

7. SEMATECH is a U.S. government-industry consortium in semiconductor manufacturing with the mandate to provide the U.S. semiconductor industry with the capability to achieve world leadership by 1993 using American-made equipment and material. The fiscal 1990 budget is $223.9 million of which $100 million comes from U.S. government sources and $123.9 million from 14 member companies.

8. JESSI is the Joint European Submicron Silicon project organized by European governments and companies. It encompasses all aspects of the semiconductor manufacturing industry and seeks to develop the next generation of semiconductor products. The annual budget is estimated to be in excess of $4 billion, coming from six European countries and 32 research institutions and companies.

9. GATT is the General Agreement on Tariffs and Trade. It was created in 1948 to be a multilateral forum for establishing rules of international trade. The Uruguay Round refers to the current phase of negotiations.

ANNEX 1 List of Research Programs Within the Framework Program of the European Community (1987–1991)*

AIM	Informatics in medicine
BAP	Biotechnology
BCR	Applied metrology
BRIDGE	Biotechnology
BRITE/EURAM	Industrial technologies/advanced materials
DELTA	Informatics in education
DOSES	Statistics
DRIVE	Informatics in road safety
ECLAIR	Agroindustrial technologies
EPOCH	Climatology and natural hazards
ESPRIT	Information technologies
EUROATA	Machine translation
FAST	Forecasting and assessment
FLAIR	Food technologies
JOULE	Nonnuclear energies
MAST	Marine science
MONITOR	Forecasting, analysis, and evaluation
RACE	Telecommunications
SAST	Strategic analysis
SCIENCE	Scientific cooperation
SPEAR	Research evaluation
SPES	Economic science
STD	Science and technology for developing countries
STEP	Environmental protection
TELEMAN	Remote handling systems
VALUE	Dissemination of results

*Status as of September 1, 1989.

Source: Commission of the European Communities, Directorate-General for Science, Research, and Development, *Catalogue of Research Programmes Within the Framework Programme of the European Community 1987–1991*, Brussels, September 1989.

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Appendix C

List of Participants

Michael A. Aisenberg
Manager, Federal Government Relations
Digital Equipment Corporation

Hamid Alavi
Economist
The World Bank

Alastair Allcock
Counselor, Science, Technology, and Energy
Embassy of the United Kingdom of Great Britain and Northern Ireland

Ernest Ambler
Director Emeritus
National Institute of Standards and Technology

Cezary Ambroziak
Counselor for Science and Technology
Embassy of Poland

Chris Anderson
Washington Correspondent
Nature

Sayaka Aoki
Graduate Student
Johns Hopkins University

William T. Archey
Vice President, International Affairs
U.S. Chamber of Commerce

John A. Armstrong
Vice President for Science and Technology
IBM Corporation

Pamela Atkins
Bureau of National Affairs

Michel Aubry
Counselor for Science and Technology
Embassy of France

Louis J. Baccei
Vice President, Research, Development, and Engineering
Bausch & Lomb, Inc.

Kenneth Baker
Director, Scientific Affairs
Monsanto Company-Europe/Africa

Leonard M. Baker
Vice President-Corporate Technology
Union Carbide Corporation

Stephen Band
Independent Consultant

Albert Barber
Vice Chancellor
University of California, Los Angeles

Marcel Bardon
Director, Division of Physics
National Science Foundation

Richard Barker
Partner
McKinsey and Company

Susan Barkett
Special Assistant, Subcommittee on Science, Research, and Technology,
Committee on Science, Space, and Technology
U.S. House of Representatives

Tim Bearddez
Scientific American

David Z. Beckler
Associate Director
Carnegie Commission on Science, Technology, and Government

Francois Bégin
Marketing Communications Group

Edwin Behrens
Director, Technical Affairs/National Government Relations
Proctor & Gamble Company

Isabelle Benoliel
External Relations, Directorate General I
Commission of the European Communities

Beverly J. Berger
Washington Representative
Federal Laboratory Consortium

Arpad A. Bergh
Division Manager, Applied Research Program Development
Bellcore

Walter Berl
Professor
Johns Hopkins School of Advanced International Studies

Ted Berlincourt
Director, Research and Laboratory Management
U.S. Department of Defense

Joe Bhatia
Vice President for Government Affairs
Underwriters' Laboratories

A. G. W. "Jack" Biddle
President
Computer and Communications Industry Association

Jules Blake
Senior Policy Analyst
Office of Science and Technology Policy

William A. Blanpied
Senior International Analyst
National Science Foundation

Erich Bloch
Director
National Science Foundation

Jorge Boche
Graduate Student
Johns Hopkins University

Jacques Bodelle
Research and Development Representative
ELF Aquitaine

Robert Boehme
Bureau of European Affairs
U.S. Department of State

Jennifer Bond
Senior Science Resources Analyst
National Science Foundation

John P. Boright
Acting Deputy Assistant Secretary for Science and Technology Affairs
U.S. Department of State

Charles Bouchard
Director, European Office
Merck & Company, Inc.

