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1. Introduction

We have the privilege and the responsibility of living through one of the greatest technological revolutions in the history of humankind. Two major features characterize such technological revolution: it is aimed at generating and processing information; its outcome is process-oriented, and, therefore, its effects are pervasive cutting across the entire realm of human activity.

As in all historical breaking points of scientific advancement, there is a whole constellation of discoveries taking place simultaneously, according to an interconnected, self-reinforcing pattern. Some of these discoveries concerned new products, such as special materials; others are technical application of existing technologies, such as space navigation and operation. Yet, the core of the current technological revolution resides in the ability to generate and process information, and to introduce such capacity into the actions and functions through which we work, produce, consume, manage, enjoy ourselves, live and die. What microelectronics does is to process information in increasingly powerful, yet decreasingly costly, miniaturized circuits. What computers do, on the basis of microelectronics, is to process, and eventually generate, information, at an ever greater speed, and accuracy, with increasing capacity of memory, and with a broadening range of accessibility from non-expert knowledge to the computing system, thus decentralizing and diversifying the information power. What telecommunications do is to transmit and interconnect information, thus bringing together, at a decreasing cost, and with increasing carrying capacity, all information-processing machines (including human beings), regardless of distance and (almost) of time. What automation does is to introduce preinformed, flexible devices into all activities. What the new media (potentially) do, is disseminate audio and image from everywhere to everywhere, with the possibility of differentiating along a time sequence the elements of the message, as well as with the potential for interactive systems as decentralized as society wishes to have. And (maybe the most relevant technology for the future) what genetic engineerig does is to decode the information system of the living matter to reprogram it.

The visibility of such revolution is very recent. Although, as always in science, there is a long process of convergent discoveries, over time, the coming into widespread applications of much of the technologies took place in the early 1970s, with the two discoveries that we believe to be qualitative leaps between science and its social uses: the microprocessor, and the gene-splicing techniques. As usual in intellectual history, such a sudden, profound transformation of the tools through which we approximate nature, by combining information, matter, and energy, has triggered a pandemonium of pseudo-technological prophecies and ideological social forecasting that considerably obscures the actual process of historical transformation. Technology has never been and will not be, an independent variable operating in a social vacuum. Scientific revolutions take place in a given social context, being affected by it, and, in return, deeply contributing to the organization and evolution of society. Thus, it is simply irrelevant to attempt analyzing the effects of technology on society, by considering technology in itself, as most of the pseudo-scientific literature on the current informational-technological change generally does. On the other hand, there is a tendency among social scientists and political leaders to underestimate the specific role that technology has on economies and societies. There is some underlying assumption that the old mechanisms of power and profit-searching are the keys to understand, and to direct, the movement of history, the life of people. And yet, it is of fundamental importance to understand that new information technologies are completely transforming our societies, from their very roots. Such transformation does not come only from the characteristics of the new technologies, but from the interplay between current scientific discoveries and the socio-economic context in which such discoveries are generated and utilized. This analytical perspective is not of mere academic value. Since it implies that, by and large, the technological revolution under way is socially undetermined: its effects might be completely different, and even opposed, according to the socio-political management of the process of technological innovation. Furthermore, given its tremendous capacity of information-processing, and given that it is precisely this informational capacity that differentiates the human species, the uses of new technologies will amplify and accelerate whatever trends are dominant in our societies. What the new technologies actually do is to reveal and surface in the open the angels and devils that simultaneously inhabit us.

This report addresses these questions by examining the specific effects of new technologies in some fundamental dimensions of our socio-economic structure: the new international economy and the fate of Third World countries in such new conditions; the changing patterns of work and employment; the technological environment in which our everyday life will be taking place; and the implications of this scientific revolution for the fundamental issue of war and peace. To be sure, other aspects and dimensions of the social implications of the new technologies ought to be considered to be able to assess comprehensively their impact. But, the analysis presented here is geared to a more specific purpose: to define the conditions for social uses of new technologies that would be appropriate for policies decided by each country according to its own interests and perspectives. Thus, the issues explored in the report seem to be the main questions to be addressed by institutions and organizations confronted with a major technological revolution that takes place in the midst of a world wide process of economic restructuring, and on the edge of a dangerous realignment of macropolitical strategies.

2. High Technology and Economic Restructuring in the Aftermath of the Crisis

The technological revolution does not take place in a social vacuum. It develops in a very specific socio-economic, historical context, whose characteristics deeply affect the form and goals of the uses of technology, and ultimately, of technology itself (Rosenberg, 1982; Blackburn, Coombs and Green, 1985). This is not to say that technological discoveries happen necessarily as responses to the needs of "the system". Science and research have their own pace of development, with moments of qualitative breakthroughs and acceleration of discovery produced by the interplay between scientific research, the institutional framework where it takes place, and the social demand for technological applications.

The current technological revolution gained its momentum throughout the 1970s at the moment when the world economy was undergoing a major structural crisis whose causes and charcteristics we have examined elsewhere (Castells, 1980). In the mid-1980s, the key centers of the world economy have restructured some fundamental mechanisms, so that the processes of capital accumulation and social order, on which the system relies, are adequately performed (Camus, Delattre, Dutailly, Eymard-Duvernay, Vassille, 1981; O'Connor, 1984; Bowles, Gordon, and Weisskopf, 1983; Carnoy, Shearer and Rumberger, 1983). It is in this sense, and only in this sense, the structural crisis of the 1970s is over. This does not mean that different, new crises could not develop (given, for instance, the existence of some "economic time bombs" such as the U.S. federal government budget deficit or the financial debt of many Third World countries). Also, it could seem paradoxical to consider the crisis (at least, this crisis) as having come to an end while much of the world's population is starving to death, when desperate poverty is the daily exerience of most human beings, and when unemployment spreads over all countries, including the OECD area, particularly among the youth.

Yet, we should remember, without indulging into cynicism, that misery and human suffering are not necessarily causes or symptoms of a crisis, in the structural, analytical sense of the concept. A system (for instance, the capitalist-based world economy) is in crisis only when the means it requires for its functioning and development are inadequate to attain its structural goals, as imposed and determined by the economic interests and social values institutionalized in the political institutions. From this specific perspective, the world economy was in crisis in the mid-1970s, when inflation, social unrest, and political challenges were threatening both private capitalist profit, and political control in key areas, both in the center and the periphery. Also, from this specific perspective, capitalism has reformed itself, through a process of social struggles and victorious political battles, and has recovered some of its dynamism, and much of its social control, by shrinking the number of people benefitting from the system and reaching out, to almost the entire planet to inter-connect all segments of potential beneficiaries of this leaner, more aggressive, more determined, new breed of capitalism. In recent years (maybe around the 1970-80 period), a new model of economic growth has emerged that represents a similar departure from Keynesianism and welfare-state capitalism that such reform-minded capitalism model represented vis-a-vis liberal capitalism before the 1930s Depression. Because it is my hypothesis that high technology has played a major role (as a tool, not as a cause) in this dramatic process of economic restructuring, it is necessary to outline, very schematically, the characteristics of the new model of economic policy, to pinpoint the specific role of new technologies in relationship to each one of the major economic axes (Carnoy and Castells, 1985). Such a model is not necessarily linked to a particular political party or Administration, or even to a country, even if the Reagan or Thatcher governments seem to be the closest examples of the fulfillment of these policies. But very similar policies have developed in most Western European countries, in those governed by Christian Democrats and Liberals, as well as in those governed by Socialists, and even in Communist-led regions (Italy) or Communist-participated governments (France, for a certain period). At the same time, in most Third World countries, austerity policies, inspired or dictated by the International Monetary Fund and world financial companies, have also developed along the same lines, establishing not without contradictions and conflicts (Walton, 1985), a new economic logic, that is not only capitalist, but a very specific kind of capitalism that we will try to describe briefly (Carnoy and Castells, 1985). Obviously, the generalization of such a model of economic policy (which is not historically irreversible) does not imply that all governments are alike or that politics does not matter. The issue is that when a system reaches a historical limit, and the socio-political process is unable to impose a new, alternative system, the only possibility for society not to disintegrate is to consolidate, reinforce, and make more dynamic, the already institutionalized structural logic. Because the economy (under capitalism) structures society, and because the economy is highly interdependent at an international level, individual governments in individual countries find themselves faced with the dilemma of adjusting to the dominant logic in the most advantageous manner, or to undertake an uphill battle that is unlikely to succeed as an isolated enterprise. Thus, most countries are embarking along the lines of a new model of economic policy that is organized around a major series of measures, coming at the same time from governments and private business:

1) Control of inflation through fiscal austerity and monetary restriction, aimed at the partial dismantlement of the welfare state (Taylor, 1983). In the case of the U.S., such fiscal austerity does not concern military spending, therefore triggering a huge budget deficit -- something only the U.S. economy can afford for a short period.

2) Reduction of labor costs, at the same time on wages, working conditions, and social benefits. Consequently, the share of business' profit increases proportionally, all other conditions being equal (Bowles, Gordon, Weisskopf, 1983).

3) Increase of productivity of companies, and of profitability of business, by lay-offs, reduction of working time, speed-up of work and, above all, technological innovation. (Reich, 1983; Ernst, 1983; Dosi, 1984).

4) Restructuring of industrial sectors, disinvesting massively from those sectors, regions, and companies that become less profitable, and investing in new products and activities, generaly in high-technology manufacturing, corporate services, miscellaneous consumer services, an real estate (Bluestone and Harrison, 1982; Summers, 1984). A major development within industrial restructuring (particularly in Europe and Latin America) is the shrinkage of the public sector, and the alignment of public companies on the logic of profitability (Mistral and Boyer, 1983).

5) Tremendous growth of the "informal economy", that is, of all kinds of cash economic activities unregulated and uncontrolled by the state, regardless of the legality of their status (Castells and Portes, 1986). This includes,

certainly the astronomic cash flow in criminal activities (particularly in drugs production and distribution), but it mainly refers to undeclared salaried work, unpaid taxes, absence of compliance with health and safety regulations, labor legislation, etc. (Portes and Walton, 1981; Portes and Sassen-Koob, 1985). In countries like the U.S., massive immigration from undocumented workers fuels the process of the increasing penetration of the center by the periphery (Portes and Bach, 1985). The informal economy represents today a key element of all economies alike, not only for the survival of the poor, but for the dynamism of small businesses, accounting for much of the growth and new employment (Sassen-Koob, 1984; Maldonado and Moore, 1985), and for the transfer of value from the informal sector to large corporations through subcontracting arrangements and networks of decentralized production.

6) Opening of the world market, and increasing internationalization of the economy, taking advantage of the most favorable locations for production, management, and control of the markets, within a system interconnected worldwide. This is a common strategy, for both companies and governments, and paradoxically, it simultaneously triggers protectionist reactions, as soon as industrial sectors, regions, or countries, start losing in this cutthroat competition (Bienefeld and Godfrey, 1982; Little, 1982).

7) Relative control of world prices of raw materials and energy from the center, assuring the stability of the price system and exchange flows (OECD, 1984).

Of course, this sketchy presentation of the dominant economic model emphasizes its coherence and internal logic, without considering the contradictions it implies, and the potentially destructive deviations of its own rationality. For instance, in the case of the U.S., the claim for fiscal austerity and a balanced budget is translated into a greater deficit, with a shift within the budget from social expenditures to military expenditures (what, following Herbert Marcuse, we name the transition from the Welfare State to the Warfare State) financed, without inflation, by the influx of capital from all over the world, thus drying up sources of investment everywhere else, and pushing upward the dollar (in spite of its current manipulated downward trend), therefore wrecking the US balance of trade, in a series of connected ill-effects that threaten the whole model when considered in its actual dynamics.

Nevertheless, we think it is useful to keep in mind the characteristics of the post-Keynesian economic model of capitalism, because the technological revolution has matured precisely during its rise, and in fact it is playing a major role in the feasibility of the model's implementation. In turn, the lines of technological development are now being shaped by the predominant social and economic uses that they have being assigned.

The new technologies are at the core of the current process of economic restructuring in the following way:

a) <u>They contribute to a qualitative increase in productivity</u>, across the board, in manufacturing, agriculture (down the line, through biotechnology), and in services. In fact, productivity growth is particularly crucial in this fundamental aspect of the economy. Because new technologies are primarily aimed at processing information, and this is precisely the matter of most services, the deepest economic impact of the new technologies will occur in services and office work (Noyelle, 1984; Stanback, 1979; Hirschhorn, 1985; Baran, 1985).

Yet, for the moment, the most immediate impact in industrial productivity has been in manufacturing, and particularly in the automobile industry. The UNIDO report on the matter (UNIDO, 1984) writes that "The position of the [automobile] industry in the industrial system has altered. No longer will it be a creator of jobs. It will be a pioneer in the introduction and use of technologies and materials of several kinds and in so doing it will transform its inter-industry linkages. These changes are unlikely to be limited to the OECD countries, even though their present force is concentrated in that area" (page 17). In fact, during the 1980s the automobile industry is experiencing a major transformation in the production process and in the overall logic of industry, being the main user of industrial robots, and of CAD/CAM systems of flexible manufacturing. Adding the developments in new materials, it seems that in a few years the automobile industry will have shifted from an electro-mechanical industry to an electronics-plastics industry (UNIDO, 1984), dramatically increasing productivity and reducing employment in production. Similar trends can be observed in key industries such as electronics (Ernst, 1980; Cohen and Zysman, 1986; Jacobson and Sigurdsun, 1983), and telecommunications (Borrus, Bar, and Warde, 1984).

This impact cannot be equated to a negative effect of new technologies on employment, a more complex issue that we will examine in detail below. But, in any case, the general impact of new technologies on business tends to increase productivity and quality, reduces costs, and improves profitability, thus contributing in a good deal to stimulate investment and overcome the economic slump.

b) At the same time, the potential (or actual) impact of new technologies on job-suppression, places management in an advantageous position regarding workers and unions, to obtain concessions in wages and working conditions in exchange for maintaining employment, or of slowing down the phasing out of jobs. Thus, although technology per se is not an instrument of capital, it is being used as a bargaining factor in the redefinition of the power relationships between management and labor, a key component of the overall economic restructuring (Institut Syndical Europeen, 1980; AFL-CIO, 1984; Bluestone and Harrison, 1984; Boyer, 1985).

c) Technological change is also the source of new investment, the main engine of economic recovery, for two reasons: On the one hand, such as written in the 1984 OECD Report, "Higher than expected growth of non-residencial private investment seems to be explained by the increase of marginal productivity of investment in those countries where the share of computers and other high technology equipment in the companies' investments has significantly increased. Thus, it would seem that the profitability for a given investment increases [because of new technologies]. Investments that were previously under the threshold of profitability become profitable now. This phenomenon is particularly important in the U.S. and Japan" (p. 10, our translation from the French version of the Report).

On the other hand, in anticipation of the demand for new technologies, there is a rush of investment in the high technology sectors, thus stimulating the economy out of recession, while deeply reshaping its structure in terms of "sunrise" and "sunset" industries, regions, and countries (Bluestone and Harrison, 1984; Celada, Lopez-Groz and Parra, 1985; Markusen, 1984; Henderson and Castells, 1986; Gordon and Kimball, 1986).

d) New technologies stimulate markets, particularly for upper income households, by generating new products (such as home computers and new communication devices) or creating new lines of old products by introducing into them informational devices (from cars to kitchens).

e) Yet, as we will see below, the most immediate contribution of high-technology in economic recovery has been the role it has played in skyrocketing defense spending, the most important single item to dynamize the US economy in the 1980s, and, through it, the world economy (BusinessWeek, 1985). Other countries such as France, Great Britain, Italy, West Germany, Brasil, and Israel, also heavily rely on weapons production and export (to the Third World) to improve their trade balance (Dumas, 1982).

f) Last, but not least, new technologies, and particularly telecommunications, are the material condition necessary for the process of internationalization of the economy, probably the key feature of the new model of accumulation. Only through the integrated system of telecommunications and computers is it possible to both integrate and decentralize production, distribution, and management, in a worldwide, flexible, interconnected system. The new telecommunication technologies are the electronic highways of the informational age, equivalent to the role played by the railways systems in the process of industrialization (Nicol, 1985).

Also, world production and distribution is only possible because of the twin processes of perfect standardization of parts (that can be assembled even if produced in very distant locations), and flexible customized production (that can adapt a basic product to specific characteristics targeted on the final market) (UNIDO, 1984; Henderson and Scott, 1986). Both processes are dependent upon automated production, and flexible electronic tools able to be re-programmed. The world-assembly line and the planetary bazaar, require both the electronic factory and on-line management.

Thus, new technologies are a key component of the process of economic restructuring that determines a new international division of labor whose characteristics are decisive for the making of our future world.

