

Information Technology: The Dual Challenge to European Society

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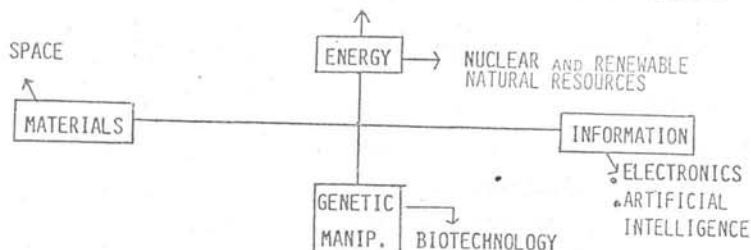
A. The New Scientific and Technological Context

1. The changing technical system

There is no doubt that our technical system is undergoing structural changes with regard to its four basic pillars, i.e. energy, materials, living organisms and information/communication (see chart. 1).

Nuclear energy and new renewable natural resources are significantly reshaping the current energy system, predominantly based on non-renewable resources. New (composite) materials are mushrooming everywhere: fundamental changes in space technology, warfare technology, advanced microelectronics and telecommunications, automobiles, chemical goods, housing and even medicine are associated with or due to a new generation of materials. Radical breakthroughs in life sciences and technology are at the origin of the new biotechnology which are at the initial stage of transforming large parts of industrial and services activities such as agro-food, health, chemistry, environmental management, and energy.

[Chart 1] A Fact: The Emergenc of a Net "Technical" System



Replacing the "Technical" System of The XIX Century
(A Simplified Description)

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The author is solely responsible for the opinions here expressed.

Table 1. Principal Scientific Breakthroughs Which Justify the Term "New Biotechnology"

- Fundamental discoveries in the life sciences, particularly of the role of DNA as the molecular carrier of the stored information in all genetic material.
- Techniques for the manipulation, alteration, and synthesis of genetic material (either directly or via cell fusion) to create new life forms.
- Techniques based on microbiology for cultivating screening, and selecting useful cells or microorganisms and manipulation of their behaviour under controlled conditions.
- Techniques for plant cell and tissue culture for accelerated propagation of useful plants.
- Downstream processing techniques for extraction, treatment, purification, and conversion of useful materials following the biomass production stage.

Source: The FAST Report, Eurofutures The Challenges of Innovation, Butterworths, London 1984, page 12.

The most important changes are, however, in the information/communication technology in connection with microelectronics and in the long run with the artificial intelligence "revolution."

It is not my intention to discuss here in detail the emergence of a new technical system. If I made these short references to the changing technical system, it is because I intended to underline one important fact: the changes in each of the four basic pillars are strongly interrelated and interweaved. The new biotechnology owe much to the development of microelectronics. The same applies to the NIT (New Information Technology) in relation to materials technology.

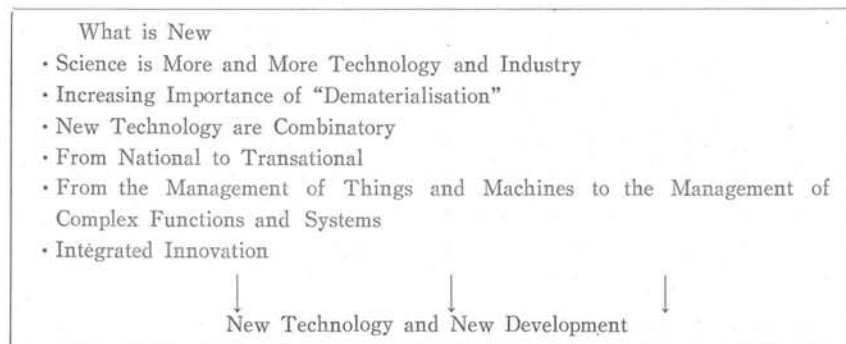
2. The strategic role of science and technology: the new dimensions

Technology is changing simultaneously in all its components, and science and technology have acquired (again) at the present time a strategic importance in our economy and society for, at least, the four following reasons (chart 2):

- *science is more and more industry, and industry is more and more science*

Not only the distinction between basic and applied research has become loose and ill-defined, but it is increasingly difficult to produce radical technical innovations without significant advances in science. While it had

[Chart 2] The Strategic Role of Science and Technology



been possible to invent the steam engine without knowing the existence of the water molecule, today new steps in highly advanced information technology (for instance the 5th generation computer) are hardly possible without new advances in complex and sophisticated areas of knowledge.

