INTRODUCTION

The Technological prospective for Latin America project starts from the premise that a necessary precondition for the building up of a development strategy is a prospective view of the elements of the process of change - social, economic, international, technological - which will be crucial in the next decades. The project is centred on the technological and scientific dimensions of change. It intends to identify the main trends of technological change which will predominate in the next decades, and their social, economic and cultural impact on Latin America. The final objective is to contribute to the formulation of a science and technology strategy adequate for the future development of the countries of the region.

The project started at the end of 1983 under the sponsorship of the UNU, and received afterwards financial support also from IDRC. As a result it was transformed into a UNU-IDRC joint effort, although the coordination of the project remained always a direct responsability of the UNU.

The institutions that participate in the project are the following:

CENDES (Centro de Estudios del Desarrollo) Universidad Central de Venezuela, Caracas, Ven.

NPCT (Centre of Science and Technology Policy) Instituto de Geociências, Universidade Estadual de Campinas, SP, Br.

GASE (Ecological Systems Analysis Team) Fundación Bariloche, Arg.

CEBRAP (Brazilian Centre of Analysis and Planning) São Paulo, Br. (This organization participated until 1986)

UNAM (Universidad Nacional Autonoma de Mexico) Ciudad de Mexico, Mex.

CEUR (Urban Regional Studies Centre), Buenos Aires, Arg.

The work of the project was organized into the following research areas:

Socioeconomic Dynamics. The objectives of this area are, a) the analysis of the present conditions of Latin America, and of the world context in which it is inmersed; b) the formulation of the socioeconomic and political strategy required to attain the society proposed by the project.

Coordinator: André Furtado

Trends in Science and Technology. The objective of this area is to analyze the trends in science and technology, and to evaluate their impact on society.

Coordinator: Renato Dagnino, NPCT, UNICAMP, Br.

Environment and Development. This research area studies the present regional situation regarding the relationship environment - development, and the character od that relationship in the context of the socioeconomic strategy proposed by the project.

Coordinator: Gilberto Gallopin, F.B., Arg.

Scientific and Technological Capability in Latin America: This area studies the present capability of the R and D systems of the regions, and the measures required to prepare them to confront the scientific and technological challenge posed by the demands of the new strategy of development.

Coordinator: Hebe Vessuri, CENDES, Ven.

Political Economy of Science and Technology: This research area is concerned with the structure and internal dynamics of the R and D systems. Its objective is to reach a better understanding of the connection between the R and D systems and the productive systems of the region.

Coordinator: Leonel Corona, UNAM, Mex.

The Urban Dimension of Technological Change in Latin America: This area studies the impact of the new technologies in the urban environment.

Coordinator: Pablo Gutman, CEUR, Arg.

The activities of the project are coordinated by an *ad hoc* committee composed by the research areas coordinators, under the chairmanship of the Project Coordinator.

In what follows a brief preliminary review of the results of the project is presented. The report is divided into six chapters:

I Background and Methodology
II Trends in Science and Technology
III The Urban Dimension of Technological Change in Latin America
IV Environment and Development
V Research and Development Capabilities in Latin America
VI The Scientific and Technological Strategy for the region.

The chapters II to V correspond roughly to the fields covered by the research areas mentioned above. The research areas Research and Development Capabilities in Latin America and Political Economy of Science are included in a single chapter. The main results of the Socioeconomic Dynamics research area are not presented in a separate chapter; they constitute a central part of the frame of reference of the first and last chapters of the report.

The bibliography has been grouped by research areas but, as can be seen through the titles, there are documents that cover subjects which can be included in more than one research area.

It should be taken into account that this report does not attempt to be an *abstract* of the results obtained by the project. Given the diversity and scope of the work performed - which can be seen through the bibliography - a complete presentation of results would has been an impossible task in such a brief document. The purpose of the report is to give a reasonably clear idea of the general character of the output of the project, and the main criterium used for the selection of the material to be included is its relevance for the formulation of the scientific and technological strategy.