3. High Technology, the New International Division of Labor, and the Future of the Third World

3.1. Introduction

The new technologies are transforming the "new international division of labor" that emerged in different areas of the world during the 1970s, as a response to the structural economic crisis (Frobel, Henricks, and Kreye, 1980). Such international division of labor was mainly organized around the policies of multinational corporations that relocated their production "offshore", in countries where low wages, lack of environmental and health controls, pro-business, repressive government policies, and favorable fiscal exceptions, substantially reduced production costs in comparison with the core countries (Palloix, 1977; Peet, 1984; Nayyar, 1978; Schmitz, 1984). Thus, a new North/South division of labor started to take place between high-technology industries and advanced services in the North, and assembly operations, low-skilled manufacturing, and extraction of natural resources in the South (Brandt, 1980). Multinational corporations were important agents in such process, particularly in the most dynamic industries, such as electronics (UNIDO, 1981; Ernst, 1983), and in those sectors that undertook global economic restructuring such as automobile (Maxcy, 1981; UNIDO, 1984). Yet, along with the multinationals, small and medium companies from the newly industrializing periphery, as in Hong Kong (Chen, 1979; Schiffer, 1983), Korea or Taiwan (Browett, 1985), followed a similar strategy of producing for the world market on the basis of their comparative advantage of low-production costs. It followed a realignment of the world economy, an intensification of world trade, and the surge of a group of newly industrialized countries (Browett, 1985; Bradford, 1982; Bienefeld and Godfrey, 1982). So, through a combination of decentralization of productive investment from the core, and of dynamism of indigenous capital in the periphery, supported by development-oriented national governments, new economic actors have entered the international arena, increasingly differentiating the so-called Third World.

The development of high-technology industries and technological change are both furthering and modifying this new international division of labor. The transformation of the process takes place along different, although inter-related lines, that we will analyze sequentially for the sake of clarity:

3.2. Automation and Decentralization of Production

Cheaper and more effective automation of the work process, could increasingly allow corporations to retain their factories in the core countries (sometimes relocating in rural areas), while still lowering their production costs (Rada, 1982; Cohen, Zysman et al., 1986). In fact, the threat of unemployment, and the policies of economic incentives by regional governments in the depressed regions of the USA and Europe, enhance the chances for an inter-regional, rather than an international division of labor (Glasmeier, 1986; Sawers and Tabb, 1984; Massey, 1984; Flynn and Taylor, 1985). Such possibility is being extended to sectors, such as textiles and garments, that were considered to have become the exclusive turf of the newly industrialized countries, as newer, electronically-based technologies, such as laser-cutting, and CAD/CAM production lines are installed in the remaining old industries of Europe and the U.S. (UNIDO, 1984; Botkin, Dimancescu, and Stata, 1984).

Nevertheless, it does not seem that the process that Rada (1982) labels "relocation back north" is actually taking place. Table 1, compiled by Scott (1985), shows an upward trend in the proportion of imports, particularly from Asia, for the U.S. semiconductor companies.

In spite of the possibilities offered by automation, there is a process of productive decentralization expanding over the world, and many U.S. companies are transforming themselves into "hollow corporations", selling products that are manufactured elsewhere (BusinessWeek, 1986). What is actually happening is an increasing internal division of labor within the industrialized periphery. The first ring of NICs (Korea, Taiwan, Hong Kong, Singapore, Malaysia and the industralized areas of Brasil and India) are now concentrating more sophisticated, higher skilled production activities, that in the case of Korea and Singapore could even surpass some Western European countries (Government of Korea, 1985; Botkin, Dimancescu and Stata, 1984). Simultaneously, less developed countries, with a large pool of unskilled, extremely cheap labor, enter the productive line at the low end, particularly Thailand and the Phillipines (Henderson, 1986; Lim, 1982; Scott, 1985; Akrasanee, 1977). (See Table 2.) Yet, the more automation enters the process of production and management and the less low wages play a role in the comparative advantages of a given location. One of the greatest paradoxes of the effects of automation on employment could be that the most directly hurt would-be Third World countries whose incipient process of industrialization, whatever exploitative, was based upon the differential cost between unskilled labor in core and periphery. Probably, the next round of differentiating

TABLE 1

U.S. Semiconductor Production and 806.30 / 807.00 Imports

Year	Value of all US shipments in SIC 3674 ($000,000)[a]	Total 806.30/807.00 imports ($000,000)[a]	Total 806.30/807.00 imports as percent of US shipments in SIC 3674	Total 806.30/807.00 imports from Asia ($000,000)[a]	Total 806.30/807.00 imports from Asia as percent of total 806.30 / 807.00 imports
1969	1572.9	127	8.1	77	60.6
1970	1501.2	160	10.7	90	56.3
1971	1599.6	178	11.1	98	55.1
1972	2704.8	254	9.4	170	66.9
1973	3647.7	413	11.3	297	71.9
1974	4305.1	684	15.9	479	70.0
1975	3276.9	617	18.8	469	76.0
1976	4473.8	879	19.6	721	82.0
1977	5322.6	1120	21.0	974	87.0
1978	6435.4	1478	23.0	1300	88.0
1979	8266.7	1916	23.2	1667	87.0
1980	10500.8	2506	23.9	2205	88.0
1981	11701.5	2825	24.1	2458	87.0
1982	12429.9	3131	25.2	2787	89.0
1983	--	3383	--	2876	85.0

[a] all values in current dollars.

Sources: (a) U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, and Annual Survey of Manufactures; (b) U.S. International Trade Commission (1980, 1981, 1984, 1985); (c) U.S. Tariff Commission (1970); (d) Flamm (1985).

TABLE 2

Principal Sources of Assembled Semiconductor Devices Imported into the United States under Tariff Items 806.30 and 807.00

Year	HongKong	Indonesia	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand	All Asia ($000,000)[a]
1969	49.2	--	22.9	--	--	9.8	14.8	--	228
1970	44.6	--	23.2	--	--	17.9	8.9	--	254
1971	32.7	—	30.9	--	--	23.6	12.7	--	270
1972	25.4	--	26.9	--	--	37.3	10.4	--	452
1973	19.4	--	23.6	8.3	1.4	33.3	12.5	--	740
1974	17.1	--	22.9	21.4	2.9	22.9	12.9	--	977
1975	11.8	—	17.1	30.3	5.3	26.3	7.9	--	858
1976	13.1	--	20.7	25.6	7.3	28.0	7.3	--	1240
1977	8.0	1.1	21.8	27.6	6.9	24.1	9.2	1.1	1567
1978	6.8	1.1	17.0	34.1	9.1	22.7	5.7	3.4	1948
1979	4.6	2.3	13.8	33.3	11.5	23.0	4.6	2.3	2212
1980	4.5	2.3	10.2	34.1	15.9	25.0	4.5	3.4	2518
1981	3.4	2.3	9.2	34.5	18.4	23.0	4.6	4.6	2536
1982	3.4	2.2	8.9	36.0	20.2	19.1	4.5	3.4	2800
1983	1.2	2.4	16.5	36.5	21.2	12.9	4.7	4.7	2676

[a]All values in constant dollars.

Source: Calculated by Allen Scott (1985) from Table 3-7 in Flamm (1985).

labor costs will be between skilled labor, including engineers. And this is what countries like Singapore (but also Brasil) are trying to offer.

Several reasons seem to explain the companies' behavior in keeping their decentralized location pattern, in spite of the lesser role played by low wages in their economic strategy. The first is the investments already made in the area. Thus, when they automate, they often automate in the same Southeast Asian location. Scott (1985) has shown that, contrary to some assumptions, U.S. semiconductor plants in Southeast Asia are highly capital-intensive (the average weighted-average capital-labor ratio, for 1983, was $26,594 for the companies in Scott's sample). The second reason is the interaction between these companies and a dense network of suppliers, locally owned, that have clustered around the multinational plants, constituting an industrial milieu. The third reason is the growing availability of cheap skilled labor, as countries like Singapore, Hong Kong, Taiwan, or Korea, dramatically improve the quality of their technical education. The fourth reason is the continuing reliance on governments' support, in terms of tax incentives, infrastructure, subsidies, and relaxed regulation, far above what companies could expect to have in the U.S. or Europe. And the fifth and major reason, that we will examine in some detail, is that direct connection to expanding markets in Asia, anchors the companies in the region, so that they continue to locate there although as a result of factors which differ from those that motivated their decentralization in the first place. Thus, in a very fundamental sense, the decentralization of production at the world level, and the increasing interconnection of all economic processes across national boundaries, seem to be irreversible.

3.3. Market-oriented location policies

Interestingly enough, while unskilled labor costs are becoming a less important factor for the location of companies because of increasing automation the current trend points toward a greater internationalization of the companies' structure in order to locate closer to their different markets, thus modifying the tendency of the 1970s, where export-platforms were aimed at the world market (Henderson and Scott, 1986; Lee, 1984; Balassa, 1982; Perlo, 1985). This is a fundamental point that requires some explanation.

The internationalization of the economy and the intensification of world trade in the last two decades led to national economic policies that are increasingly dependent upon their performance on the world's scene. International economic competitiveness is a key political factor for any government's fate, domestically as well as in foreign affairs. To reinforce the competitive chances of its national companies, many governments have engaged in restrictive practices of trade, as well as in export incentive measures, so that national corporations can build their home basis for their subsequent assault on the world economy (Cohen and Zysman, 1983). This strategy has become known as the Japanese Model (Johnson, 1982), but it is increasingly the fact of many NIC countries, Korea (Rosenberg, 1980), and Brasil (Costa Souza, 1985) being the most prominent in this respect.

The EEC has stepped up its control on "unfair competition" of non-EEC countries in Europe, particularly for Japanese exports, and in advanced electronics (there is for instance a 17% surcharge on all imported semiconductors). In the U.S. in the period 1983-86 there has been a dramatic surge of public protest against imports, particularly from Japan, that, in spite of Reagan's free trade philosophy, has led to the imposition of a number of quotas on several products, and even to the threat of a commercial war with Japan (BusinessWeek, Apr 8, 1985). Because of the mounting danger of protectionist measures, companies from all countries are positioning themselves to be present in their key foreign markets, often with the support of their own governments, given the strategic importance of the conquest of international markets by national (or nationally-backed) companies. Thus, American and Japanese companies are establishing themselves in increasing numbers in the EEC; Japanese companies (particularly Toyota, Honda and Nissan) are locating in the U.S.; Korean companies settle in Canada; investment from all over the world is pouring into the U.S., most of it in securities and real estate, but a substantial amount goes into setting up new companies or buying old ones, particularly in the West and the Southwest (Schoenberger, 1985; Glickman, 1985).

Large potential markets, such as Brasil, Mexico, or China, are being tapped by foreign investment, locating there to take over the expansion of new segments of consumers throughout the world. In sum, the target is still the world market, but the strategy of multilocation is increasingly more important vis-a-vis the export-platform strategy. The consequence for the Third World is two-fold: on the one hand, most investment tends to concentrate inside the economies of the most industrialized countries. On the other hand, domestic markets within the NICs, and in the Third World in general, will have to be shared with international companies, at least in those commercial lines considered profitable. Thus, it follows an increasing dependency, although not necessarily more underdevelopment, of those Third World countries which are somewhat industrialized.

This trend fundamentally alters the current international division of labor because it strongly articulates anew productive location and presence in the market, even though such production facilities will continue to be financially and technologically dependent from the core economies. The development of new technologies plays a major role in this new pattern of the international economy. Let us see why.

3.4. Telecommunications and Multilocation

This is, first of all, because new telecommunications technologies allow the integration of management, as well as internal technological transfer within the same company between its different units, regardless of their location (Nicol, 1983; Piercy, 1984). Thus, a country can use a multilocational strategy to penetrate markets around the world, while keeping its own internal coherence, on the basis of easy inter-personal communication and data transmission (UNCTC, 1984). This is particularly important because while "off-shore" production does not require day-to-day contact between the center and the periphery of the company (given that it generally concerns routine, assembly operations), productive location close to a market implies a greater coordination of the company's strategy (UNIDO, 1984), something that is only possible thanks to the power, flexibility, and decreasing cost of new telecommunication technologies.

Secondly, this new strategy of internationalization on the basis of multilocation is, to a large extent, the result of the opportunity that high technology products and services represent to take over entire countries as protected markets in areas of the world in great need of devices that incorporate new information technologies, yet are still far behind the current leaders in the field of high technology manufacturing. In this sense, Western Europe appears as the most rapidly growing, promising market for high technology companies in the forthcoming years. This is why, all multinationals, including the European ones, are striving to position themselves in that market. Yet the U.S. is still the fundamental market for high technology (particularly considering the current renovation process of industrial equipment in the U.S.). That explains that much of the U.S. productive facilities of high technology companies will still remain close to their own market. Also, Japanese and European companies are trying to penetrate the US market by investing heavily in it, or setting up joint ventures. Even more so, when the presence in the US technological milieu appears to be a pre-requisite for competing in the race for industrial innovation. For instance, French-government owned electronics giant Thomson, recently acquired an almost bankrupt, highly inefficient American company Mostek, based in Dallas, to buy an additional entry into the US electronics battlefield. Japan is the second largest industrial market in the world (Nazakawa, 1985), but its many ways of disguised protectionism are still keeping it at bay from deep penetration from foreign competition (Borrus, Millstein and Zysman, 1983; Johnson, 1982). Yet, the deregulation of Nippon Telephone Company in 1985, and the monetary and financial policies undertaken in the Fall of the same year by the Nakasone Government seem to signal an awareness of the Japanese establishment to the dangers of a backlash in both the US and EEC, should their protectionism continue unabatedly. As a result of such development, it is likely that at least a segment of the Japanese market will join the world economy, further penetrating it along a clearly defined North-North axis. High technology industries, the most dynamic industrial sector today, tend to locate both in terms of their technical labor (the key production factor) and in terms of their markets, in the OECD countries, whose technological—economic lead is thereby self-reinforced. At the same time, some new potential markets for high technology production appear in oil-producing countries (particularly in the Middle East), and in a few NICs (fundamentally, Korea, Brasil, Mexico, India, and in a few years down the line, China), but they are still very limited in terms of the market, and very distant from the core in their technological capability (with the important exceptions of Singapore and Korea). Much of the Third World (particularly Africa) appears to be left out from the current process of technological modernization, both in terms of markets and of production. The technological revolution for most of the world seems to be limited to the telecommunications networks of some directional centers or, to the enclaves of some large, internationally-oriented companies, and sadly enough, to increasingly sophisticated weaponry. High technology, in its process of uneven development, is profoundly altering the world's economic geography.

Thirdly, the need to access to key technologies witheld by multinational corporations has motivated numerous governments to actively seek the location of these multinational in their countries. Because of the vital need for technology transfer, corporations obtain financial, material, and legislative advantages that amount to a significant bonus to the multinational strategy (UNIDO, 1981; Balassa, 1982). Countries, and regions within countries, enter the competition to obtain the companies' favor. Since in most cases the employment effect of such locations is very limited, and government and local capital financing account for the majority of investment, it seems that the search for technological know-how is the main reason for national governments' efforts to lure high technology companies. Thus, the technological gap is not only the consequence, but also a major cause of the new process of economic internationalization, by favoring the multilocation of the new industries. We are shifting from a strategy based on export-platforms, to a new one relying on the export of the productive platform itself, so that it can penetrate the national markets, and be subsidized by the national governments, in exchange of some drops of the precious know-how generated by the current technological revolution.

Thus, productive decentralization from the North is still likely to continue, but not for the sake of cheap labor. Instead, access to the markets, and particularly to large, expanding markets, such as China or Brasil, seem to be the primary factor for the current movement of increased internationalization of manufacturing.

3.5. The New World's Economic Hierarchy

At this point we should introduce into the analysis the specific economic policies through which different countries are trying to find their way out of the structural economic crisis. It is only by studying the interplay between current policies of economic restructuring and qualitative changes induced by the diffusion of new technologies, that we will be able to understand the emerging international economy.

Three are the main factors favoring the capacity of a given country in the current economic conjuncture to engage in a process of recovery (OECD, 1984; Layard, Basevi, Blanckard, Buiter, and Dornbusch, 1984; Mistral and

Boyer, 1983): the size of its domestic market; its technological capability; its ability to generate public spending without high risk of inflation (for instance, by being able to finance a budget deficit with foreign capital buying government bonds). The simultaneous action of the three factors reinforce each other, establishing a strong hierarchical relationship between countries in the international economy. If we consider how these 3 factors rank countries between themselves (an exercise that we will not undertake here to avoid further complexity of this report), we find a common sense ordering of the world economy, with the U.S. on the top, closely followed by Japan; behind them (at an increasing distance) the EEC; further behind the newly industrialized countries, mainly comprising the growth economies of the Pacific Basin, Brasil, and to some extent Mexico, India, and from now on, China; the incipient industrialized areas of OPEC countries; they are followed by the majority of Third World Countries, increasingly deteriorating their relationship to the center of the world economy; in the low-end of the structure, a growing number of countries and regions, therefore of people, with an ever looser connection to the overall economic structure.