□ *the dematerialisation process*

The dematerialisation takes several forms:

- employment in services higher than those in manufacturing and agriculture combined,
- the rapid decline of the hardware component cost over the unitary cost of a product (like a computer) compared to the increase of the software and "orgware" cost,
- more and more knowledge and "intelligence" embodied with materials, equipments and products,
- electronic mail, electronic currency, leasing,...
- image processing and new computer graphic design.

The dematerialisation process means that emphasis will be increasingly shifting from goods to services, from products to functions, from tools to relations, and from means to aims. University teaching and research will be reoriented in both methods and fields of knowledge. Take the example of the ownership (and its protection) of information goods: how to define the theft of a computer software? The same question arises with regard to embryos transfer; new legal concepts and definitions must be invented! Industry is also affected, how to measure the productivity of immaterial goods and services? Is patenting microorganisms similar in nature than

patenting a mechanical device? Evidently, dematerialisation also implies that new roles are played by the state, the consumers, and others.

□ *new technologies are combinatory*

A stick is a very simple technology. You can use to help yourself if you have some physical problems or to defend yourself against aggression. You can also show the road to somebody who asked for a street or design two hearts on the sand if you are a romantic lover. Thus, you can use a stick as such for many purposes. Though simple, a stick is a multifunctional tool.

Take now a microprocessor. If you don't combine it with some other things, you can just put it in the rubbish because a microprocessor itself is useless. You have to put it into a washing machine or an aircraft. You have to combine it with typewriter or a toy. This is why the most important type of innovation in NIT concerns (or should concern) the application of NIT, the *how* and *for what* NIT based processes and products are *used*. The more an enterprise masters the combination (integration) nature of NIT, the better it will be presented on the market.

□ *the transnationalisation of economic activities*

The transnationalisation of economic activities is not a new phenomenon. What is new is the scope, the variety, and the tendency towards the generalisation of the phenomenon.

Transnationalisation is different from "internationalisation"; transnational corporations are intrinsically and extrinsically tied to "world" markets, flows, exchanges, strategies, and targets. The same applies to transnational organisations in the other fields. The transnationalisation of an economy led by private agents (the transnational corporations), often with the support or the "laissez-faire" from government, is the dominant feature of present trends.

This has many important effects on technological and economic developments while being, in turn, affected by technical progress. New telecommunications devices are largely contributing towards the increased and stronger private transnationalisation, while transnational corporations, represent the strongest demand for new and better telecommunications. Furthermore, it is rather easy to understand the existing relationships between the present phase of transnationalisation and the pressure for deregulation.

Though science is (or should be) "transnational" by definition, reality

remained so far distant from this postulate. Today, transnationalisation of science is rapidly growing, at least if one considers for instance the number of "World congresses" organised every year in all disciplines and areas, and the number of attendants (several thousands)! The phenomenon, however, is not homogeneous and "oneway". The increasing activism of the scientific profession pushes towards new barriers and "national" frontiers in science and technology.

Two main "messages" are voiced by these new dimensions. First, the management of things and machines, while remaining of basic importance, is increasingly loosing its primacy to the benefit of the management of people and systems. Integrated innovation, based on better technical organisation and social innovation, is the way by which a new stable development can prosper, and a new technology can be better utilised.

Secondly, we must avoid the "machines-mania".

