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## THE NEW TECHNOLOGICAL REVOLUTION AND THE THIRD WORLD

## A NOVA REVOLUÇÃO TECNOLÓGICA E O TERCEIRO MUNDO

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### ABSTRACT

The paper analyses the general characteristics of the new wave of technological innovations and explores its possible impact on Third World countries. The conceptual background used is the Kondratiev-Schumpeter theory of the long cycles of the economy.

**Palavras-Chave:** Technological innovations; Kondratiev-Schumpeter theory; National Project; Explicit and implicit policies of science and technology; Appropriate technologies; Development; Environment.

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### RESUMO

O artigo analisa as características gerais da nova onda de inovações tecnológicas e explora seu possível impacto sobre os países do Terceiro Mundo. O pano de fundo conceitual utilizado é a teoria de Kondratiev-Schumpeter dos longos ciclos econômicos.

**Keywords:** Inovações tecnológicas; ciclos longos de Kondratiev-Schumpeter; Projeto Nacional; Política Explícita e Implícita de ciência e tecnologia; Tecnologias apropriadas; Desenvolvimento; Meio-ambiente.

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## 1. INTRODUCTION

In the first part of this document we make an analysis of the general characteristics of the new wave of technological innovations, and in the second part we explore its possible impact on Third World countries. The conceptual background of the analysis will be the Kondratiev-Schumpeter theory of the long cycles of the economy.

In an article published in 1935, Kondratiev<sup>1</sup> concluded that “on the basis of the available data, the existence of long waves of cyclical character is very probable”. In relation with their origin he adds, “In asserting the existence of long waves, and in denying they arise out of random causes, we are also of the opinion that the long waves arise out of causes which are inherent in the essence of the capitalist economy”. Kondratiev, although pointing out the association of technological innovations with the long cycles, did not establish a causal relationship between them. It was Schumpeter who, in 1939, proposed a theory for the cyclical behavior of the capitalistic economy<sup>2</sup>. In his view the cause of the cyclical behavior is technological innovation, which is promoted by entrepreneurs. The Kondratiev long cycles are the product of a series of articulated innovations, each of them constituting an “industrial revolution”. A long cycle, in this view, would be a succession of technological transformations that affects the economic system.

The first Kondratiev long cycle was based on the steam engine and the textile industry; the second on the railroad and the metal-mechanical and steel industries; and the third, on the internal combustion and electrical engines, and on chemical industry. In each of these cycles, the whole profile of the productive system was transformed from energy and transportation to final consumption goods. The Kondratiev-Schumpeter theory is still under discussion, and many gaps must be filled before a complete picture of the dynamics of the cyclical behavior of the economy can be built. We accept, nevertheless, this theory as the frame of reference of our analysis, first because it constitutes a conceptual construction internally consistent, it does not contradict the facts, and it has more explanatory power than any other proposed theory or hypothesis. Second, but more important, because we are at present confronted by a recession of the world economy that has all the characteristics of the downswing of a long cycle, associated with the emergence of a wave of technological innovations which is deeply affecting the structure of the whole economic system. So, whatever the difficulties we can

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<sup>1</sup> N.D. Kondratiev, “The Long Waves in Economic Life”, *Review of Economic Statistics*, Vol. 18 (1935), p. 105-115.

<sup>2</sup> J.S. Schumpeter, *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalistic Process*, (New York: Mc Graw Hill, 1939).

have in applying the theory to past long wave, there is little doubt that it is the best instrument we have with which to understand the present one.

## 2. THE CHARACTER OF THE NEW TECHNOLOGICAL WAVE

### The Specificity of the Present Cycle

The fact that the Kondratiev-Schumpeter theory refers to cycles, i.e. to a recurrent phenomenon, stimulates a dangerous tendency to predict the evolution of the present crisis on the basis of past experience, particularly the crisis that culminated in the thirties. This approach does not take sufficiently into account the fact that although the economic, or techno-economic, mechanisms which originate the oscillations seem to be fairly similar in all cycles, the global socioeconomic and political context in which they operate changes with time, due largely – but not solely – to the transformations induced by each cycle. Thus the process of change that each crisis represents has an specificity which cannot be understood simply in terms of incremental changes in a constant set of more or less quantifiable variables. There are elements of discontinuity that, although difficult to quantify, could play an essential role in the evolution of the crisis.

In our view the main elements that differentiates the present cycle from the previous one, are the following:

**The emergency of the Third World:** In the thirties the world broadly divided into the countries we call now developed – basically Europe, USA, Canada and Japan – and a vast conglomerate of countries, most of them colonies, with little participation in the world structure of power, and whose role was to export raw materials, and to import manufactures from the industrial powers.

The Third World – a result of the post-war organization – is now an active protagonist in the international scenarios that cannot be disregarded by the big powers. Some of the most important political events of this century due to their short or long term repercussions – such as the Chinese and Cuban revolutions, and the Vietnam war – have had as protagonists countries of the Third World. Central America and the Middle East are only two examples of regions of the Third World whose problems affects directly or indirectly the world power structure. One of the main concerns of the advanced countries is the always present danger of the appearance of other centers of “unstability” in the periphery.

From the point of view of the world economy, the Third World is also a presence that cannot be ignored in the way it was practically ignored in the thirties. As it is well

known, the enormous external debt of the developing countries is one of the determining factors of the future evolution of the international financial system. Besides, the industrialized countries still depend, to a considerable extent, of raw materials produced in the Third World, and some developing countries are starting to compete with the advanced countries in the field of exportation of manufactures.

Due to several factors – mainly the imitative style of development adopted, and the rapid growth of the population – the Third World countries have now stronger and more diversified economic links with the industrialized powers than in the past, in such vital areas as capital, technology and food. This mutual dependence means that the crisis cannot be manipulated by the developed countries with complete disregard for the consequences for the rest of the world. One of those consequences could be the emergence of serious social perturbation in critical regions of the Third World, and past experience shows that those perturbations can propagate with dangerous effect for the present precarious world order.

**The emergence of the socialist countries:** In the interwar period, the only socialist country in the world was the Soviet Union, relatively isolated, and with little direct influence on the power and economic structure. Now the post war expansion of the Socialist block in Europe, the incorporation of China – besides smaller countries such as Cuba, Ethiopia and Vietnam – has converted the socialist world into a critical element in the future evolution of the international system.

In most prospective studies made in the developed countries however, the socialist world appears almost as a constant in the sense that no possible quantitative or qualitative import changes in its relation with the rest of the world are envisaged, with the exception of a possible military confrontation. It is implicitly assumed that the evolution of the crisis can be forecasted considering almost solely its direct effects on the capitalist world.