While this world's hierarchy is well known, it is important to recall it in order to insist on two key facts: a) It is an interdependent structure, not just an order of importance; it is made up not just of distance, but of asymmetrical, actual relationships; there is not simply a separation between core and periphery but a highly differentiated, complex structure whose precise workings have to be unveiled in each specific conjuncture.
b) Technological capacity is a fundamental factor in the organization of the whole structure. And it is a particularly dynamic one. Given the speed of the technological revolution, the technological gap is growing, and it will

become irreversible (thus making irreversible the asymmetrical world structure) in the absence of countertendencies prevailing against the current dominant trends.

3.6. High Technology and the Position of Europe

This is no only true for the Third World, but for Western Europe as well. The Common Market is in fact rather uncommon, because of its imperfect and arbitrary integration. The lack of flexibility of its economies, and the bureaucratization of the public sector have rendered Europe entirely dependent on the pace of the US economy to engine its own recovery: in the last decade, in spite of the US recession, the American economy created 20 million new jobs (admittedly, including fast food teenage workers) while Western Europe lost, in net balance, about 5 million jobs. Furthermore, European high technology industries, with few exceptions, are in a shameful state, broadening their gap with their Japanese and US competitors, or simply having surrendered to technological supremacy to join the bandwagon of the victors (as it is, for instance, the case of Olivetti). As states a 1984 official report of the European Community (EEC, 1984, our translation to English): "Europe, because of competitive pressure, will have to embrace new technologies, one day or another. If it allows increasing the current technological gap with US and Japan, the assimilation of new technologies will take place under the worst possible conditions. Its competitiveness will be reduced, unemployment will soar, technological dependency will translate into industrial, economic, and cultural dependency." And yet, the perspectives are rather grim, from an European perspective, since, according to the same document, in 1984, "European industry is losing ground in information technologies. Eight out of ten personal computers sold in Europe come from American makers; nine out of ten VCRs sold in Europe come from Japan. European companies have only 30% of their national share of integrated circuits and only 13% of the world market. In this sector [integrated circuits] Europe as a whole represents one third of the world market, yet it only controls 40% of its own market and 10% of the world market. [...] The situation continues to deteriorate. All European makers of mainframe computers have had to pass agreements with Japanese or American companies to obtain technology transfer" (page 5). Other estimates are even more pessimistic, and assign to Europe a mere 7% of the world market of semiconductors (the core of information technologies), against 53% to the US and 39% to Japan (The Economist, Nov 24-30, 1984).

And yet, Europe does have first class scientific institutions and a strong technological basis, that has been able to keep pace in the fields of avionics, missiles, communications equipment, nuclear power, and, to a lesser extent, in biotechnology (FAST, 1985). Nevertheless, two major flaws seem to be causing a decisive handicap for Europe: the first is the inability to translate scientific discoveries into industrial and commercial applications; the second (not unrelated to the first), is the failure of European research and technological development in two key fields: microelectronics and computers. Because they are the core of information technologies, and because it is information technology that commands the current stream of technological innovation, it is doubtful that Europe will ever bridge the existing gap. Some European programs of technological cooperation, such as ESPRIT (FAST, 1985), are now trying to bring together resources and political will to avoid technological dependency that in today's world will be translated in dependency "tout court". The launching of EUREKA in 1985 under the initiative of the French government, could be a major step in such direction. Yet, EUREKA is too closely associated with the political battle against the SDI program, a battle many European governments are reluctant to enter precisely because of their fear of losing access to a key source of new technologies. Overall, Europe is waking up to the awareness of the key role played by the technological revolution in the restructuring of our world. It remains to be seen if the political priority given to the technological "aggiornamento" can overcome cultural and bureaucratic resistances to the utmost effort of mobilization Europe would require to at least keep pace with the US and Japan in the technological race. The issue concerns the entire world, and particularly the Third World. Because only if there is a technologically advanced Europe, the Third World will be able to bargain for its technological development with a plurality of partners, without being immediately confronted with the techno-political rivalry between the two superpowers, or having to choose between U.S. or Japanese economic domination.

3.7. High Technology and the Evolution of the Third World

The impact of the technological revolution on the place of the Third World in the international division of labor is even more dramatic and far-reaching. In fact, together with the process of economic restructuring, the impact of the new technologies blows up the very notion of "a Third World", if it ever existed. The situations of many countries are becoming not only different (they always were) but they even belong to contradictory processes, whose dynamics pull them apart from each other, into distinct historical constellations.

For the sake of clarity we will risk a highly schematic presentation of the differential impact of the current techno-economic restructuring for several groups of countries with specific positions in the international division of labor:

3.7.1. A first group includes the few truly newly indutrialized countries, basically Korea, Taiwan, Hong Kong, and Singapore, with Malaysia striving to join them. They are the ones connecting more and more closely to the core economies, and particularly to the dynamics of the US market. They have used new technologies both as a tool to modernize their industry, making it more competitive, and as a product-line for jumping into the world market, with increasingly higher sophistication of their electronics industries. For instance, Korea's electronics labor force amounted, in 1984, to about 350,000 workers (Government of Korea, 1985), that is more than all Silicon Valley and Route 128 combined, although at a much lower level of skill. Therefore, one can think that the "four Asian tigers" have joined the industrialized world, and are even likely to surpass some European countries in the near future, by being able to shift from the export strategy based on low-pricing, to a new industrial competitiveness based upon the dynamic accumulation of new technologies and new technological products. It must be recalled that such accomplishment is not the result of laissez-faire capitalism, or of the beneficial effects of off-shore production by multinational corporations. All four cases are government-led processes of economic development (see Schiffer, 1983, and Castells, 1985, for Hong Kong; Hamilton, 1984, and Luedde-Nemeth, for Korea; Wade, 1984, and Lee, 1982, for Singapore; and Chen, 1979, and Browett, 1985, for the overall argument). With the exception of Singapore, the multinationals play a minor role in exports (74% of Hong Kong exports and 75% of Korean exports come from local, non-subsidiary companies). And the domestic market is decisive for their industrial expansion, with the obvious exception of the city-states (Singapore and Hong Kong). The export-led strategy leaping forward to join the industrialized world by the means of the technological revolution is clearly an exception in the overall historical trend, although it is an important exception from which we can learn many lessons about the development process and the potentials for a fruitful assimilation of new technologies. Incidentally, authoritarian regimes such as those governing the four countries are neither a pre-condition or a consequence of the development process. If anything, authoritarianism is likely to be undermined by the complex civil society emerging from a developed, highly internationalized economy.

3.7.2. A second group of countries corresponds to the model of the so-called "new international division of labor", experiencing dependent industrialization linked to decentralized production by multinationals or their subcontractors on the basis of cheap labor and low government regulations. The second ring of Southeast Asian countries (Lee, 1981) could be included here (Vazquez, 1985), particularly Thailand, the Philippines, and some of Malaysia, along with a number of Caribbean islands, some of them specializing in routine key-punching operations for data-processing services, beamed back and forth by satellite. Also, some areas of some countries, basically included in a different position in the world economy, might fit into this model: the Mexican border regions (Perlo, 1986), the Chinese Special Economic Zones, and some Brazilian industries (such as shoes and leather) entirely aimed at exports on the basis of low labor costs. For this group of countries, the new techno-economic model has a contradictory, two-fold effect. On the one hand, production can be dispersed across the world and reunited by technological means in a single process. Also, small companies, using data transmission equipment can actually tap the world market, while keeping a lean, flexible organization. On the other hand, automation, could make easier and relatively cheap to keep industrial production in the North, at a moment when political uncertainty and the cost of managerial and expatriate technical personnel seem to call into question some of the advantages of off-shoring. Although empirical evidence on the matter is scant, our educated guess would suggest that off-shore production will continue but at a slower pace for these countries. The second round of peripheral industrialization will not take place on the sole basis of an export-oriented strategy. Domestic markets will be fundamental for a lasting process of development.

3.7.3. A third category includes those countries whose population size and industrial potential make feasible, at least in theory, a process of technological modernization aimed, simultaneously at their domestic market and at the world economy. Generally speaking, it would seem that technology transfer and capital accumulation will have their dynamic component in an export-oriented strategy, around which the rest of the economy would experience a gradual incorporation. Brasil, Mexico, maybe Argentina, more recently China, and to some extent India, could be examples of this specific situation. For these countries, the eruption of new technologies is a mixed blessing. On the one hand, they can accelerate their pace toward modernization, leaping forward over the traditional sequence of industrialization. On the other hand, their main comparative advantage (low production costs) is partly offset by automation. Besides, their need for access to technological know-how places them in a much greater dependency vis-a-vis the core economies, since autonomous technological capacity cannot be developed in a few years, while the pace of innovation dramatically accelerates. For instance, if we take the example of the most industrialized among them, Brazil (currently the tenth largest industrial output in the world), its first item for exports is currently military equipment, including tanks, armored cars, helicopters, and light planes. Its competitive advantage is low-price for cash-short Third World governments in need of military hardware, along with the absence of any political conditions attached to the sale. Yet, the increasing sophistication of weaponry forces Brazil to enhance its technological level very quickly if it wants to survive in this lucrative market. This will imply a considerable effort in obtaining technological licensing and know-how, that will render Brazilian industry increasingly dependent on its sources of innovation in the core economies. At the same time, the modern, multinationalized sector of the industry will come increasingly under pressure to automate to keep its share of the world market; for instance, this is the case for the Brazilian automobile industry that will be among the eight largest automobile-producers in the world, and the largest in the Third World, by the end of this decade (UNIDO, 1984). Thus, new industrialization will be less labor-intensive, increasing the problem of absorption of the surplus work population, whose migration from the countryside could be accelerated by the bio-technological revolution in agriculture.

This process is just at its beginning, given the incredible low-level of penetration of new technologies in most semi-peripheral countries, even as industrialized as Brasil. For instance, in 1984, in the entire Brazilian industry, there were only 50 industrial robots, 15 CAD systems, and 850 numerical control machine-tools present in only 266 industrial companies, out of the 120,600 such companies in the whole country. All companies with some level of automated equipment are foreign, or subsidiaries of multinationals. Concerning services, a similar low-level of information technology appears to exist, for instance, less than 5% of banks branches (the first service industry to use new technologies in all countries) use on-line communications systems (Costa Souza, 1985). On the other hand, being aware of the strategic importance of information technologies, Brasil is trying to create an endogenous basis for such development. For instance, it has forbidden the import of mini- and micro-computers, so that Brasilian computer makers can grow on the basis of their own market. Nevertheless, it seems doubtful that Brasil, or any other country in the Third World, could develop its own technological basis without relying on technology transfer from the multinationals. What is the interest for these companies to agree to such a transfer? Not cheap labor, but markets, particularly if they are sizable and could expand in the future. This is why China is receiving top attention for from U.S., Japanese, and Western European companies. In exchange for the technological and managerial know-how the Chinese expect to receive from foreign companies, what these companies look for, primarily, is to position themselves into a billion-people-market that will gradually increase (they hope) its purchasing power.

So, three processes are simultaneously taking place associated with techno-economic restructuring in the largest countries of the Third World: the positioning of the multinational companies in such large, protected markets, using their technological know-how as their primary bargaining chip; the strategy by these large countries to increase their competitive edge in the world economy, what requires their technological modernization in the mid-term, while still playing simultaneously a strategy based in low-prices allowed by cheap labor; the expansion of their industrial capability on the basis of large domestic markets that will be served by an increasingly efficient, technologically advanced industry.

The question arises of the compatibility between the three processes. For instance, if the price for technology transfer is opening up the domestic market to the multinationals, it will be difficult for the national companies to build up enough strength on their own turf to be able to compete abroad in a second stage (remember that Japan and Korea grew first in their industrial might on protected domestic markets). On the other hand, if protectionism arises, it is unlikely that technology transfer will happen at any significant level. Take another major issue: employment, and therefore solvent demand. If large-scale automation is required to compete in the world economy in terms of quality standards, the technological modernization of the industrial basis is unlikely to generate enough jobs to dynamize the urban economy and to broaden the domestic market. So, it will be increasing competition, by both national and multinational corporations, on a relativley small upper-level urban market.

The overall effect seems likely to be the increasing disarticulation of the national economy (and to some extent of society), not between multinational corporations and indigenous capital, but between a highly dynamic sector incorporated to the world economy, both as a producer and a market, and a series of destructured segments that will mix their roles as subcontracting sweatshops for the internationalized sector, as caterers of goods and services for specific domestic sub-markets, and as daily inventors of survival strategies.

3.7.4. A fourth group of countries comprises the major oil-producers. In principle, their wealth in revenue (in spite of the leveling of oil prices), makes them potential markets for technological modernization and areas susceptible to industrialization. In some cases, like Nigeria and Indonesia, their population size is also a major potential asset. National development strategies have sought in recent years to use their financial resources to create an industrial basis aimed mainly at import substitution, although still keeping in mind the world market, particularly in petrochemicals. Yet, a number of different elements have fundamentally flawed developmental processes:

a) Exacerbated nationalism and ideological fanaticism, often manipulated by the superpowers, have pitched countries against each other (Iraq, Iran notably), wrecking their economies, killing their people, and diverting technological modernization from the industry to the army.

b) Instability of political institutions, widespread corruption, and the unsettling of intra-national ethnic and cultural cleavages, have channeled the resources into the bureaucracy, for the personal advantage of its members, emphasizing the fact that development is a social process, before becoming an economic equation. Such seems to be, particularly, the case of Nigeria during the 1970s (Lubeck, 1985).

c) The attempt to create a national industrial basis, in the midst of the opening up of the international economy, turned major public investments into gigantic money losers, hastily financed by international banks, thus transforming oil-revenues surpluses into unpayable foreign-debt, so deepening financial dependency, and halting the process of autonomous industrialization, Venezuela and Mexico being perhaps the most typical cases.

With the possible exception of Mexico (whose connection with the US economy makes it more permeable to direct technological modernization), most of the oil producing countries will be users, rather than producers of new technologies, and they are being targeted as important potential markets by high technology corporations, ready to sell them the consumption of the technological revolution at a high price, while maintaining, by and large, a dependent economy and a traditional society. In some cases, oil-hungry governments, such as France, are exchanging technological products for oil, for instance with Nigeria, enlarging the practice of barter that is becoming a major use in international trade.

As a general trend, oil producers have been unable to use their resources to generate industrial development, partly because the coincidence of the high technology rise with the oil bonanza, has restructured the international economy, deepening the technological dependence of oil producers on new industrial equipment, and making more difficult to enter the competition in the world economy on the basis of heavy industry, precisely the one which the oil producing countries were trying to build. Political manipulation opened up profitable markets for high tech weapons. Financial greed lent massive capital to the "nouveaux riches" to tie them, along with the rest of the world, to the "global debt bomb" (Carnoy, 1985). The process we have described refutes the assumption according to which capital supply is the source of development. Neither the largest inflow of capital in recent history, nor the existence of unlimited technological possibilities, were able to engage in the path of development countries submitted to their own archaic structures, and frequently prisoners of the superpowers' geopolitical games.

3.7.5. Most of the Third World countries are being largely bypassed by the current technological revolution, except for its military implications, consumer electronics products, and the connection of its directional centers to an integrated network of world telecommunications. Thus, only a few segments of the productive structure, and increasingly narrow markets participate in the process of new peripheral industrialization. Furthermore, new agricultural technology is contributing to increase labor redundancy in the modern, capitalist exploitations, thus accelerating rural-urban migration. Numerous raw materials are being replaced by synthetic, advanced materials, condemning large areas of the world to economic obsolescence. Not only functional and social distance is increasing between countries, but also between regions of the same country. The downturn of the core economies is also hurting the export capability of most Third World countries, while they are unlikely to enter the competition in the new information technologies (Eward, 1984; Saunders et al., 1983). High interest rates in the center, and fluctuating exchange rates for national currencies, are imposing an unbearable burden of servicing the interest on foreign debts in increasingly depressed economies (World Bank, 1985). Unemployment, misery, hunger, illness, and individual violence, are on the increase all over the Third World, and particularly in the large urban centers. New technologies by themselves have little influence on such trends. Yet, the peculiar world-wide economic structure to which they contribute relates to the increasing social and economic disarticulation of most Third World countries. By interconnecting economically and technologically valuable elements of each country at the world level, and disconnecting social groups, regions, cities, individuals, and some times entire countries, that do not belong to the new, dynamic techno-economic system, the current process of restructuring is fragmenting the social fabric of the planet into pieces, and recomposing only some of them, into a structure that fits predominantly the interests of dominant governments and corporations, and of those areas or institutions for which they have a specific concern.