Finally, the present report is based on written material produced by the research areas, and on discussion with the area coordinators. Any error or misinterpretations is my exclusive responsability.

1 - BACKGROUND AND METHODOLOGY

There is a general agreement that we are entering one of the most important periods of technological change in history. The new wave of innovations - centered on microelectronics - affects all fields of human activity.

In the Third World the new innovations, due to their low cost, changes on the economies of scale, diversification of products, and possibilities of descentralization, have aroused 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 developing countries; it is not so clear however, which are the conditions and prerequisites for that promise to come true. A brief look at the past clarifies 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 ccuntries; 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 the socialist countries. The results is that for the first time in history a sizable part of humanity has all its material 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 frustation of hopes in the Third World countries are many and complex, but we may select for bried consideration mainly those most directly associate with the application of science and

technology for development. We will refer specifically to Latin America, the region studied by the project.

A Balance of the Past

It is not necessary to describe in detail the socioeconomic development of Latin America - and most of the Third World - in the last decades. It was based upon the evolution of the developed economies, particularly Western Europe, in the post-1945 period. The success of the Marshall plan, and the rapid acceleration of technological progress were associated in those countries with a period of prosperity without precedent in the history of capitalism.

Two elements - the influx of capital and the introduction of new technologies - were adopted by the dominant classes of Latin America as pillars upon which to sustain economic and social development. Besides the intrinsic advantage of those technologies, and the pressure of the advanced countries - basically through expanding multinationals - to disseminate them, this strategy of development offered two important advantages. The first was its simplicity. It was the mechanical translation of a conception originated in advanced countries and accepted on the basis of its demonstration effect. Second, it seemed to ensure economic growth - its association with social progress was taken for granted - without substantial changes in prevailing social and economic structures.

The result of this strategy are well known, and a few indicators are enough to describe, in general terms, the present situation. The GNP per capita of the region was 10% lower in 1983 than in 1980. The rate of inflation in the most industrialized countries of the region - Argentina, Brazil, Mexico, Venezuela, Chile - have reached values without precedent in the past, and the external debt of the region amounts to about 340 billion dollars.

Those figures indicate only the overall situation, and do not reflect the most important results of the strategy of development. During most of the period we are considering, the rate of economic growth of the countries of the region was high: between 1965 and 1981 the GNP of the region quadrupled, while the GNP per capita doubled. However, the benefits of that sustained growth reached only a minority of the population, because the pattern of industrialization was mostly directed to the requirements of a bourgeoisie and a middle class with the same pattern of consumption of their equivalents of the advanced countries. The rest of the population was, at the end of the period, in a situation not much better than in the past.

The reasons for that failure have been amply discussed in Latin America using different conceptual approaches, the most important being depency theory, which places the main cause of the persistence of underdevelopment in the Third World countries on their mode of insertion into the international economic structure. As for the *direct* mechanism responible for the failure it was, in our view, the incapacity of the countries of the region to adapt the institutional subsystem to the changes of the technoeconomic subsystem induced by the wave of innovations, particularly the redistribution of income and the internationalization of the economy.

The redistribution of income in the developed countries as a consequence of the introduction 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 upper and middle classes of the advanced countries. The result 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.

The internationazalization 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 solely, on the market forces -

controlled fundamentally by private enterprises - but also on the bargaining capacity of the nation states. Most of the Latin America states were, and are, intrinsically weak, due basically to the lack of social consensus. 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 "neocolonialism".

A New Starting Point

Summing up, it is clear that the wave of innovation associated with the previous long cycle failed to generate more and better distributed wealth in Latin America as it did in the advanced countries. As a consequence, while the developed countries are entering a "post-industrial" era, the countries of Latin America - as well of the most of the Third World - are receiving the impact of the new wave without having received the benefits of the previous one, or of the industrial revolution more generally.

