THE USA-EUROPE INDUSTRIAL COMPETITION

by

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Thierry Dejeux

THE USA-EUROPE INDUSTRIAL COMPETITION

ABSTRACT
The new industries which emerged from the first industrial revolution have made the USA and Europe two economic powers.
They both stuggle to maintain their supremacy in the most sensitive technological fields.
However, the decline of competitiveness has incited the European nations to unify themselves into a common market in order to face the American industrial giant.

RÉSUMÉ
Les nouvelles industries qui ont émergées de la première révolution industrielle ont fait des USA et de l'Europe deux puissances économiques.
Celles-ci luttent pour conserver leur suprématie dans les domaines technologiques les plus sensibles.
Mais le déclin de la compétitivité a poussé les nations européennes à s'unifier en un marché commun afin de faire face au géant industriel américain.

AUSZUG
Die neuen Industrien, die aus der ersten industriellen Revolution entstanden, haben aus den USA und Europa zwei ökonomische Mächte gemacht.
Sie kämpfen immer noch, um ihre Führerschaft auf den empfindlichsten technologischen Gebieten aufrechtzuhalten.
Der Abbau jedoch des Konkurrenzwillens hat die europäischen Länder dazu angeregt, sich in eine europäische Wirtschaftsgemeinschaft zu verbünden, um sich vor dem amerikanischen industriellen Riesen behaupten zu können.

RESUMEN
Las nuevas industrias que emergieron de la primera revolución industrial han hecho de USA y Europa dos poderes económicos.
Ellos luchan por mantener su supremacia en los más sensitivos campos tecnológicos.
Pero, la baja en competividad ha incitado a las naciones europeas a unificarse dentro de un mercado común para hacerle frente a la gigante industria americana.

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INTRODUCTION

Two European electronics companies refuse to cooperate in a joint venture, causing the end of the electronic industry in the European Economic Community (EEC), to the benefit of foreign products.

The American Department of Justice agrees on the creation of an industrial research consortium that would have been prohibited ten years ago by the antitrust laws.

Japan declares its will to "lead IBM rather than follow", and to create its own computer technology on artificial intelligence and knowledge-based engineering.

The huge telecommunications group AT&T organizes secret negotiations with European firms, and plans to use its economic strength to enter foreign markets.

The European Economic Community established ESPRIT, the European Strategic Program for Research in Information Technology. Its meeting attendees accuse the USA of exploiting the International Traffic in Arms Regulations to deprive Europe of information technology products and engineering.

Is openness and cooperation in sciences and engineering disappearing? Is this the sign of an industrial cold war?

Actually, the world is experiencing a scientific and economic competition whose rewards are money, national wealth, pride, standards of living, and above all, the global future of the competing countries.

This competition is not only a trade war, but is a global war over technology, a war that any country can lose and be relegated by the next century to the state of a developing country.

This competition is even perceived by the Eastern Block as the "greatest challenge in the Socialist Community of Nations' postwar history: the technological challenge".

The real goal in this industrial race is, of course, economic power. But these economic implications are sometimes difficult to categorize since each country has its own economic and social perspectives. Besides, the definition of industrial victory might be different from one system to another. It can be profit as well as marketplace or employment.

To understand the different strengths and strategies of each block, we shall proceed in the second chapter to an examination of the American and European capacity at managing their resources, and their ability to exploit them. Many factors such as ideology, industrial policies, education, economics and society must be considered for a better comprehension of the challenge.

The battlefield of this industrial competition has several fronts, the most important of which are the micro electronics, the biotechnologies, nuclear and natural sciences and telecommunications.

America and the nations of Europe have different systems and competitive positions. So, it will be possible to state the relative positions of the competitors in very specific economic areas. Only then can one attempt to establish a fair comparison. This will be discussed in chapter three.

This report will then conclude with an outlook of the future through the creation of the EEC, the raising of a new power that might change the face of the conflict and lead to new industrial relationships.

I THE HERITAGE OF THE 19th CENTURY

A) THE BIG MUTATIONS OF 1873-1896

The last quarter of the nineteenth century was marked by several industrial and economical crises:

- Between 1873 and 1875, Germany was subject to the consequences of its war with France, and the USA was victim of bad speculations pertaining to the Stock

Exchange. This spread to Great Britain and France.

- Then, in the mid 80's a recession centered on the railroad companies occurred.
- And finally, at the beginning of 1890, the textile, naval construction and railroad industries declined in the USA and United Kingdom, and then in the rest of Europe. Prices fell to 30-40 % and unemployment increased up to 11 %.

These crisis were caused by the agony of the first industrial revolution, and the raising of a new one based on petrol and electricity. Production rates resumed in the USA, Germany, England and France.

B) THE RAISING OF INDUSTRY

At the end of the 18th century, new inventions and constructions of large capacity factories took place in Europe and America. Steel production was improved by British and French scientists, and exploited by the Germans. Organic chemistry (gas, celluloid, coloring) improved in England, France, Belgium, Germany and the United States gave a monopoly (up to 90 % of markets) to Germany.

Then, new forms of energy were found: oil (first derrick in 1859 in Pennsylvania) and electricity (by Volta, Edison and Grame). These new forms revolutionized

industry and increased mechanization. This led to the creation of the telephone (Bell) and telegraph (Popov). Industries such as metallurgy, textile, mining and transportation are accentuated and gave birth to new industries (domestic appliance, telecommunication, etc).

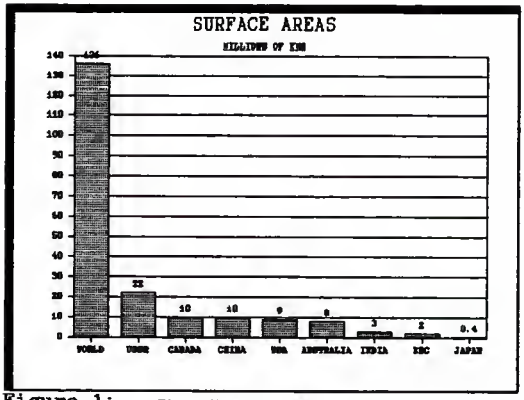

Figure 1: The USA largely excels Europe. Density balances this difference with 30 pers./km^2 in the US and 140 pers./km^2 in the EEC.

A new growth dynamism started, benefiting both Western Europe and North America, and involving an augmentation of standards of living and thus consumption.

German, French and American engineers invented and developed the automobile using steam, electricity and then gas. The large scale exploitation of gas fields in Texas started in 1900 and gave to the US industry an important advantage. Besides, new improvements allowed decreases of prices and thus increases of sales: The United States is starting to assert itself against European industry.

C) TAYLORISM AND FORDISM IN THE USA

To these technical innovations was added a new organization of work and man-power qualification. In the US, F. Taylor invented the scientific organization of work based on task distribution, and H. Ford established assembly lines and standardization. These methods, set to fight the low level of qualification of the American labor force, were first adopted by a car industry: from 1909 to 1920, the "Ford T" production doubled each year from 20,000 to 2,000,000 units while prices were divided by two. Then, the firm competitiveness was even improved by interesting the workers in the factory's production.

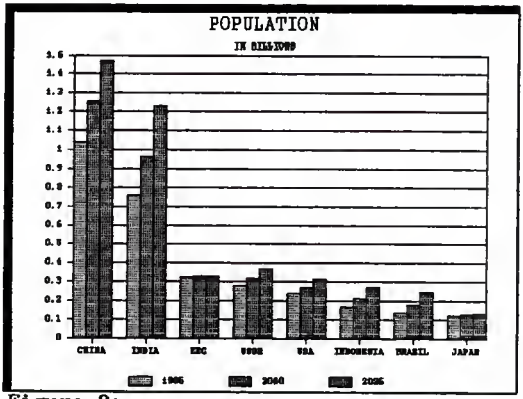

Figure 2: The EEC figures after the two big reservoirs of Asia, and shows a huge economical potential (at least theoretically). However, it will be passed by the USSR, the USA and the Third World which is booming.

So, at the beginning of the 19th century, the USA embarked on a new kind of growth: mass production using

mass consumption, which became the basis and the foundation of an industrial competition between the United States and Europe.

II THE ECONOMIC FACTORS

Many different factors allow countries to have better abilities to manage their economic resources than others. In this chapter, we will highlight the most important factors, such as ideology, policies, education, employment and industrial organizations, which gave to the USA and Europe their industrial supremacy.

A) THE AMERICAN STRENGTH

1) Overview

The United States of America is the dominant force in the overall economic war. It represents the largest domestic market, has the greatest percentage of its GNP devoted to research and development, and benefits from the results of an important defense research program that has continued since World War II (computer, nuclear sciences,..). Besides, the USA has the largest number of companies participating in this battle of competition and

innovation. The computer science field, for instance, has benefited a lot from continuous programs of investment. Developing countries such as Korea, Singapore, Taiwan, India and Malaysia can, through their educational systems and skilled work forces, get a competitive advantage in some markets. Japan, of course, has a big advantage created by the combination of cultural and work forces practices. These advantages have allowed Japan to develop many applications from basic sciences. Much could be said about these Asian competitors whose management and work concepts are very innovative and sometimes revolutionary to the western countries. So, the following chapters will only focus on a comparison between the USA and Europe, two continents of similar cultures, but of different strength and strategies.

2) The Ideology

Individualism was the only hope to survive for the first who reached the shores of America. This ideology of self reliance, making one's way, and survival of the fittest even became part of the Declaration of Independence and the Constitution. One early conception was to combine the idea of individualism and property with economic profit, providing interest for the community as a whole. So the role of the government was limited to protecting a person's body and property (in 1928, more people worked

for US Steel or General Motor than for the government in Washington). Thus, the US economy grew such that, during the twenty years after World War II, the nation's economic strength was so vast and unchallenged that it could do everything it wanted, without counting the costs.

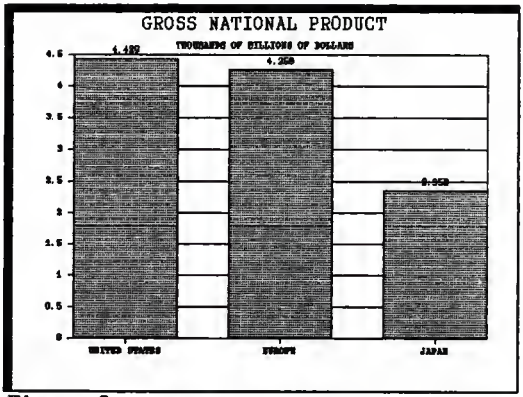

Figure 3: The GNP of the European nations have to be put together so that they can balance the strength of the United States.

However, the first problems raised (Vietnam war, antipoverty program, inflation, oil shock, East Asian competition, etc) caused the USA to experience its first trade deficit with Japan and Germany in 1969. Since then, foreign competition has become even tougher, but only in the 80's did America begin to recognize that there was a problem. The merchandise trade deficit had grown to $ 150 billion in 1985, and the current account deficit was over $ 100 billion.

The causes of the American competitive deterioration are many: low rates of savings and investment, high cost of

labor, adversarial labor relations, an overvaluated dollar, high interest rates, short term management, decrease of manufacturing innovation and efficiency, poor education, lack of engineers, and so forth. This deterioration is compensated by four important elements: the place of the US in the world economy, the role of the government, the governance of the corporations and the relations between managers and the managed, and the rights and duties of membership in US society:

- The American premise is that the place of the nation in the economy be determined by free trade in an open marketplace. But a new premise is that the successful community must, first of all, define its needs, set its priorities and select the right mix of procedures for achieving them. The marketplace, one procedure that the Asians use very well and the Soviets do not, is one of the most important factors of a successful economy.

American cooperation is expanded nationwide to maintain this national place. In 1982, the Justice Department allowed some 40 US companies (AT&T, IBM, GM, DuPont,..) to form the Semiconductor Research Corporation, whose purpose is to fund research and transfer the results for industrial use in order to enhance the ability of the USA to compete more efficiently worldwide in information technology.

- Views about the role of the government are in conflict: The first view considers that the government's authority should be checked, balanced and separated among the three branches. The second view thinks that government should intervene in case of crisis or when interest groups demand it. Actually, 19 % of the GNP is disposed of by the government (versus 10 % in Japan). But the trend is more to stimulate competitiveness rather than subsidizing and protecting economic sectors. It encourages investment and efficiency.

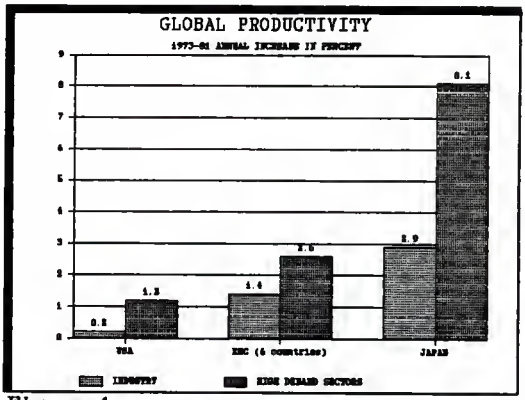

Figure 4: The European model has trouble defining itself between the Japanese intensive growth (high technological success that helps employment) and the American extensive growth (less productive but high employment).

- The goal of enriching the companies' shareholders has always been held paramount, often involving a loss of competitiveness in the world economy (preference for short term returns rather than investments in innovation). This also means that Americans have to finance their companies with more debt than their foreign

competitors, increasing their cost of capital and reducing the rate of growth. This is quite significant in comparison with the German and Japanese companies. On the other hand, US managers do not assume as much responsibility for employment security as their European counterparts, which is a policy that maintains consumption, but does little for production.

- While the nation recognizes certain rights as belonging to the citizens (such as income, education, health or employment), a new premise holds that duties are also required; so the poor and the weak are expected to work as much as the rich and the strong, and wages are to be related to productivity. These concepts are not always followed in Europe.

The American ideology may not fit the changing economy as well as before. Individualism has marked the nation's history and has made it strong. But by the 1980's, the United States had become very dependent on the rest of the world for funds, markets, products and resources. Besides, while international competition is increasing, the USA is confronted with internal crises such as urban disintegration, projected shortages of electric power in the 90's, poverty and ignorance among the growing underclass.

Nevertheless, the USA keeps its traditional strength that

is openness to change and experimentation, entrepreneurial zeal, a sense of fresh possibility and respect for innovation.