3. Beyond technological triumph

The "machines-mania" is a widespread phenomenon (and danger). When we think about the future, our vision is dominated by machines. We see only robots when we think of the factory of 2005. The same applies to the office of tomorrow—we just see nice computers with nice colours and nice design—or the farm of the future—the farmer will be comfortably seating behind a control desk while different types of automated machines will be working in the field! The images of our houses are even more gracious; everything will be done by domestic robots, while we will be working at distance from home (even from our garden!) using our time on a free basis!

These are the images actually given and disseminated, in general, by the press and media as well as by many experts and scientists. Furthermore, a popular idea is spread by engineers and technologists as well as by the producers themselves: machines are better than people. They perform better than human beings. Technological accidents and risks are due to human factors rather than technology. Machines work 24 hours without tea or coffee breaks. They don't strike, they don't unionise. They just work. These ideas are, however, wrong and misleading, because they forget that machines are societal products and that technology is a man-machine relationship.

In the prevailing misconceptions, tools are reified. Societal potentials are

subjugated by machines, and the only imperative which sounds correct to the greatest majority of the dominant elites is the follow-up: people must learn to adapt quickly and properly to the new conditions and skills required by the new machines (tools and systems). What really counts is the competition on the world markets.

Competition does not give sufficient time to see how machines should *also* be changed to adapt to people's needs and conditions. Market is the best way through which the adaptation of machines to people is made. Stated in this form (as these ideas are usually stated) I find them ill based from the viewpoint of empirical evidence and ideologically biased. The real life suggests that the market is quite often artificially created by suppliers, and that man-machine mismatches are also due to machine's inadequacies and rigidities. In fact, any form of technological triumph is fallacious, because the real world is far more complex and "irregular" than it implies.

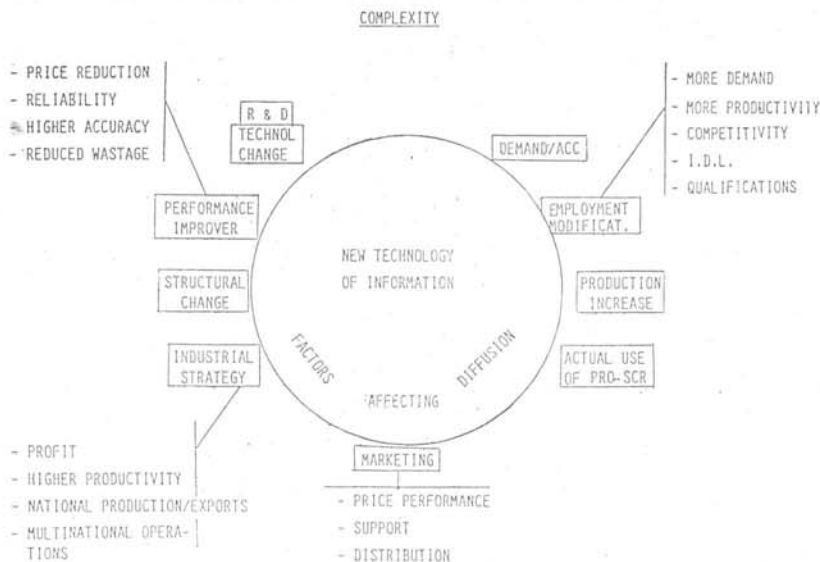
4. The explosion of complexity

Linear and simplistic analyses (and solutions)—as many as we have heard this maining—are not of great help in forecasting and assessing the implications and consequences of new information technology for the economy and society. Take the example of the nature and variety of the factors effecting the diffusion of new information technology (Chart 3).

Each of the influencing factors is, in turn, effected by many other variables. The performance level of the NIT, for instance, depends upon price reduction, the reliability of hardware and software, the level of accuracy, the value of reduced wastage, and so on. The industrial strategy factor is affected by the level of profit returns, higher productivity, national production versus export policy, multinationalisation, etc.