We believe that in the medium and long term perspectives, the assumption that the socialist world can be considered essentially as a constant is misleading. The recent events in Poland, and previous ones in the same country and in Czechoslovakia, Hungary and the German Democratic Republic are clear manifestations of a process of internal evolution which is no less important because it is only sporadically visible. Besides, the growing trade relations not only with Western Europe, but also with other regions or countries, indicates that the presence of the socialist world increasingly transcends the purely political and military spheres.

**Social conscientization:** This is an element difficult to be precisely defined. It refers essentially to the type of reaction of the general population – particularly in the developed countries – to possible consequences of the crisis.

One of the most important characteristics of the crisis of the thirties was the fact that it did not induced serious social upheavals in the capitalist centers. Despite the hardship and suffering produced by the unemployment during the recession, and after by the world war, the capitalist advanced countries emerged from the crisis practically untouched.

This does not mean obviously that capitalism was not questioned. What is important, however, is that the criticism was made almost exclusively in terms of its replacement for an alternative system, the socialist. As a consequence, besides the minority which questioned ideologically the system, most of the rest of population accepted the effects of the crisis as a kind of “natural” calamity, a conjunctural phenomenon inherent to the society in which we live.

The situation is now radically different. The emergence of the “welfare state” introduced a factor which was absent in the prewar capitalism: the notion that the Access to the elements which are essential for personal well being – such as employment, health care and education – cannot depend solely on the free play of blind economic forces, but is a right that should be protected by the state.

It is difficult to imagine that the industrialized countries could impose now on their population the hardship and deprivation of the thirties, without provoking social perturbations which could endanger the very basis of the capitalist society. The fact that ultraconservative governments – as the present ones in the USA and the UK – maintain the central components of the welfare state – above all the protection to the unemployed – shows that they are conscious of the danger.

**Questioning of the basic values of present society:** This is one of the most important differences between the present crisis and the previous one. It is expressed through a variety of forms, from the “countercultures” up to the insistence on the principle that development should be centered on the human being rather than on economic growth. Despite the diversity of forms its central element is the questioning of a basic paradigm of our society since the Industrial Revolution: the concept, explicit or implicit, that “progress” is almost synonymous of production of material goods.

These alternative conceptions of development are important enough in the advances countries, to justify their inclusion in one of the scenarios of a prospective study

of the OECD. In the countries of the Third World that questioning reinforces or complements a line of thinking which appeared much earlier – basically with Gandhi in the first decades of the century – based on the conviction that the Western model of development or progress is to a great extent culturally determined, and only one among other equally valid alternatives.

The common element of most of those alternative visions of development is the conception that the problem of the developing countries is not to close the “gap” which separates them from the developed countries, but rather to build a different society, which could promote the harmonic development of the human possibilities, without the type and amount of material inputs of the traditional development.

A determinant component of the strategy to implement those models of development is what is called “self-reliance”, which means that development should be based, as much as possible, on the resources, aspirations and cultural characteristics of each society.

**The destructive nuclear system:** All elements of the crisis mentioned above imply the possibility of conflicts. The form and extension of those conflicts is conditioned by the fact that we have now a nuclear destructive capacity ready to be fired equivalent to about a million Hiroshimas.

The crisis of the thirties did not end due to the application of Keynesian Economic measures; it ended as a consequence of the Second War. A global war can also put an end to the present crisis, but in this case it would be through the disappearance of its protagonists.

**The physical outer limits:** During the previous crisis, the variables which were considered relevant from the point of view of development – although this word only appeared in the post war period – were almost exclusively the economic ones *strictu sensu*. The social, political and technological – variables were given some consideration – above all after the war – but the conscientization that the natural resources and environment constitute absolute limits to economic growth only appeared in the sixties. We know now that material consumption cannot grow indefinitely without taking into consideration its effects on the equilibrium of the biosphere, our natural habitat.

The results of that conscientization are beginning to be translated into concrete action. The increasing resistance of a significant part of the population, principally of the industrialized countries, to projects which could seriously affect the environment, show that what we can call the cosmic conscience – the awareness that we live in a rich but

finite planet – is reaching the general public. The reaction at the governmental level is slower, but concrete measures are beginning to be taken – or at least discussed – at the national as well as at the international forums.

There is no doubt that in the next decades those outer limits will play an increasingly important role in the social and economic planning.

### **The New Wave of Technological Innovations**

The character of the new wave of innovations will be a central determinant of the type of society which will emerge from the crisis.

In a recent paper Carlota Perez<sup>3</sup> has made an important contribution to our understanding of how the waves of technological innovations interact with society. She starts pointing out that, in Schumpeter's theory, the whole process of "creative destruction" generated by one, or by a group of innovations, develops within the economic system conceived as a self-regulated entity relatively independent of the social milieu. Society is affected by, and affects the economic process, but it is mainly an environment.

In Perez approach, society is seen as composed basically of two subsystems: the techno-economic, and the socio-institutional, the first having a much faster rate of change than the second. The structural crisis produced by a cluster of technological innovation is not only a process of "creative destruction" in the economic sphere, but involves also deep transformation in the socio-institutional system. As the rate of response of the two systems is different, the long cycles are the result of the resistance offered by the socio-institutional system to the transformations taking place in techno-economic system. For Perez, the long waves represent different "modes of development", which are the response to the appearance of successive distinct "technological styles". The modes of development stretch from trough to trough in each cycle, but the technological styles evolve from the peak of one cycle to the peak of the next. This is due to the fact that a new technological style begins when the previous one approaches the limit of its possibilities. A most important point in Perez's theory is that the final form that a mode of development will take does not depend solely – or almost solely – on the characteristics of the new technological style: "The final form the structure will take, from the wide range of possible, and the time span within which the transformation is effected to permit

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<sup>3</sup> C. Perez, "Structural Change and Assimilation of New Technologies in the Economic and Social Systems", *Futures*, (October, 1983), p. 357-375.

a new expansionary phase will, however, ultimately depend on the interest, actions, lucidity and relative strength of the social forces at play”.

The new innovations belong to several technological fields – microelectronics, biotechnology, materials, energy – but what gives them the character of a “wave” associated to a long economic cycle is the fact that they tend mutually articulated into a “cluster” which defines a new global technological paradigm.

The central element of the cluster, the one which determines the character of the new technological paradigm, is microelectronics. C. Perez has summarized the role of microelectronics as follows: “Today, with cheap microelectronics widely available (together with the consequent low cost of information handling), a new techno-economic paradigm is coming together and diffusing. It is no longer ‘common sense’ to continue along the – now expensive! – path of energy and materials intensity. The ‘ideal’ productive organization, which has been evolving since the early seventies, brings together management and production into one single integrated system (a process we might call ‘systematization’), for turning out a flexible output of preferably information-intensive, rapidly changing, products and services. Growth would presumably be led by the electronics and information sectors, requiring massive externalities from all encompassing telecommunications infrastructure, which would bring down to negligible levels the cost of access for producers and consumers alike, the skill profile tends to change from mainly middle range to increasingly high and low range qualifications, and from narrow specialization to broader and multipurpose basic skills for information handling. Diversity and flexibility at all levels substitute homogeneity and massification as ‘common sense’ best practice”<sup>4</sup>.