3) US Industrial Policy

Industrial policy in the United States is enforced through its laws, departments of the government, regulatory agencies and federal bureaucracies. Antitrust laws, for example, regulate commerce and competition. They are made to facilitate market entry, competition through efficient production, and the establishment of prices commensurate with quality. Their penalties and enforcement have been recently decreased to improve the competitiveness of American firms. The abandonment of the largest legal case: USA versus IBM was representative of that change. This help to competitiveness comes through the International Trade

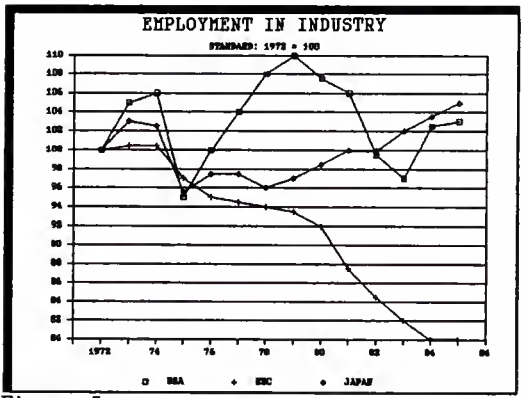

Figure 5: In the USA, industry employment is flourishing and unchanged after the oil schock. In Europe, the service sectors have not been able to catch up with the losses of the industrial sectors.

Commission and the Department of Commerce.

Competition invites technological innovation, and the antitrust laws have encouraged and protected competition in research and development, a basis of the US economic strength.

The impact the government has on technology through its capital practices influences very much the nation's industrial policy and thus its place on the economic market. These practices include the control of the currency, exchange rates, saving rates, and management of the government agencies that loan and borrow money. The relationship between defense and the domestic economy is also very important.

Imports and exports are regulated by prices, which contributes to control employment. To deal with a balance of trade strain, the governments usually set trade barriers such as import duties, quotas and other restrictions. To reestablish a favorable balance of trade, they reduce the value of the currency, such as Great Britain did in the 60's, and the USA in 1985-86. Import barriers are also set by the US government to slow down the flow of foreign imports into America. Protectionism in the USA is aimed at reducing the trade deficit which was approximately $ 60 billion in 1986 and $ 100 billion in 1987 (with $ 50 billion just for Japan).

4) The Educational System

The educational system of a nation is a critical element in its ability to manage todays' high-tech environment, and by consequence, to achieve and maintain improvement in international competition.

The results of the US educational system in sciences and technology in the 20th century are impressive. The USA has more Nobel Prize winners than any other country and their achievements have led to great technological innovations such as the telephone, the light bulb, the moving picture, the airplane and xerography.

Unfortunately, the last 15 years have shown signs of deterioration (less Nobel Prizes and more successes in foreign trained scientists). In 1985, 43 % of all patents issued in the USA went to foreigners. Besides, failures are being noticed in junior high and high school: few students studying sciences or mathematics, lower quality of teachers, higher dropout rate of students, dependence on foreign students, resistance to change, etc. In 1968, the government spent over $ 200 million on universities' R&D versus $ 25 million in 1981. The US position continues to slip vis à vis Europe, Japan and even the USSR, causing a shortage of technically advanced people. Unless an important change occurs, the education level of Americans may become a weakness in the technology war.

5) The Industrial Strength

This chapter will only emphasize the high-tech industry which is the main battlefield of the industrial war, and focus on the efforts in R&D.

The foundations of the traditional US economic strength are the steel and automobile industries. They gave to America enormous advantages in the markets after World War II. But new competitors have come and threaten the position of this leading manufacturing and exporting nation.

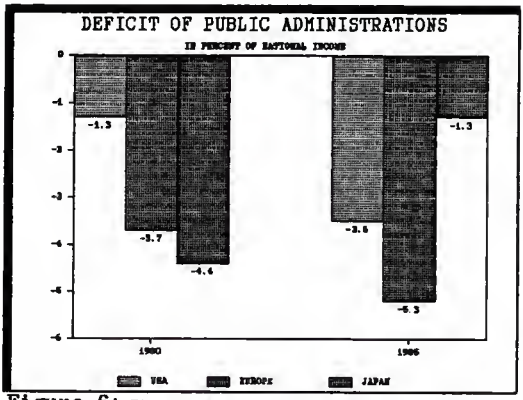

Figure 6: The economic crisis has resulted in the USA in decreased taxes but increased expenses, and in Europe in diminished benefits and increased expenses.

Like Japan, major American government agencies are at the head of the technology competition, such as the National Sciences Foundation, the National Aeronautics and Space Administration (NASA), the Department of Energy and the Department of Defense.

The Defense Advanced Research Project Agency (DARPA) is one of the most important research funding agencies of

the Department of Defense. It was created in 1958 to carry out long-term, high-risk and high-impact research and development. Some of the projects were then assigned to NASA. Its success in computer technology is one of the greatest accomplishments in this field, and about 75 % of its funding are spent in this industry.

On March 23, 1983, President Ronald Reagan decided to create new defensive weapons by establishing a Strategic Defense Initiative (SDI), better known as the "Star Wars" program. Over $ 30 billion would be spent in R&D funds in sciences and high technology.

Other very large programs in the Department of Defense are in the field of software development, with a 12 % annual increase of demand in very high speed integrated circuits and all related fields.

The National Sciences Foundation is also an important government organization whose mission is to support basic scientific research. In 30 years, it has become a large funding source in sciences and engineering (especially basic research). The official goal is to increase this support in fields related to education and long-term US economic competitiveness (e.g. manufacturing automation). In 1987, the budget was $ 1.6 billion with $ 105 million just for computing.

Many programs in energy-related work are supported by the

Department of Energy, performed in several national laboratories (at Argonne, Brookhaven, Lawrence Livermore, Los Alamos, Oak Ridge and Sandia). The main categories of research are the basic energy sciences, health and environmental research, fusion energy and so forth.

Congress has received other proposals advocating the creation of a Department of Industry and Technology (Senate bill S1233) and a Department of Sciences and Technology. These two proposals are receiving the most serious consideration.

These examples show that US research spending is dominated by defense requirements. The percentage of military research and development to total research was 72 % in 1985 (compared to 47 % in 1978). This gives this US industry a big advantage in R&D relative to the Europeans. But the amounts of money which are invested in armament are very heavy financial burdens for the USA, especially when they are developing products that everybody hopes will never be used. These burdens prevent the USA from competing more efficiently with Asia who spends most of its R&D on commercially relevant technology.

6) Employment

More than 30 million new jobs have been created in the United States since 1970, whereas there has been basically no progression in Europe. Between 1981 and

1984, 650,000 jobs have been lost every year in the EEC (European Economic Community), and at the same time, the US won 1.5 million. These results are explained by the increase of the American active population, partially caused by the massive coming out of females (64 % of the 25 million newly created jobs between 1972 and 1985).

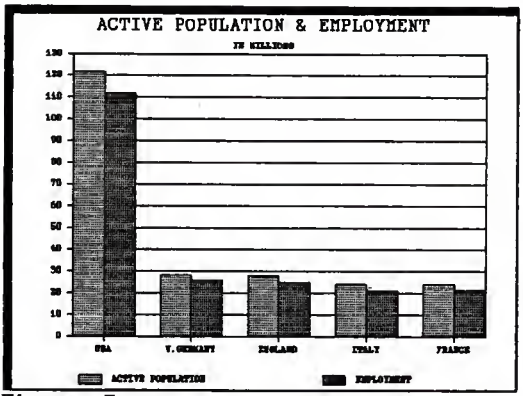

Figure 7: West Germany and the USA have the same unemployment rate (6-6.5 %) vs. Great Britain, Italy and France (10-11 %).

29 out of these 30 million are in the service sector, and mainly in small enterprises, which are very vital: 668,000 new enterprises have been registered in 1986 versus 533,000 in 1980.

These macro-economic factors are not enough to justify the dynamism of the American employment market. The economy's rate of growth is not the main reason. (Some European countries, for instance, have had higher gross product increases). In opposition to the USA, higher productivity in Europe has resulted in wages increases,

but also in rising unemployment.

The origin of good employment in the US comes from workforce flexibility and mobility as well as the absence of restrictions for hiring and firing. Besides, the American philosophy of individualism gives a spirit of independance, responsibility, competition and entrepreneurship, in opposition to the European workers who rather rely on national support. As a matter of fact, central administration in Europe has too much power as far as decision making is concerned, but not enough for mobilizing resources. So, Europe has much to learn in terms of attitude and behavior as well as institutions. (The USA does not have the laisser-faire approach, but bases its success on cooperation between public and private sectors). On the other hand, the side effects for American workers are low salaries, precarious jobs, little social protection and poverty.

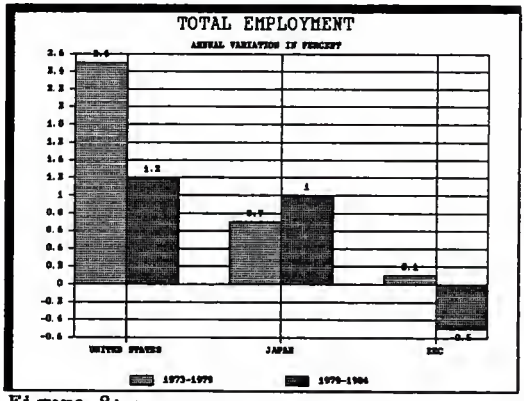

Figure 8: The creation of jobs in the United States has occurred along with contraction of employade in Europe.

7) Conclusion

Huge companies, big private and national research and development and high technology programs backed with a large domestic and foreign marketshare and high employment are the major strength of the American industry over its European counterparts. Coordination, cooperation, education and hard work are the long-term conditions of this leadership. However, these traditional strengths are showing serious signs of weakening.

B) THE EUROPEAN STRATEGY

1) Overview

The Europeans lost their technological supremacy in the twentieth century in part because of the devastation of wars and the collapse of the empires. Another reason has been the failure of individual companies to protect their marketshare by not reinvesting profit in plant modernization and capacity. Nationalism is also a cause of segmentation of their marketplace, preventing the large-scale economy necessary for competitive high-technology manufacturing.

Europe recognizes the importance of the technology competition and places almost the same emphasis on R&D as the USA. However, their reactions are slower and the systems remain mainly based on a conservative research

and investment basis.

There are also problems in the EEC (European Economic Community) and NATO (North Atlantic Treaty Organization) alliance in terms of cooperation, standards and consensus. For instance, disagreements in agricultural policy slow down agreements in high technology. And despite the big successes of the Airbus and the European Space Agency, there is not yet the massive infrastructure needed to compete with the USA and Japan.

Europe is also the victim of strong bureaucracies with centralized power, such as in the Postal, Telephone and Telegram Companies. Their political maneuvers have often delayed improvements in telecommunication industries. Although France (with its Telematique Programs) and Portugal have established goals to revolutionize the digital telephone system, it is not obvious that a unified digital network system can

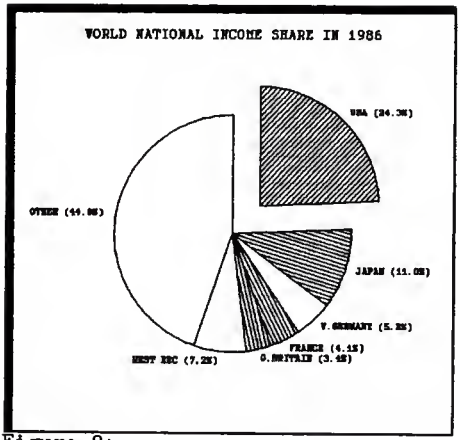

Figure 9: With almost 20 % of the world production, the EEC is close to the USA and largely surpasses Japan. But separately, the European nations are far from being competitive.

be created, leading to difficulties in building integrated information systems and continentwide programming environments.

Europe is experiencing conflicting interests, competing suppliers and traditional rivalries, and there have been very few changes since Thomas Jefferson named European nations "nations of eternal war".

2) The Major Ideologies

* **Great Britain**: The English government is a symbol of durability and constancy. This is due to a successful balance between deference for authority and respect for the rights of individuals, constitutional flexibility, the encouragement of political opposition and a preference for negotiation over violence to resolve conflicts (except for Northern Ireland).

During the 70's, international pressure and growing divisions within political groups (e.g. Labour Party and Trade Union) reduced this cohesion. This political division came after World War II along with a decline of British international competitiveness and a loss of geopolitical influence.

The government made efforts in the 60's and 70's to improve the industrial relations system, to reduce wage costs and to increase productivity. These efforts achieved very little success, and the present government

of Margaret Thatcher is providing ideological changes. Thatcher's is the first postwar government to deny any obligation to secure full employment and to challenge both the cost and the rightfulness of public provision of housing and health care. By the end of 1984-85, spending on national defense and police programs was 40 % bigger than in 1978-79. Education and transport remain constant, housing expenditures were divided by half, and income support, health and social services have grown. The economic recovery of the acting British government began in 1981: output grew at about 3 % annually and inflation fell from 10 % (1980) to 5 % (1984). Export growth has averaged 5 % per year during this period, but the foreign balance remained negative due to poor competitiveness and increase of imported goods and services. Pressures on profit are increasing, along with

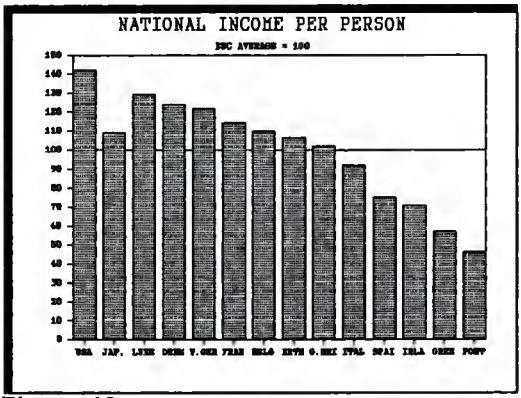

Figure 10: 1 unit on the Y-axis represents 1 volume of goods & services. The Americans remain the richest and Japan got ahead of the EEC where the difference of GNP per person reaches 300 %. In 1970, the figures were respectively 157, 94 and 100.

a continued decline in competitiveness. Finally, the 13 % unemployment in the first half of 1985 is the record postwar level, and will probably not improve much. Opinions are divided about what responsibility the government has for the modest recovery in output, unemployment and competitive weakness in manufacturing.

Britain's ideological symbiosis has been weakened by the Thatcher government's policies (nationalized industries, laisser-faire, etc). The society's values are moving towards individualism, reliance on the market mechanism and a view of the community as a set of self-interested competitive actors.