The explosion of complexity means that most of the prevailing approaches in science and technology forecasting and assessment must be revised in order to make them less reductionistic and less deterministic. A forecasting and assessment activity which would be limited to purely scientific and technological variables (including economic factors) is destined to yield misleading and fruitless results. The same applies to those approaches which assume that the role of the societal system vis-à-vis scientific and technological changes is purely adaptative. Many forecasts on the diffusion of teleconferencing and teleworking are proving to be wrong, precisely because they simply extrapolated market potential estimates and assumed

[Chart 3] Complexity



that people would adjust to new technology and adapt it. People's response, such as in the case of the failure of PRESTEL (in the UK) and Bildschirmtext (in the FRG), has been significantly different; they rejected the product and services offered and made relatively clear the type of product and services that they would have preferred. Even in the United States, teleconferencing plans have been slowed down. AT & T recently announced that they cancelled the plan for a teleconference network in six large American cities out of the 42 cities originally envisaged.

It may probably happen that other cities will be cancelled while new forms of teleconference networks and services will be emerging because the new forms will be more appropriate, i.e. more closer to the people's needs.

B. Challenges to Europe

According to the results of the FAST studies, NIT raises a dual challenge to Europe (Chart 4).

1. The dual challenge

The societies in the European Community have two basic requirements in common: external strength and internal social cohesion. What makes new

[Chart 4] The Dual Challenge

→Survival
External/Internal

THE DUAL CHALLENGE

→ SURVIVAL
EXTERNAL/INTERNAL

YES, IF EUROPE DOES NOT MASTER THE NEW I.T., THE SURVIVAL OF EUROPEAN INDUSTRY AS AN AUTONOMOUS, CREATIVE "ENTITY" IN A FREE WORLD TRADE ECONOMY IS AT RISK

THE NEW I.T., HOWEVER, POSES A DUAL CHALLENGE TO EUROPE

INDUSTRIAL

←→ SOCIETAL

EUROPE MUST MASTER THE NEW I.T. TO ENSURE THAT DEVELOPMENTS AND APPLICATIONS ON N.I.T. BENEFIT SOCIETY AT LARGE, DO NOT CONTRIBUTE TO AGGRAVATING INEQUALITIES AND DISEQUILIBRIA (GROUPS, REGIONS, COUNTRIES, AGES, SEXES,.....) BUT HELP TO SOLVING KEY PROBLEMS SUCH AS EMPLOYMENT, EDUCATION, SOCIAL COMMUNICATION, ENERGY EFFICIENCY..... ETC

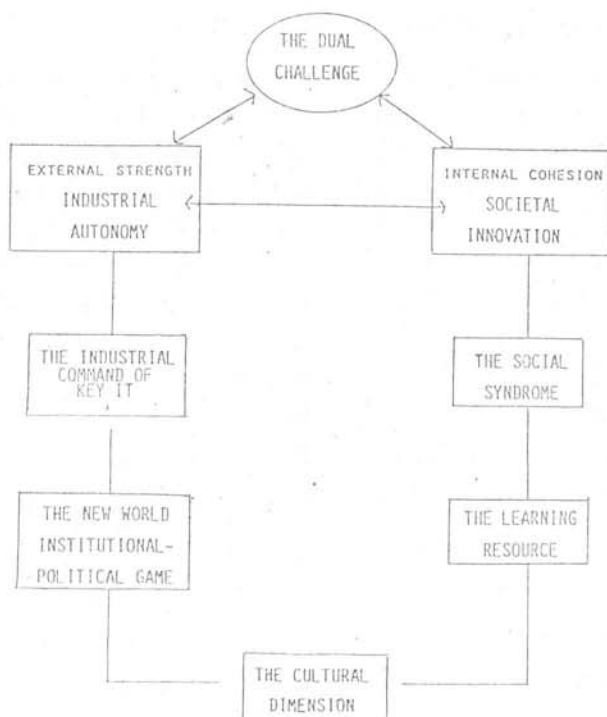
information technology potentially dangerous to Europe is that it threatens both of these fundamentals. The two aspects of this dual challenge are intimately intertwined and inseparable. This concept of a "dual challenge" is based on the recognition of a fundamental fact emerging clearly from the whole work of FAST—the concept of industrial "competitiveness" and "survival" is much too narrow, at both global and regional levels. At the global level, it will not be possible to solve the major issues confronting mankind on a purely competitive basis. A stimulating blend of competition and cooperation is required. At the regional or national level, it is necessary to recognize that the robustness of societies depends not only on their external competitiveness and techno-industrial strength but also on societal flexibility to allow for continuous social innovations and for the adaptation of technological achievements to social and industrial needs.