The dominant characteristic of the new wave is that its impact seems to be more important to the organization of production, the labor process, and the social division of labor, than the general profile of the productive system. The Industrial Revolution, with the first great modern wave of technological innovations and the emergence of the proletariat, consolidated the capitalistic economy, and changed Western society. The subsequent technological waves changed the whole profile of the productive system, but did not alter significantly the structure of capitalist society; this new wave, in our view, will affect the very basis of the industrial society as can be seen by considering briefly the process of automation and robotization.

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<sup>4</sup> Perez, C., Microelectronics, Long Waves and World Structural Change: New Perspectives for the Developing Countries, **World Development**, forthcoming issue.



It is clear that in the advanced countries the basic cause of unemployment is the fact that every day we need less labor to produce the same amount of goods and services. This historical tendency that started to intensify almost from the beginning of the post-war period, but whose effects were to a great extent concealed by a high rate of economic growth, will be enormously accelerated by the progress of microelectronics. Its main impact will be in the social division of labor. The suppression of most forms of physical or routine work will gradually eliminate the proletariat in the Marxist sense, because the role of wages will fundamentally change.

In modern societies access to goods and services is conditioned essentially by wages in the widest sense: the remuneration of labourers works in any of its forms. In the future this central role of wages will decrease firstly, because one of the consequences of automation, by imitating most jobs which do not require “non programmable” skills or creativity, will obliterate most significant forms of hierarchy in the labor process; secondly, because direct participation in the productive system will become a diminishing fraction of total human activity, and so its importance as determinant of distribution, will be greatly reduced.

The transition to the new “mode of production” will undoubtedly take a long time to be completed – of the order of two or three generations – but its first effects are already with us. Practically all forecasts of levels of unemployment for the advanced countries predict a continuous worsening of the present situation. A recent study by the FAST<sup>5</sup> programme (Forecasting an Assessment in Science and Technology of the Commission of the EEC) suggest that the 12 million unemployed today will be about 20 million at the this decade.

According to A. Lipietz<sup>6</sup> the production of goods and services can, under the impact of microelectronics, evolve in two directions: one would be the reconstruction, or the performance, of the discipline of the old mass production organization with the workers “filling the holes” in a claim of robots. The other direction would be the development of qualified polyvalent teams able to organize and monitor the whole process of production.

The second option is the best one for the workers and society in general, but it contradicts the entrepreneur’s traditions, the labor, social relations, and the present organization of production.

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<sup>5</sup> International Symposium on Perspectives on Science and Technology Policy, Guanajuato, Mexico, February, 1984.

<sup>6</sup> Lipietz, A., Accumulation, crises et sortie de crises: quelques reflexions methodologiques autour de la notion de “Regulation”, Communication à Nordic Summer University, Helsingor, 2-4 March 1984, Long Waves Crisis and Technological, Social and Political Development.

The growing recognition that the character of present unemployment confronts the advanced countries with a problem that cannot be solved without a complete questioning of the relationship between technology, employment and work, is leading to proposals that, although still very general, point in the right direction.

In a recent paper, Prof. W. Zegweld<sup>7</sup> summarizes the basic philosophy of the new approach:

The problem is to organize the breaking down of barriers between traditional wage-earning employment and work in the widest sense of the term. Such work can provide income but also offers a social role, contact with others, and opportunity for creation or enterprise. It must not be proposed in a single, rigid setting identical for all but must be flexible enough to meet the wide variety of demands and respond to freely expressed choices. Instead of offering everyone a problematical full-time job, the aim is to allow everyone to find and choose a job in which working hours, level of pay and social security coverage are no longer pre-determined and closely linked but can be adapted, above an indispensable minimum, to wishes of the individual ...

In Gorz's opinion the characteristics of the social necessary work do not allow for any creativity or personal development of the worker. The only solution is the reduction of the working time through the distribution of the social necessary work on the whole population.

"The depersonalization, standardization and the division of labor is what allows the working time and makes it desirable. In other words, the heteronomy of work, consequence of its socialization and of its multiplied productivity, makes possible and desirable the liberation of time, the expansion of the autonomous activities."<sup>8</sup> In this view "the choice is between the liberatory and socially controlled abolition of work or its oppressive and antisocial abolition."

That is the challenge confronted now by society, particularly in the developed countries, and it is still too early to know with certainty how the process of change will evolve. We believe that the first option will finally, prevail, mainly because the oppressive imposition of new forms of work would be extremely difficult in a society where social control is largely based on the discipline imposed by the traditional relationship between work and employment, precisely the relationship that the new technologies can radically change. Second because it allows to satisfy one of the oldest aspirations of our species: to liberate human beings from routine work which does not require any creative capacity.

<sup>7</sup> Zegweld, W., "Technology Employment and Work". Paper presented to the International Symposium on Perspectives of Science and Technology Policy (Guanajuato, Mexico, February, 1984)

<sup>8</sup> Gorz, A., *Adieux au Proletariat, Au-delà du Socialisme*, Editions Galilée, Paris, 1980.

### 3. THE NEW TECHNOLOGIES AND THE THIRD WORLD

In our analysis of the impact of the new wave of technological innovations on the Third World we will consider mainly the Latin American case. The reason for this selection is that the diversity of the Third World makes any global treatment too general and that the new technologies are entering faster and more massively into Latin America than into any other Third World region. What we can learn in this exercise can provide a frame of reference – or at least a general guideline – to study the process in other regions.

#### The Experience of the Past

In the Third World the new innovations, due to their low cost, small-scale applications and possibilities of decentralization, have aroused at least among governments and international agencies, the hope for a new and more egalitarian development. There is no doubt that the new technologies have the potential of greatly improving the situation of the Third World; it is not so clear, however, which are the conditions and prerequisites for that promise to come true. A brief look at the past will clarify the point. The present wave of technological innovation is but the culmination of the process of technological change that began with the Industrial Revolution. Those innovations started to enter the Third World at the very beginning of the expansion of capitalism, but the so-called process of “modernization” acquired its real momentum only after the Second World War and the ensuing wave of decolonization.

The technologies introduced in the Third World during that process, if sensibly used, held also the promise of more and better distributed wealth. This can be clearly seen in the industrialized countries; despite the fact that the basic characteristics of the capitalist system have not changed, it is undoubtedly true that the benefits of increased productivity have reached the great majority of the population of those societies. The same can be said of most of the socialist countries. The result is that for the first time in history a sizable part of humanity has its basic needs satisfied at an adequate level.