Latin America confronts now a situation which leaves little room for the superficial optimism prevalent at the beginning of the post-war period. The previous strategy of development based on the massive influx of capital and technology is no longer viable. Besides the external debt, which makes very difficult for the region to incorporate more foreign capital, the world recession is a fundamental factor in restricting the trasnference of capital from the centre to the periphery.

The above analysis may appear to be a gloomy picture of the future but it is not mean to be so. Its main objective is to stress - although it may look redundant - that the incorporation of the new technologies can only be a part of a global socieconomic, political and cultural strategy. Without that wider strategy, the incorporation of the new wave of innovations will have the same fate that had the previous one.

The Present World Crisis

In our view a prospective view on the impact of the new technologies should start from two basic premises: the first one is that the impact

of the new wave of innovations on society can only be properly evaluated in the context of the present world crisis, or better perhaps, process of transformation. The second premise, closely related to the first, is that the character of the social impact is not solely determined by the nature of the technologies but also, and mainly, by the socioeconomic and cultural strategy adopted to incorporete them.

In relation to the crisis, the fact that the well known Kondratiev--Schumpeter theory refers to cycles, 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 1930's. This approach does not take sufficiently into account the fact that the process of change that each crisis represents has an specifity 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, play an essential role in the evolution of the crisis.

In our opinion, the main elements that differente the present crisis from the previous ones are the following.

The Emergence of the Third World: In the thirties the world was 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 economic 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 scenario 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 Vietnan war - have had as protogonists countries of the Third World. Central America and the Middle East are only two exemples of regions of the Third World whose problems effects directly or indirectly the world power structure.

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.

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 in the power and economic structure. Now the post-war expansion of the Socialist block in Europe, the incoporation of China-besides smaller countries such as Cuba, Ethiopia and Vietnan has converted the socialist world in a critical element in the future evolution of the international system.

The present process of change in the Soviet Union and previous events in other socialist countries are clear manifestations of a process of internal evolution which is not 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.

Questioning of the present values of western society : until no more than two or three decades ago there was the general feeling that the process of world unification iniciated by the expansion of the western powers, and enormously accelerated after the war, mean essentially "world westernization". The colonization of most of the world, and more recently the one way transference of technology and the diffusion of western style insutrialization with its implicit cultural values, seemed to condemn to almost complete obliteration the achivements of other cultures.

This process is starting to change, firstly because the Western world has began to have serious doubts about the soundness ans racionality of its own conception of progress and development; in its search for alternatives it is becoming aware that other cultures can perhaps made decisive contributions to a more integrative, less reductionist vision of the world. Secondly, because the other cultures have started to assert their own identity and to reject a supposedly universal concept of development which does not take into account their own specificity.

International Inequality: The magnitude of the gape that separates the developed countries from the so called Third World have never been so great in modern history. At the beginning of the western expansion, with the ensuing process of colonization, the average material level of living of the population of the colonized countries was not much lower that that of the European countries. Now the difference, measured in terms of material consumption, is of the order of more than ten to one. As important or more than its numerical value, however, is the qualitative change being produced in the character of the gap.

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 fundamental 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 most 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 the industrial society - is considered their fundamental objective. The central countries, on the other hand, are entering what is being called the "post-industrial society", a stage of development whose *problematique* is very different from the one the developing countries still confront.

As it is well known however, 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 receive the impact of the new one. In other words, they will have to confront problems far more complex that the ones facing the advanced countries.

The New Wave of Innovations: The new innovations belong to several technological fields - microelectronics, biotechnology, materials, energy - but what gives them the character of a "wave" is the fact that they tend to be 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 paradigm, is microelectronics.

The dominant characteristic of the new wave is that its impact seems to be more important to the organization of production, the labour process, and the social division of labour, than to 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 capitalist 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 will affect the very basis of the industrial society, as can be seen by considering briefly the process of automation and robotization.