The basis for Europe to participate in the international division of labour

is highly exposed if not already in imminent danger. If Europe does not master the new information technology, the survival of the European industry in a free-trade world economy is at risk. This is equivalent to putting the existence of our open economies and of our open societies into question. *Unfortunately, the questions of industrial survival and societal design are often treated as if they were separate or even conflicting objectives.* Although a necessary condition, industrial and economic success of Europe vis-à-vis its main competitors does not guarantee a similar societal success.

Economic growth will not by itself reduce inequalities in a society⁽¹⁾ or between societies. A "no-social-innovation" scenario will in any event be characterized by greater divisions in society than those of today. An elite will in any event profit from new technology, while the benefits may be shared by the general public. There is a risk that most people will be in a

[Chart 5] The Long-term Strategic Issues for the Community



(1) "Vie Quotidienne et Nouvelles Technologies de l'Information", FAST, FS 10, 1982, and FAST, FOP 38, 1982, par V. Scardigh.

passive consumer role vis-à-vis new information technology. Therefore we must:

Ensure that developments and application of NIT benefit the society at large and do not serve only the needs of a small exclusive elite (e.g., certain regions of Europe or of the world, certain professions, certain age groups, or a certain sex) possibly even aggravating the social and economic conditions of the others. Ensure the needs of society and of the individual influence directly, at an early stage, developments in NIT; only in this way can NIT become an indispensable tool in combatting key problems such as energy provision, employment, social communication, education and training, and societal alienation of minorities, etc.

These are the central aspects of the dual challenge. To cope with it, five issues are of "strategic" importance to the European Communities and its long term development (Chart 5). Because of shortage of time, I shall limit my comments on three of them, only.

2. The industrial command of key IT

Information technology not only pervades a wide range of products, services and production processes and consequently becomes a component of strategic importance to the future industrial basis, it also forms an important sector by itself. By 1990 the electronics sector proper may become the largest single manufacturing sector (about \$600bn), and if we include information activities in general, it may employ up to 50% of the work force in Western Europe⁽²⁾. Charts 6 to 8 show the general weak position of European IT industry on the world markets. The present domination of the USA and Japan in advanced IT is the result of mid-to long-term strategic thinking and determined efforts over many years.

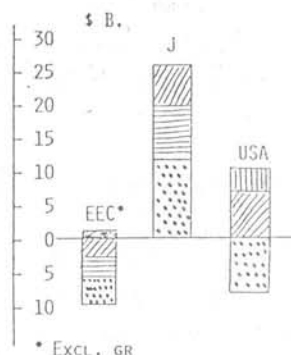
Instrumental in this success is the level of R & D. In spite of the leading position of the USA and now Japan, both governments stimulate the rapid growth of this technology even further by goal-oriented, long lead-time R & D programmes, which pilot the acquisition of new technology assets and serve to focus and attract independent industrial R & D investment.