As we all know, the impact of the new technologies in the Third World was very different. Benefits have only reached privileged minorities, and the majority of the population lives in conditions which are not much better, and sometimes worse, than before the beginning of the process of modernization.

The causes leading to the frustration of hopes in the Third World countries are many and complex, but we may select for brief consideration only those most directly associated with the application of science and technology for development.

During the post-war period Latin America created the institutional elements and the intellectual capacity necessary to implement science and technology policies adequate to its own development needs. Nevertheless, and despite some encouraging developments, the appraisal of those decades is far from positive. It is true that in some sectors of economy, particularly in industry, there was some improvement in technological capacity, but the general picture is one of frustrated expectations.

Scarcity of human resources, deficiencies in the state planning organizations and in the planning methodology have been considered to be the main causes of the lack of success. But this is not a very convincing explanation in view of the historical evidence of other countries. The USSR, starting almost from zero with little planning methodologies and hand, became a scientific and technological and economic power only comparable to the USA. It is sufficient explanation that the USSR has a socialist economy: France confronted with the challenge of European economic integration, managed to correct its post-war technological inferiority and to harmonize its scientific and technological development with national needs. And Japan had almost no research and development planning available when it first emerged as a competitor on the world markets.

As the scarcity of human resources – one of the factors always cited in relation to the supposed inefficiency of the region's R and D systems – the historical evidence of continuous emigration of scientists and technologists seems to show that they, far from being scarce, are excessive in relation to demand. This "brain drain" has, in the last years, been caused more by internal expulsion – for political reasons, or for lack of governmental support R and D – than by demand from advanced countries.

The reasons for the failure should be sought in the style of development adopted by most Latin American countries.

The basic paradigm for economic and social development was originated in the developed countries, and particularly in Western Europe, in the post-war period. The Marshall Plan for the reconstruction of Western Europe which provide capital, and the acceleration of technological progress, brought to these countries prosperity without precedent in history. The process was of course more complex, but their two elements – influx of capital and technological progress – were converted by the ruling classes of the developing countries into the two pillars on which economic and social development could be built. This approach offered two important advantages: first its simplicity, which showed the mechanical translation of that strategy from the countries, where it was conceived to the periphery; second, and perhaps more significant, the fact that it

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seemed to ensure progress without substantial modifications of prevailing social and economic structures.

As to the scientific and technological components, the same imitative criteria were applied. The structure and the general principles of the R and D system of the advanced countries were imitated. It was assumed that a “modern” scientific system – in the sense of subjects of research, quality of personnel, type of equipment, etc. – was going to be naturally linked with the productive system through the classical chain of basic research, applied research and experimental development.

As we know now, the above plan did not work as foreseen. The wave of innovations failed to generate a better distribution of wealth in Latin America – despite the fact that the aggregate GNP increased in most countries of the region at a greater rate than the population. The imitative style of development adopted stimulated a pattern of consumption based on the model of the upper and middle classes of the industrialized countries, and consequently only accessible to a minority of the Latin American population. Besides, the pattern of production so generated strongly increased the economic and technological dependence on the industrialized powers – one of the indicators being the external balance of payment deficit.

We are now in a new starting point which leaves little room for the kind of superficial optimism that has prevailed in the past. The development strategies adopted in the last decades – based essentially on the influx of external capital and technology – will become much less viable in the future. Due to their great external debt, most Latin American countries are not in a condition to absorb more external capital. Besides, the crisis that affects the industrialized countries will restrict the flow of the capital to the Third World.

As for direct and indirect aid from the industrialized countries, the prospects are still worse, as proven in the Cancun, Ottawa and London meetings. In those events there was little agreement among the participants, but one thing remained clear: the advanced countries will take all the measures they consider adequate to solve their own problems, without much consideration of their effects on the developing countries.

The above view is shown clearly in all the prospective studies and global models elaborated in the past years, predominantly in the developed countries; as in Interfutures (OECD); Presidential Report on the Year 2000 (USA); Brandt Report, and in UNITAR models of the North-South relationship. All those present more or less the same picture for the developing countries at the end of the century: the gap that separates them from the developed countries will be the same or greater than now in relative terms or, in the

best hypothesis, will diminish only marginally in some of the relatively more advanced developing countries. In absolute terms – the provision of basic needs – the situation in a great part of the Third World will probably worsen.

Are those prospective studies reliable? We believe they are. If we accept their implicit premise – that the objective of Third World countries should be to close the gap in quantitative terms, which basically means to accept the prevailing criteria of socio-economic development – the situation seems indeed hopeless.

This becomes clearer if we consider the quality of the gap, not only its numerical values: at the end of the Second World War, the development objectives of both central and peripheral countries were, to a certain extent, similar. In developed countries, particularly in Western Europe, poverty was still a problem, and part of the population had not reached an adequate level of satisfaction of its basic needs. Servicing these needs was therefore a common objective of developed and developing countries alike, although their starting points were different.

Today that situation has changed radically, for Third World countries the satisfaction of the basic needs of a great part of their population – in other words, the attainment of the benefits of industrial society – must be their fundamental objective. The central countries, on the other hand, are entering what A. Touraine calls the “post-industrial society” and A. Toffler the “third wave”, a stage of development whose problematique is very different from the one the developing countries still confront.

As is well known, moreover, historical changes do not follow regular chronological sequences; there is always overlapping among them. This implies that the developing countries, although they have not completed the previous stage, will nevertheless suffer the impact of the new one. In other words, they will have to confront a problematique far more complex than the one facing advanced countries.

There are few indications that the governments or the ruling classes of developing countries have any clear ideas about how to confront the new situation. In Latin America at least, the common reaction to the recession has been the traditional one: to restrict economic activity, to impose more sacrifices on the mass of the population, and to wait passively for the end of the crisis, as if it were a natural phenomenon that we have no means to control. There is no indication that the basic premises of the style of development are being questioned. It is manifest therefore, that from the point of view of socio-economic conditions, developing countries are not in a better position to absorb the present wave of innovations than they were when they received the impact of the previous one.

As for the scientific and technological systems there is no doubt than in most countries the R and D systems have considerably improved in the last decades. However, in most cases the old problem of the relative irrelevance of those systems in solving the specific problems of their own societies still remains. The cause of those problems is well known: in a imitative style of development which imports the patterns of consumption and the life styles of the central countries, it is almost impossible for the local R and D systems to compete with the advanced powers in generating different or better technologies to produce the same goods services. Despite their capacity, practically all of those systems are still far from the goal of being able to participate on equal footing with the R and D systems of the central countries in the more advanced fields of scientific and technological research.