The value of currency must also be considered for evaluating British productivity. After World War II, its economy deteriorated, and its unemployment reached 12 %. But despite this problem, it was able to compensate the poor performance of its economy and the increase of labor cost by devaluation of its currency relative to the USA. As a result, the USA was actually excelled by Great Britain in that period.

Ideological coherence and solid economic performance go together. The dysfunction of ideology in Britain is connected with its falling from imperial power to the bottom of the second rank nations. The United Kingdom has probably stopped being a global and economic power, and

as one British observer noted recently, "the rational task of modernization in Britain is to make the United Kingdom a relatively thriving but nonetheless second-rate country" (Anthony Barnett).

* **France**: 'The policy the government put into action in 1976, and which it has followed ever since, is to adapt France to the new conditions of the world, that is the rise in the price of energy, and the emergence of the developing countries. It is aimed at assuring the competitive capacity of the French economy, the conditions of employment and the standard of living'. (Extract from an address of former premier Raymond Barre).

'To extract ourselves from the economic crisis, we must pull out of capitalism. Since this crisis is capitalism's strategy for recovering profit and restoring its power, we must invent another logic of development towards another ends, and with other incentives. To get out of the crisis, we need to radically reverse the present trends'. (Left Wing reform).

These two radically different views of economic policy represent the position of the right and the left that have for long divided French politics and society. (The left emphasizes social justice and equal distribution of wealth whereas the right prefers individualism and

equality of opportunity.) For instance, the liberal government of Raymond Barre nationalized the French steel industry and denied the US automobile companies permission to build new plants in Lorraine. Several years later, the socialist government of Laurent Fabius allowed the nationalized automaker Renault to become profitable even at the expenses of employment.

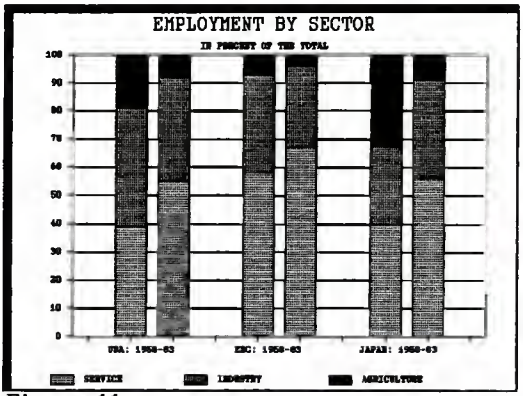

Figure 11: The sector of services offers most of the employment, especially in the USA. Industry remains important in Europe but has decreased.

Besides, Fabius encouraged the French electronic companies to seek joint ventures or licensing agreements with American and Japanese competitors.

Therefore in France, where power is alternated between left and right and where there is no political consensus, it will continue to be difficult to make policies that would make the country competitive in the world economy. However, the creation of the European Economic Community (EEC) will make France more open to foreign competition.

The policy of the former government (Valéry Giscard d'Estaing, elected in 1976) was a strong franc, uncontrolled prices, "voluntary" wage control, and growth of healthy competitive firms in order to lower unemployment. The consequences were good: exports increased. Therefore, France outperformed its EEC trading partners and had the smallest budget deficit of any western nation. On another hand, private investment continued to stagnate, inflation remained above 10 % and unemployment continued to raise.

In 1981, François Mitterand was elected president based on the French preference for traditional values. The socialist policies went against the global trends. For example, while the foreign competitors were lowering their inflation rates, France's continued to rise. The stimulation of consumption caused foreign goods to flood the French market, trade suffered deficits and the franc weakened steadily.

The French industry, despite some competitive positions (armament, nuclear development, aeronautics and space equipment), remains unprofitable. In 1980, only 6 % of total French business turnover was in electronics, compared to 41 % for the USA and 20 % for Japan.

The major electronics companies such as Bull (computers), Thomson (consumer electronics) and CGE (telecommunica-

tions) were nationalized in 1981, along with other major companies. But after a few years, Bull and Thomson were allowed joint ventures and licensing agreements with both Japanese and American companies. French managers convinced the state that it was cheaper to buy the dominant technology than to develop a uniquely French one. So Thomson's losses fell from $ 260 million in 1982 to $ 14 million in 1984, CGE remains very profitable, and Bull has also cut its losses.

France's late entry into high-tech industries, combined with ineffective or damaging public policies has put French firms at a competitive disadvantage. Nevertheless, the new managers are doing their best to manage by the traditional capitalist criterion of profitability, forced by the reality of global competition.

* **Germany**: Events following World War II increased the influence of individualism in West Germany (equality of opportunity, competition to satisfy consumer desires, limited state power, etc). But this increase is superficial, and is not a fundamental shift from historic German communitarism ideology and practice.

The German economy is the leading economy of Western Europe. Its unemployment is only slightly higher than the "successful" American economy, and most of its export-oriented industries have done remarkably well.

One of the major characteristics of West Germany since 1975 is that groups of industries in the economy show sharp differences in terms of performance. The sectors fall into three groups: one group of industries is very threatened and is likely to disappear. This is the case of steel and textile (as in almost all industrialized nations). The second group is the new industries with spectacular growth: computers, micro electronics and consumer electronics. But German industry tends to be dominated by a third group composed of machine tools, chemicals, automobile and industrial electronics. This group is more "mature" than the second one, and is crucial for the health of the national economy.

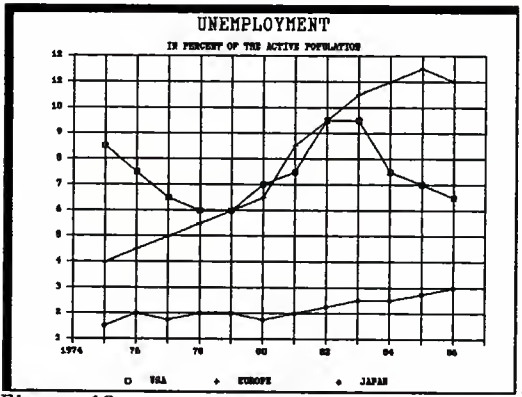

Figure 12: The situation has reversed since 1974: Now, the US unemployment rate is half of European's, but twice Japan's.

The performances of these sectors have been very competitive, and their economic strength lies in the nature of production where the application of high

technology is very important. The electronic sector has some powerful companies such as Bosh, Siemens and AEG, and the automobile sector Daimler-Benz, BMW and Volkswagen, that all provide high quality products.

The German "organized capitalism" is the framework within which a firm can adapt to changing international competition. It is executed by four sets of private and regional institutions: banks, industry organizations, regional governments, and skilled worker dominated trade unions.

- The Deutsche Bank has established five venture capital firms, each one with a complete autonomy to explore investment possibilities. When the bank discovers a likely target, officers can quickly mobilize considerable resources.

- Industry organizations also play a crucial role in shaping sectoral economic policy. In the USA, industry organizations are often special-interest groups or lobbying organizations. In Germany, however, there are some ideological distinctions from the US version: their role is more to set the "framework" for industrial "order". But both try to limit, by defensive ways, the damage of public-sector policies, or to protect against unfair competition from foreign industries.

- The third component of West German strategy for industrial adaptation is the regional (land) government. The "laender" of Baden-Wuerttemburg and Bavaria have taken major industrial policy initiatives to transform the economy of their regions. They arrange creative public sector financing, promote export and commit significant funds and policies toward education so that the public sector can improve innovation and change.

- The last component of innovative economic adaptation is the skill base of German workers. The employers and government have realized that unionized workers are skilled workers, and the German's companies producing services need them to adapt and remain internationally competitive. The German unions have a large stake in the upgrading of worker skills, and use them in flexible system manufacturing.

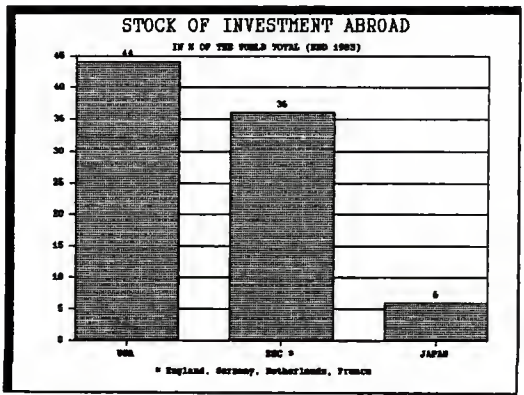

Figure 13: The United States and Europe are close in terms of investment abroad. Japan is far behind.

Several factors could hurt industry in West Germany. For

instance, they remain very export-dependent and have few natural resources. So, the national economy is sensitive to recession in the world economy and any possible new oil shock. They have to rely on a vast nuclear power industry, causing difficult relationships with unions and the "greens" (ecologist party).

Germany is a highly organized society with good industrial efficiency. Thus, ideological consistency is particularly important and takes a communitarian form, especially aimed toward economic adaptation of the country, an adaptation made successful through combative industrial relations.

Great Britain, France and Germany, the three leading nations of Europe, have therefore three entirely different ideologies and socio-economic features. While England has a durable and constant government, its political and economic influence has decreased significantly, and its worldwide competitiveness has collapsed. On the other hand, French industry is a little better but suffers from an important lack of consensus, and political left-right divisions. Finally, although a very good industrial organization makes Germany one of the best industrial nations of the world, the country remains very sensitive to foreign factors.

3) Education

* In **Great Britain**, the educational system has produced a huge share of world class scientists. For instance, Britain has made fundamental contributions to computing and the system is geared to outstanding training for the elite.

However, just as in the US system, it has a lack of ordinary engineers, scientists and technicians, while quality is decreasing and expenditures in research and development are being reduced. Besides, most new British PhD's often acquire research experience abroad and are reluctant to return home. So, as well as the US, Great Britain's future as an industrial nation will not be ensured by its present educational system.

* **France** has a distinguished scientific history and a strong traditional system. French history in physics and mathematics is perhaps unparalleled, and French students are well grounded in these topics, despite the fact that education is very centralized. However, the rigid examination system inhibits creativity in opposition to the English system which encourages it. One of the major problems is the inadequate number of engineers, a problem only recently recognized. The older engineers going to retirement may not be efficiently replaced.

* In **Germany**, finally, the engineering tradition survives, students are well grounded in mathematics and sciences, and Germany has several very good universities. The government also provides important financial supports. But a lack of opportunities in the country often force German scientists to work abroad, particularly in the USA, which has benefited American projects (such as the Manhattan Project to develop the atomic bomb, and the space program).

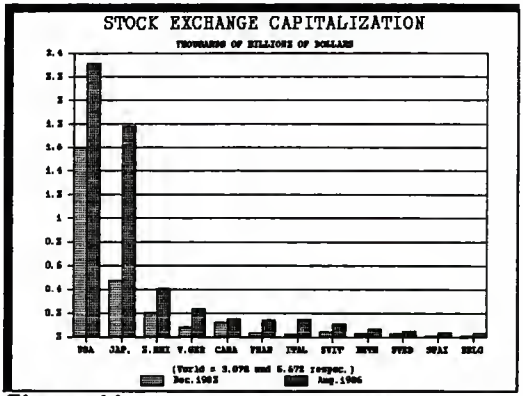

Figure 14: Between 1983 and 1986, the total value (in $) of stock has been multiplied by a ratio 2-7 for Europe and 1.5 for the USA. During the same period, the dollar lost 25-35 % of its value relative to the other currencies.

Education is a strategic factor in the industrial competition. It is the supply of the troops required on all the fronts of the industrial war, and the next generation will pay the price for ignoring the problem today. While the USA has the best universities, the European educational systems are the greatest weapons in

the technology war. The quality of education (high scientific level and important percentage of the population) produces good engineers and researchers that may balance the economic and political weaknesses. An excellent mean to stay out in front of the global competition is to use (and eventually sell) skills and knowledge. Germany and France are strong in both sciences and engineering education, and Great Britain is strong in sciences. The educational system in Europe and the United States can balance the quality of Japanese engineers with better PhD level researchers. The link between educational quality, inadequate number of engineers, uncompetitive products, marketshare and unemployment is too important for the problem to be ignored.

4) Trade Practices

Foreign trade is another mechanism of industrial relationships. In the Western nations, foreign trade is one of the most regulated aspects of the economy, and industry contributes a lot to the trade balance.

One method to deal with a balance of trade strain is to establish explicit trade barriers such as import duties, quotas and other restrictions. Another way to reestablish a favorable balance of trade for a nation is to reduce the value of its currency. Great Britain did it in the 60's, France in the 80's and the USA tried in 1985-86.

In 1986, due to an appreciation, the yen became much stronger in the USA than in Europe, creating a favorable trade climate for the Japanese on the European market. As a defensive tactic, the EEC imposed a 20 % duty. However, the Japanese were still able to quadruple their sales of compact disk players.

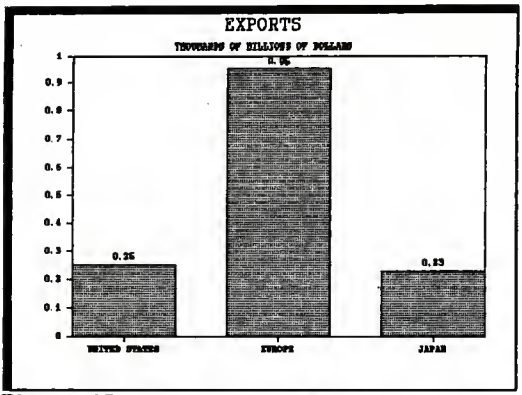

Figure 15: Once the European countries united, they out trade the USA and Japan by almost 400% in terms of exports.

This shows that the commercial sector is more sensitive to forces affecting their profits than the governments that manipulate those forces.

To reduce the increasing flow of foreign goods, import barriers are erected. Examples are the French threats to veto Britain's import of New Zealand butter, the federal restrictions of Japanese VCR and cars imports, or the exorbitant EEC tariffs on foodstuffs.

A more sensational method of technology war is Dumping (particularly used by the Japanese on the US market of micro electronics), which consists of selling products

below costs. The reasons are gaining marketshare, maintaining employment and reducing unit manufacturing costs by increasing production. Nevertheless, such offensive tactics are restrained by the International Trade Commission and the Department of Commerce. For instance, in 1986 Japanese photocopiers (sold 7-63 % below their normal prices) were dumped in the European market. The EEC responded by imposing a 16 % duty on 12 Japanese companies. As a result, Matsushita began the manufacturing of its photocopiers in West Germany in 1987: an even more threatening response for the European manufacturers.

5) National Projects

The industrial competition, although it takes place in a global context between the USA and Europe, is not a uniform struggle everywhere. Different countries have different backgrounds and strategies. In the battle to stay competitive, the fragmented community of Western European nations suffers from a lack of coordination and standards, a small marketplace and aging industrial plants. However, the nations have recently accepted the need of alliances and are now trying to compete through national organization and large companies.