Charts 6 to 8 highlight four important facts:

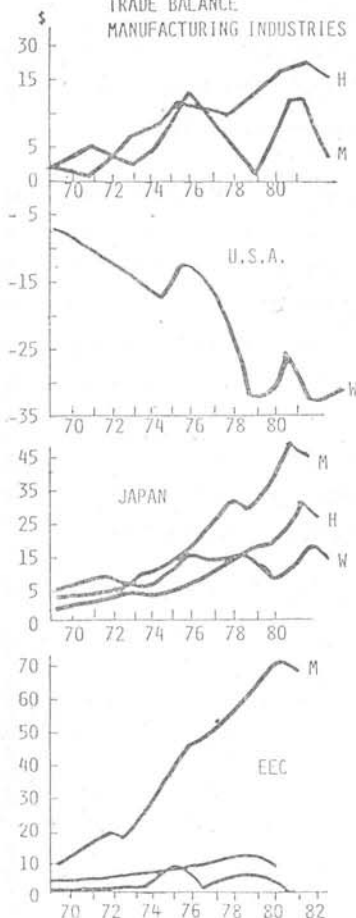
(2) "Microelectronic Innovations in the Context of the International Division of Labour", FAST, FOP 39, 1982.

[Chart 6] The Need for the Industrial Command

TRADE BALANCE
MAIN ELECTRONICS
PRODUCTS



TRADE BALANCE
MANUFACTURING INDUSTRIES



- The trade balance of the EEC countries as a whole in 1983 concerning the main electronic products was in deficit with the very minor exception of the telecommunication area (because of the national monopolies).
- European countries have performed well on international trade in the 70's in those manufacturing industries that are characterized by medium R & D intensity. The USA dominated in those industries with high R & D intensity, while Japan performed well both in high and medium

R & D intensity industries.

- Out of the first 15 semiconductor producers in the world, only two are European (Philips, n°6, and Siemens, n°14). Seven are Japanese, and 6 are from the USA.
- Japanese electronic manufacturers in 1983 held control of 23 factories in Europe. There was no factory controlled by European electronic manufacturers in Japan.

This does not necessarily mean that Europe's decline is unstoppable. However, the situation is less favourable to Europe than to the USA and Japan. Amongst other reasons, one which is worth mentioning, is what I call *the distortion factor of technological innovation in Europe*. Europe is suffering from a distortion effect of innovation on *the supply side* emanating from the USA. The major technological innovations in energy, new materials, information and communication technology are largely military. With the exception of the new biotechnologies, space technology, computer and microelectronic technology, new materials technology owe their growth to the strategic, military push.

[Chart 7] Japanese Electronics Manufacturers in Europe

UK = 10
 WG = 9
 F = 2
 B = 1
 E = 4
 IRL = 4
 LUX = 1



As of 14th February, 1983

In these areas, the United States have acquired a great comparative advantage since the Second World War. They won the leadership. They are orienting the world investments in related advanced R & D. As in the case of the Initiative for Strategic Defence, Europeans are "obliged" to follow, to imitate or to move in other directions but at a very high cost

[Chart 8] The Social Syndrome

The Changing Relations between
Technology—Growth—Employment

The Crisis in Growth and in Employment Seems to be Due to a Great Extent to:

1. The Relative Atrophy of a Subsystem of the "Technology" (A Few Product Innovation, and the Hypertrophy of Another Subsystem of the "Technology" (Too Much Process Innovation) Leads to a Marked Malfunction of the Economy

—Distortion between a Stable Consumption Pattern
and a Dynamic, Changing Production Mode

2. Factor (1) is Cross-Impacted by Stronger Competition at the World Level and *Within* Community Countries
3. Relationships between the Type of Innovation Growth and Employment

Sectors	Type of Innovation	Charac- teristics	Effects on	
			Growth	Employment
Equipment Goods	Process	Efficiency	Costs down	—
Consumption Goods	Product (Final Cons.)	Growth + Employment	+	+
Intermediary Goods	Product (Intern cons)	Autonomy	Maybe +	Maybe +

and risk. In the meantime, military R & D expenditures have reached 70% of total public R & D expenditure in the USA. Considering the size of USA expenditures, R & D expenditures of the Department of Defence alone represents (1983) 10% of the total public R & D expenditures of the OECD countries and is equivalent to the total R & D public expenditures of the FR or Germany.