Sara Bowden
Senior Policy Analyst
Office of Science and Technology Policy

Richard Bradshaw
Executive Secretary, National Science Board
Task Force on EC 92
National Science Foundation

Fiona Branton
Minority Counsel
Committee on Commerce, Science, and Transportation
U.S. Senate

William M. Bremer
Vice President, Drug Safety Research
The Upjohn Company

Harry G. Broadman
Chief Economist
Committee on Governmental Affairs
U.S. Senate

D. Allan Bromley
Assistant to the President for Science and Technology and
Director, Office of Science and Technology Policy

Annice Brown
President
Technology Transfer International

William B. Brown
Director, Planning and Research
Virginia Department of World Trade

C. D. Burdick
Staff Scientist
Litton Industries

Jerome A. Burgman
Senior Consulting Scientist
PPG Industries, Inc.

William Burlant
Corporate Fellow
GAF Chemical Corporation

Brian Burrows
Vice President, Research
USG Corporation

Daniel Burton
Executive Vice President
Council on Competitiveness

Gary Byrd
Consulting Engineer

Fletcher L. Byrom
Chairman and Chief Executive Officer (retired)
Koppers Company, Inc

William D. Carey
Senior Consultant
Carnegie Corporation of New York

Michel Carpentier
Director General, Directorate General XIII/ Telecommunications, Information Industries, and Innovation
Commission of the European Communities

Dennis Cearlock
Senior Technical Director
Battelle Pacific Northwest Laboratory

Marta Cehelsky
Director, Issues Development, Office of Legislative Affairs
National Science Foundation

Edwin Chen
Science Writer
Los Angeles Times

David Cheney
Assistant Project Director, Technology
Council on Competitiveness

Mary-dell Chilton
Executive Director, Biotechnology Unit, Division of Agriculture
Ciba-Geigy Corporation

Deborah Cichon
Science Resources Analyst
National Science Foundation

Mary Clutter
Assistant Director for Biological, Behavioral, and Social Sciences
National Science Foundation

Roger J. Cochetti
Vice President
COMSAT-Mobile Communications

Timothy Coffey
Director of Research
Naval Research Laboratory

Leon M. Cole
Chief, Economics Div178178ision
Congressional Research Service

Robert E. Cole
Vice President
Kaiser Aluminum & Chemical Company

John W. Collette
Assistant to the Vice President E. I. duPont de Nemours & Company, Inc.

James M. Compton
Acting Deputy Undersecretary, International Programs
U.S. Department of Defense

Jean-Pierre Contzen
Director General, Joint Research Center
Commission of the European Communities

Stephen Cooney
Director, International Investmen and Finance
National Association of Manufacturers

Richard Cooper
Department of Economics
Harvard University

Colleen Cordes
Reporter
Chronicle of Higher Education

Ann Cory
Bureau of European Affairs
U.S. Department of State

Larry Crume
Vice President, International Business Development
Lotus Development Corporation

Liz Crutcher
Staff Writer
Engineering Times

George B. Cvijanovich
Senior Staff Scientist
AMP, Inc.

Christa Dauner-Summers
U.S. Economic News

Jonathan Davidson
Director, Washington Office
University of South Carolina

Herman Dehennin
Ambassador
Embassy of Belgium

Donal Denham
First Secretary
Embassy of Ireland

Peter Jon de Vos
Deputy Assistant Secretary, Bureau of Oceans and International Environmental and Scientific Affairs
U.S. Department of State

Arthur Diness
Director, Engineering Sciences Directorate
Office of Naval Research

Linda Distlerath
Director, U.S. Issues
Merck & Company, Inc.

Colonel Thomas Doeppner
Consultant
Institute of Electrical and Electronic Engineers

Ross Dowbenko
Director, Technology Acquisition
PPG Industries

Edward J. Doyle
Chairman, Committee on Competitiveness
Institute of Electrical and Electronic Engineers-USA

Jean-Jacques Duby
Group Director of Science and Technology
IBM Europe

Ivan Dunstan
President
European Committee for Standardization

Linda Durkee
Bureau of National Affairs

Peter Dyvig
Ambassador
Embassy of Denmark

Albert A. Eisele
Managing Director
Cornerstone Associates

Carol Ezzell
Washington Bureau Chief
BioWorld

William K. Fancher
Manager, Technology Planning
Xerox Corporation

Leo C. Fanning
Staff Director, Professional Activities
Institute of Electrical and Electronic Engineers-USA

Paolo Fasella
Director General, Directorate General XII/Science, Research, and Development, Joint Research Center
Commission of the European Communities

Gilbert Fayl
Counselor, Science and Technology
Delegation of the Commission of the European Communities

Daniel J. Fink
President
D. J. Fink Associates, Inc.