* In **Great Britain**, British academicians have established a committee to consider the British competitiveness of

success in the fifth generation programs. This committee recommended a restructuring of information technology in the United Kingdom through the "Alvery report", supporting industry with a 60-40 % cost sharing between government and industry. The program gathers the Department of Trade and Industry, the Ministry of Defense, Education and Sciences, and will cost from $550 million to $580 million on a five-year life. Emphasis is placed on software engineering, man-machine interfaces and intelligent knowledge-based systems. Such a project shows that the British government understood the necessity of important national programs. It was created quickly and well planned.

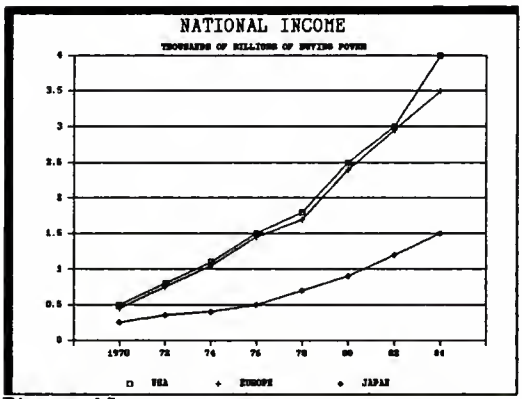

Figure 16: 1 unit on the Y-axis represents 1 volume of goods & services in each country, with regard to inflation. The USA and Europe are close together but Japan is catching up.

Other weapons of the British industry are large and up to date companies. ICL for instance is the principal British computer firm with a sales volume of about $ 1.5 billion

and has a special supplier relationship with its government, as most of the European suppliers have. It is very active in the U.K. and NATO research establishments, and participates in the Alvery, ESPRIT and ECRC programs (see chapter IV-D). But despite a big R&D center, the company fails to establish a strong presence in the international market. General Electric Company (GEC) is another important British firm. This $ 7.5 billion firm is strong in the new technology areas and is active in electronic systems and components for defense, energy and computing applications. One of its divisions alone exceeded $ 1.1 billion in sales in 1984. Plessey (electronics), Feranti (computer and electronics), and INMOS (subsidiary of Thorn EMI) are trying to expand the British market by hundreds of millions of pounds in the world marketplace.

* In **France**, many companies became nationalized when François Mitterand was elected president in 1981. By 1987, France had the largest government-owned data processing sector (outside of the communist countries) with 28 % of goods and services produced by companies in this sector. But this ownership has not been all bad and the major high technology companies improved their financial position with the aid of $ 5 billion of government funds. However, eventual privatizations or

"denationalizations" may change their international competitive positions.

The "Groupe de Recherche Coordonée" is one of the general national programs. It is made of universities, national laboratories and companies such as Bull, Compagnie Générale d'Électricité and Thomson-Brand, under the management of the "Centre National de Recherche Scientifique". The research topics are man-machine interfaces, robotics, intelligent knowledge-based systems, software engineering and so forth. The funds come from the Ministry of Industry and Research, French Telecom and Ministry of Defense. Other developments are planned, such as a nationwide cable television system using lightwave technology ($ 170 million, 6 million homes wired by the mid 90's) and research in software (Prolog by A. Colmerauer, Ada by

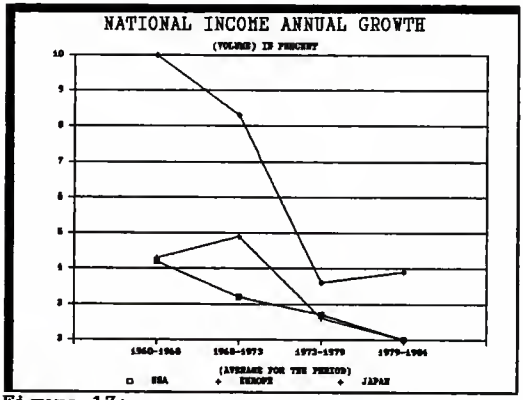

Figure 17: The loss of economic growth is global since the 1973 oil shock, but the decrease is more accentuated in Europe than in the USA.

J.Ichbiah). France's industrial strength lies in nuclear technology, aviation and telecommunications, but there are no consistent coordinated programs in information technology, and R&D funds have been reduced to 8 % since 1981.

Thomson-CSF is one of the strongest companies in the French electronics industry. In 1985, it invested 18 % of its sales ($ 800 million) in research, and has worldwide sales of over $ 4 billion. Bull, ranked 16th in the world, is the leading French computer and data processing company (as ICL in Britain and Siemens in West Germany), but has the reputation of not trying anything until it has been done by IBM. New manufacturing and marketing agreements with Honeywell and NEC should offer it new opportunities. This should also reduce its vulnerability to foreign competition, since, as in the Japanese market-place, consumers tend to buy domestically produced goods.

* **Germany** has groups that work in wide ranges of industrial areas. The "Bundesministerium für Forshung und Technologie" (BMFT) and the government's Research Ministry support federal programs. The government and its industries have also begun important communication projects to follow the Japanese and the French and will implement a fiber optic network at a cost of $ 70 million.

Siemens is the key German electronics and communication company in the technology competition: it had $ 16 billion of sales in 1984, and was in 1985 the number two equipment supplier in Europe, behind IBM. Employing over 30,000 people in research and development, it has strong support from the BMFT, and also covers the fields of nuclear energy and materials. A joint venture with GTE allows it to enter markets in Italy, Belgium and Taiwan, and is related to the European programs ECRC and ESPRIT. However, strong companies do not always lead to the greatest marketshare. American and Japanese companies remain at the head of the competition.

* **Holland** is well represented in Europe through its firm Philips, a large $ 20 billion firm with an excellent reputation for its work in basic research in the electronic sciences. It is part of the ESPRIT program and collaborates with Siemens. 4000 people are engaged in research, and R&D laboratories are even established in the USA (as Olivetti in California or Siemens in New Jersey).

European national projects take different aspects. In England, organized committees backed by the government try to restructure industry while big companies keep fighting to maintain their international positions.

France also relies on national programs and high technology. The recently nationalized companies receive big help from the government but remain very vulnerable. In West Germany and Holland, industry welfare is based on the good interrelations between the big companies and national programs. However, all those projects are of little consequence on the world scale, and the only means the European nations have to keep ahead of the competition is to gather themselves into a unified system.

III COMPARISON OF THE TECHNOLOGIES

This last quarter of the twentieth century has seen the apparition of the third industrial revolution: electronics, genetics, materials, energy and space engineering. Most of the time, progresses realized in a field have been conditioned by improvements in others. For example, thanks to silicium, material science has been at the origin of computer science, artificial satellites, telecommunications, nuclear sciences and space discovery.

The scientists' and public's interest for some fields such as biology or computer sciences has been a determinative factor which led the United States (and Japan) to large research and development programs. In Europe, the mistrust of the Germans towards the new technologies slowed down their innovation in nuclear and chemical industries. The French tried to be the "Japan of Europe" but decreased their R&D efforts from 2 to 1.8 % of the gross product. Actually, Europe is experiencing a scientific and technical slippage: before 1939, the countries of the EEC obtained 90 Nobel Prizes versus 13 for the USA. Between 1970 and 1984, the Americans got three times more! So, of all the technical revolutions that have metamorphosed the world economy and society, has the United States or Europe played the decisive role?

A) THE MICRO ELECTRONIC REVOLUTION

Most of the inventions in the field of electronic components come from the USA: the US engineer Lee de Forest invented the vacuum lamp in 1906, allowing the creation of radio, television, remote control and computer. In the 40's, the Hungarian mathematician Johannes von Neumann who immigrated to the USA, imagined the first structure of the computer. So, the first computer (using lamps), the IBM 650 of International

Business Machine, was created by Watson in the 50's. It weighed 3 tons. Miniaturization was necessary for practical applications. The AT&T research laboratories (Bell Labs) with William Schockley created in 1948 the first transistors, much smaller, faster and more efficient than the vacuum tube. In 1958, by putting several transistors together on a silicon slab, the Texas Instrument Company developed the first chip. The first computer using chips was then created by the Univac Company. By 1970, one chip already contained more than one thousand transistors. In 1955, Schockley left the Bell Labs and established his own enterprise in California, in the "Silicon Valley". Many firms have followed him, such as the Fairchild-Semi conductor, and later, Intel (1968) which developed micro electronic chips. Since 1973, their efficiency has quadrupled every four or five years, as their costs have

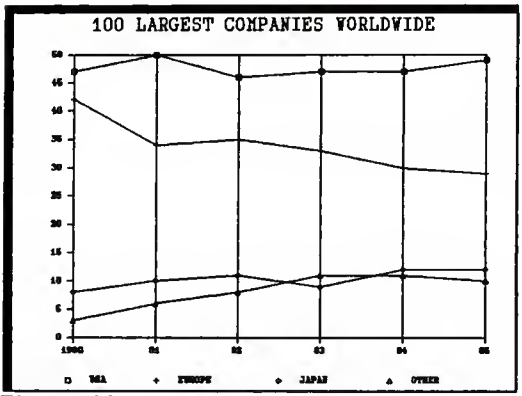

Figure 18: Within five years, the number of big companies has changed from 47 to 49 in the USA, and from 42 to 29 in Europe.

decreased from 30 to 50 % per year. These successes gave the United States some economical and political advantages in the 60's such as the conquest of the moon, but above all, mastery of the computer industry, from the personal computer to the $ 10 billion super computer. If the aircraft industry had made similar progresses, the Boeing 767 would cost only $ 500 and would make the tour of the world in less than twenty seconds!

Thus the American research in this field deserves all the credit of the modern electronic industry for having been the leader of the four electronic revolutions.

In 1984, the fifteen first worldwide electronics companies are: Texas Instruments (number 1 with 10 % of the world market), Motorola, IBM, AT&T, ITT and General Electric (USA), Philips (Swedish), Thomson (French), GEC (United Kingdom), Siemens (German), and Matsushita, Hitachi, Fujitsu,

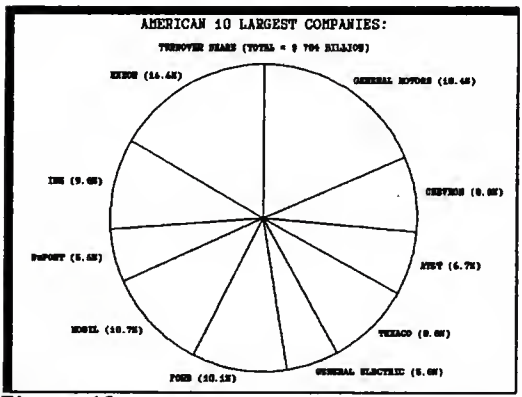

Figure 19: The ten largest American companies weight almost twice the ten largest European companies (see next figure).

Toshiba and Nippon Electric Company (Japan). But half of the global benefits goes to the American firms, while the world turnover of electronic industry is reaching $ 170 billion and probably around $ 850 billion in 2000.

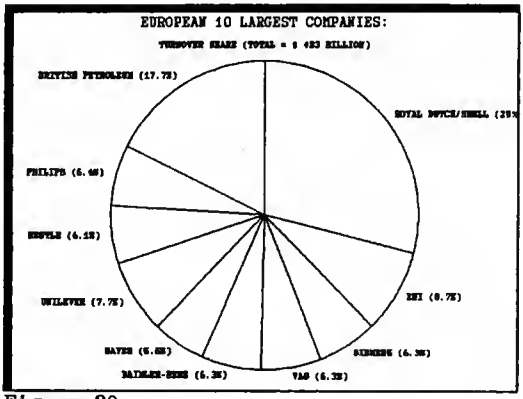

Figure 20.

Now, the USA is aiming to produce computers incorporating artificial intelligence. A technological challenge is not occurring with Europe, but with Japan, and its issue is still uncertain. It is already sure that the fifth generation computers will not be European.

The industry of computer science is composed of different fields:

1) Memories and Components

The world market of electronic components develops very quickly. It doubles every four years: $ 5 billion in 1978, $ 10 billion in 1982, $ 21 billion in 1986. This doubling is in spite of price decreases from 30 to 50 % per year. Europe succeeded in placing its leading

companies (Philips, GEC, Siemens, Thomson) among the 15 first firms of electronic components. But their position on the market worsen every year at the benefit of the Japanese firms which, since 1978, have taken an advance in memory production (they got 80 % of the marketshare by 1982). In 1983, the NEC company produced 100,000 units per month, followed by the other Japanese companies a few years later. AT&T which, so far, kept its memories for its own use, decided to commercialized them in 1984. It was immediately followed and overtaken by Hitachi. However, the USA remains the leader in terms of micro-processors, design and manufacturing equipment and all related sophisticated technology. Siemens (Ger) started its production of memories with a delay of two years, and Thomson (Fr) with five years. The Europeans do not own the market and are only spectators: they fulfilled their own demand at only 40 % in 1984.

The American firms such as IBM, have financial ease: its profit in 1983 reached 34 billion dollars. This profit ranks IBM at the third place of the world computer market, and represents a third of the national budget of a country like France. With such an advantage, preparing for the future is easy: in its five-year plan of 1978-1982, it has invested $ 20 billion with 50 % for research and development.

In Europe, Bull (Fr) is 12th, ICL (GB) is 13th, Olivetti (It) is 14th, and Siemens (Germ) is 16th. They are losing now on both technical and commercial fields, and only hold 10 % of the present market (IBM dominates 2/3 of the European market). The cause is a weakness in electronic components and bad strategies.

The failure of the group Unidata is very illustrative of these bad strategies: it was created in July 1973, gathering Siemens, Philips and CII (Fr), and was aimed at manufacturing a new line of European products: Unidata. But three years later, the French Ministry of Industry stopped the program for the benefit of a fusion between the national firms CII and Honeywell-Bull. The major reason of this failure is a French mistrust of an eventual "Germanization" of CII, and a strategic mistake to consider that an American alliance with CII would open the US market (which will never be realized).

2) Super Computers

Until 1984, the 92 super computers were shared between Cray Research (68), Control Data (20) and Denecolor (4). The cost of a super computer was $ 10 million in 1984, and the total market was around $ 15 billion in 1986. They are now much below that, since the NEC, Fujitsu and Hitachi companies are in the market.

The areas of utilization are aeronautics, aerospace, oil

prospection, electronic circuits design, and so on. They have a vital importance for the US defense department. So, IBM planned to enter this market by 1985.