In conclusion Third World countries do not seem to be in a better position than they were in the past to absorb the new wave of innovations and to generate through them more and better-distributed wealth. On the contrary, the economic crisis, the tendency to concentrate capital and technology associated with the new innovations, and the social impact of the process of automation, telematics and robotization, make the incorporation of the new technological wave even more difficult than the previous one.

### **The Causes of the Failure**

The first requirement to plan an adequate socioeconomic strategy to absorb the new wave of innovations is to have a reasonable clear idea of the causes of the failure in the previous long cycle.

We have already referred briefly to the general causes of that failure: an imitative style of development originated basically on the mode of insertion of the Third World countries into the international economic structure. This subject has been amply studied in Latin America, particularly in the context of the dependency theory, and we do not need to discuss in detail here. We want to focus on the direct agent or mechanism responsible for the failure to benefit from the previous cycle.

In our view, the immediate cause of the poor performance of Latin American countries economies in the third Kondratiev long wave was their failure to adapt the socio-institutional subsystem to the changes of the techno-economic subsystem induced by the wave of innovation. This is suggested by the key socio-institutional transformations associated with the last long wave: the redistribution of income, the strengthening of

labor unions and their institutional acceptance, and the internationalization of the economy<sup>9</sup>.

The redistribution of income in the developed countries as a consequence of the mass production technological style had two main effects: to enlarge enormously internal markets, and to change the pattern of product demand. The market that previously was divided between luxury and staple goods evolved to meet the demand of the middle income sector which, including the middle class and a considerable proportion of the workers, comprised the majority of the population. In Latin America there was no significant redistribution of income, in most countries on the contrary, there was a continuous concentration of income in the upper classes. The most important consequence from the point of view of the productive structure was that the demand for non-staple goods came only from those minorities with an income equivalent to the upper and middle classes of the advanced countries. The result was that the pattern was that the pattern of production was not determined by the demand of the majority of the population as was the case in the advanced countries, but by the demand of that privileged minority. Thus, the imitative style of industrialization, with the concomitant massive and apparently indiscriminate transference of technology, was not a consequence of technological backwardness – even with the same basic technological elements, the composition of the final goods “package” could have been different – but rather a response to the pattern of product demand.

Secondly, at the beginning of the period, we saw the industrialization of Latin American countries occurring with a small and poorly organized labor force. Structural unemployment, aggravated in many countries of the region by the existence of a large, poor peasantry which migrated to the cities, put most of the industrial working force on the defensive. On the other hand, the chronic instability of the governments of the region made them suspicious of the any potentially contestatory movement, and they used every possible means to repress or control trade union activities. Thus, despite a long history of struggles the trade unions of Latin America – with the exception of Argentina, and Chile,, during the Allende Government – never had the social and political power of their counterparts in the advanced countries.

Finally, the internationalization of the economy with the rapid expansion of the multinational enterprises, and with the intercountry trade and investment regulated by international agreements, generated a new situation in world economic relations. The insertion of a country in the world system did not depend any more solely, or almost

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<sup>9</sup> Perez, C., *Futures*, (October 1983), p. 368-371.



solely, on the market forces - controlled fundamentally by private enterprises - but also on the bargaining capacity of the nation states. Most of the Latin American states were, and are, intrinsically weak. Besides, the ruling classes whose vested interests were articulated with foreign interests have lacked the political will to fight for a more equitable world order, the only element that could have counterbalanced, at least partially, the superior political and economic power of the advanced countries. The natural result of that unequal struggle has been dependency or "neocolonialist".

#### **4. THE INCORPORATION OF THE NEW TECHNOLOGIES: ELEMENTS FOR AN STRATEGY**

##### **The Socio-economical Change**

The absorption of the new Technologies in such a way that it could benefit the whole population depends crucially on the capacity to generate the changes required to adapt the socio-institutional system, to the techno-economic structure emerging as a result of the gradual consolidation of the new technological paradigm.

It would be impossible to make a detailed description of those changes, but we can at least identify those without which the successful incorporation of the new technologies will not be possible.

The first one is related to food production, whose main determinant is population. The average rate of demographic growth in Latin America is about two percent which implies that the region should more than double food production in the next thirty years, taking into account that considerable part of the population is now underfed. Such expansion of production - based mainly on increase of productivity, rather than on the incorporation of new land - should be guided by two main objectives: to provide for the whole population, and to increase the income of the rural worker, whose cheap labor have been heretofore basic to the growth of the modern sector. The second objective is to contribute to the generation of the economic surplus required for the expansion of the industrial and service sectors.

The transformation of the rural areas means a radical modification of the land tenure system, and the careful selection of the technologies and methods of production to be introduced. Although the combination of technologies and the organization of production should try to minimize migration to the cities - basically through a sustained improvement in the wellbeing of peasants - the net result will be a decrease of the

manpower required for rural activities, with the ensuing increase of the labor force potentially available for the other sectors of the economy.

The second element, and the key to any desirable scenario, is that the benefits of the process induced by the wave of innovations should reach the whole population. It can be estimated that more than forty percent of the Latin American population is outside, or almost outside, than non-staple goods market, and a considerable part of it even below an adequate level or provision of staple goods. The effective incorporation of the whole population into the market of goods and services, through a redistribution of income, represents a formidable social, economic and technological challenge. But, besides its intrinsic desirability, it is also the central component of a strategy that could allow the region to confront successfully the impact of new innovations.

The main effect of redistributing income would be a change of the pattern of product demand, including services. The *average* income, which conditions the market, would be less than in the advanced countries, and consequently the pattern of consumption of non-staple goods should be different. It would be a process similar to the one that earlier changed the pattern of goods demand in the advanced countries.

The second result of the process, by expanding the productive system, would be increased employment by counterbalance – at least in a transitional period – the effect of automatization and robotization. As in the case of agriculture, the selection and introduction of new technologies should be carefully controlled through a strategy adapted to the specific conditions of the region.

These socio-economic changes are very few, but should be present in any desirable society. Most important, they would allow the region to constructively confront the new wave of innovations. The employment impact of automation – socially most difficult to absorb – would be delayed by the incorporation of a greater mass of population to the market. This would give Third World countries an important advantage over advanced countries. The fact that the former will have to change their patterns of consumption, would give them the opportunity to adapt material consumption to a new concept of well-being, more in accordance with the resources and values of post-industrial society, where free time devoted to creative activities, and the preservations of an equilibrium with the physical environment, will be principal characteristics. When the full impact of automation finally reaches Third World countries, that new conception of development, and the experience of the developed countries, could help them to absorb change with a minimum of social hardship.

## Traditional Technologies and the New Innovations

The transition to the new society confronts the Third World with a problem which is very different from the one faced by the central countries. In most developed countries, and particularly in the rural areas, tradition technologies – hardware as well as software – are still responsible for a considerable part of production, including services. It will take a long time and difficult socio-institutional, economic and cultural changes to replace them by the technologies associated to the new technological paradigm. How that process could be implemented with a minimum of social and cultural disruption in the societies involved?