People, regions, countries, and governments, react against such trends. In most cases, there is a survival reaction, with the expanding informal economy defining its own rules of the game on the local shop floors of most Third World cities. Also, new unintended forms of connection between center and periphery take place. For instance, drugs production and trade on a huge, international scale. Thus, when Bolivia becomes switched-off the system because of the collapse of the world's tin markets, together with the reluctance of foreign capital to invest in a class-conscious, highly politicized country, Bolivian peasants are tapped by drug traffickers, and make coca production and (illegal) export of coca paste the major export of the country (Flores and Blanes, 1983). Such a large, uncontrolled cash-economy, in dollars, wrecks the country's monetary system, triggering unsustainable inflation. Colombia, with a stronger, more diversified economy, is at the core of cocaine traffic, and Peru, Ecuador, some areas of Brasil and Mexico, are also now entering the race. Thus, new ties are being established between the center and the periphery that pervert the dreams of universal development by the means of technological progress. There is a connection between Silicon Valley and Bolivia, but it takes the form of the technological switch-off of Bolivia from the new international economy, along with its delinquent tie-in with cocaine traffic, aimed at markets such as the one represented by to Silicon Valley engineers for them to be able of keeping pace with their frantic race of technological innovation.

Some countries do react against their internal fragmentation and global marginality, rallying around their national governments to strive for political autonomy and economic modernization aimed at their domestic markets, responsive to their people's needs. In different contexts, and with diverse ideologies, Mozambique, Nicaragua, or Peru, are trying to keep afloat their societies without submitting to the logic of global imperatives. Yet, the path is so narrow, and aggression and/or opportunistic manipulation by both superpowers so blatant, that we still have no example of a country setting its own national development path with relative autonomy vis-a-vis the international economy or to the geopolitical strategies. As soon as people and nations have to address the issue of their articulation to the world's economic structure, old and new patterns of dependency combine to close the exits and channel countries toward one of the two logics: the international division of labor, currently structured around high technology industries and financial institutions; or the political alignment in the power blocs organized around the superpowers striving for strategic supremacy. In both cases, Third World countries will have to deal inescapably, with the new technological equation.

Thus, new technologies have not yet transformed the world into a global village of communicative human fellows. Rather, the new techno-economic restructuring is fragmenting people and isolating countries, to recombine them into a reconstructed image made of the silent fulfillment of invisible structural interests.

4. High Technology, Work, and Employment: Jobless Economy or Occupational Transition?

The potential impact of new technologies on employment is probably the main source of both hopes and fears for the economy, as well as for the majority of people. On the one hand, productivity gains allowed by the diffusion of the technological revolution into virtually all sectors of activity could pave the way to economic revitalization. On the other hand, the generalization of labor-saving technologies is feared to worsen unemployment, both functional and structural, at a moment when millions of jobs, particularly in manufacturing, are being lost in the OECD countries. In fact, much of the social and political debate around the issue of new technologies is being played around the question of their implications for employment. Such a polemical background makes particularly difficult a serious, objective assessment of the matter, particularly in the absence of solid empirical research on a comparative basis and for a sufficiently long span of time. This is why we will proceed with great caution, pinpointing, one after another, different questions underlying the more general issue under study, because one of the intellectual reasons for the confusion of this debate is the tangling of several issues in a single question, generally presented in such a way as to suggest a preconceived answer.

At the most elementary level, it is clear that new technologies, when introduced in the process of work, both in the factory and in the office, considerably <u>reduce working time</u>. Scattered evidence on the basis of case studies points in this direction (for instance, Hunt and Hunt (1983) for the impact of robotics; Maeda (1981), Cockroft (1980), and Drennan (1983) for office automation; and Jansen (1984) for the general trends for several industries in Germany, etc.). Yet, an evaluation of the overall impact on employment requires the measurement of both direct and indirect effects over a relatively long period of time. The most rigorous of a handful of studies conducted with such methodology is the simulation performed by Leontieff and Duchin (1984) for the impacts of automation on employment in the period 1963-2000 on the basis of a dynamic input-output matrix of the U.S. economy. At a general level, they found that, taking into consideration only the impact of computer-based automation on the work process, 20 million fewer workers would be required in 2000 in relation to the expected number of jobs required for the same output while keeping constant the level of technology. This represents a saving of 11.7 percent in required labor. Nevertheless, the impacts are very differentiated by industries and occupations. Interestingly enough, services (and particularly office activities) are predicted to have a greater job loss than manufacturing, due to the massive introduction of labor-saving office machines. Consequently, clerical workers and managers will see their share significantly reduced by new information technologies, while professionals will increase very substantially; and craftsmen and operatives in manufacturing will maintain their employment share (see Chart 1 and Tables 1 and 2).

Yet the argument is proposed that, while technological change undoubtedly suppresses jobs (for instance among assembly manufacturing workers, typists, or drafters), the new industries, spurred by demand

Table 1. Levels of Employment[a] under Scenarios S1, S2, and S3 in 1978, 1990 and 2000 (millions of person-years), USA

		Scenarios S1, S2, and S3	BLS Estimates[b]
1978	Professionals	13.9	13.3
	Managers	9.5	9.6
	Sales Workers	5.9	5.9
	Clerical Workers	15.9	15.6
	Craftsmen	11.8	12.0
	Operatives	14.0	14.3
	Service Workers	11.1	10.6
	Laborers	4.3	4.5
	Farmers	2.8	2.8
	Total	89.2	88.6

		Scenario S1	Scenario S2	Scenario S3
1990	Professionals	19.8	21.2	20.9
	Managers	14.4	14.4	12.4
	Sales Workers	9.1	8.9	8.2
	Clerical Workers	24.7	21.2	16.7
	Craftsmen	18.0	17.9	17.5
	Operatives	22.0	21.8	21.1
	Service Workers	16.7	16.8	16.8
	Laborers	6.6	6.6	6.4
	Farmers	4.2	4.2	4.2
	Total	135.5	132.9	124.1
2000	Professionals	25.6	28.4	31.1
	Managers	19.0	17.1	11.2
	Sales Workers	12.4	11.8	10.2
	Clerical Workers	32.6	25.0	17.9
	Craftsmen	23.3	22.9	23.4
	Operatives	27.6	26.1	25.8
	Service Workers	22.3	22.4	23.0
	Laborers	8.7	8.6	8.7
	Farmers	5.3	5.3	5.4
	Total	176.8	167.7	156.6

[a]Includes all private sector employment (jobs) plus employment in public education and health. Does not include public administration, armed forces, or household employees.

[b]Calculated from [U.S. Department of Labor, 1981] using the employment definitions of the IEA Model.

Source: Leontieff and Duchin, 1984.

Table 1. Composition of Employment[a] under Scenarios S1, S2, and S3 in 1978, 1990, and 2000 (percentages), USA

		Scenarios S1, S2, and S3	BLS Estimates[b]
1978	Professionals	15.6	15.0
	Managers	9.5	10.8
	Sales Workers	6.6	6.7
	Clerical Workers	17.8	17.7
	Craftsmen	13.3	13.6
	Operatives	15.7	16.1
	Service Workers	12.4	12.0
	Laborers	4.9	5.0
	Farmers	3.2	3.2
	Total	100.0	100.0

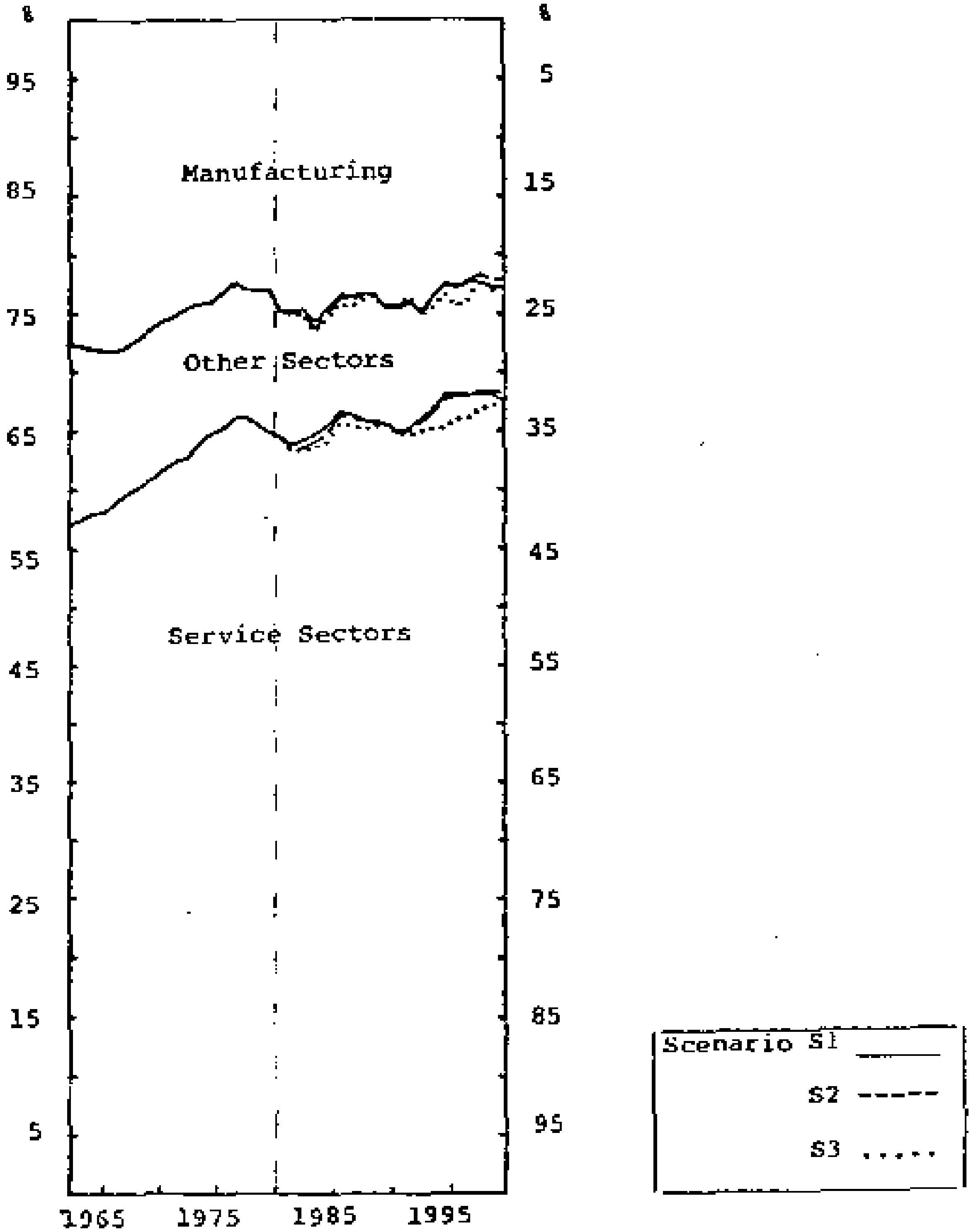
		Scenario S1	Scenario S2	Scenario S3
1990	Professionals	14.6	16.0	16.8
	Managers	10.6	10.8	10.0
	Sales Workers	6.7	6.7	6.6
	Clerical Workers	18.2	15.9	13.5
	Craftsmen	13.3	13.5	14.1
	Operatives	16.3	16.4	17.0
	Service Workers	12.3	12.6	13.5
	Laborers	4.9	4.9	5.2
	Farmers	3.1	3.1	3.3
	Total	100.0	100.0	100.0
2000	Professionals	14.5%	16.9%	19.8%
	Managers	10.8	10.2	7.2
	Sales Workers	7.0	7.0	6.5
	Clerical Workers	18.4	14.9	11.4
	Craftsmen	13.2	13.7	15.0
	Operatives	15.6	15.6	16.5
	Service Workers	12.6	13.4	14.7
	Laborers	4.9	5.1	5.5
	Farmers	3.0	3.2	3.4
	Total	100.0	100.0	100.0

[a,b]See Table 1.1.

Source: Leontieff and Duchin, 1984.

CHART I

Percentage Distribution of Employment among Service, Manufacturing, and Other Sectors, 1963-2000, USA



Note: Manufacturing is defined to include IEA #12-66 and #86. The residual category, Other Sectors, includes Agriculture (IEA #1-4), Mining (IEA #5-10), and Construction (IEA #11). All remaining sectors are included as Services. Public administration, armed forces, and household workers are not included.

Source: Leontieff and Duchin, 1984.

for new capital goods, as well as for computer operations and for handling of automated equipment, will add a substantial amount of new jobs, thus allowing a technological leap forward by means of structural shifts in employment, not unlike what happened during the transition from agriculture to manufacturing and services (see for instance Lawrence, 1984; Nakazawa, 1985; and Dosi, 1984). As a matter of fact, Leontieff and Duchin's projections do take into consideration the tradeoff between "old job" destruction and "new job" creation in many instances. For instance, they write "While the reduction in demand for semi-skilled occupations and laborers, which are directly attributable to robots, is about 600,000 in 1990 and almost 2 million in 2000 under Scenario 3 [the one including fast technological change], the net demand [for labor] is about the same as under Scenario 1 [technology being held constant], apparently due to the offsetting effects of increased production of capital goods" (op.cit. 1984, page 1.19). Yet, overall, the net effect is the decreasing level of labor requirements, for a given level of output and a fixed final demand, as shown in the tables. Furthermore, actual projections of employment changes for the 1982-1995 period show that high-technology employment induced by demand for new capital goods is growing very fast but represents a very small proportion of all jobs--in fact, less than 6 percent (Riche, Hecker, and Burgan, 1983). Table 3 provides the BLS projection on the dynamism of high-technology industries in the U.S., while putting into perspective their limited role as generators of new employment for the economy as a whole.

Gordon and Kimball (1985) have developed this argument by pinpointing, at the same time, the rapid growth of new technology-based

Employment and Employment Growth, by High-Tech Industries and Occupations: 1982 to 1995

Industries / Occupations	Employment, 1982 (thousands)	Employment growth, 1982-95[a] (thousands)	Employment growth, 1982-95[a] (percent)
All industries[b]	91,950	25,795	28.1
High-tech industries[c]			
Group I (48 industries)	12,350	4,263	34.5
Percent of all industries	13.4	16.5	
Group II (6 industries)	2,543	867	34.1
Percent of all industries	2.8	3.4	
Group III (28 industries)	5,691	2,029	35.7
Percent of all industries	6.2	7.9	
All occupations[d]	101,510	24,600	25.2
High-tech occupations[e]	3,287	1,508	45.9
Percent of all occupations	3.2	5.9	

[a]Data for 1995 based on moderate-trend projections.
[b]Employment covers all wage and salary workers
[c]Group I includes industries where the proportion of workers employed in high-tech occupations[e] is at least 1.5 times the average for all industries. Group II includes industries with a ratio of R & D expenditures to net sales at least twice the average for all industries. Group III includes manufacturing industries in which the proportion of workers employed in high-tech occupations[e] is equal or greater than the average for all manufacturing industries; two manufacturing industries that provide technical support to high-tech manufacturing industries are also included.
[d]Employment covers all civilian workers
[e]Engineers, life and physical scientists, mathematical specialists, engineering and science technicians, and computer specialists.

Source: Richard W. Riche, Daniel E. Hecker, and John V. Burgan, "High Technology Today and Tomorrow: A Small Slice of the Employment Pie," Monthly Labor Review 106 (November 1983), Tables 2 and 4.

industries, such as electronics, and yet their inability to account for enough jobs to replace those disappearing as a result of both technological obsolescence and economic restructuring. Thus, employment in electronics in the U.S. tripled between 1960 and 1980, jumping from 1.6 percent of the total labor force in 1965 to 2.1 percent in 1974, and to 2.9 percent in 1986. That year, with 2,731,000 people in the industry, electronics accounted for twice as many jobs as the automobile (857,000) and iron/steel industries combined. And yet, electornics only represented 12 percent of manufacturing jobs, and 2.9 percent of all U.S. employment. In 1984, eating and drinking places were employing almost twice as many people as electronics, government six times more, and non-government services seven times more. Besides, future rate of growth in high-technology manufacturing is likely to slow down, and this without considering the potential losses due to sharp downturns in the industry (such as that of 1984-85), and increasing international competition, particularly from Japan (Borrus, Millstein, Zysman, 1983). As shown in Table 4, the main high-technology manufacturing industries are expected to create about 830,000 new jobs until 1995. This figure, as Gordon and Kimball write, "constitutes less than half the number of manufacturing jobs lost in the U.S. economy between 1980 and 1983. High-technology industries will continue to expand more rapidly than total employment but nevertheless is expected to contribute less than 9 percent of all new jobs in the period 1982-95. In other words, all but a small proportion of the new jobs established in the foreseeable future will originate in spheres outside high-technology industry while high technology itself will have little impact on reducing unemployment in the U.S., Western Europe, or the Third World" (Gordon and Kimball,

TABLE 4

Projected Employment Increases: Selected Electronics Sectors, 1982-1995

Sector		Employment Increase, 1982-1995[1] (000's)
Completed Missiles & Space Vehicles		35
Computers & Peripheral Equipment		266
Communication Equipment		117
Electronic Components		289
Scientific & Controlling Instruments[2]		123
	TOTAL	830[3]

Notes: 1. Based on projections for "moderate" employment growth.
2. Does not include entire sector.
3. Data excludes computer and DP services.