3) Micro Computers

With the microprocessor revolution in 1971, new possibilities opened up for computer science: small, simple and cheap computers can be now manufactured. At the beginning, nobody really saw the new important market of personal computer.

In 1976, Steven Jobs and Steven Wozniak developed the first models of the brand Apple, which will have a worldwide supremacy for several years. In 1985, more than 500 firms (most American) are present in this field, but the Europeans such as the British Sinclair and the Italian Olivetti are also at a good position.

This profitable new market attracted the big companies: In 1983, IBM commercialized its PC (personal computer) and took the third place in Europe with 16 % of the marketshare. Before it are Apple (21 %) and Commodore (18 %), while Olivetti took the fourth place with 9 %. In 1984, IBM took the first place from Apple, both in the USA and Europe. Meanwhile, AT&T decided also to manufacture micro computers.

4) Software

In the American-Japanese world of computer science, the

only area where Europe competes with the USA and dominates Japan is software. This is a strategic sector with high development potentials. British and French firms of computer services and counsel are well placed on an European level and rival

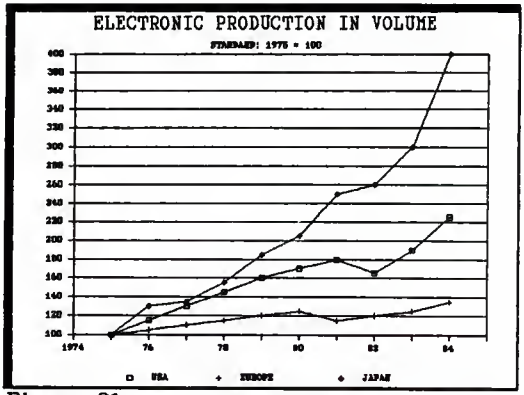

Figure 21: The American production is higher than Europe's, but cannot compete with the Asian vigour.

American firms. Some French software has even acquired an international reputation: the program "Caddia" designed by the Marcel Dassault company has been in worldwide commercialization since 1982. The same way, the "Ada" language created by a French team has been adopted by the Pentagon. The Japanese also appreciate the European innovation: their big five-generation computer programs use the language "Prolog" written by Alain Colmerauer from the University of Marseille in 1971.

5) Large Public Electronics

* In the 50's, the US black and white television manufacturers RCA and Zenith had a worldwide monopoly.

Because of the difficulty to enter the Japanese market, they preferred to sell their patents to local enterprises that could accustom themselves to that kind of production. At the beginning of the 60's, the same bearing was naively done for the technology of the color television which was just mastered. So, starting in 1969, the US technology was commercialized by Japan, which improved and automated the production processes. When RCA and Zenith reacted three years later, it was too late, and one third of the US color television marketshare was already lost.

In Europe, the managers found a way to protect their market by creating individual national standards (e.g. the Pal/Secam system) that are incompatible: this allowed them to keep 75 % of their market. In 1983, the Dutch company Philips became the leader in Europe with five million televisions produced.

The market for color television has now been largely cleared. Competition has been hard and openings are decreasing such that the companies tend now to orientate to other fields.

* The VCR (video cassette recorder) was invented in 1976 by the American engineer Alexander Poniakoff. However, his invention did not interest the US firms and became an Europe-Japan competition. One can choose between the

standards Beta of Sony, VHS of Japan Victor Company (JVC) from Matshushita, and V2000 of Philips. The Thomson and Telefunken VCRs are manufactured and packaged in Japan and then sent to France and Germany. One million VCRs are produced every year by one 3000-employee firm in Japan. This is as many as Philips produces in all its European factories!

B) THE BIOTECHNOLOGIES

"Biotechnology" (biology + technology) is one of those fancy compound words that are created along with the advent of new technologies. The biotechnologies are the branch of sciences and knowledge, as well as their industrial applications, that deal with the vital processes, origin and development of plants or animals. They gather very diversified fields such as physics, microbiology, chemistry, genetic engineering and so forth. The purpose of their applications is principally to develop ameliorated products (two-headed corn, ice resistant potatoes, bigger animals, etc) or increase the efficiency of production process.

The biotechnologies began to attract the interest of the European public in the mid 80's, both to stimulate competition and to fight cancer. Ten years before, the biotechnologies had teased the fear and then the interest

of the American public and businessmen who have financed more than two hundred private R&D groups between 1975 and 1985. In 1980, they were declared a national priority in Japan. In Europe, widely distributed journals and magazines consecrated the biotechnologies with many articles whose titles were used ten years ago in the United States, such as "Genetics: The witches of life", "After the chips, the enzymes" and "The biotechnology is getting out of prehistory". But their appearing is still too recent for the employees and company managers to really understand the functions of enzymes and genes, and the real possibilities of life science, as well as the consequences for society.

Scientists have dominated the field of industrial enzymes since the 30's. In 1984, the Danish firm Novo and the Dutch Gist-Brocades had about two thirds of the world production. But waves of revolutionary innovations came from the United States, where synthetic productions happen to be much more efficient. The Europeans only tried to improve manual methods.

Many trials are made thanks to US universities and some associations between small research laboratories and large private firms which sponsor the programs.

In this field, the Europeans have often been at the origin of fundamental improvements. But since the 70's,

this field has been dominated by American researchers. The first step of life understanding was done in 1953 at the University of Cambridge (United Kingdom): the American James Watson and the English Francis Crick discovered the structure of the DNA molecule, source of the genetic patrimony. The catalytic properties of enzymes have been used in an industrial way for several decades in Europe. In 1973, when the US biologist Herbert Boyer (Berkeley University) and Stanley Cohen (Stanford University) discovered it is possible to reprogram cells, they opened the terrible field of genetic manipulation. This involved creation of research laboratories where bacteria samples were sent into the market. The genetic engineering companies such as Biogen founded by Walter Gilbert in 1978, transformed enzymes into products able to generate big profits. The US pharmaceutical group Eli Lilly is now commercializing

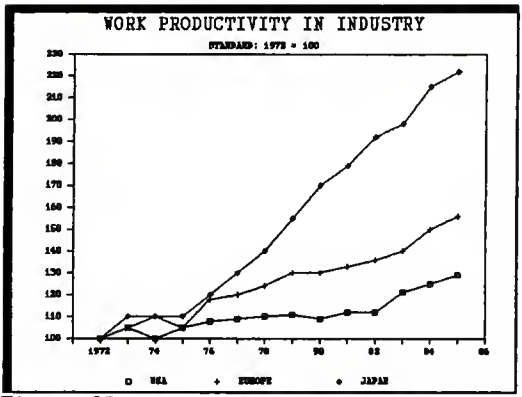

Figure 22: The US work productivity is the slowest. In the best industrial sectors, it has increased up to 11% per year!

insulin. In 1985, more than 200 private firms exist in the USA, and less than half a dozen in Europe. Despite many important discoveries, Europe has left to America the quasi monopoly of commercial exploitation, and their vitality in research and development potential will probably give the Americans a prosperous economic future in fields such as pharmacy, agriculture and food products. The European reign in microbiology, which started a century ago with the discoveries of the scientist Louis Pasteur is now over. Meanwhile, even the US Office of Technological Assessment forecasts that this is a short term leadership, and US industries in biology will have to withdraw at the benefit of the Japanese.

C) NUCLEAR SCIENCES AND TECHNIQUES

The scientific backing of Europe, important in computer science and more limited in biotechnology, is compensated by its strength in nuclear research. Europe is at the first position in particles physics, thanks to the Nuclear Research European Center (CERN). Created in 1953 in the suburbs of Geneva, this center contains the best scientists of the European Community, which is, in this case, an exemplary European cooperation. Europe is at the head of R&D for peaceful use of the atom, rapid neutron reactors, surgenerators or basic research in nuclear

fusion. In these fields, many successes have been achieved.

The first surgenerator to pass the stage of prototype will not be American nor Russian, but European. The "SuperPhénix" reactor built in 1985 in Greys-Malville, France is not a French realization. It was designed by the three European electricity suppliers: Éléctricité de France (Fr), Ente Nazionale per l'Energia Elettrica (It), and Rheinisch-Westfälisches Elektrizitätswerk (Germ), grouped in the French firm NERSA ("Nucléaire Européenne à Neutrons Rapides, Société Anonyme"). Since its creation in 1974, NERSA has been enhanced by the addition of Belgian, Dutch and British electricity suppliers.

After having mastered fission, scientists are now studying fusion, a method that liberates large amounts of energy using cheap material found in quantity. These studies passed the first important step on June 30, 1983 at Culhan, near Oxford (GB) with the completion of an experimental devise called JET as "Joint European Torus". Financed at 80 % by the EEC, this system, which is the most powerful in the world, gives the European researchers an important advantage over their competitors in America, Japan and USSR.

However, this strength of the European scientific and technical potential in nuclear engineering will not have

any economic consequences before the end of the century. Conventional reactors (using fission) provide an energy 20 % cheaper than fuel plants, but surgenerators are twice more expensive than conventional reactors, and will only be operational by 2020.

D) NATURAL SCIENCES

While the micro electronic revolution astonishes and disquiets the public with robots and micro computers, and the biotechnologies disconcert and disappoint sometimes by the slowness and invisibility of the developments, the economic and human consequences of the natural sciences are important.

The term "natural sciences" gathers all the producers of biological components, natural and artificial genes and enzymes, microbial blocks, as well as the enterprises using these technologies to create biological macromolecules (proteins and amino acids) or traditional chemical molecules (sugars, alcohols, etc..). New processes in biology (enzyme and genetic engineering, microbial fermentation) are progressing over the traditional chemical methods where they win many advantages, despite the fact that they are not very efficient yet. This is the case of the motor-fuel obtained by fermentation of agricultural raw materials

such as sugar cane or beetroot, which is not ready to replace traditional gasoline obtained from cracking and distillation of oil. But in the mid 80's, biotechnology victories are more and more numerous.

1) Depollution

Because of the amount of transformed materials, processing hazardous wastes and "depollution" are among the main applications of natural sciences. The damages caused by men can be limited by using certain bacteria which eliminate the noxious products. So, the US firm General Electric has patented a bactery (the "Pseudomonas") that can degrade petroleum, improving the fight against ecological disasters such as black tides. Some others can also be genetically transformed to destroy pesticides and herbicides like DDT or Dioxin. Few laboratories exist in Europe, and most of them are in the United States.

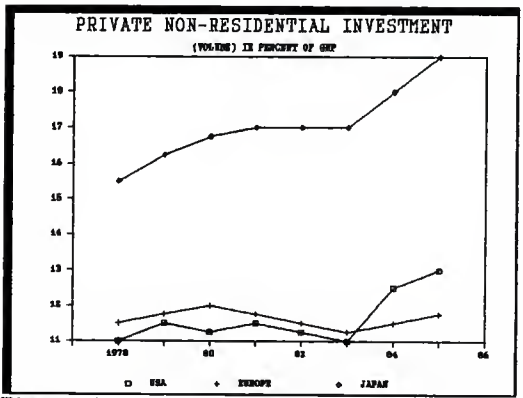

Figure 23: After the decrease due to the first oil shock, investment has resumed at different growth rates.

2) Biometallurgy

Washing minerals ("lixiviation") with particular bacteria is a method that permits obtainment of some metals (copper, uranium or zinc) economically. With this method, the USA works the copper mine at Bingham, Utah, the biggest of the world. One fifth of the world's copper production is obtained through this biological process.

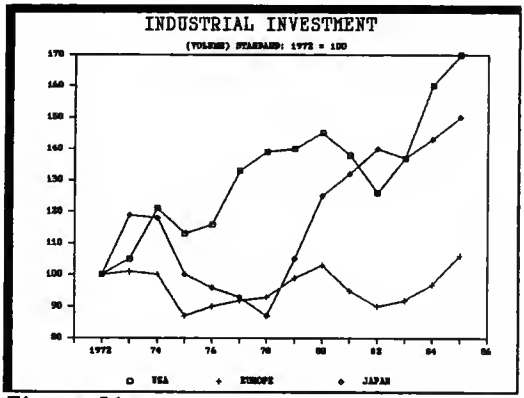

Figure 24: The United States is ahead in terms of investment volume. The economic growth of a country depends on the increase of investment rate.

Research continues to improve that process and develop applications of it for other metals, like iron. The USSR, Australia and Canada are working toward that objective, while Europe is very uninvolved due to its lack of metallic raw materials. Perhaps Europe could replace that lack by exporting its savoir-faire.

3) Chemistry

Among all the top worldwide industries, chemistry is one

in which Europe is very well represented. Germany is particularly well placed with the three big firms Bayer, Hoechst and BASF, whose sales are close to the American company DuPont de Nemours, as well as the British firm Imperial Chemical Industry (ICI).

But like the biotechnologies, chemistry is experiencing an evolution that will change the processes of fabrication. The biggest innovation was synthesis chemistry with the coming of artificial colorings. In 1905, the researcher and entrepreneur Adolf von Baeyer had a financial success with his discovery of indigo which is still the most demanded color in the world (used for blue-jeans). It is now produced by Amgen at Thousand Oaks, California, with new biological processes that threaten the European industry of artificial coloring, a consequence of the European delay in genetic engineering.

4) Pharmaceuticals

As well as in biotechnologies and most of the areas of natural sciences, Europe is fragile in the field of pharmaceutical products. Most of the medical drugs and reactives obtained by genetic engineering come from the United States. Meanwhile, Europe keeps challenging and competition is tough.

Despite the fact that the European scientists are at the origin of fundamental discoveries, the USA is about to

establish its supremacy for commercial exploitation. The quest for insulin is a very representative example of the struggle between Europe and the United States: Since 1983, the US firm Eli Lilly has commercialized human insulin produced by bacterial ways, using the Genentech process. The small Danish Firm Novo is facing this giant by producing insulin with pork livers. The market is around six hundred million dollars, and it is likely that the US firm will win the challenge thanks to the strength of its R&D program.

As far as the rest of medicine production is concerned (vaccines, hormones, blood derivatives, antibodies, etc), the biggest share goes to more than 200 American private R&D companies.

5) Food Products

In the field of food products, Europe has succeeded in developing performing techniques, but has the handicap of the cost of raw material. Among the first worldwide companies on the market of alimentary products, are the two European firms Unilever and Nestlé, with a turnover of respectively $ 33 billion and $ 26 billion. Since the beginning of the century, the Europeans have been using unicellular organisms proteins, replacing vegetable proteins such as soybean that was imported from the USA. These proteins are obtained from cereal, sugar, dairy

products, vegetable wastes or petroleum products.