Steven H. Flajser
Director, Government Relations
Fairchild Space & Defense Corporation

William B. Fletcher
International Trade Analyst, Office of Industries
U.S. Trade Commission

Donald G. Freeman
International Economist
Texas Instruments, Inc.

Christine French
Program Manager, Division of International Programs
National Science Foundation

Larry French
Corporate Vice President
North American Philips Corporation

Aviva Freudmann
Atlantic Trade Report

Alton Frye
Vice President and Washington Director
Council on Foreign Relations

Irving Fuller
Director, Advanced Technology Trade Policy
Office of the U.S. Trade Representative

Robin Gaster
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Office of Technology Assessment

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Embassy of Belgium

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National Science Foundation

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States News Service

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U.S. Agency for International Development

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Senior Economist, Industry Development Division
The World Bank

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Georgetown University

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Office of the U.S. Trade Representative

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National Science Foundation

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Consultants International Group

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Innovation Associates

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American Chemical Society

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Federal Republic of Germany

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Staff Writer
Optics and Photonics News

Sebastian Remoy
Research Associate, Industry, Technology, and Employment Division
Office of Technology Assessment

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Acting Director, Division of International Programs
National Science Foundation

Karin Rindal
Corporate Manager for International Trade Regulation
EG&G, Inc.

Anthony Rock
Director of Policy Planning and Support, Bureau of Oceans and International Environmental and Scientific Affairs, Office of Science and Technological Cooperation
U.S. Department of State

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U.S. Department of State

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National Science Foundation

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U.S. Department of Defense

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Managing Partner
The 150 Trust

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Special Assistant for Trade
Commission of the European Communities

Norman Snow
Washington Representative
PACCAR, Inc.

Howard Sobkov
Graduate Student
Johns Hopkins University

Masazumi Sone
Director, Research Coordination and Future Technology
Nissan Research and Development, Inc.

Carlos Souto
Counselor for Industry and Scientific Affairs
Embassy of Portugal

R. Barry Spaulding
Deputy Commissioner, International Division
New York State Department of Economic Development

Steven R. Speech
Field Operations Manager, Federal Systems Research and Development
3M Company

Dwain F. Spencer
Vice President, Corporate and Business Development
Electric Power Research Institute

Elmer B. Staats
Former Comptroller General of the United States

H. Guyford Stever
Corporate Director and Science Consultant

Marjorie Sun
Writer
Science

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Deputy Associate Director, National Security and International Affairs, Special Studies Division
Office of Management and Budget

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Staff Correspondent
Japan Economic Journal

Marie-Helena Taquet
Student
George Washington University

Michael L. Telson
Energy and Science Analyst, Committee on Budget
U.S. House of Representatives

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Johnson Controls, Inc.

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Science and Technology Relations Manager
ICI Americas

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Liaison, Houston Area Research Center

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Technology and Information Policy Program
Syracuse University

Laura Vandam
Technology Review

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Vice President for European Operations
Booz Allen and Hamilton

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Intern
Office of the U.S. Trade Representative

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Economist, Subcommittee on International Finance, Committee on Banking, Housing, and Urban Affairs
U.S. Senate

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International Consultant and Former Chairman, IFF, Inc.

Zhenquan Wang
First Secretary
Embassy of the People's Republic of China

Stanley Warshaw
Acting Director, Office of Standards Services
National Institute of Standards and Technology

James E. Wavle, Jr.
President and Chief Operating Officer
Centocor, Inc.

Thomas A. Weber
Director, Division of Advanced Scientific Computing
National Science Foundation

Leif Westgaard
Science Counselor
Embassy of Norway

Richard White
Research Staff Member
Institute for Defense Analyses

Wendy White
Information Service Manager, Office of International Affairs
National Academy of Sciences

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Bristol Myers Squibb Company

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National Science Foundation

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Office of Science and Technology Policy

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Johns Hopkins University

John Yochelson
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Center for Strategic and International Studies

Katherine Yuracko
Policy Analyst
Office of Science and Technology Policy

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President and Chief Executive Officer
Siemens Corporate Research, Inc.