Sources: Adapted from V. Personick, "The job outlook through 1995: industry output and employment projections," Monthly Labor Review, November 1983, 24-36, Table 5.

op.cit., 1985, p. 23).

Now, the real issue is not the direct tradeoff between jobs eliminated through labor-saving technologies and jobs created in the high-technology industries, but the overall effect of technological change on economic growth and, thus, on employment in all activities, and very specially in services. Robert Z. Lawrence (1984) has built a powerful argument on the beneficial effects of information technologies on employment by stimulating production and employment in the capital goods sector; by increasing productivity, thus alleviating disputes over redistribution; and by extending productivity increases to the service sector. He considers it unlikely that the impact of information technology on the economy will be disruptive, because of at least three major reasons: (a) their introduction proceeds at a relatively slow pace: increases in output per worker due to information technology in the U.S. will not be raised more than 1 percent per year; (b) high rates of investment in new technology will probably take place during expansionary phases of the business cycle, in which disruption is less frequent; and (c) even more important, the strongest impact will be during the 1990s, when the rate of growth of the labor force will substantially decline in the U.S. and in Europe. (The annual growth rate of the U.S. labor force will decline from 3.5 percent in 1970-82 to 2.3 percent in 1982-1990, and then to 1.4 percent in 1990-95; for Europe, corresponding figures are 0.9 percent for nine EEC countries in 1980-85, 0.66 percent in 1985-90, and 0.37 percent between 1990 and 1995.) Under these conditions, he proceeds to a simulation of employment growth in the U.S., after which he concludes that "The decline in the U.S. labor force growth of 2.1 percent is more than twice the rise in output per manhour, but would probably be the maximum due to a rapid increase in information technology. The U.S. economy needs to be no more successful at creating jobs than it has been in the past to absorb the labor potentially displaced by information technology" (op.cit., 1984, p. 31). Furthermore, it is true that in the recent past, during the 1970s, the two countries that introduced the most information technology in their economics (Japan and the U.S.) were precisely the countries more able to create jobs, while Western European economies, less able to incorporate the technological revolution (The Economist, 1984), suffered higher unemployment rates. The case is particularly striking for Germany, which, as of 1980, had a share of high-technology employment in manufacturing similar to that of the U.S. and Japan, but which performed very poorly in their rates of change in these strategic industries during the 1970s (see Table 5).

This is what allows Lawrence to state that "In European economics, in particular, the new information technologies are viewed with alarm. This alarm is not related to the inherent technological or economic impacts of the technologies, but to the structural problems in European labor markets . . . The key to the superior ability of the U.S. and Japan to adopt the new technologies lies in the flexibility of their labor and capital markets" (Lawrence, op.cit., 1984, p. 48).

Shifting from a comparison of countries (always unconvincing because of the number of uncontrolled factors leading to a similar outcome) to an analysis of industries, Japanese data shown in Table 6 indicate a positive correlation between industrial adoption of IT and employment growth. The study by Castells and others on the impact of

Table 5. Information Technology[a] - Changes in Employment and Employment Shares in Manufacturing

Information Technology Employment

	1973	1980[b]	Percentage Change
United States	2534	2982	17.7
Germany	1321	1149	-13.0
Japan	1210	1188	-1.8
United Kingdom	957	811	-15.3
Sweden	91.4	96.7	5.8

Information Technology Employment as a Share of Manufacturing

	1973	1980[b]	Percentage Change
United States	13.5	15.5[c]	14.8
Germany	16.5	16.1	-2.4
Japan	15.6	16.7	7.1
United Kingdom	12.7	12.6	-1.0
Sweden	10.2	11.3	1.1

Source: UN Yearbook of Industrial Statistics (New York: UN, 1979, 1981).

a. Office computing machinery, electrical machinery, and professional goods.

b. German data are for 1979.

c. 16.8 when computer services included.

Table 6. Japanese Equipment and Adoptation of Information Technologies

	Percent change in employment 1973-82	Percent of establishments using IT (in 1982)
Food and tobacco	22.2	43.6
Textile mill products	-40.5	38.8
Apparel and other finished products	4.0	47.8
Lumber and wood products	-45.0	36.5
Furniture and fixtures	-20.5	58.9
Pulp, paper, and paper worked products	-18.8	52.1
Publishing, printing, & allied industries	-5.2	69.2
Ceramic, stone, and clay products	-18.2	48.6
Iron and steel	-18.2	59.9
Non-ferrous metals and products	-12.7	60.6
Fabricated metal products	-13.9	61.0
Machinery	-10.9	74.2
Electrical machinery	8.8	71.5
Transportation equipment	-7.2	72.6
Precision machinery	13.6	68.4
Total	-8.3	59.3

Source: Japan Ministry of Labour, Statistics, and Information Department, Yearbook of Labour Statistics, 1982.

technological change on employment in Spain for the period 1975-1983 (Castells et al., 1986) found no significant correlation between job loss and the introduction of technology for the 64 sectors of the Spanish economy. A more detailed analysis on the evolution of employment in the five automobile companies located in Spain showed a positive correlation between the introduction of robots and the level of employment, company by company. The obvious intervening variable was the ability of the company to compete internationally because of stepped-up technological capability, thus enhancing its share of the market and making it able to maintain its labor requirements in spite of higher productivity. Similar findings were obtained on the relationship between office automation and employment in the Spanish banking sector. As for the U.S., a study by Lawrence (1984b) indicates that shifts in employment across sectors in the 1970s (when information technologies accelerated their diffusion throughout the economy) were not significantly different from those in the 1960s.

Thus, it seems that, as a general trend, there is no structural relationship between the use of information technology in the labor process and the evolution of aggregate employment. Jobs are being displaced and new jobs are being created, but their quantitative matching varies across countries and periods, therefore supporting the hypothesis that such differences are probably due to the characteristiscs of institutional frameworks, and to the dynamics of each national economy.

Nevertheless, if jobs are created through the dynamism of a newly revitalized economy, they are very different from those phased out.

Rumberger and Levin (1984) have shown that, while many of the occupational categories with highest rates of growth in 1982-95 are directly linked to information technologies, thus upgrading the skills of future required labor, those occupations with the fastest absolute growth, accounting for the bulk of new jobs, are concentrated in low-skilled, low-paid service activities, with little educational requirements (see Table 7). So, computer service technicians will grow by 97 percent in 1982-95, but they will only add 53,000 jobs--while building custodians will increase only by 28 percent, but such a growth will translate into 779,000 new jobs on top of the 2,800,000 building custodians already in operation in 1982 . . .

It is on the basis of this trend that many authors (for instance, Bluestone and Harrison, 1982; 1984; Markusen, 1983; Rumberger, 1984) defend the idea that the new occupational structure tends to be increasingly polarized, with low-paid service jobs replacing relatively well-paid, unionized manufacturing jobs, and with the middle-income groups shrinking their share of the wage-earners' population (Kuttner, 1984; Thurow, 1984). High-technology industries are themselves characterized by a bipolar distribution of skills and ages, with an increasing proportion of employees in electronics (over 50 percent in 1984) being in the non-production category, and a concentration of low-wage, low-skill jobs among production workers (Gordon and Kimball, 1985). In 1984, the average hourly wage of production workers in electronics was $8.89, compared with $13.09 in steel and $12.54 in the auto industry. Gordon and Kimball report usual starting wages in operative work in electronics in the range of $3.50 to $5.50 per hour. Similar trends are reported by Carnoy (1985) on "Silicon Valley"; by

Table 7
Employment, Education, and Relative Earnings
in the Greatest Declining and Growing Occupations: 1982–1995

	Employment 1982 (thousands of workers)	1995	1982–95	Relative Earnings[a] (percent)	Modal Education[b] (years)
Declining occupations					
Farm laborers	1,211	1,019	192	53	<12
Private household workers	1,023	850	173	30	<12
College and university faculty	744	632	112	136	17+
Farm owners and tenants	1,407	1,304	103	119	12
Postal service clerks	307	252	55	122	12
Total	4,692	4,057	635	78	—
Growing occupations					
Building custodians	2,828	3,606	778	69	<12
Cashiers	1,570	2,314	744	49	12
Secretaries	2,441	3,161	720	67	12
General clerks, office	2,348	3,044	696	67	12
Sales clerks	2,916	3,601	685	52	12
Total	12,103	15,726	3,623	61	—

[a]The average weekly earnings during 1979 of workers in each occupation relative to the average weekly earnings of all workers.
[b]The level of education completed by the majority of workers employed in each occupation in the spring of 1980.

Sources: Employment data from George T. Silvestri, John M. Lukasiewicz, and Marcus E. Einstein, "Occupational Employment Projections Through 1995," Monthly Labor Review 106 (November 1983), Table 1; Earnings and education data calculated from the 1980 Public Use sample, U.S. Bureau of the Census.

(Compiled by R. W. Rumberger, 1984.)

Scott (1985) for Orange County; and by Gordon and Kimball (1985) for Santa Cruz, California. As Table 8 shows, women and minorities account for a growing majority of production workers in high-technology industries, and they tend to be concentrated in the lower end of the occupational scale.

Thus, we observe an evolution of the employment structure of the U.S. characterized by:

(a) A fast rate of growth of high-technology and advanced-services-related occupations, yet accounting for a small proportion of new jobs, and even a lower share of overall aggregate employment.

(b) A bipolar occupational structure in high-technology employment between a majority of upgraded, professional, non-production jobs (most of them held by white males), and a sizeable minority of low-skilled, low-paid production jobs increasingly reserved for women and minorities, with the greatest share for minority women.

(c) A massive increase of service jobs that will account for about 75 percent of all new jobs in the period 1982-95. Most of these jobs will be in low-skill, low-pay occupations, such as janitors, cashiers, secretaries, waiters, and the like. It follows a general pattern of de-skilling and downgrading of labor in the overall occupational structure (Levin and Rumberger, 1984).

(d) At the same time, high-level occupations such as professionals and technicians will significantly increase their share of employment, from 16.3 percent in 1982 to 17.3 percent in 1995 (Silvestri, Lukasiewicz, and Einstein, 1983), while operatives will decline somewhat

TABLE 8

High Technology Occupational Structure:
Gender, Ethnicity and Race.

(1) U.S. High Technology Industry

	White Female	Minority (Male & Female)	White Male
Production	38.4%	24.4%	37.2%
Technical	15.8%	14.3%	69.9%
Professional	11.9%	8.4%	79.7%

(2) Santa Clara County

	White Female	Minority (Male & Female)	White Male
Production	30.2%	46.4%	23.4%
Technical	16.7%	28.0%	55.3%
Professional	13.3%	14.4%	72.2%

(3) Santa Cruz County

	White Female	Minority (Male & Female)	White Male
Production	48.4%	29.4%	22.2%
Technical	25.3%	23.0%	51.7%
Professional	24.0%	12.7%	63.4%

Sources: 1980 EEOI Summary Report of Selected Establishments from the Technical Services Division, OSP, Equal Employment Opportunity Commission; R. Gordon and L. Kimball, Small Town High Technology: The Industrialization os Santa Cruz County, 1985. We are very grateful to Lenny Siegel, Pacific Studies Center, Mountain View for supplying the EEOI raw data from which the U.S. and Santa Clara tables are calculated.

(from 12.8 percent to 12.1 percent). Along with the preceding trend towards downgrading of many service jobs, it would seem as though the process of bipolarization will actually concern the entire occupational structure, though the bottom would certainly be of greater size than the top. Thus, re-skilling and de-skilling, downgrading and upgrading, operate at the same time, with a changing emphasis following different industries and occupations.

Nevertheless, the question arises of the specific relationship between new technologies and the emerging profile of the occupational structure as described. In other words, the secular transformation toward a service economy, and the specific characteristics of such service activities, would seem a much greater source of the new occupational structure, including the process of bipolarization and the occupational segregation by gender and race, than the introduction of information technologies in the process of work.

A serious attempt to answer empirically such question has been undertaken, for the U.S., by Ronald Kutscher of the U.S. Bureau of Labor Statistics (Kutscher, 1985). Kutscher proceeds in two steps, first analyzing the specific impact of technological change on employment by industry and by occupation, between 1967 and 1978, comparing the actual level of employment to what would have resulted while holding constant input-output technological coefficients at their 1967 level. He then goes on evaluating the impact of technology on future employment change by calculating a factor analysis on the 1977-1995 projections by industry and by occupation, sorting out the specific impact of input-output coefficients, once having controlled the effect of other factors, in particular GNP growth. It has to be noted that Kutscher's definition of technological change is very broad, and relates to the technical coefficients of the input-output matrix, thus embracing a broader set of phenomena than the introduction of information technologies, to include all changes in the goods or services required to produce each industry's goods or services. Yet, his findings are a good approximation to what we are looking for, at this very general, exploratory stage of our research.

Table 9 provides Kutscher's estimates on the specific effects of technology on the evolution of employment in the 1967-1978 period. It had a significantly negative effect on agriculture and on manufacturing, a positive effect on construction, a slight negative effect on wholesale and retail trade (offsetting the positive effects of the increase in output), a positive effect on finance, insurance, and real estate employment, and a very positive effect on "office services". From data not shown in the table, negative effects on manufacturing have been concentrated in textiles, apparel, iron and steel, and motor vehicles; positive effects on "other services", primarily concerning miscellaneous business services and non-profit organizations.

The statistical analysis for occupational change between 1967 and 1978 shows a positive effect of technology on the share of professionals and technicians, a negative effect on operatives and farmers, and a lack of impact on clerical workers. Concerning future trends, the analysis is made more complicated by the projective character of the data. Also, Kutscher has kept a high level of disaggregation to make possible his factor analysis, so that the trends are less clear for the 1977-95

Table 9
Employment by Major Sector
Percent Distribution

	Actual 1978	1978 with constant 1967 input-output coefficients	1978 with constant 1967 input-output and employment output coefficients
Total	100.0	100.0	100.0
Agriculture, forestry and fisheries	3.9	3.6	5.5
Mining	0.8	0.8	0.7
Construction	7.0	7.6	5.1
Manufacturing	24.5	24.5	29.6
Durables	14.6	14.7	17.2
Non-durables	9.8	9.6	12.4
Transportation	3.6	3.5	3.0
Communications	1.5	1.3	2.0
Public utilities	1.0	1.1	1.1
Wholesale and retail trade	26.0	27.2	24.2
Finance, insurance and real estate	7.6	7.5	6.8
Other services	20.3	18.2	17.3
Government enterprises	1.8	2.4	2.0
Households	2.2	2.2	1.8

period. Yet, Tables 10 and 11 provide some hints by pinpointing the industries and occupations most affected in their decline or increase by technological factors. It does appear that, in terms of decline, traditional manufacturing and manual workers of those industries are the most badly hit by technological progress, while clerical jobs do not appear among the 40 occupations with the largest decline. High-tech manufacturing and advanced services are the industries whose employment is most positively influenced by technology. Yet, the occupations showing the largest increases in employment <u>due to technological change</u> are not necessarily the typical high-tech occupations, but service-related occupations. Thus, security-related occupations, household repair and maintenance, and financial experts outweigh communications mechanics or computer programmers in their increase as a consequence of technology. Services are not only the predominant source of job creation, but the expanding employment sector as a result of technological progress, once accounted for the effects of GNP growth, productivity, and staffing patterns. It is noteworthy to observe that such an overwhelming trend for the expansion of service employment does not mean the demise of manufacturing. Manufacturing employment added 4.5 million jobs between 1959 and 1979, though it lost 2.2 million jobs in the 1980-82 recession, dropping to 19 percent of total employment in 1982. Yet, it will not decline further according to the projections up to 1995, adding another 4.3 million jobs and retaining its share of employment at about the same level. The difference is, of course, that new employment creation (about 23 to 28 million jobs between 1983 and 1995) will take place entirely in the service sector, and predominantly in the "other service" category (including such industries as business

TABLE 10

Largest Declines in Employment Resulting From Technological Change, As Measured by Input-Output Coefficients, 1977-1995

Selected Industries	Selected Occupations
- Iron & ferroalloy mining	- Metalworking operatives
- Nonferrous metal ore mining	- Factory material repairers
- Sugar	- Foundry workers
- Wooden containers	- Metal engineers
	- Glassware operators
	- Miscellaneous machine operators, binary metals
	- Machine operatives, leather leather and leather goods
	- Roadbrake operators
	- Automotive engineers
	- Road car repairers

Source: Kutscher, op. cit., 1985 (our selection).