In all modern societies access to goods and services is conditioned

essentially by wages in the widest sense: the remuneration of labour in any of its forms. In the future this central role of wages will decrease, firstly because one of the consequences of automation, by eliminating most jobs which do not require "non programmable" skills or creativity, will obliterate most significant forms of hierarchy in the labour 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 the distribution of good and services will be greatly reduced.

The transition to the new "mode of production" will undoubtely take a longe time to be completed - of the order of one or two generations - but its first effects are already with us. The problem is not whether or not traditional forms of work and employment will be abolished - that change is inherent to the transformations induced by the new technologies - but rather the way in which they will be abolished.

The Environmental Limits: The conscientization that natural resources and the environment constitute absolute limits to economic growth only appeared in the decade of the sixties. We know now that material consumption cannot grow indefinitely without taking into consideration its effects on the equilibrium of the biosphere.

That awareness, however, is not reflected at the high levels of social decision making where a deep ambiguity prevails in relation to environmental policies. Never in history has mankind had the capacity to forecast the results of its actions as it has to day; the enormous amount of information accumulated at world level by national and international organizations, and the modern means to process it, makes it possible to have, if not an accurate long-term picture, at least the general trend of some of the variables which condition our future. Yet, there has probably never been a greater inconsistency between a predicted future and the measures taken to rationally cope with it. We have become aware that the resources of the earth are finite, but we still consider indiscriminate economic growth the universal panacea for all our social and economic diseases.

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 World War. A global war can also put an end to the present crisis, but through the destruction of manking and of most of the biosphere in which we live. Whether the physical annihilation of our race will be complete or not does not mater very much. There can be survivors, but all we associate today with humanity and civilization would have been totally obliterated.

Besides the continously increasing danger of collective suicide, the cost of the arms race is one of obstacles to the solution of the problem associated with poverty that effect a great part of the world. In 1985 the global military expenditure - 940 billion dollars - exceeded the total income of the poorest half of humanity.

The first five elements we have briefly examined show that, if we consider this crisis in the context of the theory of the cyclical long waves of the capitalist economy, the present crisis has a character which makes it very different from the previous ones since the beginning of the Industrial Revolution. The last two elements - the physical outer limits and the nuclear destructive system - show that this crisis has no precedents: for the first time in history, humanity can be destroyed by its own actions.

In conclusion we are in a extremely complex situation: we are confronting a future whose evolution is very difficult to forecast, and at the same time we need some guides for action in a long term horizon, because we are aware that the only solution for our present predicament is to formulate and implement alternative development strategies, based on objectives more in accordance with the aspirations of the majority of the population, and with the possibilities and constraints posed by the advance of our scientific and technological knowledge, and of our understanding of the physical universe in which we live.

We do not pretend, of course, that to stress the need of long term prospective studies constitutes an original proposal. The widespread perception of the importance of such type of work is demonstrated by the well known long-term global forecasting studies iniciated in the 1960's. There is, however, less agreement about what type of prospective approach is really relevant for the present situation of the world.

Tendential vs. Normative Forecasting

Tendential vs. Normative Forecasting

The series of long-term global forecasting started in the 1960's with two contrasting views of the future. H. Kahn's *The year 2000 - A Framework for Speculation on the Next Thirty Years* published in 1967 presented an optimistic view of the future, without important discontinuities or qualitative changes.

The other current of tought in forecasting, instead of a future of unending progress, sees humanity rushing towards an almost unavoidable catastrophe. In this view neo-Mathusian ideas are combined with the modern concept of "outer limits". This world view has its best known advocates in Anne and Paul Ehrlich - *Population Resources and environment*, 1970; and *The Population Bomb, 1971;* J. Forrester - *World Dynamics*, 1971; and Dennis Meadows and co-workers - *The Limite to Growth*, 1972. In those forecastings the growth of population and consumption, with the ensuing pressure on natural resources and the physical environment, is leading humanity to a disaster resulting in a sudden decline of population and a miserable level of living for the survivors. Largely as a reation to the "Models of Doom" several world models appeared in the early seventies, the best known been the Fundación Bariloche or Latin American World Model, and the Mesarovic - Pestel Model under the auspice of the club of Rome.