Following the sudden raise of oil prices in 1973 and the decrease of the price of soybean, many production units closed. New processes were invented by Hoechst, Phillips Petroleum and Imperial Chemical Industry, which is now in first place in worldwide sales. A development in that direction is necessary to alleviate the lack of proteins which will threaten the planet by 2000. But danger comes from the countries possessing cheap carbonaceous raw material, as for instance OPEC, if they decide to use their resources to enter that market. If Europe should lose its competitiveness in raw materials, at least it could continue exporting its technology.

6) Biological Fuel

Several countries in the world now use new natural technologies to create ethanol utilizable as motor fuel. In 1975, Brazil inaugurated the program "Proalcool" allowing it to produce four billion litres of ethanol from sugar cane. The objective for 1987 was 11 billion, or in other words, a third of their own consumption. The United States uses corn, and the biggest plant, the National Distillers & Chemical Corporation, produced 150 million litres of ethanol in 1984.

As far as Europe is concerned, it is still at the experimentation stage. Since 1983, France, the most

advanced country in this field, has tested different products for its program "Carburol" with a yearly capacity of 50 million litres. This is not only due to the high costs of the agricultural policies, but also to the small quantities of natural raw materials. Europe is disadvantaged compared with the USA or Brazil in terms of cultivable surface area. Nevertheless, this race for "green gold" will last for decades. The slow pace of this evolution gives Europe time to catch up with the delay.

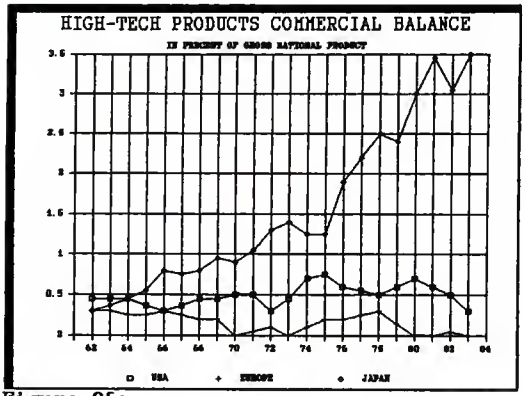

Figure 25: High technology exports are dragging Japanese commerce and therefore growth. This explains the lack of dynamism of the USA and Europe.

The field of natural sciences is still very small although it aims to represent 25 % of the gross product of the European nations. But the mutation has just begun, and we shall experience before the end of the century some spectacular developments such as in electronics,

which will also involve new competitions between the USA, Europe, Japan and OPEC.

E) TELECOMMUNICATIONS

Telecommunications and electronics have been incompatible for a long time due to a difference of functioning (analogic vs. binary). The coming of satellites in 1965 revolutionized communications. The first one, Intelsat 1, more famous under the name "early bird", was American, although the launching was conceived by the German Werner von Braun. Satellites were improved with a rate of 100 % within a 20-year period, at the expenses of the transcontinental metallic cables.

We are now living in an environment of teleconferences, telecopy, remote-controlled automated workshops, stock consultation, and computer interconnections. The US creation of the laser also improves telecommunications since it can generate signals in fiber optics, a new method of telecommunication 1000 times superior. A standardization of data processing is being done, started by the French firm CIT-Alcatel, which installed in 1970 the first entirely electronic communication center.

Unlike Alexander G. Bell who founded AT&T to exploit his invention, the other telecom services (telephone, telegraph, telex) where managed during one century by

national administrations. So there is now a certain harmony in the repartition of the market: the EEC owns 30 %, the USA 50 % and Japan only 10 %. Europe has, in this field, a local industry strong enough to compete efficiently, and the European Common Market is even having commercial surplus. Meanwhile its competitiveness is decreasing as research and development costs are heavy, and Japan offers cheap products. Europe is now weak in the high development sectors such as radiotelephone, opto-electronics and satellite connected stations, which are mainly dominated by AT&T, IBM and the Japanese NEC and Fujitsu-Fanuc. Europe also has the disadvantage of possessing too much equipment that cannot be paid off before it becomes obsolete.

As far as the satellite industry is concerned, the USA owns more than 2,000 satellites, with 2/3 of the world's communication capacity by Intelsat of Hughes Aircraft. But Europe remains present with three important firms: Arianespace (European), Satcom (gathering the British Aerospace and the French Matra), and Eurosatellite (French SNIAS and Thomson-CSF, and German Messerschmitt-Bolkow-Blohm). Many European satellites are now regularly launched.

A transatlantic optical cable, the TAT 8, is planned to connect New Jersey in the USA and Penmarch Point in

Brittany via the United Kingdom during 1988. This takes a part of the satellite market, with a cost of $ 335 million and a ratio 1/4:3/4 at the benefit of AT&T. Is this a reflection of the future of commercial relations? Besides, mistakes in the European strategies have prevented the European electronics industry to be ready, despite some exceptional industrial cooperations. Because of fears of being dominated by a neighbor, most European nations prefer to choose a Nippo-American alliance.

F) AGRICULTURE

Agriculture is another of the few fields where the Europeans feel superior to the rest of the world, and consider themselves as the fountain of appreciation for the finer things in life. But techniques change and tastes evolue; therefore, the 20th century will bring important developments.

The cheese industry, for example, which is one of the most traditional, needs enzymes taken from the stomach of young calfs (yuk!). But the increase in demand requires the establishment of new technologies related to biotechnologies. Again, an American company Genencor (San Francisco) started to commercialize in 1985 the necessary enzyme, rapidly followed by the Dutch firm Gist-Brocades. The processing time in cheese fabrication has been

reduced from 12 to 6 months, causing a big decrease in prices.

Fermented beverages will also be subject to these kinds of transformations. Wine, for instance, has had a very traditional process of fabrication for centuries, where the two stages of fermentation used lactic enzymes. The University of California at Davis has succeeded in discovering a micro organism able to combine the two stages into one alone, therefore reducing operational costs and duration. The French Institute of Agronomic Research is now working on a similar process, but the delay in genetic engineering is a big handicap. It happens not to be enough to have the raw material (milk and grapevine) and to only buy the patents, since US innovations may create a deficit in the commercial balance of the European nations. This can also change the

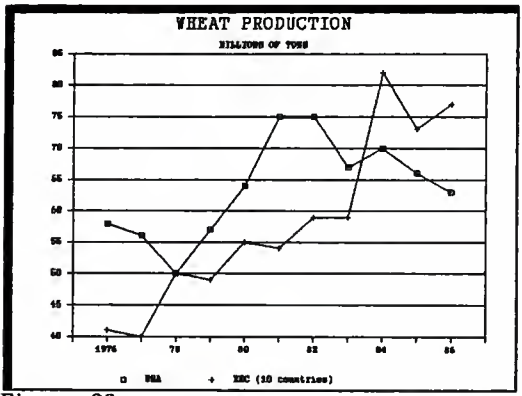

Figure 26: The increase of wheat production within the past ten years ranges from 1.2 (USA) to 1.9 (Europe). The USA-Europe competition is tough in agriculture as the farmers want their marketshare...

relative importance of the agricultural products, which is about to occur to the European beetroot. A biological process for creating sugar has existed since 1973. In 1985, one third of the US consumption was fulfilled by isoglucose which is 25 % cheaper than the traditional sugar, and by 1990, corn syrup should take half of the US market. Europe has kept a conservative behavior which puts it further and further back from the United States despite the good position of the French firm Orsan (10 % of the total production). In the field of amino acids, Japan is the world leader with 75 % of the global market ($ 1.5 billion in 1985).

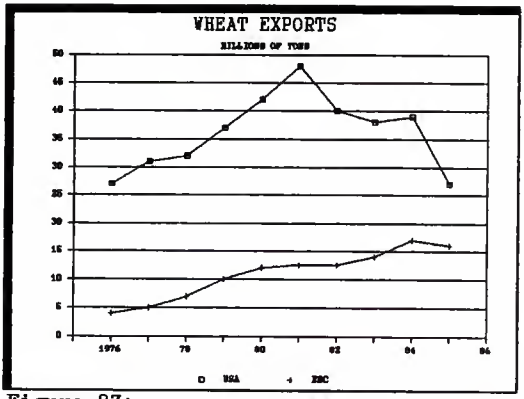

Figure 27: ... while the 1981 sudden decrease of US exports is followed by a steady increase of European exports.

The EEC policies have an important responsibility in that delay: all the countries try to protect their own agriculture and follow a politic of high remuneration, while the USA (and Japan) gives financial aids to decrease the costs. In the USA, products are cheaper for

the consumers, but they pay taxes to finance public aids to the farmers. In Europe, the consumer directly pays the farmers who are overproducting, especially milk and butter. The management of these stocks has required in 1984 30 % of the EEC budget, upsetting industrial countries such as the United Kingdom or Germany. Besides, these products are sold at high prices. So, there are now industrial products that benefit exports, called "restitutions", an appropriate method for stimulating exports.

However, there are still imperfections. For example, the EEC custom duties are such that companies prefer to exhaust the system, buy raw material at world prices, and, once transformed, resell them to the EEC, causing losses of added value. There are also many political troubles, difficult to remove because of disagreements between some countries, the need to reduce expenditures, as well as the inertia and complexity of the system.

G) CONCLUSION

The scientific sectors covered by this section are only some examples of the industries present in the technology war. Nevertheless, they are representative enough of the competitive trends to make fair comparisons between the USA and Europe.

- Some fields are entirely dominated by a unique competitor: this is the case of the strategic industry of micro electronics whose American leadership is uncontested. Europe has some big companies present in the areas of memories and components, software and micro computers, and its large public electronics market is, in some sort, protected by standards. So it can fulfill its own demand but its competitiveness declines.

- The USA has also acquired a recent leadership over Europe in biotechnologies, but this may be precarious due to the coming of Asian countries. However, Europe still has the knowledge it can export.

- The nuclear and telecommunications industries show a good market repartition between the two blocks. Meanwhile Europe is leading these industries thanks to very successful common programs such as RACE or JET (see chap IV-D).

- In natural sciences as well as in agriculture, Europe is either uninvolved because of a lack of raw materials (biometallurgy and food products) or suffers from scientific delay or conservative policies (biological fuel and agriculture). Most of the research laboratories are in the USA, which is about to obtain a monopoly of production. Europe keeps competing successfully in depollution, pharmaceuticals and overall in chemistry where it is very well represented.

The **TABLE** 1 and 2 in the appendices offer a precise competitiveness ranking and companies' evaluations between the United States and Europe.

As a whole, and ignoring Asia, the USA is driving at an industrial supremacy over the European nations. These countries alone are too weak on the worldwide scale to fairly compete, and only an economic restructuring of Europe could reverse the situation.

IV THE UNITED STATES OF EUROPE

In this crisis near the end of the twentieth century, the European countries look very vulnerable. Their structural fragility means that the USA (and Japan) are better prepared for the post-industrial revolution. So, will Europe of the XXI century be a second rank zone in the technologic and economic fields? The huge competition between Europe and the United States to master innovation is far from being over.

A) THE CONSTRUCTION OF A UNIFIED EUROPE

Since the 70's, the Europeans have experienced several defeats in the technologies of information and biology,

as well as in micro electronics. But these are long-term changes, and Europe may have time enough to catch up with the delay. The rapidity of change of electronic industries and the stability of biology industries represent different opportunities to seize. But in that objective, the European nations have a major advantage over the USA and Japan that, so far, they have used with hesitation, mistrust and awkwardness: the European construction.

After having built the Europe of agriculture, Europe of coal (1st industrial revolution), and Europe of steel (2nd industrial revolution), the Europe of the 3rd and 4th industrial revolution remains to be built. Coopérations have already succeeded in nuclear sciences with the NERSA and JET programs, and the Ariane rocket which puts in orbit more satellites of telecommunication than the American space shuttle.

B) MANAGEMENT OF HUMAN POWER

Unlike some specific dispositions, particularly in the area of professional formation, that profit of the EEC financial aids, the treaties of Paris and Rome do not give much consideration to the labor force. Europe must improve in socio-cultural considerations. Having focused on the economic dimension has given the following

results: there is no European solidarity or identity. Nationalism behaviors are very pronounced (more than in the 50's), and mistrusts toward the neighbors are very strong. This is part of the failures of most attempts to form industrial co-operations. So, it is necessary in enterprise problems or consumer's daily decisions to think European first, and not Japanese or American. Social protections which are the most important of the world (such as disease or elderly expenditures) are financial burdens and reduce economic efficiency. Moreover, high unemployment rate and long-duration unemployment are at the origin of dequalification and devalorization of European man-power. Isolated policies for acceleration of economic growth and reduction of labor time are failures, enlarged by lacks of coordination with the other countries. This causes a

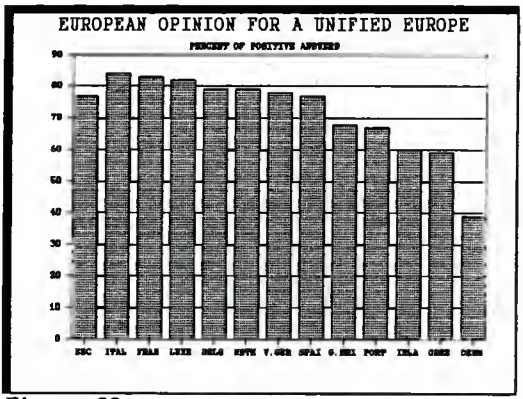

Figure 28: The Italians are enthusiastic... and the Danish cautious. These figures are the average of surveys made in Nov. 1984, Apr. 1985, Nov. 1985 and Apr. 1986, except Spain, Portugal and the EEC: Apr. 1986.

decrease of political, economic and financial autonomy.
A restructuring of the educational system is also needed so that more students will be accepted at the universities and the exchanges between the different countries will be augmented.
The creation of a standardized European telecommunications system will be a powerful factor for information circulation, enhancing the exchanges of culture and men, which is the basis of the European community.

C) CREATION OF A MARKET

The European Community has launched the ambitious program of eliminating all remaining barriers by the year 1992. Right now, there are no national tariffs or import quotas, and the twelve members have agreed on a Common Agricultural Policy of price supports and production management. In commerce, the European nations have already ceded a certain sovereignty to the Community.
Utilizing a big market is what allowed the growth of the United Kingdom two centuries ago, the United States and Germany one hundred years later, and the current leadership of Japan.
The EEC accounts 321 million people versus 238 million for the USA and 121 million for Japan, so it should be

economically stronger. But this is not true since the European Common Market is not entirely common yet. Some subtle barriers still remain, as for instance, custom controls, protected public markets, national inspections laws, technical standards, sanitary norms, regimes and industrial policies. They prevent a good flow of products and services among the different countries.