TABLE 11

Largest Increases in Employment Resulting From Technological Change, As Measured by Input-Output Coefficients, 1977-1995

Selected Industries	Selected Occupations
- Electronic components	- Termite treaters
- Communications	- Protective signal operators, installers, & repairers
- Credit agencies & financial brokers	- Private detectives
- Business services	- Survey workers
	- Communications equipment mechanics
	- Central office operators & repairers
	- Directory assistance operators
	- Installers, repairers, section maintainers
	- Credit reporters
	- Employment interviewers

Source: Kutscher, op.cit., 1985 (our selection).

services, professional services, medical care, hotels, personal services, and non-profit organizations), which will account for one-third of new jobs, and putting "other services" employment in in 1995 at 31 million jobs, or one-fourth of total U.S. employment.

The interesting point, though, about the factor analysis performed by Kutcher, is that the general trend toward employment in services is due, to a large extent, to GNP growth, but also, to some extent, to the specific effect of technological change on the structure of employment. Thus, technology is having a double effect on the type of jobs created in the new economy: on the one hand, being a major factor in economic growth, it accelerates the shift toward the service economy; on the other hand, it stimulates employment growth in high-tech manufacturing and in new services as a direct effect of technology itself.

Therefore, it seems to be a statistical relationship between the characteristics of the current technological revolution, and the specific profile of employment structure emerging in the new economy, at least in the U.S. Productivity increases through automation in both factories and offices, "frees" labor, which is used by an ever-expansionary service sector, whose lower level, increasingly more important than the upper strata, concentrates most women, minorities, and immigrants in low-skill jobs. These occupations, lacking in organizational strength, become also low-paid, ill-protected jobs.

So, high technology does not create unemployment by itself, particularly taking into consideration the declining rate of growth of the labor force. When used to spur economic growth, it frees enough productivity to stimulate profitable investment as a response to expanding final demand, thus also expanding employment outside the high-tech world. Yet, high technology seems to contribute to a new occupational structure characterized by polarization, segmentation, and individualization of labor relationships. It probably does so, in spite of the upgrading of much of the labor working in high-technology industries, by contributing to the dissolution of the social fabric that for decades protected the wage-earners from sheer imposition of the management's logic. Otherwise, it would be inexplicable why clerical work per se is less well paid than assembly-line work, or that electronics production workers cannot match the wages of their auto industry counterparts. It is the dissolution of old activities, and the subsequent creation of new ones, under the powerful drive of technologically-led economic growth, that accounts for the current structural transformation of employment. New technologies do not necessarily cause unemployment, yet they do transform the kind of employment, and therefore the nature of work and of work relationships.

5. New Communication Technologies and Everyday Life

New technologies are transforming all domains of our life, from the schools of our children to the biological reproduction of human life. But perhaps the most important development in the relationship between new technologies and social life is the coming of the "home information revolution" (Dutton, Kovoric, Steinfield, 1983). It refers not only to the increasing use of home computers, but to the transformation of a large proportion of households into real communication hubs (Williams, 1982). By 1984, about 7 percent of U.S. households were equipped with home computers, 21 percent had programmable video games, and 37 percent subscribed to the kind of cable-TV service (up from 25 percent in 1980). The progression in home electronics equipment in recent years is spectacular, in spite of some slump in the home computer market in 1984-85. Sales of consumer electronic products reached $19 billion in 1983. Home computer sales accounted for $2 billion in 1983, against $1.3 billion in 1982. Even telephones increased their sales dramatically (by 60 percent in 1983), reaching 31 million domestic telephone units in 1983. Cable-TV was a $6.1 billion industry in 1983, with a spectacular progression until 1982. In 1984, 67 million U.S. homes (above two-thirds of all homes) had been wired for cable, and actual penetration of service had risen to 32 million homes (Business Week, 1981; Williams, 1982; Baldwin and McVoy, 1983). The technological development of communications in the field of news and entertainment has an even greater potential impact. To the 150 million television sets in use in the United States (99 percent of homes have at least one set, 50 percent at least two) has now been added the explosion of video-cassette recorders (VCRs) (currently in about 28 percent of U.S. households) and video-disc equipment, along with a new development in specialized radio, video, hi-fi musical equipment, and new forms of television (very sharp, small 13-inch color TV sets, expensive giant screens, and, soon, digital TV with perfectly clear images, able to hold the picture, divide the screen, "zoom in" parts of it, etc.). The increasing use of satellites and the affordability of roof-top discs will allow reception of literally hundreds of channels, potentially submerging the receivers' capacity of assimilating signals and information.

Yet, if we know what the current developments are (Business Week, 1984; New York Times, 1984), it is most uncertain what is the actual use of all this equipment. Home computing seems to be more diffused among professionals, and basically for word processing functions, since more business-oriented activities are generally performed in the work environment. Income tax accounting is a frequent use of personal computers, but it certainly does not use up all the computer's potential. Games seem to be the most general use of the home computer, but, in fact, the video-game industry is in deep crisis, after the initial surge, once the excitement and the novelty leveled off. Thus, while home computers are here to stay, and while their use will develop steadily, with the foreseeable dramatic reduction in their cost and the user-friendly models that the industry will provide, their impact on the home (and on society) will be less in terms of their own informative capabilities than as a piece of a broader system, whose ability to interact in communications networks is likely to be the most important element.

It is in the field of on-line information services that the new function of the electronic home has been most frequently forecast. Though this perspective is generally associated with cable, and to the image of the wired city, a variety of other competing technologies aim at the same target: to deliver a variety of information, with some possibilities of two-way interaction. Packet-type data radio and television allow sending information in bursts, including codes to identify the signal, thus bypassing the current cable operators. But the main source of information delivery is likely to be the telephone, once reconnected to digital transmission capabilities, and with the speed and cost improved through the combination of laser and optical fiber. In fact, different technologies are not mutually exclusive. Given the cost of two-way cable, cable companies are already planning to set up systems that would allow sending information through the already installed wire and receiving the feedback from homes through the telephone line (Williams, 1982).

But . . . technologies for what? What will be the services provided by all these communications wonders? We are told that, by 1990, about one-third of U.S. homes will have some kind of videotext service. What will be the informational content of such a service? Dorkick, Bradley, Names, and Martin projected the following adoption of services by the U.S. population in 1995 (Business Week, 6/29/1981; Dorkiek et al., 1979):

Type of Information Delivered	% of All U.S. Households
- Addresses, numbers, calendars of events	45%
- Home security (police, fire)	40%
- Shopping by catalog	30%
- Directory of goods and services	30%
- Personal message system	30%
- Games	30%
- Public information, such as zoning, regulations, laws	25%
- Library services	20%

Other sources add weather information, electronic banking, electronic mail, energy monitoring, and the like.

One wonders at the real usefulness of the home delivery of these services from the point of view of the consumers, particularly given the current availability of most of this information through the telephone. Are the yellow pages more appealing on screen? Do we really need minute-by-minute updates of the weather forecasts? Is tele-shopping really a viable alternative to shopping centers? Some of the applications of videotext, such as electronic newspapers featured on the TV screen, have already been discounted, as being too inconvenient for readership and because people are not really able to find any specific use for them after watching TV news and reading the home-delivered morning newspaper. In fact, current experiences of videotext services have been generally disappointing. The French "telematique" system has not really taken off, in spite of the massive support of the French Post Office. The British Pretel system has had a moderate success because of its capacity of conveying a broader range of miscellaneous information. In the U.S., the average pay-cable household takes only 1.3 pay services. People are generally reluctant to pay for services for which they do not have a compelling need, or which they used to have free through the telephone line. Electronic mail, already in fast development, particularly in its facsimile transmission service, concerns more offices than homes. Yet, it could produce some impact on home-delivery of mail through increasing cost of personal mail, given the shrinkage of the market for this kind of service, and thus the higher cost per unit of mail. If this trend develops, we could see a combination of three types of mail: electronic messages through computer hookups; self-pickup electronic mail at neighborhood post offices transformed into computerized transmission centers; and the home delivery service as an elite consumer item at an extra cost.

In fact, the main uses for electronic home services could develop along these different lines:

(a) Home security, with wired systems of alert in case of an emergency. This is actually the hottest item in the cable business, outside of entertainment.

(b) Public information, such as government regulations or available services (i.e., health, education, libraries, children's programs, etc.). This could be provided as a service by public agencies, thus increasing their reach and capabilities, though certainly reducing the level of personal contact with citizens.

(c) Electronic banking, which is already being heavily encouraged by banks. In fact, this development is a good example of what is really happening. It is well known that people prefer to deal personally with a bank teller in all money transfers. Automated banking machines have increased the security risks for handling money, in terms of cashing in the street, in terms of potential errors, and in terms of the increased risk of misuse of stolen bank cards (which, unlike credit cards, have no limit of liability if the loss is undeclared). Yet, banks are reducing personnel, closing branches, and generally automating. With the potential of home electronic banking, this movement will dramatically accelerate -- not because of customers' convenience, but because of the dramatic breakthrough in productivity that this will represent for the banking industry. In this sense, home electronic services are likely to develop in the future, as home banking, because of the internal logic of large service organizations, and the economic advantage represented by the automation of most routine functions. Once some key services are almost mandatorily executed through cable or telephone line, many others will be branched into the same network. In this sense, we do foresee a slow but steady trend toward the "telecommunicated city". The likely impact will be (as is already being observed) a decrease in functional travelling around urban areas, and a concentration of activities around three major poles: work places, homes, and pure leisure time and places. At first sight, it seems ideal to be able to concentrate the fact of going out (outside work) just for the pleasure of doing so. But we know that people are very rarely able to take time and travel for just going out: this is the privilege of youth, and of a small proportion of the middle class, to be able to choose, and to afford, casual leisure. For most people, they use the city in between the functional activities they "had to do", playing on the margins of instrumentalism and expressiveness, without necessarily having to decide on the optimal use of their time. Internalizing functional activities at home and at work apparently leaves more room for the free use of the city in terms of pure choice. But it also increases the functional zoning of time and space, in such a way that public space becomes the space of leisure (for those who have the time and the money) and the space of wandering (for those who do not fit in the functional assignment of work and residence).

Urban cultures have always been characterized by the mixture of uses. Land use zoning started to segregate peple and activities, thus leaning toward the disintegration of the social tissue of cities. Now, electronic zoning dramatically enhances this tendency, transforming places into uni-functional units, unless an unprogrammed activity could take place. But then there is a chance that spontaneity and weirdness (if not deviance) will become increasingly associated.

The real "revolution" occurring at home under the impact of new technologies is actually in entertainment. Homes are becoming increasingly equipped with a self-sufficient world of images, sounds, news, and information exchanges (Sabbah, 1985). The most interesting aspect, nevertheless, is that, even if the TV set is the centerpiece of the system, television, as we have known it, is on the decline, at least in relationship to its former overall dominance. In recent years, there has been an increasing demand for a more diversified TV, with more emphasis on entertainment and on specific matters, varying according to subsets of the audience. Cable TV was supposed to be a response to this demand for a diversified and decentralized TV programming, and this explains the rapid development of local cable systems in the 1970s. Yet, the current state of the industry has not supported the hopes for community TV, more directly connected to people's everyday life. The same national TV networks, as well as some major corporations, stepped into the new, promising markets, and transformed it into an extension of TV programming, with more targeted audiences. In fact, cable-TV has become one of the most concentrated sectors of the media industry. Yet, instead of controlling the viewers' growing desire for autonomy, the taking over of cable-TV by the big networks only accelerated their disaffections, actually provoking a crisis in cable-TV itself. Its development leveled off in 1982.

Companies have responded by raising fees, concentrating on the most profitable sectors of the market, introducing new pay-per-view technology, and slowing the pace of introduction of new services--all of which results in deepening the crisis for the cable industry. For instance, in spite of all the talk on the promise of two-way cable, and the publicity of systems such as Qube in Columbus, Ohio, only 500,000 homes are equipped with interactive cable. What is really taking the place of traditional television is <u>video</u> (Sterk, 1984). In 1985, about 28 percent of U.S. households have VCRs. Worldwide, the 1984 figures are 40 million VCRs, with projections for 1990 being 70 million. The same projection estimates that, by 1990, home video will be a $10-billion-a-year industry in the U.S., which is more than the entire American film and music industries combined. The number of video-cassette stores climbed from 6,000 in 1982 to 14,000 in 1984. Big supermarkets are becoming distribution points. And movie theaters are selling video cassettes of the most popular movies they have shown. Video production is growing. In 1982-84 about 2,000 titles were released, at an average price of $40, with rentals as low as one dollar a night. "Raiders of the Lost Ark", the leader of the new industry, sold 800,000 cassettes in the first year of its release, distantly followed by "Jane Fonda's Workout", which sold 170,000 copies. Yet the biggest explosion is still in the making: it consists of musical video (stereo VCRs and video albums), which, it is estimated, will represent about 25 percent of the entire home-video market by 1988.

The main element in the enticement for video is increased freedom of the time of viewing, as well as of the content. The possibility of TV recording, as well as of "pirate recording", offers an unlimited field of accumulation of images, sounds, and information, a new kind of library that finally departs from the Gutenberg Galaxy. Thus, television will still be used as a source for news and instant information (from sports to live televised warfare, as in the Falklands war). So, homes will increasingly become at the same time instant receivers of planetary information (thus actually creating the global village), and personal refuges of selective consumption of images and sounds. Technologically speaking, most homes will become self-sufficient entertainment centers, thus increasing the tendency toward a home-centered private life (Morfoot, 1982).

Furthermore, the trend is not only toward home-centered entertainment, but toward the individualization of the communication experience. The simultaneous development of highly specialized radio stations, and of "walkman" devices, is perhaps the most spectacular expression of the new trend. Not only will people be able to stay at home, seeing nobody, and yet receiving news from the entire world, or filling their eyes and ears with a large variety of experiences, but they will also be able (as they are already) to leave home without leaving their inner experience of sound and information through these earphones that protect them from the world they do not want to perceive--which is to say, everything that is not pre-programmed and, more and more so, not personally pre-programmed.

Certainly, these are only tendencies, and they can be reshaped by purposive action, as well as by the interaction with other elements of our culture and our social organization. Besides, there is nothing wrong with the great possibilities that video offers to people who want to control to some extent the audio-visual culture in which we live. Sometimes, the actual social effects are quite unpredictable. For instance, it has been generally assumed that the video explosion would hurt movie theaters as much as TV did. Such is the case in Western Europe, but in the U.S. the number of screens is actually on the rise (from 16,500 in the late 1970s to about 19,000 in the mid-1980s), most of the audience being composed by youth in search of an autonomous space, away from home.

The electronic home is, above all, a self-sufficient unit of communication in a world increasingly dominated by images and information. People could stay at home and yet communicate, though this communication will be selective and specialized. If we add the technology of individualized communication (pocket-type distribution of data, "walkman"-type receiving devices, wrist TVs and receiving stations, portable and disposable telephones, etc.), we can concede that the new technologies lead toward the de-localization of experience in the sphere of private life, as they do for work-oriented organizations. Homes could become dissociated from neighborhood and cities, and still not be lonely, isolated places. They would be populated by voices, by images, by sounds, by ideas, by games, by colors, by news. And yet, you (we) could switch it all off in one gesture, as we already do. So, we know that the world (at home) is only there if we wish it so. From a strictly technological point of view, there is no more mediation between the individual and a global culture, satellite-transmitted, then specialized, and targeted to specific people and to specific moods. Thus, in-between, there is no more society.

Joshua Meyrowitz, in his recent major book on the social effects of electronic media (Meyrowitz, 1985), argues that the electronic environment blurs social roles and identities, separates physical space from social perception, and mixes public and private spheres in the same frame of reference. Francoise Sabbah (Sabbah, 1985) goes even further. For her, the new media are our new reality. We construct our categories to interpret what we live through, and by the images we constantly receive from a variety of media. People would tend to relate their actual experience to the symbols and meanings constructed in their minds by the pervasive presence of media's messages. Not only the medium is the message, but the image becomes the real experience, around which we tend to construct our relationship to the world.

The result is the fragmentation and individualization of human experience, and in the absence of powerful antidotes (such as community life or strong social networks), the dissolution of solidarity ties, the end of shared codes of communication, and, in the last resort, loneliness as a way of life.