Steven Zelinger
Trial Attorney
U.S. Department of Justice

Zhiwei Zhang
Correspondent, Washington Bureau
Science & Technology Daily

Bernhard Zimburg
Science and Technology Attaché
Embassy of Austria

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National Academy of Sciences

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Consultant, Advisory Committee for the International Council of Scientific Unions, Office of International Affairs
National Research Council

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News Report
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Senior Program Officer, Government-University-Industry Research Roundtable
National Academy of Sciences

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National Research Council

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National Research Council

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Study Director, Committee on Science, Engineering, and Public Policy
National Academy of Sciences

Del Wright
Administrative Assistant, Office of Government and External Affairs
National Research Council

Patrice Zechman
Administrative Specialist, Office of International Affairs
National Research Council

List of Acronyms

AFNOR	Association Française de Normalisation
AIM	Advanced Informatics in Medicine
AIP	Academy Industry Program
ANSI	American National Standards Institute
BCR	Community Bureau of References
BRITE	Basic Research in Industrial Technology for Europe
BSI	British Standards Institution
CAD	Computer-aided design
CCITT	Consultative Committee on International Telegraphy and Telephony
CEC	Commission of the European Communities
CEN	Comité Européen de Normalisation (European Committee for Standardization)
CENELEC	Comité Européen de Normalisation Électrotechniques (European Electrical Standards Coordinating Committee)
CERN	Organization Européene pour la Recherche Nucléaire (European Organization for Nuclear Research) (Acronym represents previous name, Conseil European pour la Recherche Nucléaire)
CIMOSA	Computer Integrated Manufacturing Open System Architecture
CNMA	Communication Network for Manufacturing Applications
CNRS	Centre National de la Recherche Scientifique
COCOM	Coordinating Committee on Export Controls
COMETT	Community Program on Cooperation Between Universities and Enterprises for Education and Training in Technology
CPMP	Committee for Proprietary Medicinal Products
DARPA	Defense Advanced Research Projects Agency

DELTA	Development of European Learning through Technological Advances
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DRAM	Dynamic Random Access Mechanization
DRIVE	Dedicated Road Infrastructure for Vehicle Safety in Europe
EC	European Community
ECU	European Currency Unit
EEC	European Economic Community
EEIG	European Economic Interest Grouping
EFTA	European Free Trade Association (Norway, Sweden, Finland, Iceland, Austria, Switzerland)
ELDO	European Launcher Development Organization (superseded by ESA)
EMPA	Eidgenössische Materialprüfungs-und Versuchsanstalt für Industries, Bauwesen und Gerwerbe (Federal Institute for Testing Material and Research)
EN	European Norm
ENEA	Comitato Nazionale per la ricerca e lo sviluppo dell' Energia Nucleare e delle' Energie Alternative (National Commission for Nuclear and Alternative Energy Sources)
ENS	European Nervous System
EOTC	European Organization for Testing and Certification
ERASMUS	European Action Scheme for Mobility of University Students
ESA	European Space Agency
ESI	Electro-Scientific Industries
ESPRIT	European Strategic Program for Research and Development of Information Technologies
ESRO	European Space Research Organization (superseded by ESA)
ETSI	European Telecommunications Standards Institute
EURATOM	European Atomic Energy Community
EUREKA	European Research Cooperation Agency
FCCSET	Federal Coordinating Council for Science, Engineering, and Technology
FDA	Food and Drug Administration
G7	Group of Seven (United States, Japan, Germany, France, Britain, Italy, and Canada)
GATT	General Agreement on Tariffs and Trade
HDTV	High Definition Television
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IPCC	Intergovernmental Panel on Climate Change
IRDAC	Industrial R&D Advisory Committee

ISO	International Organization for Standardization
ITER	International Thermonuclear Experimental Reactor
JAERI	Japan Atomic Energy Research Institute
JESSI	Joint European Submicron Silicon Initiative
JTC	Joint Technical Committee
KfK	Kernforschungszentrum Karlsruhe GmbH (Nuclear Research Center)
MAG-LEV	Magnetically-Levitated (high-speed ground transportation)
MCC	Microelectronics and Computer Technology Corporation
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NIST	National Institute of Standards and Technology
NRC	National Research Council
NRIM	National Research Institute for Metals
OECD	Organization for Economic Cooperation and Development
OSTP	Office of Science and Technology Policy
PBX	Private Branch Exchange
PCAST	President's Council of Advisors on Science and Technology
PCN	Personal communication network
PTT	Post, Telegraph, and Telephone
RACE	Research and Development in Advanced Communications Technology for Europe
RPI	Rensselaer Polytechnic Institute
RTD	Research and technology development
SCK/CEN	Studiecentrum voor kernenergie/Centre d'Etudes de l'Energie Nucléaire
SBIR	Small Business Innovation Research Program
SEMATECH	Semiconductor Manufacturing Technology Consortium
SNCI	Service National des Champs Intenses
VAMAS	Versailles Activity for Materials and Standards
VHSIC	Very-High-Speed Integrated Circuit
WIPO	World Intellectual Property Organization