It is obvious that the traditional and the emerging technologies will have to coexist during the transitional period and that the character of the process will greatly depend on how both types of technologies are blended or – using a widely accepted terminology – on how the traditional technologies are upgraded.

To delineate a frame of reference for a policy on the generation of upgraded technologies, we should first examine the role that those technologies should play. In a UNCSTD paper it is stated that “traditional technologies ... are not just one type of existing technology. To the degree that they are economically viable, they also stand for cultural pride, socio-economic functioning and political stability. They still constitute the backbone of the economies in most developing countries”.

The above is basically true, but requires some qualifications. Traditional technologies are used mostly in rural areas and, at least in Latin America, there are few places where it can be said they constitute the backbone of the economies. In most of those countries – a typical example is Mexico, with a great rural population – modern technology, in the form of agriculture based on the organization and technology of the typical capitalist enterprises, now accounts for the bigger part of agricultural production.

The situation, of course, varies widely in different countries, but is generally true that in the places where traditional technologies still predominate, the economic and political stability is attained at relatively low levels of standard of living. The migration of the cities is only one of the consequences of that situation.

As for the cultural values, all societies are dynamic, they change in time, including the technologies they use, and this does not imply the loss of their cultural identity. Europe changed totally its technological basis during the Industrial Revolution preserving, nevertheless, the central features of its culture. It might be said that it was due to the fact that Europe developed those new technologies endogenously, starting

from its own traditional technologies and its own creative capacity. However, Japan also transformed during the 19<sup>th</sup> century its productive system through the introduction of the technologies generated in Europe, and it cannot be said that Japan lost its cultural identity during the process.

In fact what seems important is not so much whether the technologies are endogenous or imported – transference of technology has been present all through history – but rather the way they are introduced. Japan imported the foreign technologies in its own terms, and all the decisions on the way and forms to absorb them, including the necessary modification of the Japanese society, were taken internally. As a result, and it could be said paradoxically, the transformation in Japan seems to have involved less hardship for the population than the same process in Europe, despite the fact that in this last case the technologies were endogenously generated.

The above does not mean that the traditional technologies are not important, and should be replaced indiscriminately by “modern” technologies. *What we want to stress is that the upgrading of them is only a part of a wider strategy of transition to a new society, the society that will emerge not only through the present wave of new technologies, but also through the process of political, social and economic change which is under way all over the world.*

On the basis of those premises we can now see what characteristics the upgrading of traditional technologies should have. In our view, the main ones are the following:

The first, and obvious one, is to increase the productivity of the traditional technologies, to improve the working conditions of the labor force involved, and to ensure that most of the economic benefit of those changes will remain inside the community.

The second one is that the technologies to be upgraded – hardware as well as software – should be selected carefully, not only from the point of view of their economic or ecological merits, but also considering their capacity to preserve *positive* local cultural or social traits.

The third characteristic is that they should be compatible with the global strategy of social and economic change. A technology may bring some immediate benefits by its upgrading, but it can also introduce or maintain rigidities that might pose obstacles to the process of transformation.

The combination of those criteria will allow the selection and upgrading of a coherent set of traditional technologies which will facilitate the transition to the new conditions with the least possible hardship for the population, above all the poorer one. Most processes of social change are traumatic, basically because new ways of production are introduced before the social organization has had time to adapt to the new conditions. In a certain way, it can be said that new technologies “explode” inside society, forcing it to adapt to them, whatever the social disruption and human suffering involved. The upgrading of traditional technologies, if accompanied by a careful strategy of selection and timing in the introduction of the new technologies, can minimize the hardships of the process.

The fourth characteristic, and perhaps the most important one, does not refer to the technologies, but to the process of generating them.

The local population – if possible through their own organizations, formal or informal – should participate in the whole process, from the identification of problems up to the management and control of the resulting technologies. The recognition of the importance of people’s participation is based not only on an ideological position – the admission that people have the right to participate in their own development – but also on pragmatic and operational considerations.

It has been shown time and time again that many development plans in every field have failed because the opinion of the people involved was not taken into account. This is not because peasants are specially “conservative”, but mainly because people generally tend to reject changes in their ways of living and doing things unless they have participated in some way in their generation. In the advanced countries there is a degree of direct or indirect participation that normally ensures the acceptability of new technologies. However, historical experience shows that those mechanisms sometimes fail, and new technologies are rejected when they reach the market for reasons that are not more “rational” – perhaps less so – than the ones that induce the rural poor to reject innovations introduced from outside.

This is particularly important in the rural areas of Third World countries, where the direct or indirect mechanisms of participation existing in the urban areas or in the advanced countries are almost completely lacking. Moreover, and this also a difference with the urban areas or the advanced countries, the scientists and technicians of the R and D systems belong to a different economic and cultural milieu, so they lack an adequate frame of reference as to which type of technology is best suited to the needs and conditions of the rural people.

The need for the participation of the peasants becomes more evident considering that the local population is the depository of the traditional empirical knowledge – including, besides the environment and concrete technological solutions, the socio-economic and cultural characteristics of the community – which can only be transmitted through an active interchange between scientists and the local people.

### **The Scientific and Technological Challenge**

The socially adequate incorporation of the new technologies represents a formidable scientific and technological challenge of the Third World.

Although in most developing countries the R and D system have considerable improved in the last decades. The old problem of the relative irrelevance of those systems to solve the specific problems of their societies still remains. The cause of those problems is well known: in an imitative style of development which imports the patterns of consumption and the life styles of the central countries, it is almost impossible for the local R and D systems to compete with advanced powers in generating different or better technologies to produce the same goods and services. Besides, and despite their improved capacity, practically all of those systems are still far from the goal of being able to participate on equal footing with the R and D systems of the central countries, in the most advanced fields of scientific and technological research.

The above is aggravated by the fact the most important new technologies are highly science-intensive. Taking again the case of microelectronics it is a well know fact that it is a field in which very few countries – mainly USA and Japan – can compete at world level, and inside them, fewer and fewer enterprises can remain in the market. Besides, the traditional vertical integration of the electronic industry is rapidly increasing under the impact of microelectronics: the output of the great enterprises comprises all the spectrum of production including a rapidly diversifying set of final goods.

In most developing countries the main participation in the electronic industry is in assemblage and this due to the relative advantage of cheap and abundant labor. The result of this division of labor between developed and developing countries, is that there is no or only a negligible transference of technology. Besides, and due to the rapid advance of automation, the central countries will most probably start to transfer the assemblage factories to their territories. In biotechnology – one of the most promising innovations for the Third World countries – the concentration and control by the advanced countries seems to be less than in the electronic industry, but it also requires a high R and D capacity. Besides, it depends very much on local conditions and bio-

resources and, consequently most of the solutions should be endogenous or adapted to the local milieu.