6. High Technology and the Military Connection: War and Peace in the New Technological Era

There is a close relationship between the origins of the current technological revolution and the military and space programs in the U.S. (Dumas, 1980: Dellums, 1983: Fallows, 1981; Markusen, 1985a.) Government support was decisive in the fields of semiconductors, computers, and communications during the take-off period of the 1950s and 1960s (Carlson and Lyman, 1984; Siegel and Markoff, 1985). Generous funding to the universities, and safe, assured contract for development of new technologies to private companies, created the basis for an industry-research-government partnership that made possible much of the technological breakthroughs in information technologies. Furthermore, the emphasis from the military has always been on performance, rather than cost, thus favoring innovation and long-term investment, rather than immediate success in the commercial market. So, in spite of all the ideology about the role of small business and entrepreneurialism in the launching of a new technolgical era, government support, and product specification by the military laid down the organizational basis for new technologies to be generated. The interesting point is that the research undertaken directly by government institutions failed, while the most successful programs were those carried out by independent institutions or companies under government contract (Carlson and Lyman, 1984). Yet, the characteristics of the products required by the military and space programs largely influenced the informational devices that became the keystones of the new technological era. Key requirements were

<u>mobility</u> and <u>miniaturization</u> (Markusen, 1985a), given the small space that the flying, rolling, or sailing machines would allow for the complex machinery, they would bring aboard, along with their weapons and men in charge of them. That was the beginning of an evolution that will soon end up in a new era of vehicles which are entirely based on electronics, regardless of the aerodynamic capabilities of their increasingly bizarre shapes. When Jack Kilby co-invented the integrated circuit at Texas Instruments in 1959, practically all of its production went to the military markets (Mutlu, 1979). Yet, even at that time, that was not an economic imperative. The simultaneous co-inventor of the IC, Bob Noyce (then at Fairchild, and later the founder of Intel), did not work for the military, and Fairchild sold only a small proportion of its production to that market (Lyman and Carlson, 1984). Thus, one can see, at the same time, the crucial role of the military-induced contracts in the high-technology industries, and the product diversification of the industry in commercially oriented products. Carlson and Lyman (1984), show the <u>decreasing</u> share of government markets in the semiconductor industry, when the industry matured. With the coming of the microprocessor (by Ted Hoff, at Intel, in 1971), and the generalization of chips-applications, including the development of micro-computers, the demilitarization of high technology industries accelerated its pace. Along parallel lines, the advances of Japanese technology, in the absence of military markets, demonstrates that there is no necessity for association between information technology and weapons production (Borrus, Millstein, and Zysman, 1983).

Nevertheless, the process of technological discovery in the particular situation of the U.S. in the 1950s and 1960s did produce such an association, and led to a series of consequences in the way high technology industries developed and in the products and processes they turned out to generate (DeCrasse, 1983). As late as 1970 about 22% of all U.S. electrical engineers, about 50% of aeronautical engineers and about 30% of physicists were working in military-related projects (Dempsey and Schurde, 1971; Rutzick, 1970). Defense spending poured into some very specific regions and industries where a combination of scientific technical skills, and conservative political climate could support the new industries, particularly in Silicon Valley, Orange County, and Texas (Markusen and Bloch, 1985). Much of the new dynamism of the Sunbelt since the 1970s is related to the political bias that these areas enjoy from the Defense Department (Markusen, 1986).

At the same time, the nurturing of technological innovation triggered all kind of civilian applications on their own, so that during the 1970s, two convergent lines of high technology industries developed in the U.S., one closely connected to the military (aircraft, and communication equipment, for instance), another in which defense spending, while important, represented a relative minority of the trade (about 7% for computers, or about 13% for semiconductors, in 1982). The situation in the early 1980s has become thus quite mixed, as shown in Table 1 that evaluates the Defense share in the defense-related, high technology industries (Markusen, 1985). The basic picture is this combination of two trends; one, the original military connection of the 1950s-60s period, and the other the second stage, the blossoming of technological civilian applications of the 1970s, spearheaded by the microporcessor whose invention was entirely alien to the military market (actually, it resulted from an order by a Japanese pocket-calculator maker) (Braun, 1982; Rogers and Larsen, 1984).

TABLE 1

Table 1. Major Defense Industrial Base Sectors, Employment and Defense Shares

SIC	Industry	Employment (000) 1977	1982	% Change 1977-82	Defense 1982 BIE[a]	Defense Share 1983 DEIMS[b]	Output Growth[a] 1982-87
3721	Aircraft	222.8	266.6	+28%	270%	85%	+58%
3761	Missiles	93.9	89.6	+ 6%	68%	85%	+84%
3724	Aircraft Engine	106.3	128.8	+21%	54%	64%	+53%
3764	Missile Propulsion	17.0	25.2	+48%	54%	64%	+33%
3728	Aircraft Parts	101.9	146.1	+43%	41%	57%	+35%
3769	Missile Parts	10.9	20.5	+88%	41%	57%	+35%
3662	Radio, TV Comm Equip	333.0	471.3	+42%	58%	61%	+54%
3811	Eng & Sci Inst	42.2	43.1	+ 2%	34%	49%	+60%
3674	Semiconductors	114.0	164.5	+44%	13%	23%	+51%
3675-9	Other Elec Dev	226.0	315.8	+39%	17%	29%	+49%
3822	Measuring Dev	197.0	246.0	+20%	n.a.	35%	n.a.
3883	Optical Instr	29.9	50.6	+69%	26%	17%	+38%
3489	Ordnance	19.0	27.4	+44%	78%	100%	+55%
3731	Shipbuilding	176.4	166.5	−05%	62%	75%	+24%
3483	Ammunition, Exc Small	20.6	23.3	+13%	91%	98%	+56%
2892	Explosives	11.5	11.9	+ 3%	34%	44%	+59%
3795	Tanks	12.1	18.0	+49%	94%	99%	+47%
3484	Small Arms	17.5	17.5	0	14%	66%	−43%
3482	Small Arms Ammo	12.2	10.1	−17%	25%	n.a.	+130%
3573	Computers	193.7	339.6	+75%	7%	n.a.	+141%

a Henry, 1983. From Bureau of Industrial Economics, Department of Commerce, input-output model. These appear to be lower than the following column because of different methods of incorporating foreign sales. Both chart indirect as well as direct demand impacts.

b Shutt, 1984. From the Department of Defense, DEIMS (Defense Economic Impact Monitoring System), using an input-output model from DRI.

Compiled by A. Markusen.

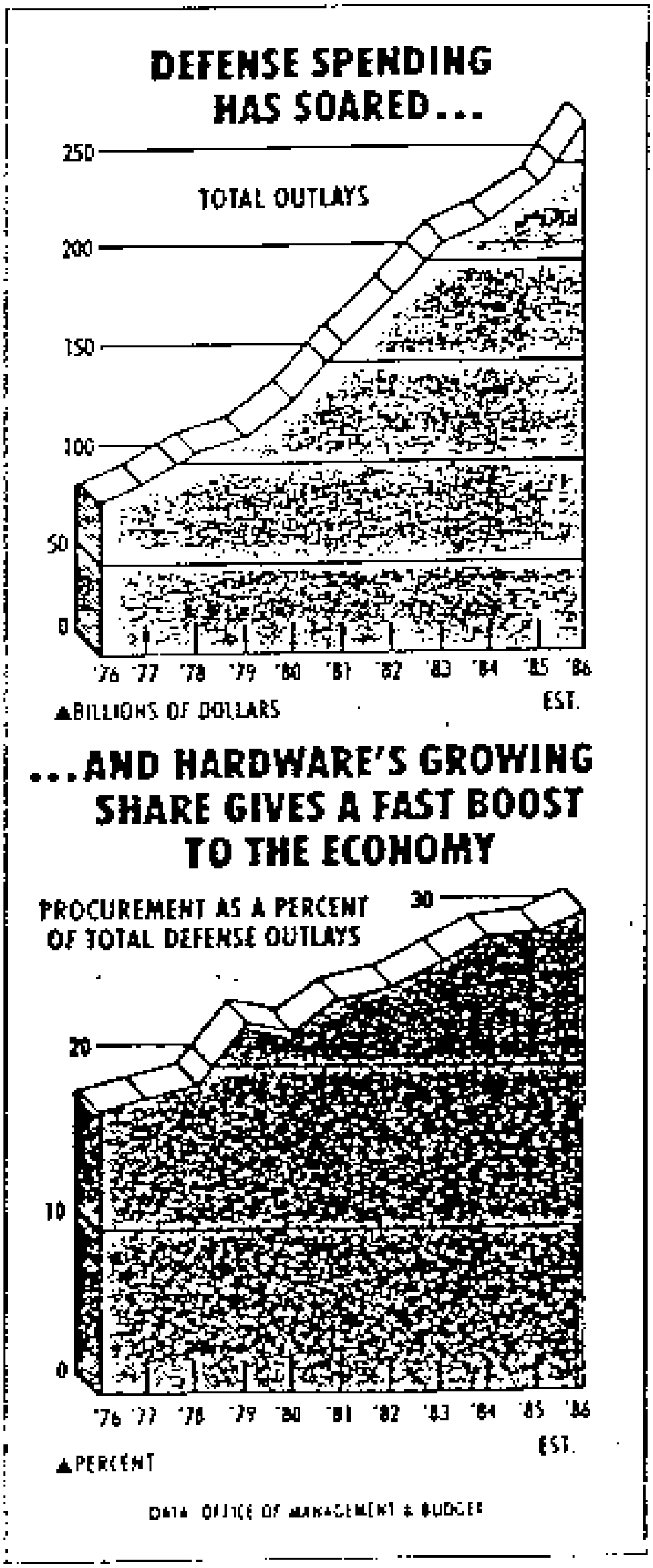
Nevertheless, the tendency is being reversed again, and in quite a decisive manner, because of the qualitatively new military build-up undertaken by the two Reagan Administrations. As it is known (BusinessWeek, Oct 21, 1985), since 1981, defense outlays in the U.S. have increased by 60%, and Defense Department spending has more than doubled in real terms, jumping from 2.8% annual increase during the Carter Administration to about 7.5% annual increase, on average, in the Reagan Administration. Defense accounts for about 30% of the annual federal budget, for a staggering amount in excess of 300 billion dollars. Chart 2 shows the steep increase in defense spending, as well as the increasing share of procurement (that is, military equipment) in the Defense budget. Nevertheless, it is also true that as a percentage of the GNP, if defense spending has risen from 5.4% under Carter to 6.7% under Reagan, it is still lower than the 8.9% of GNP it averaged between 1954-1964, and lower than the 7.4% of GNP it represented in 1970. Furthermore, the Soviet Union spends close to 30% of its GNP in direct or indirect military expenses, so apparently justifying the U.S. build-up. Yet, it has to be reminded, that U.S. GNP is almost three times that of the Soviet Union (Coates and Kilian, 1985).

Thus, the rate of increase of U.S. military expenditures is significant; the committment of the U.S. government to the military appears all evident; and, most important, the sheer size of the U.S. economy translates an even moderate proportion of its GNP (between 7% and 10%) into a colossal mass of resources that, effectively targeted, could ensure military supremacy for the U.S.

The economic effects of such a military policy are decisive (Gansler, 1980). Experts consider that between 15% and 20% of employment gains, and

CHART II

Evolution of Defense Spending in the U.S., 1976-86



(Compiled by BusinessWeek)

about 0.5% of the growth of GNP, generated in 1982-84, can be attributed to defense spending (BusinessWeek, Oct 21, 1985). More fundamentally, a deficit-financed policy of military expenditures can be seen as the new form of "perverted Keynesianism" that has pump-primed the American economy out of the recession, as we have argued elsewhere (Carnoy and Castells, 1984). By targeting high-technology industries that produce new military hardware, such a military-industrial policy has done more than stimulate the economy; it has favored new industries, new regions, and new sections of the labor force, skewing it toward white male engineers and technicians (Markusen, 1986). The whole U.S. economy is being restructured under the current process of government-induced, military-oriented, high-technology development (DeGrasse, 1983).

Other countries, particularly France, Great Britain, Italy, West Germany, Brasil, Israel (besides, of course the Soviet Union and Warsaw Pact countries), are following similar paths toward economic recovery, making up for their trade gaps with weapons sales, mostly to Third World countries. Arms sales have already become the number one export items for France and for Brasil. Thus, in some fundamental way, the complex effects of military spending and high technology manufacturing have become a key element, if not the backbone in the most advanced industrial economies, with the exception of Japan. And even for the latter; it seems that Japanese companies are finally making inroads into the U.S. military procurement contracts, with both the attractive quality and the price of Japanese would-be advanced weaponry producers (Coates and Kilian, 1985) We believe this feature is to stay in the foreseeable future, particularly with the collaboration of Japanese companies in the SDI program. While military markets do not represent the predominant share of high technology industries, they are a key component, from which technological innovation flows to the entire economy. The tendency is not irreversible, as the case of Japan until now again shows, but it is a hard fact of our current economic structure. Nevertheless, it would be a major mistake to consider that high-tech military development is the consequence of an economic policy (implicit or explicit) designed to overcome the crisis of the 1970s, or more specifically, the 1980-82 recession. To be sure, the economic pay-off of defense spending is an important argument to keep it as a priority in most countries. Besides, in countries like the U.S., the political connections of the Reagan Administration to Defense-related industrial areas, such as California and the Southwest are not indifferent to the military build-up. Yet, if Reagan has failed to follow his own economic ideology, and endangered the U.S. and the world economies by embarking in the largest budgetary deficit in history, it has not been for the sake of a short-term reflationary process. The military build-up is motivated, fundamentally, by a political goal, the goal of re-establishing U.S. military supremacy, after the dangerous slippages of the 1970s, and the new strategic balance achieved by the Soviet Union (Gabriel, 1985). After all, it is crucial not to forget that, whatever the important economic matters are, policies of the state are above all else <u>political acts</u>. Thus, the Reagan Administration's policy (as the French military nuclear policy) is determined basically by the pursuit of the military-based, national interest of a superpower. What is new is the means attempted in achieving such supremacy. Unlike the military policies of the last three decades, the U.S. are trying to leap forward, as they did during World War II, by transforming its technological edge (shared only with a non-military power, Japan) into a decisive military superiority. In this sense, the Strategic Defense Initiative (regardles of its technical feasibility or of our own political or moral judgments) is a major indication of the new direction in which military policy, and therefore world policy, have already embarked. And such is the really fundamental, historically new connection between the military and the current technological revolution.

So much has been written about the "Star Wars" program, and such a large debate has (rightly so) surrounded its proposal by the Reagan Administration that we are in danger of overlooking its significance. And yet it is just the tip of an iceberg, the announcement of a new cold giant, a warfare initiative of extra-planetary dimensions (Thompson, 1985).

The strategic concept behind SDI is (a least in the rationale of their proponents) to shift from equivalent offensive capabilities to self-assured defensive capability. Or in strategic terms, from the "Mutual Assured Destruction" (MAD) pattern, to another situation in which destruction becomes impossible, or at least the likelihood of substantial destruction is greatly reduced. To do so, General Abrahamson and his team at the Pentagon, and the scientists at the University of California-operated Lawrence Livermore and Los Alamos National Laboratories together with the weapons-development facility at Sandia National Laboratory, count on the combination of three technologies, unevenly publicized (IIS, 1986). The first, is a network of satellites equipped with electronic sensors able to detect instantly the launching of a missile anywhere on Earth. The second, a computer system able to analyze all information received by the satellites, and give all necessary instructions to the defense weaponry system. The third, consists of a series of laser-rays weapons (the last version of which seems to be the free-electron laser) targeted, directly or through reflective devices, at the adversary missiles and satellites. In addition, space navigation and stationing technologies, such as the ones developed in the space shuttle program would provide the back-up system for the positioning, adjustment, maintenance and repair of the entire network. Theoretically, were such a system to become operational, it would make obslete the current offensive ICBM systems. We will deal below with the feasibility issue, the one fact that has focused most of the scientific debate, but the one that we believe to be secondary for reasons that we will expose later. Let us, for the moment, assume that the program works in its main lines, with long-distance laser weapons being operational in the early 1990s, and some first version of a "Star Wars" shield being close to deployment in the early years of our Third Millenium. What can be the consequences? If the U.S. does have such a shield, even in a limited, primitive version, and the U.S.SR does not, the net result is a decisive strategic advantage for the U.S. that could keep enough of its ICBM arsenal to have both a defensive and an offensive system. Besides, the defensive system can very easily be turned into a offensive one, for instance, along the lines suggested by Edward Teller, building a space-based x-ray laser, with a nuclear bomb as the source of emission. Thus, if SDI is researched, tested, and deployed, under foreseeable circumstances, the U.S. achieves strategic superiority. Of course, the U.S. could use such superiority to impose unilaterally total disarmament, including its own, and keep the shield "just in case" for the protection of itself and its allies, without further infringing on the Soviet Union's power. Such an idea (often put forward by SDI proponents) is of course unrealistic because it ignores the historical nature of power. Strategic supremacy goes along with political supremacy.

Therefore, unless the process whereby SDI-related technologies develops along a multilateral, negotiated process of disarmament and just world peace, the Soviet Union, following its own logic as a world power has only three options that we enumerate from the less likely to the most likely, at least on paper:

1) To use the current (relative) balance of power to launch a pre-emptive strike to force, at least, the disarmament of SDI, and a stable political equilibrium, in exchange for a withdrawal to the previous sphere of influence and strategic military equilibrium. Most likely, such a strike would be limited, using conventional forces, and would be aimed explicitly to a verifiable disarmament of SDI. This option is the least likely, both because of the risks that neither the Soviet union nor the U.S. want to take, and because of the difficulty to prevent the U.S. from deploying SDI on another occasion, given the fact that the technology will be available. To some extent, this option would consider SDI deployment as a "casus belli" Whatever the difficulty to imagine the event, one cannot ignore the tremendous responsability for the Soviet leaders to accept U.S. strategic superiority without reacting.