These practices cost every year a lot to Europe: 15 billion of ECUs ("European Common Unit", approximately equal to $ 0.80) for the custom formalities, and 50 billion at the expense of the consumers because of the public markets. This represents a total of twice the EEC budget, with 250 billion dollars lost every year! But the creation of an industry (electronics, biology, etc) inside a country cannot be successfully done without the protection of custom costs. This happened to England and Germany at the end of the 18th century, to Japan in the 60's, and to the USA today for its space research. Protectionism must be balanced: protecting useless and declining industries as well as not protecting strategic industries which are rising is a mistake. However, despite the fact that Europe needs efficient economic policies based on its large market, it requires the

dynamism and innovation of the American and Japanese markets. So, it needs to implant industries abroad, and not only in Africa or Eastern Europe. Creating multinational companies is necessary and is not a treason toward the other European countries, as are alliances which are dangerous for the Community interest. Meanwhile, one can wonder who will finally benefit much (European companies or foreign companies) from the market unification. It will probably be difficult for European firms to reconquer marketshares owned by foreign companies in the fields of advanced technology, pharmaceuticals or alimentation industry. This is why more than just a market is necessary, but also scientific and industrial cooperations from the different nations through Europeanwide projects.

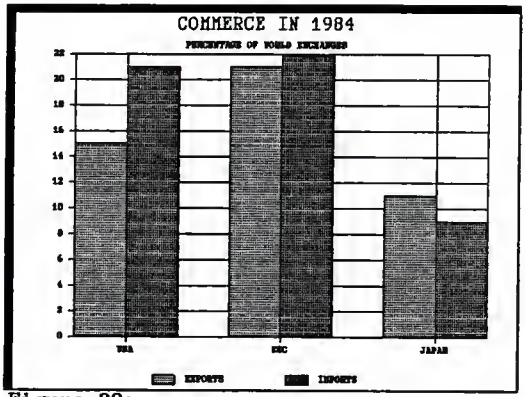

Figure 29: The EEC is the first global commercial power. Its exchanges with the rest of the world are balanced, while the US is in deficit and Japan excels.

D) BIG INDUSTRIAL AND SCIENTIFIC PROJECTS

There are several reasons to promote European unification:

- First of all, one must orient cross-national cooperation in the fields with good future prospects, while, so far, it has only been used in traditional sectors such as agriculture, steel and textiles. The success of the Ariane rocket is much more motivating and shows through a concrete realization that the Community is able to succeed in technical areas. This is part of the strategy or growth and renewal.

- Then, it is important to reduce the technological dependance of Europe vis à vis most of the industrialized countries. The technical improvements profit first the country where they have been made and then are exported. The electronics industry is a very representative example of this situation.

- But above all, Europe has lost its freedom in terms of exports of goods including advanced technology of American origin. In this manner, from June to November 1982, the USA had extended to the European companies under US license the interdiction of exporting gas or oil technologies to the USSR. European exports of computers, electronic machine-tools, phone commutators and mass

production electronics are, or are about to be, subject to these kinds of bounds.

These three points, however, happen not to be followed by the majority of the company managers.

So, creating big European research and development programs is necessary. The US defense, for instance, spends $ 1 billion for artificial intelligence and super computers, and the Japanese MITI consecrates $ 150 million for advanced robotics, and $ 450 million for 5th-generation computers. But, in the EEC countries, the division of public and private research works is the cause of this weakness, although financial means are present. In the mid 80's, for example, 2 % of the GNP is allocated to R&D ($ 33.5 billion for the entire EEC), as much as in Japan (with $ 55 billion), and slightly less than in the USA ($ 88.5 billion). But the results are

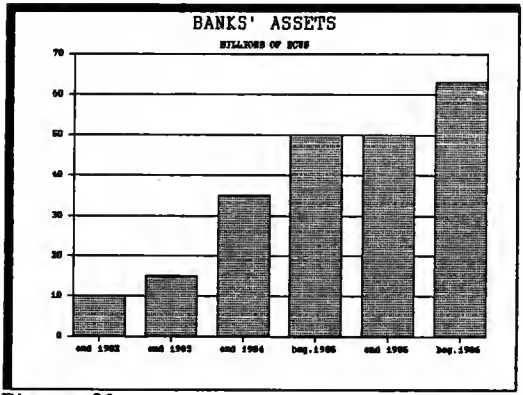

Figure 30: The European monetary system has created a zone of relative stability (although there is no real common policies yet). The ECU is very convenient for international loans and its use has progressed spectacularly.

smaller. Meanwhile, the EEC has succeeded in carrying out some common projects:

* The JET program (Joint European Torus), created in 1983, is an experimental device for nuclear fusion, financed at 80 % by the EEC.

* In 1984, the EEC adopted the ESPRIT program (European Strategic Program of Research in Information Technology), financed with 750 million ECUs, and gathering the biggest electronics groups: Siemens, AEG and Nixdorf (Germ), GEC, Plessey and ICL (GB), Olivetti and STET (It), Philips (Dutch), and Bull, CGE and Thomson (Fr).

* In 1985, the RACE program (Research on Advanced Communication in Europe) covers the advanced technologies of telecommunication.

* The BEST program (Biotechnological European Systems Team) will deal with pre-industrial applications in biotechnology.

* An attempt to keep pace with the USA in research is the EUREKA program (European Research Cooperation Agency), whose early objective was to stop the brain drain resulting from the very attractive opportunities offered by the US research institutes. It is also a response to "Star Wars" (the Reagan Administration's Strategic Defense Initiative) in advanced technology applied research.

* Other programs exist such as ECRC (with Bull, Siemens and ICL), Airbus Industry (Britain and France), as well as joint ventures in electronics (Philips and Siemens), telephone (Philips and CGE), car transmissions (Volkswagen and Renault), patents agreements (Italtel, Thomson and Siemens), and so on.

All these examples show that European projects are starting to show up. But their industrial consequences will not appear before the end of the century.

The **TABLE 3** displayed in the appendices shows the state of the European cooperations.

E) A POLITICAL ALLIANCE

The industrial weakness of Europe (which is partially true for the USA) is also due to bad political judgments. The first of them is the lack of long term strategies since the first oil shock. While the government and the enterprises are sure that it is not possible to create medium or long term actions due to the instability and unpredictability of sales, an increase of long-term planning is necessary. The EEC only focuses on problems pertaining to agriculture and budget, and tends to be afraid of big scientific projects of ten-year durations.

A redressing of demography, an improvement of the educational systems, an adaptation of social protection

and unemployment, an amelioration of financial mechanisms for innovation, and establishments of big R&D projects can only be a long term strategy.

The role of community institutions is decisive for the creation of a real common market, whose functional decisions must be taken unanimously. In these mid 80's, the EEC is obliged to go forward, despite its slowness and heaviness, and the respective reserves about economic and monetary policies, social and industrial policies. 1984 was a decisive turning: big projects started (ESPRIT), the budgetary crisis began to be solved, the reform of agricultural policy started, and projects of treaty have been adopted by the European Parliament.

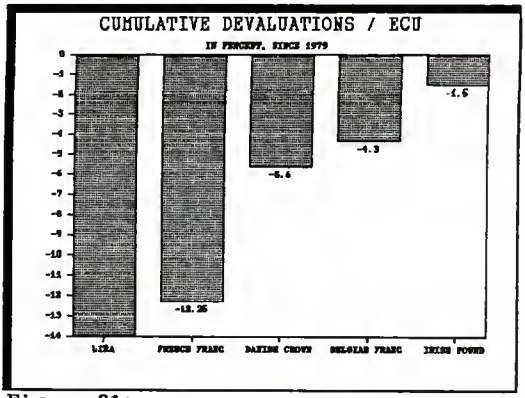

Figure 31: Since the creation of the European monetary system, the German Mark has been evaluated of 24.5 % relative to the ECU, while most of the other European currencies have been devaluated.

F) THE AMERICAN VIEWPOINT

It seems that, so far, US businessmen (and even European's) do not believe in a so called unified market. The Americans will believe in the EEC once they gain what one can expect from such a market in terms of efficiency and profitability. Those expectations cannot be fulfilled when companies hit against borders every 500 miles. The ideal is a unique market from California to Eastern Europe functioning with the same regulations and having the same needs. The proof of the unification would be an European currency, an European Central Bank, and above all the abolition of all forms of protectionism such as norms, reserved public markets, preferential subventions, and so on.

In the electronics sector, the Italtel company (Italy) is about to choose either Siemens (Dutch) or AT&T (US) as a future partner. The earliest case would mean that a unified Europe in telecommunications is going to be a reality. In computer science, some American industries (such as IBM, Digital Equipment and Hewlett-Packard) already have Europeanwide networks. They are now watching to see if the EEC governments will prefer "national champions" (Bull, ICL, Siemens, Olivetti) which are strong mainly in their home countries.

On the other hand, the American and Asian industrialists

are still uncertain whether the EEC will restrict foreigners or not after 1992, and fear a new form of "Europrotectionism". The 1992' EEC is not expected to be a totally free trade. It will, at least be a freer trade, similar to the US-Canada Free Trade Agreement.

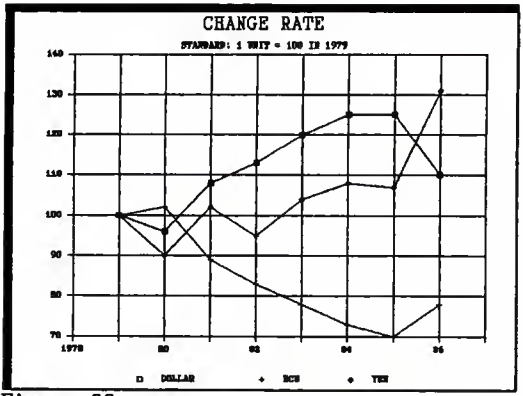

Figure 32: The fluctuations of the dollar since 1980 have been brutal. They have caused the increase of the Yen and the European currencies.

So do the Americans really want the creation of the EEC? They know that they will not cut their deficits without an acceleration of the European growth of about 2-3 %. And this acceleration requires the unification: The new Community will absorb more US-made products and will be a better economic and military partner.

However, the implementation of US companies in the EEC is not the top priority objective. For the time being, South-East Asia cause much more anxieties. So, between an industrial acquisition in Europe and a joint venture in Japan, the latest solution turns out to be the best.

Two wars were necessary to set a European Economic Community. In the industrial struggle of the end of the 20th century, while economic and military insecurity is increasing, the only way for the European nations to avoid an economic decline is to gather together. The future belongs to "continent-states", and the only means for Europe not to be marginalized lie in a commercial, economic, monetary, and also social, cultural and political union. This is a difficult challenge which, should it succeed, will open the doors to new kinds of industrial relationships.

CONCLUSION

Since the Renaissance, the Europeans have stirred the world with their intellectual achievements in art, sciences, religion, philosophy and economy. These spectacular results have dominated Western thought for several centuries.

However, great intellectual accomplishments does not involve domination of the world economic markets. Furthermore, technology demands coordination of

competition and a broad marketplace to provide manufacturing economy of scale.

Without a clear view of the great tendencies, there is no good industrial development, but only hesitating, unlucky and suicidal choices. Errors of estimation are common, even among the best scientists, politicians and economists.

Social considerations are always very important, and accurate industrial forecasts should avoid the gap between social and economic factors. The information about past failures will help describe the fundamental characteristics, as well as the big orientations of the future industrial relations.

The technology war has confused the European nations, and their antagonisms have weakened and fragmented their marketplaces. In the global competition, the Europeans are a second class power. Only the coming of a strong European Community may change their economic strength and lead them to a new, more favorable competitive position.

The Americans, on the other hand, have the advantage of an integrated economy, a big domestic market, a good scientific establishment, and great natural wealth. They are one of the leading countries of the industrial competition. But they must take care not to lose the war because of their own mistakes and irrational national

strategic policies that have already happened in the past (Vietnam war, welfare systems, etc).

Through the USA-Europe competition has appeared the Asian invasion. Japan and South-East Asia might become the world economic leaders thanks to the excellent management of their resources, and the efficient exploitation of their labor forces. They are now driving for a global technological supremacy.

It is important for the reader to be conscious of this phenomenon of international industrial competition, that most often takes the invisible shape of laws and institutions. None of us can pretend that one's professional and even private life is not affected by these technology wars. The invasion of Asian products and the formidable evolution of electronic devices are very representative examples. It is inevitable that our future way of life and standards will radically change.

Whereas the industrial competition is taking more and more considerable importance, we are witnessing a restructuring of the forces in presence, as well as a genesis of new powers. The 19th century saw trade rivalries at the level of companies, the 20th century is more aimed towards nationwide stuggles, and the 21st century will very probably feature inter-continental competitions (as they already exist militarily) and a

quasi irreversible technological gap between the industrialized nations and the Third World.

The purpose of this report is not to help the reader to select the country in which he would prefer to live for its flourishing economy, but to better understand the causes and the mechanisms that make a nation a leading economic power. Because we are the deciders of our country's strength, through our motivations, decision makings, professional capabilities and social objectives, and it is primordial for a nation to stay ahead, that the citizens be other things than just spectators.

With all the advantages and drawbacks this international competition will take in the future, from an economic, political and social point of view, one has to admit it is unavoidable. If this report has helped the reader to prepare it, then I would have reached my goal.

APPENDICES

TABLE 1: INDICES OF COMPETITIVENESS (1965-1984)

	Annual Compound Growth Rate of Real GNP/Capita* (in percent)		Percentage Point Change in Export Share of World Market (less oil exports)		Average Share of Investment in GNP (in percent)	
	rank	%	rank	%	rank	%
ENGLAND	9	1.74	8	-4.0	7	17.7
FRANCE	5	2.90	6	-0.6	4	21.0
GERMANY	6	2.66	7	-1.0	2	23.3
USA	8	2.02	8	-4.0	9	15.4
JAPAN	3	5.27	1	4.4	1	29.0
KOREA	1	7.22	2	1.5	3	22.9
TAIWAN	2	6.78	3	1.4	5	19.4
BRAZIL	4	3.44	4	0.6	8	17.5
MEXICO	7	2.33	5	-0.2	6	18.1

Source: [2] "Ideology and National Competitiveness".

* Measured in national currencies.