Europe is also suffering from a distortion effect of innovation *on the demand side* originating from Japan in particular. As you know, Japan is the present leader country in consumer electronics. Europe is "obliged" to react on its own markets to Japan's initiative. Japan's leadership is the result, among other factors, of a long standing deliberate policy to limit the opening to the international division of labour. Since the fifties, Japan has adopted a strong protectionist policy while buying everything from

outside (patents, technology,...). In the seventies, Japan was able to attack and conquer large segments of the world markets while remaining strongly protectionist on the domestic market. Japan's success story shows that it is false to consider that it is necessary to be entirely open to the world economy in order to ensure the industrial and technological development. Faced with these two disturbing pressures, Europe has considerable difficulties in finding a way to stimulate its technological innovation on an autonomous basis.

3. The social syndrome

The second challenge is specifically related to the incapacity of our economy to provide again full employment both in the traditional term as well as on a new basis⁽³⁾ and the role which NIT is playing and could play in this respect. Under this heading, the relationships between NIT and the changing nature of work is also considered. As a matter of fact, the question whether NIT is a job-killer or a job-creator is at the heart of the present economic, social and political debate on new technology, and nobody can avoid dealing with it. My thesis on this issue can be summarised as follows⁽⁴⁾:

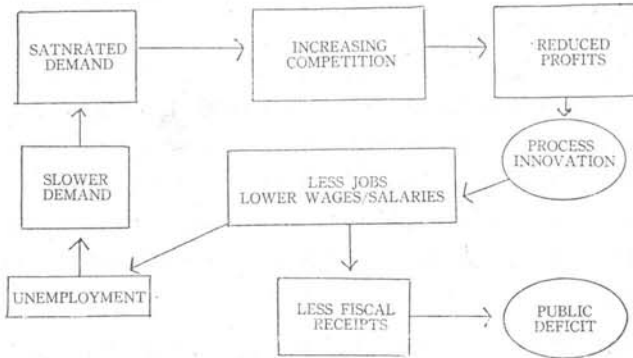
- the level of employment in a country depends upon many important factors, of which technological change, and related productivity increases, is just one;
- in the seventies, innovations in automation, information and communication technology have been characterized in most European countries by a predominance of *process innovation* over *products innovation* (both for intermediary and final demands).

The predominance of process innovation had a negative impact on employment in those manufacturing and services industries mostly concerned by NIT (see charts 9 and 10). It is difficult to say how negative this effects has been, because of a lack of adequate empirical studies in all member

(3) See chapter 3 of the FAST Report, *Eurofutures, The Challenge of Innovation*, Butterworths, 1984, pp.140-155.

(4) For more details, see R. Petrella, "Technology and Employment in Europe: Problems and Proofs," in *Science and Public Policy*, Dec. 1984, and R. Petrella "Process vs. Product Innovation and Their Impact on Employment" in *People and Jobs International*, vol. I, n°1, 1985.

[Chart 9] Growth/Employment/Technology

The "Distortion" of the
Investment Function

countries. According to some recent studies⁽⁵⁾ the negative impact has not been as important as expected. However, one has to watch the future carefully, because the more the new technologies penetrate the manufacturing industries and the services activities, the more negative impact there may be on employment.

- In fact, the diffusion of new technologies does not guarantee, *per se*, the *net* creation of jobs. What is empirically evident is that new technologies are and will displace jobs between firms, branches, regions, countries. In order that the diffusion of new technologies creates more jobs than it destroys, three conditions must be set.