2) The second option is to modify the current offensive system, based on ICBM, so to render SDI useless. To some extent, this is what the Soviet Union seems to be preparing to do, by increasing the number of ICBMs if current negotiations fail, and also by adding warheads and decoys in such large numbers that SDI's defenses would be subdued through saturation. Also, what SDI planners expect is an increase in the low-flying "cruise missile" types of weapons, and, even more important, a dramatic reduction in the boosting time of ICBMs (when they are most vulnerable to SDI's weapons) that could go from their current 5 minutes space time to 50 seconds. This is a relatively likely

development that would mean, necessarily, leaving the decision of total nuclear war to the judgement of supercomputers, with the risks that the repeated failures of Colorado-based Wimex have already highlighted (Coates and Kilian, 1985). This option has two military drawbacks: a) the threshold of saturation is not unlimited, because coincident trajectories toward key targets in a very limited time could produce the destruction of many of the missiles by the explosion of nearby "fellow missiles"; b) it merely complicates the task of SDI's programmers, thus being ultimately dependent upon the level of technological flexibility achieved by SDI's scientific warriors.

3) The third option is, of course, for the Soviet Union to engage in similar SDI development. In such case, there is a qualitative escalation in the arms race, and the increasing militarization of space. Stakes will be higher, the military waste of human resources will become even more absurd, yet from a strategic point of view, the balance of power would not be much changed with superpowers and micro-powers intertwined in limited, regional struggles because of the global stalemate, maintaining an always precarious equilibrium.

The question, the big question, is if the Soviet Union is prepared for such a technological leap forward. The predominant answer in the U.S. "expert" circles is "no" (IIS, 1986). Of course, one should be distrustful of the ideological bias of staunch anti-communists, as well as of the primitive nationalism surrounding the notion of yankee ingenuity, not yet recovered from the shock of watching the Japanese catch up, and by now, surpass the U.S. in some key technological areas. After all, the Soviet Union first entered the space race with its Sputniks, it has developed considerable capabilities in missiles, satellites, and astronautics, and it has probably the best mathematicians in the world. Some observers point out that the main obstacle for the Soviet Union to stand up at the SDI program is economic (BusinessWeek, Nov 11, 1985). At the moment when Gorbachev's liberalization could provide rising consumption standards for the Soviet people, a new arms race would force austerity on a potentially more restive generation. We believe, nevertheless, there is a more serious, inherently technological difficulty. Information is too scant, and too confidential to be conclusive about such a decisive point. But as a hypothesis, it is probable that the Soviet Union would have tremendous difficulty catching up with the current U.S. lead in SDI-related technologies. And so, because of the three key fields of research on which SDI relies, advanced microelectronics, computer software, and laser, only in the last one is the Soviet Union on the cutting edge. Computers are the big failures of Soviet technology, both in their design and in their use (for instance, apparently there are only about 30,000 mainframes in the Soviet Union, as compared with 620,000 in the U.S.) (BusinessWeek, Nov 11, 1985). Most of integrated circuits in use in the U.S.SR are copies of designs in Japan and the U.S., and custom-chip design seems to be limited to a few military applications. To be sure, they are buying, importing, spying, technology (as, by the way, everybody does), and training hundreds of thousands of engineers and computer specialists. As a matter of fact, the hopeful appointment of Mikhail Gorbachev to the leadership (well received in the research circles of Novosibirsk's scientific city), seems to be closely related to the urgent imperative of modernizing and decentralizing the Soviet state to make possible the creation of the human and institutional tissue associated with the development of information technology. Yet, such reforms will be necessarily slow, and the technological gap, in this historical period, is cumulative. Particularly crucial for the SDI type of technologies is the ability to generate software on a flexible, real-time pattern of computing. Something that demands constant interaction between computers and computer experts, precisely the kind of openness and flexibility that Soviet technology is still lacking.

So, the question is not if the Soviet Union will have full access to information technologies; it will. The point is: Will Soviet technology be able to catch up in microelectronics and software (particularly in artificial intelligence) at a speed fast enough to match the U.S. capability to deploy SDI, when and if the U.S. does it, having started much later, and on a much inferior basis, in fields where even Americans are now opening new ground? Our hypothetical answer is "no". Soviet scientists do not have time to learn and develop in time to recover their gap with the U.S. once the American government has targeted the program as a top priority, and provides it with substantial funding that is likely to succeed in linking to the SDI program some of the best scientists and engineers in the U.S. as well as in Japan and Western Europe. At least, the Soviet Union is very unsure about the issue of such a race, and this is why the entire Soviet foreign policy approach is now focused on the halting of SDI. Even if SDI is still largely a very undefined research project, it has already achieved (regardless of our moral or political judgement) a major objective for the U.S. government: it has placed the Soviet Union on the defensive, because if the U.S. succeeds, and if the Soviet Union (as it seems likely) does not match such success on time, the strategic balance will be dramatically altered, as we have tried to show.

But, before examining the far reaching consequences of such a situation (that could take place within the next 25 years, but could be foreseen within the next decade), we still have to address the question of the technological feasibility of "Star Wars", since the opinion of the scientific community in the U.S., as in Europe, is deeply divided on the issue, with some leading scientists, including former defense advisors depicting the Pentagon's schemes as quasi-science fiction scenarios (Oberdorfer, 1985).

Among the many technological difficulties that have been raised for the implementation of the "Star Wars" program, two seem to be paramount:

1) Even if laser-beam weapons could be either positioned in space or reflected by "mirrors" to be targeted on Earth, it would require a much more powerful source of energy to concentrate enough destructive power in the projected beam. Experiments with the free-electron laser try to solve such difficulty, at this point with uncertain results.

2) Yet, the main scientific challenge posed by the program is the complexity of the computer software required to handle it at the speed imposed by the extremely short time that the system will have to react in the case of emergency. According to superficial, preliminary calculations, 10 million lines of error-free codes would be necessary to run the program. Such capability is currently beyond the reach of the most advanced programming teams. Particularly, because the program cannot be tested, and thus, cannot be extricated from the innumerable "bugs" that plague all programs in the first stages of their implementation. Proponents of SDI respond to the objection with three major arguments: progress in research in software and artificial intelligence is so rapid that current notions of feasibility could become obsolete during the next decade; simulation models and new computers

particularly designed for such simulations will make it possible to test, at least partially, real use situations, particularly if wars are technologically determined, and therefore, made more susceptible of formalization; the complexity of software programs can be greatly diminished by decentralizing and fragmenting the diferent tasks of the whole defensive system into specific subsets with the connections between the different subsets being itself another subset of the system. Thus, complexity is reduced, errors are limited, and correction of errors by simulation is made less difficult. Leading computer scientists still doubt the feasibility of the decentralized approach to the software problem.

This debate could become extremely sophisticated, far beyond our competence to assess it, and in any case, it is highly inconclusive at this point in time. Nobody knows even the range of probability for such a system to work. What is sure is that the research toward the solving of problems posed by SDI is on, and it counts on the accumulation of resources and scientific knowledge unprecendented in humankind's history to support this program.

What military planners in the U.S. are counting on is not necessarily that SDI will ever become a perfect (or almost-perfect) shield for the U.S., let alone for its allies. They are betting instead that the program will be effective enough to destroy a significant number of the atttacking missiles (they speculate about a minimum of 25%). By so doing, SDI could still place the Soviet Union in strategic disadvantage at least at two levels: first, the level of accuracy of SDI's defenses being highly unpredictable (even for the U.S.!) it would make more adventurous than ever to risk a nuclear exchange; second, by destroying a significant number of Soviet ICBMs, a decisive uncertainty is created about which ones of the missiles would be destroyed. If some key targets could be saved from the attack, because of destruction of the missiles aimed at them, then, a partial success of SDI becomes a decisive element for total victory, whatever the possible meaning of that word for the remaining wrecked planet.

So, to some extent, the most realistic appraisal about SDI's prospects lead to the belief that it is not a substitute for the current nuclear strategy but a new and qualitatively crucial element within the existing framework of MAD (Mutual Assured Destruction) strategy, maybe transforming it into A-MAD (Assymetrical Mutual Assured Destruction).

Yet, with all the significance of the debate about feasibility of the SDI program, its real importance lies elsewhere. What matters about SDI is not its achievement (which is still in doubt) but the process it triggers by the simple existence of the program on technological and strategic grounds. SDI represents the most spectacular element of an overall effort by the U.S. to use the technological revolution to achieve strategic supremacy. The key issue is the transformation of technological superiority into a military one, and thus into political supremacy, for the first time since the U.S.SR exploded its first atomic device.

The effort under way is gigantic, and although it goes back to the 1960s programs, with the formation of the Defense Advanced Research Projects Agency (DARPA), and other specialized institutions, it has received a qualitative impulse during the Reagan presidency. The U.S. leads all other Western nations in R&D investment, both in absolute terms and as a percent of GNP. In dollar terms, the U.S. spends more than Germany, Japan, the United Kingdom and France, together. Using the last comparable figures for 1981, the U.S.

invested in R&D 2.5% of its GNP, compared to 2.4% in Japan, 2.7% in West germany, 2.1% in the UK, and 2% in France. But most of this research goes for military programs, unlike all other major industrial nations. In 1978, 49% of U.S. government R&D expenditures were for defense. In 1984, the share of U.S. government research expenditures budgeted to defense had jumped to 70% (Botkin, Dimancescu, and Stata, 1984). Current projections for federal government funding of SDI research, for the 1985-89 period, are presented in Table 2.

Table 2

U.S. Government Funding for SDI research programs, by function, 1985-89 (billions of dollars)

Surveillance	8,990.5
'Directed-Energy' Weapons	4,964.5
'Kinetic-Energy' Weapons	5,059.4
Systems Analysis	902.1
Supporting Missions	1,611.8
TOTAL	21,528.2

Source: Federation of American Scientists elaboration of Defense Department data, 1985

Yet, this is just for research. If SDI is ever employed, total cost of the first phase of such a defense program would cost, according to different estimates between $400 billion and $1.5 <u>trillion</u> (David E. Sanger, <u>The New York Times</u>, November 19, 1985, p. 25).

Yet, the effort is more than quantitative. A whole reorganization of the defense system is under way. On Reagan's and Weinberger's initiative, highly educated, technologically-motivated senior officers have been appointed to key positions of command since 1981 (Coates and Kilian, 1985). DARPA, credited as being one of the most innovative and well-run research agencies in the world, has been given the task to coordinate and fund research efforts to bring together government, industry, and universities in strategic areas, very much following the Japanese model, but with fundamentally military applications as the major goal (after all, DARPA <u>is</u> the Defense Department). In the fall of 1983, DARPA announced the launching of a strategic computing program, that overshadows by far the resources behind Japan's Fifth Generation computer program. The Strategic Computing Program brings together, under the leadership and funding of the Department of Defense, the two major university-industry research consortia recently formed in the U.S.: the Semiconductors Research corporation (SRC), based in North Carolina's Research Triangle Park, with the participation of about 30 universitites, with the "lead centers" at Cornell, Berkeley, Carnegie-Mellon, MIT, Illinois, and Stanford; the second joint-venture is the Microelectronics and Computer Technology Corporation (MCC), established at Austin, Texas, by 13 companies, led by Central Data Corporation (Botkin, Dimancescu, and Stata, 1984; Farley and Glickman, 1985). Such targeted efforts, along with a number of more specific, less publicized agreements, between the Defense Department, industry, and leading universities, are creating the scientific and technological basis for an entirely new form of warfare, and thus of military-political strategy. The information-based technological revolution is now deeply intertwined with the politics of global confrontation. Technology has become, more than ever, the key source of power.

Furthermore, SDI amounts to an integrated program of technological development in which the U.S. government would like to include its NATO allies. Thus, for European countries, the dilemma could be between missing the connection to the most advanced sources of technology and applied science, and being partners in a program with a predominant military emphasis. The French-inspired Eureka program has recently brought together 18 European countries in an attempt to build a different network of technological cooperation focused on civilian applications. Yet, Eureka is, for the moment, little more than a series of already existing cooperative programs (foremost among them being ESPRIT, paricularly focused on computers), plus a number of ad hoc joint ventures between governments and leading European firms in electronics, biotechnology, energy, and advanced materials. Few technological breakthroughs will come from Eureka, unless further integration is accomplished, unless greater financial and scientific resources are provided by European governments and firms. For the moment, it is more a political standpoint than a true technological alternative to SDI. This is why, most EEC countries (including Britain, West Germany, and Italy) are participating at the same time in Eureka and in SDI, as if they wanted to emphasize their will of political autonomy, yet maintaining a strong connection to a source of technological discovery that, building on the current U.S. advantage, is likely to accelerate its pace over the next years.

Thus, while the technological revolution is transforming the military strategic options, and therefore the world's political order, the overarching military concern of the most powerful technological programs, epitomized by SDI, is tying even closer science, warfare, and, ultimately, industrial development, spurred by the techno-military complex (Greenberg, 1985).

Critics of the increasing militarization of science and technology in the U.S. have pinpointed the waste of material and intellectual resources that such an orientation implies, and they have argued that the narrowing of the industrial basis to military-related high-technology manufacturing, will considerably jeopardize U.S.'s competitiveness in the international economy (Markusen, 1986; Botkin, Dimancescu, and Stata, 1984; Siegel and Markoff, 1985). Thousands of scientists in all major universities in the U.S. have stated their opposition to SDI and declared their refusal to cooperate in any such research progrms. So, the debate is not over, and SDI still remains a specific proposal highly dependent upon the political evolution of the U.S., and surrounded with uncertainty about its technological and budgetary feasibility.

Nevertheless, it seems that the close association between the new technological revolution, military programs, and the new drive towards strategic supremacy, will be well established in forthcoming years, regardless of what happens to SDI as a particular program. It is too tempting for a great power, so vigorously embattled in the last decade, to use the sudden technological lead it is enjoying (only shared in some areas with Japan) to redefine the rules of the game. This is what is likely to happen in the foreseeable future. World power will be decided, in a great deal in the research laboratories of the industrial advanced countries of the world. Of course, people's mobilization and consciousness, public opinion, and political coalitions, will still play a major role. And many local conflicts and regional wars will still be decided by the specific political equation underlying them. Yet, the major strategic equilibrium will be more and more dependent on the mastering of information technology, itself determined by the capacity of a society to generate scientific research, and to apply it to industrial and commercial innovation, ultimately leading to a pool of technological discoveries available for military uses. We enter a period of transition, in which we will see the emergence of new battles to control the technological revolution for the sake of power, while still fighting the last combats to reach a new global equilibrium under the new terms imposed by the information-driven technological era. This is a particularly challenging and dangerous time, because in such a process alternative models for the use of new technologies could still be put forward, but, at the same time, the fear of a qualitative rupture of the global equilibrium between the superpowers could trigger reactions that would unleash the devils of the old, industrial, nuclear world before we reach a socially responsible informational age.

7. Concluding Comments

The current technological revolution represents one of the most far-reaching phenomena in the history of humankind. Like all preceding technological transformations, it takes place within a particular socio-economic framework that shapes its content while being itself deeply affected by the characteristics of the technology. It is irrelevent to ask which comes first. There is a single, indivisible structure of socio-economic transformation and technological change, both dimensions being politically determined.

The effects of new technologies, based upon information processing, are pervasive across the entire social structure. This is why any research aimed at assessing the technological impact for the sake of elaborating appropriate social and economic policies to deal with it has to examine a broad range of areas that interact in their specific relationship to technology. For instance, given the importance of defense policies in the industrial development of new technologies, we must understand military perspectives as they relate to high technology production. But such military perspectives, in turn, are being profoundly modified by the impact of new technological possibilities in strategic thinking. In another example, the pace and level of expansion of consumer electronics will largely depend on the evolution of actual patterns in everyday life, which forces any serious investigation on technological change to go beyond the sphere of production and management to enter into the more complex process of understanding the emergence of new social relations. In sum, the use of an excessively narrow scope in investigating the social and economic impacts of new technologies seems to be questionable, given the complexity of the system of interactions we have to confront in this particular field of research.

Furthermore, this technological revolution is universal, and it takes place in a world that has become fully interdependent at the economic, cultural, and political levels. Thus, we also need to examine the relationship between different countries, governments, and cultures, in the process of technological change. More specificaly, analysis of the impacts of new technologies will have to be specific to each society, and will need to account for the influence of that society's place in an interdependent world as a major factor in explaining the particular effects of a given technology.

In this sense, the research presented here proposes a style of inquiry rather than concludes with definite findings. We are calling for a comprehensive, socially differentiated approach to the study of the relationship between new technologies, economy, and society. The preliminary results discussed in this report indicate the major questions to which systematic, comparative, empirical research will have to answer.

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