TABLE 2: PRODUCTIVITY & PROFITABILITY OF THE BIGGEST COMPANIES, BY SECTORS.

left column: Turnover per employee (in thousands of $).
right column: Net profitability = net benefit / turnover (in percent).

	$	%
AERONAUTICS		
UNITED STATES		
Boeing	131	4.1
McDonnell-Douglas	118	2.9
Lockheed	109	4.2
Rockwell	92	5.2
EUROPE		
Dassault	112	2.8
Aérospatiale	88	1.5
Rolls-Royce	50	4.3
British Aerospace	49	4.6
ALIMENTATION		
UNITED STATES		
Coca Cola	213	8.8
Anheuser Bush	179	6.1
General Foods	161	3.5
Dart & Kraft	136	4.6
EUROPE		
Nestlé	111	4.1
BSN	95	2.8
Cadbury-Schweppes	73	0.2
Guinness	55	5.8
AUTOMOBILES		
UNITED STATES		
Chrysler	198	7.6
Ford	143	4.7
General Motors	118	4.1
EUROPE		
Daimler-Benz	77	3.2
Renault	69	-8.9
Volkswagen	68	1.2
PSA	63	0.5
Fiat	62	4.8
JAPAN		
Toyota	329	6.2
Honda	215	4.9
Nissan	168	1.8
BANKS		
UNITED STATES		
Morgan	5308	1.01
Manuf.Hanover	2375	0.52
Citicorp	2135	0.57
Chase Manhattan	1891	0.64
Bank of America	1421	-0.28
EUROPE		
Dresdner Bank	2333	0.18
Société Générale	2230	0.14
BNP	2085	0.17
Crédit Lyonnais	2074	0.11
Deutsche Bank	2000	0.37
Nat.Westminster	1130	0.54
Midland Bank	1064	0.18
Barclays Bank	895	0.61
JAPAN		
Sumitomo Bank	10000	0.22
Fuji Bank	9060	0.20
Mitsubishi Bank	9000	0.20
Dai-Ichi Kangyo	7860	0.15
CHEMISTRY		
UNITED STATES		
Dow Chemical	217	0.2
DuPont de Nemours	201	3.7
EUROPE		
ICI	117	4.7
Ciba-Geigy	91	7.9
Bayer	88	2.7
Rhône-Poulenc	80	4.1
JAPAN		
Mitsubishi Chem.	319	1.7
Asahi Chem.	194	1.4
ELECTRIC CONSTRUCTIONS		
UNITED STATES		
AT&T	100	4.4
General Electric	93	8.2
Westinghouse	84	5.6
ITT	54	2.2
EUROPE		
Thomson	62	0.9
CGE	57	1.5
Philips	52	1.5
Siemens	51	2.7
GEC	39	7.9
JAPAN		
Matsushita	155	4.8
Hitachi	125	4.2
Mitsubishi	120	2.3
Nippon Electric	102	2.9

Source: [9] "The Expansion".

TABLE 3: COMPARISON OF THE TECHNOLOGIES: UNITED STATES-EUROPE-JAPAN

WORLD POWERS		EUROPEAN COMPANIES	EEC COOPERATION
***: dominant **: average *: backward			***: strong **: average *: weak/null
BIOTECHNOLOGIES			
Microbiology			
USA	***	Ciba, Nestlé (CH), ICI (GB)	*
EUROPE	**	Rhône-Poulenc, BSN (Fr)	
JAPAN	***	Hoechst, Bayer (WG)	
DNA Synthesis			
USA	***	Nestlé, Ciba (CH)	*
EUROPE	**	Pasteur Inst., Sanofi (Fr)	
JAPAN	**		
Cell Fusion			
USA	***	Delbard, Limagrain (Fr)	*
EUROPE	***	Plant Genetic Sys. (GB)	
JAPAN	***		
Animal Cell Culture			
USA	***	Matérieux, Sanofi (Fr)	** EUREKA Pr.
EUROPE	**	Welcome (GB)	
JAPAN	**	Pharmacia (Sw)	
Seed & Phytosanit. Prod.			
USA	***	Claeck-Luck (Be)	* EUREKA Pr.
EUROPE	**	Rhône-Poulenc,	
JAPAN	**	Limagrain (Fr), DDK (De)	
Monoclonic Antibodies			
USA	***	Immunotech, Clomatech,	** EUREKA Pr.
EUROPE	**	Celletech (Fr)	
JAPAN	**	PA Tech. (GB), Biokit (Sp)	
MEDICINE			
Pharmaceuticals			
USA	***	Ciba, Sandoz, Nestlé,	*
EUROPE	**	Roche (CH), Sanofi (Fr)	
JAPAN	**	Hoechst (WG)	
Medical Computer Science			
USA	***	Bull, Thomson, CGR (Fr)	* weakness of
EUROPE	**	GEC (GB), Philips (Ne)	the market,
JAPAN	*	Nixdorf, Siemens (WG)	sharp compet.
Prothesis			
USA	***	Ceraver, Hospal (Fr)	* potential
EUROPE	*	Gambro (No)	penetration
JAPAN	**		by US & Japan

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TRANSPORTATION

Aeronautics & Space		Casa (Sp)	
USA	***	Aérospatiale,SEP,Snecma,	*** success
EUROPE	**	Matra (Fr), MBB,MTU (WG)	of Airbus
JAPAN	*	Brit.Aerospace,Rolls-Royce (GB)	
Rapid Trains			
USA	*	Alsthom,Jeumont-Schneider	** communica-
EUROPE	***	(Fr), BBC (CH), Siemens,AEG,	tion w/o
JAPAN	***	Krauss-Maffei (WG)	cooperation
Computer Implementation & Weight Reduction			
USA	***	Renault,PSA (Fr), Fiat (It)	* PROMETHEUS
EUROPE	**	Brit.Leyland (GB), Volvo (Sw)	Pr.
JAPAN	***	Daimler-Benz,BMW,Volkswagen (WG)	

SEMI-CONDUCTORS

Integrated Circuits			
USA	***	Thomson (Fr), GEC (GB),	** limited
EUROPE	*	Philips (Ne)	but indust.
JAPAN	***	Siemens (WG)	agreements
Semi-Conductor Manufacturing			
USA	***	Thomson (Fr), GEC (GB)	**
EUROPE	*	Philips (Ne)	
JAPAN	***	Siemens (WG)	

TELECOMMUNICATIONS

Optics & Large-Band Networks			
USA	***	CGE (Fr), Plessey (GB)	* RACE pr.
EUROPE	**	Italtel (It)	but few EEC
JAPAN	**	Siemens (WG)	strategies
Satellites			
USA	***	Matra,Snias,Thomson (Fr)	*** success
EUROPE	**	BAE (GB), Air Italia (It)	Eur.Space
JAPAN	**	Fokker (Ne), Saab (Sw)	Agency
Videotex		MBB,AEG,Dornier (WG)	
USA	**		* no standard
EUROPE	***	PTT (Fr)	(GB-Fr-WG)
JAPAN	**		

COMPUTER SCIENCE

Super Computers			
USA	***	Bull,Matra,Thomson (Fr)	** help from
EUROPE	*	Norsk Data (No)	ESPRIT and
JAPAN	***	Krupp,Siemens (WG)	EUREKA Pr.
Artificial Intelligence			
USA	***	Bull (Fr), ICL (GB)	*** research
EUROPE	**	Siemens (WG)	center: Bull-
JAPAN	**		Siemens-ICL
Software Engineering			
USA	***	Cap Gemini (Fr)	** beginning
EUROPE	**	ICL (GB), Philips (Ne)	with ESPRIT
JAPAN	*	Siemens,AEG (WG)	& EUREKA Pr.

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PRODUCTION TECH.& LASERS			
Numerical Commands			
USA	***	Charmille (CH)	*
EUROPE	**	Elsag,Mandelli (It)	
JAPAN	***	Siemens,Gildmeister,Deckel (WG)	
CAD/CAM & Local Networks			
USA	***	CGE (Fr)	*** considered
EUROPE	**	Selenia-Elsag (It)	by ESPRIT &
JAPAN	*	Siemens (WG)	EUREKA Pr.
Industrial Robots			
USA	***	Renault-Automation (Fr)	*
EUROPE	***	Fiat,Comau (It), Asea (Sw)	
JAPAN	**	Volkswagen,Kuka (WG)	
3rd Generation Robots			
USA	***	CEA,Matra (Fr)	** considered
EUROPE	**	Ansaldo (Sw)	by EUREKA Pr.
JAPAN	**	Dornier (WG)	
Lasers			
USA	***	Cilas (Fr)	** intensive
EUROPE	**	Ferranti (GB)	in research
JAPAN	**	Rofin-Sinar (WG)	
MATERIALS			
Biomaterials			
USA	***	SEP (Fr)	*
EUROPE	*	Siemens (WG)	
JAPAN	*		
Ceramic & Fibres			
USA	**	Cice,Pechiney (Fr)	*
EUROPE	**	Lucas,ICI,Harewell Ind. (GB)	
JAPAN	***	Siemens,Feldmühle (WG)	
Amorphous Materials			
USA	***	CGE-Alsthom (Fr)	* EURAM Pr.
EUROPE	**	Brucker (WG)	
JAPAN	**		
Massive & Compound Polymers			
USA	***	Aérospatiale,SEP (Fr)	*
EUROPE	**	MBB,ICI (GB)	
JAPAN	**	BASF,Hoechst (WG)	
Magnetic Alloys			
USA	**	Pechiney-Ugine,Rhône-	*
EUROPE	*	Poulenc Sys.(Fr),Philips (Ne)	
JAPAN	***	Siemens,BASF,Goldschmidt (WG)	

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ENERGY

Coke Extrac.by Liquefaction & Gasification			
USA	***	CDF (Fr)	*
EUROPE	**	NCB (GB)	
JAPAN	**	GFK,Lurgi (WG)	
Solar Energy			
USA	***	CGE,Total (Fr)	* EEC center
EUROPE	**	Pragma,Ansaldo (It)	ISPRA
JAPAN	**	MBB (WG)	
Structure of Material			
USA	***		***
EUROPE	***	CERN (EEC)	
JAPAN	**		
Nuclear Energy			
USA	**	CEA (Fr)	*** JET Pr. &
EUROPE	***	Ukaea (GB)	cooperation in
JAPAN	**	KFK (WG)	surgenerators

Source: [9] "The Expansion".

Be:Belgium Fr:France Ne:Netherlands Sp:Spain
CH:Switzerland GB:Great Britain No:Norway Sw:Sweden
De:Denemark It:Italy Po:Portugal WG:West Germany

The criteria used are: Industrial equipment capability to develop high technology, propensity to produce technological advances, competency of fundamental research teams, etc..

BIBLIOGRAPHY

[1] **"BUSINESS WEEK" (Excerpts of -).**

* INTERNATIONAL BUSINESS: "The Dollar is Casting a Widening Pall Over Europe" (February 8, 1988).
* ECONOMIC VIEWPOINT: "The US Should Applaud the Coming of Europe Inc." (July 11, 1988).
* INTERNATIONAL: "Laying the Foundation for a Great Wall of Europe" (August 1, 1988).

[2] **"IDEOLOGY AND NATIONAL COMPETITIVENESS. An Analysis of Nine Countries".**
George C. Lodge and Erza F. Vogel - (Harvard Business School Press, 1987).

[3] **"INDUSTRIAL RENAISSANCE. Producing a Competitive Future for America".**
William J. Abernattry, Kim B. Clarck, Alan M. kantrow - (Basic Books Inc. Publishers, 1983).

[4] **"INTERNATIONAL COMPETITIVENESS".**
Michael A. Spence and Heater A. Hazard - (Ballinger Publishing Company, 1988).

[5] **"OCDE's OBSERVATOR. The USA, or the Big Job Creating Machine".**
(June-July 1988).

[6] **"QUALITY, PRODUCTIVITY AND INNOVATION. Strategies for Gaining Competitive Advantage".**
Y. K. Shetty and Vernon M. Buehler - (Elsevier, 1987).

[7] **"THE AMERICAN CHALLENGE".**
J. J. Servan-Schreiber - (Denoël, 1967).

[8] **"THE COMPETITIVE CHALLENGE. Strategies for Industrial Innovation and Renewal".**
David J. Teece - (Ballinger Publishing Company, 1987).

[9] **"THE EXPANSION" (Excerpts of -).**
* "STAND UP EUROPE!" (Oct-Nov 1986).
* "WHAT EUROPE CAN WIN" (June 1988).

[10] **"THE METAMORPHOSIS OF EUROPE. From 1769 to 2001".**
Michel Richonnier - (Flamarion, 1985).

[11] **"THE TAKE OFF OF FRANCE IN THE 80'S".**
Edmund Stillman, James Bellini, William Pfaff, Laurence Schloesing, Jonathan Story - (Hachette Litérature, 1973).

[12] **"THE TECHNOLOGY WAR. A Case for Competitiveness".**
David H. Brandin and Michael A. Harrisson - (Wiley Interscience Publication, 1987).

[13] **"TRADE WAR. The Theory and Practice of International Commercial Rivalry".**
John A. C. Conybear - (Columbia University Press, 1987).

[14] **"US COMPETITIVENESS IN THE WORLD ECONOMY".**
Bruce R. Scott and George C. Lodge - (Harvard Business School Press, 1985).

[15] **"WORLD TRADE RIVALRY. Trade Equity and Competing Industrial Policies".**
William A. Lovett - (Lexington Books, 1987).

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THE USA-EUROPE INDUSTRIAL COMPETITION

by

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AN ABSTRACT OF A REPORT

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MASTER OF SCIENCE

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The big mutation following the first industrial revolution has caused the rising of industries based on new concepts of innovation and mass production. Throughout this change, Europe has been progressively slipping from its world economic supremacy to the benefit of the United States.

These industrial giants have different means to manage their industrial capacities. Ideology, education, policies, employment and industrial organization are the keys of a nation's economical strength. While the USA relies on its strong industry, big R&D programs and large domestic and foreign markets, the Europeans try to organize important scientific and industrial realizations.

The economic areas that determine the actual place of the nations in the global competitiveness are the micro electronics, the biotechnologies, nuclear sciences and techniques, natural sciences, telecommunications and agriculture industries. Due to historical, natural and economic reasons, the domination of these areas by the United States and Europe is unequally shared.

But this competition is not over, and we are now looking on a renewal of Europe. An economic, political and monetary restructuring is taking place, and may be successful thanks to the creation of a common market and development of cooperative projects.

Once the European Economic Community is established, the new industrial relationships will probably involve a readjustment of the world economic balance as well as a brand new kind of global competition.