- Innovation implies *new uses* of technology. If the technology is used to do the same things or services better, then the job-creation potentials of new technology are very doubtful.
- Potential users, particularly at the local level (microsystems), must take part in the definition of the purposes and modalities of application of the new technology. The more the users participate the more probable and greater is the job-creation potential.
- Cooperation at the European level, *at the least* among the enterprises, the public authorities, the research systems and the users must be the prevailing practice, reducing to the unavoidable degree

(5) Cfr. PSI, *Microelectronics in Manufacturing Industries in Britain*, 1983 and Verein der Deutscher Ingenieure, *Anwendung der Mikroelektronik*, 1984.

the interactive competition at intra-community level. The more the development of new technology takes place under pressure of opposing national-based strategy and competition on the same markets, the less new technology will create jobs in the European Community countries.

- In other terms, our economies must change the last 15 years pattern of technological development dominated by process innovation and reestablish a proper equilibrium between process and product innovations. We are far, indeed, from the diffusion of those product innovations such as automobile, television, domestic appliances, and antibiotics, which were the basis of the growth in the 50's and 60's.

Computers cannot be considered a product innovation, as yet. It may happen that this will be so in 10~15 years and under different forms and contents than those we know today. For the time being, they are still a process innovation. They allow those who are better equipped to win and innovate better than the others. As such, they are at the origin of an important and worldwide process of market positions between enterprises, branches and countries. The same applies to telecommunications. Optical fibres, satellites and new commutation techniques (spatial and temporal) have not yet lead to the emergence of a new generation of product and services. The greatest bulk of present "new" services are rather an enhancement of existing services. This is why the telecommunication field is presently the theater of a very hard fight for survival rather than for sharing new wealth!

It is highly probable that, if the three above mentioned conditions are not satisfied, new information technology will not create new jobs, but it is clear that they will change the *quality of jobs* (nature of jobs and related qualifications) in those activities affected by the new technology.

This is why education and training at all levels under any form (including continuing education, alternate in work training, corporate learning, distance education and training...) have an increased fundamental role to play. They are not the only critical levers, neither must they be seen as systems which simply provide the skills and the capacity to learn and to acquire those skills that are requested by the new technology. This would subordinate the education further to a technological and industrial imperative,

which is clearly neither reasonable nor justified.

4. The learning resource

People are more important than technology. The nature and quality of human resources are therefore of greater relevance than the technical tools. Learning is the societal process through which human resources are developed, stimulated, enhanced. Learning is not limited to education and training. It encompasses all the societal processes which allow the members of a community to qualitatively raise, individually and collectively, their capacity for thinking, understanding, activity and innovating. A society able to generate a proper learning setting is certainly well equipped to innovate and to master the use of new processes, products, and services in the interest of people rather than under the "diktat" of the new tools.

A proper learning setting implies a great effect on the development of societal "orgware", in particular in the area of social experiments associated with the design and the development of new technology. Social experiments at local, national and European levels are the necessary conditions, together with a strong policy in favour of education and training, to ensure the availability and the experience of the learning resource in a country. If a country limits its priorities to a reactive education and training policy, technology will be the driving force, and new versions of Taylorism and Fordism will emerge. The result may well be an extreme polarisation of jobs into highly qualified, well paid and interesting jobs on the one hand, and boring, deskilled and low-paid job on the other hand.

A scenario of work can be called "work for the fittest!" The polarization of jobs may well be the most frightening example of the general risk of increased divisions in society associated with a "non-social innovation" development and diffusion of new technology.

What could and should be done to ensure proper learning? Priority action must be taken in at least four areas:

- *Education and training.* This is an area too familiar to everybody to comment in detail. Furthermore, many good and realistic ideas and proposals are on the table on all European countries. The urgency is not to invent new ideas but to implement some of existing good ideas.
- *Social experiments at the local, national and European levels,* particularly in

- local communication networks
- teleworking
- medical information systems
- transfer safety
- social services
- education integrated with work.
- *Press and mass media* with a view to promote all kinds of initiatives that will contribute to the development of a “technical culture” for the general public, rather than to promote on technology all kinds of expectations, misinformations and easy myths as it is often the case today.
- *New participation forms and organisations*
Within the entreprise (firms, office...) to ensure that all available and personal initiative and creativity have the chance to be positively used.