As important point is that the R and D systems of the Third World will have to be able to work on the new technological areas from the level of basic research, because is a well known fact that the technical options diminish rapidly down the chain of basic-applied-development research. If we try to enter mostly in the last stages – as it happened in the past – the result will be, as before, that we will use the technologies entirely developed in the advanced countries, and adequate to their own conditions and possibilities.

The other obvious option is to let the multinationals to devise our own “appropriate” technologies, an option which is being already offered by some of them. We have enough experience about the consequences of the type of dependency generated by such a policy. There is no doubt that the Third World countries will have to import foreign technologies – no country in the world is entirely self-sufficient in this field – but is has to be an integral part of an strategy whose final objective should be to reach an adequate level of autonomy in technological decisions.

The weakness of the R and D systems of the Third World countries is considered one of the main obstacles they will have to confront. In our view however, the relative backwardness of the scientific and technological capacity of the region is not a cause, but rather a *result* of socio-economic development.

Our position, developed in detail elsewhere<sup>10</sup> is that all countries have a science policy – explicit or implicit – which is determined by the character of its national project – i.e., the set of objectives (or model of the country) *to which the social classes which have direct or indirect economic and political control aspire*. History shows that when a national project demands an autonomous policy, scientific and technological backwardness is never an insurmountable obstacle, as it is strongly suggest by the experiences of Japan, China and the Soviet Union.

On the other hand, new innovations offer the developing countries the opportunity to enter those technological fields in their early stages of development. As it takes some time to transform those innovations into transferable technological packages, this would allow, at least to the most advanced Third World countries, the development of the technological versions more adapted to their own conditions and needs. This

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<sup>10</sup> A. O. Herrera, “Social Determinants of Science Policy”, in Charles Cooper (ed.), **Science, Technology and Development**, (London; Frank Cass, 1973).

possibility is well illustrated by the success of Brazil in the arms industry<sup>11</sup>. Through an intelligent policy of exploring the specific needs of the developing countries, Brazil has become one of main exporters in one of the most sophisticated and competitive technological fields of the world. If applied to civilian needs, instead of to destruction, there is no reason why that strategy could not be as successful as it now – unfortunately – in the arms race.

In a recent paper, Giovanni Dosi develops the concept of “technological paradigm” – a parallel concept to Kuhn’s scientific paradigm – and of technological trajectory, the way the paradigm evolves<sup>12</sup>. A technological paradigm is not a closed system whose evolution is unequivocally determined, but consists of a core of knowledge and basic technological elements which offers a variety of possible trajectories, whose direction is to a great extent determined by the social environment. The main objective of R and D systems should be the exploration of possible technological trajectories, in order to concentrate on those best adapted to the conditions of the region. This task, given the relative weakness of private enterprise and of the R and D systems of the region, will require a strong support from governments; not only as financial assistance, but through well articulated policies with clearly defined priorities.

## **The Environmental Dimensions of Development**

Any long term strategy of development should have, among its central objectives, the attainment of a society intrinsically compatible with its physical environment. This is particularly true in the Third World regions, where the rapid increase of population and the predatory exploitation of natural resources by the great powers, is endangering the equilibrium of most ecosystems.

In the case of Latin America, for instance, the gravity of the situation is not receiving the attention it deserves.

Despite the growing awareness about the problems posed by the environment and the natural resources, and despite the attempts made by national and international organizations to translate those preoccupations into practical actions, environmental degradation, the irrational use of natural resources, their exhaustion or misuse are still factors that threaten the living conditions and even the survival of millions of people in

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<sup>11</sup> R. Dagnino, “A Indústria de Armamentos: o Estado e a Tecnologia”, **Revista Brasileira de Tecnologia**, Vol. 14, (Brasília, 1983), p. 5-17.

<sup>12</sup> G. Dosi, “Technological Paradigms and Technological Trajectories”, **Research Policy**, 11 (1982), p. 147-162.



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Latin America. The general situation has aggravated in the last decades, particularly with reference to the inhabitants of the rural areas of the region.

According with recent estimations, and taking into account only the process of expansion of the agricultural frontier in South America, this process will result in the transformation of some 60 million hectares of virgin or semi-virgins ecosystems in the next 15 years. Sixty percent of those transformations are expected to involve large negative impacts, with a serious degradation of the ecological productive basis.

Summing up, it can be said that the ecological systems of Latin America are being subjected to intense transformations, through the direct and indirect activities of the different social actors, and are also being exposed to perturbations never encountered in the past, through the impact of new pressures and technologies, bringing those ecological systems to a situation of permanent disequilibrium. There is now a relatively wide consensus among specialists, about the long-term ecological unsustainability of the prevailing development pattern in Latin America.

In our opinion, the formulation and implementation of a strategy to cope with the problem of the environment, requires a reasonably clear understanding of the origin and causes of the present situation. A brief look at the past will help to locate the problem in an adequate perspective.

It is a well known fact that ancient civilizations were essentially peasant's societies. Despite the political, social and cultural importance of the cities, the great majority of the population was rural, and the economic foundations of those societies were agriculture and cattle raising. Most of the productive system was devoted to the satisfaction of the basic needs of the population: food, housing, and clothing. The very possibility of survival of those societies rested on their capacity to provide for the basic needs, specially food, on the basis of local production.

The trade between distant regions was limited to a few goods of relatively little volume. The massive transportation of the agricultural production to great distances was not possible; besides, as agricultural productivity was relatively low, very seldom a community had important surplus for exportation, even in the case that transportation was materially possible.

On the other hand, due to the fact that they were agricultural societies whose wellbeing and even survival depended almost totally on local production there was not a neat separation between producers and consumers. Most of the population was rural and provided its basic needs through self-production. The relatively small urban population

not directly engaged in primary production had to depend on the peasant's capacity to generate surplus. Any alteration in the efficiency of production has affected directly and immediately the producer-consumer.

The above could be synthesized by saying that there was a direct and effective mechanism of feedback in the relationship society-physical environment. A practice in agriculture which could cause a serious negative impact on the ecological equilibrium had to be rapidly corrected, because the wellbeing of the community was dependant on that balance. The others key natural resources – besides water and soil – for those societies were building materials and fuels. The former – essentially clays, stone and timber in different combinations – were commonly abundant, and the relatively low population density seldom generated and excessive pressure over those resources. The same can be said of fuels, which mainly timber and cattle dung.

All those civilizations were able to create, by the mechanism of feedback and through a long process of trial and error, technologies which were adequate to their physical environment. The survival for thousands of years of civilizations living in relatively restricted ecological spaces shows the efficiency of those feedback mechanisms.

The situation briefly described above persisted in its essential characteristics until relatively recent times. In Europe it lasted until the end of the Middle Ages; in the rest of the world it started to change with the colonial conquest and expansion, but in relatively isolated regions some of its elements have remained until today.

With the emergence and expansion of capitalism the mechanism of feedback we have referred to was to a great extend destroyed; the main reasons were two.

The first one was the emergence of an ever increasing separation between producer and consumer. In the previous societies – independently of the possible benefit of the producers – most of production was devoted to satisfy directly perceived needs. With the development of capitalism the units of production respond to the market demand, but its immediate motivation is profit and not the satisfaction of a need perceived directly by the productive unit as such. The vast diversification of production which far transcends what we call basic needs makes demand increasingly indirect. The diversification and expansion of the productive system result in an ever increasing pressure on the natural resources and the environment. Besides, due to the fact that new natural resources are being continually incorporated into the economic cycle, and that the processes of production are very different from those used in the past, the very character of that pressure upon the physical environment changes, rendering obsolete the experience accumulated by mankind during thousands of years.

As a consequence a fundamental dichotomy appears in the relationship society-physical environment. The capitalist enterprise makes its production plans of the principle of maximization of profit, and its temporal horizon is given basically by the amortization of its investments. The possible effects on the environment and on the global reserve of natural resources are “externalities” which are not normally taken into account<sup>13</sup>.

As a result the mechanism of feedback referred to previously become highly indirect. When the society at large starts to perceive the environmental damage and attempts to take corrective measures, it becomes apparent that in this field social interests and enterprise objectives are divergent. For the enterprise any regulation to protect the environment means normally an increase in the cost of production, and therefore it goes against its basic goal of increasing profit; consequently, it reacts using every possible means to impede or evade regulation. On the other hand, the very philosophy of the capitalist system makes governments reluctant to implement measures which in any way could interfere with the free play of the economic system.

The second cause of the deterioration of the feedback mechanisms is the increasing internationalization of the economy. The productive system of a country, and particularly of an industrialized one, is no more integrated at the national level. A great part of the natural raw materials is imported from countries of the Third World, displacing in this way the environmental impact of the periphery. In the last years a policy of transferring to the periphery specially polluting industries has also began. The result of this internationalization of the environmental damage – including the predatory exploitation of natural resources – is that the countries where the multinational enterprises are located do not suffer directly the consequence of the damage, despite the fact that they consume most of the produced goods.

On the basis of the above, we can identify some of the very general lines of a frame of reference for the definition of an environmental policy.

It is obvious that the policy prevalent today in most of countries based mostly on the correction – on prevention, in the best of hypothesis – of the direct physical damage caused by productive activities is not a solution. Those measures can temporally mitigate some of the negative effects of the economic activities on the environment, above, in, or near human settlements, but have little relevance for long-term time horizon. The long terms effects of human activities on the environment depend on the overall structure of

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<sup>13</sup> We refer to capitalism because historically it is in this system that the problem first appeared, but it would be perhaps more accurate to refer to the industrial society. The socialist countries, with the possible exception of China, do not seem to have anticipated the environmental

the economy which includes social organization of production, spatial distribution, process technologies and methods of production, relationship between economic and natural cycles, and type and amount of the goods and services produced. These factors, in turn, depend essentially of the style and strategy of the development, i.e., on the goals and aspirations of the society involved. In conclusion, the environmental policy cannot be simply a set of preventive or corrective measures, but the natural result of a strategy of development in which an harmonious society - nature relationship is a central component of the philosophy of development.

The international dimension is an essential component of a long term environmental strategy. The effect of economic activities on the environment cannot be controlled solely through appropriate national policies, because the characteristics of local impacts depend largely, and increasingly, on the overall organization of production at world level. Only the creation of a reasonably equitable world order could make possible the implementation of environmental policies which can ensure a long term stable equilibrium with our physical habitat.

## 5. TECHNOLOGICAL PROSPECTIVE

It is obvious that the success of the strategy of change outlined above depend basically on the political will of the social forces involved. Lacking that political will little can be done by the R and D systems alone. However, all societies are dynamic and evolve, even if at the level of political decision making there is little will to change. Those process of transformation are protracted and complex, but there are always degrees of freedom for action.

One of the errors of the past was the rigidity of the R and D planning, based on the implicit assumption that development was a more or less linear process; the result was a lack of flexibility to adapt to changing conditions or to new options.

To avoid - or to minimize - the type of errors incurred in the past, it is necessary for the developing countries to make their own studies on technological prospective. Since these studies are being done in the advanced countries they are based on the implicit assumption that the future of the Third World countries is a dependent variable of the future of central ones.

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problems much better than the capitalist countries.

Those studies include not only which will be the future development of the new technologies but, and mainly, which will be their impact on the economic, social, political and cultural characteristics of the countries involved. Two basic criteria should guide those studies. The first one is that it is not possible to “project” the future, because in a period of deep crisis as the one we are living through the areas of uncertainty – political, social, economic, technological – are too large. So the aim is to detect main trends and possibilities, and to explore the degrees of freedom of the national and international systems. The final goal should be to build up a flexible strategy which can allow the R and D systems to be prepared to profit from the degrees of freedom and from the resulting new options.

The second criterion is that these studies should be normative. A commonly used classification of scenarios distinguishes tendential or positive scenarios, describing a possible future assuming the persistence of main recent tendencies, from normative scenarios, which propose a set of possible and desirable objectives to guide actions. In our view this classification, although analytically useful, is somewhat misleading. To assume the persistence of present trends implies a decision to ignore the tendencies and potentially of chance inherent in any social system, and that decision is essentially “normative”. The difference between the two groups of scenarios is really which type of “norm” they use; in the tendential group, the norm is given by present trends, while in the other group, that role corresponds to a selected desirable and viable future.

In conclusion, the basic approaches followed in the two types of studies are essentially similar. Forecasting, starting from the specific circumstances of its authors selects – through the choice of variables – one or a set of options among a whole range of possible futures. In Marie Jahoda words, referring to the limits of forecasting “the historical context in which we live inevitably determines the starting point of our work, as it does that of others ... rational argument is one though not the only factor influencing the way individuals, groups and governments view the future and take action accordingly.”<sup>14</sup>

There are not “objective” visions of the future, because there is not a predetermined future, there only options. Forecasting is as much a tool for shaping the future, as it is an instrument for exploring it. In this context the difference between positive and normative studies is mainly formal; both are normative, the basic difference between them being the type of “norm” they use.

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<sup>14</sup> Jahoda, M., “Introduction”, in **World Futures: The Great Debate**, Ed. Ch. Freeman and M. Jahoda, Martin Robertson, London, 1978, p. 4.

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