The seconde generation of global long-term forecasting appeared at the end of the seventies or the beginning of the eighties. The most important among them are *Interfutures* (OECD), the *Presidential Report on the year 2000* and the *Brandt Report*.

From the point of view of their basic approach, those global forecasts have been divided into two groups: *tendential* and *normative*. The former describes a possible future assuming the persistence of the main tendencies observed at the time. The normative approach proposes a possible and desirable future, and intends to identify the actions required to go from the present towards that future. With the exception of the Bariloche study, all those explorations of the future are basically tendencial. In the TPLA project we selected the normative approach.

We can now make a comparison - from the point of view of their objectives an methodology - between what we can call the studies of the North, and the studies of the South. We cannot obviously attempt a detailed analysis here; our purpose is only to show the implications of the prospective approach adopted.

In relation with the Third World, the findings of the forecastings made in the North are basically coincident. At the beginning of the next century the gap between the rich and the poor countries will be greater than now, or will diminish marginally in the more advanced developing countries. In absolute terms, the situation in the poorest part of the Third World will probably worsen.

The main implicit premises of the studies of the North are essentially two: the first one is that there will not be essential changes in the present social and international structure, although they admit some adjustments, and possible changes in the pattern of distribution of power among the advanced capitalist countries. The second premise is that the Third World countries will not produce actions that can alter significantly their present situation in the world economic and political power structure; in other words, that the future of the Third World is a dependant variable of what will happen in the advanced countries.

In the studies of the South the basic premises are different: they start on the assumption that the present crisis far trascends the economic and technological dimensions, and question the very basis of the present social and world order, including its underlying values. As in all periods of transformation a wide scope of new options is opened and they offer the Third World countries the opportunity to actively participate in the construction of a new and more equitable world order.

It has been argued that an esential difference between the two groups of studies, is that the one from the North takes as a basis observable present trends, and so is "objective", i.e., do not introduce scenarioes based on subjective valorative judgements, as would be the case of the South studies. To what extent this argument is valid ?

In the studies of the North the privileged variables, the ones that determine the state of the system, are mainly economic and technological, and they cannot *per se* introduce radical changes, or discontinuites, in the global evolution of the social and international systems. Besides, and most important, those variables are to a great extent controlled by the advanced countries, and are amenable to quantitative treatment. So through an adequate information on their values and tendencies, the North can expect to maintain a reasonable control over them even in situations of rapid change.

To incorporate the possibility of transformations that can alter the "tendential" future, it is necessary to consider also the social actors involved - which are the ultimate agents of change - and this is what the South

prospective studies do. In the Bariloche Model, the proposed society is supposed to represent the will and aspirations of the majority of the population. The TPLA project, based on socioeconomic scenarios, selects desirable options among the range of possible futures determined by the interplay of the social actors - national as well as international - involved.

It is clear, therefore, that a crucial difference between the two groups of studies lies on the choice of trends - represented by variables - and that selection has to be explained by factors other than whether or not those are observable or "objective".

In our view the selection of variables is mainly determined by the fact that the countries of the North have a privileged position in the present world order, and so it is only natural for them to avoid or understimate variables - over which they have little control - that can alter an already unstable situation. In a position of privilege, any change is potentially dangerous, and to ignore, reject, or minimize it, has been a recurrent attitude all through history.

It is clear then, that the basic approaches followed in the studies of the North and the South are not so different as they seem to be. Forecasting, starting from the specific circunstances of its authors selects, through the choice of variable, one or a set of options among a whole range of possible futures. To assume that present trends will continue into the future without significant changes is, in present circunstances, at least as "normative" or "subjective" as to assume that those trends are not viable in the long term perspective, and consequently that the crisis have degrees of freedon which allow for a multiplicity of possible futures. In both cases there is a choice of a future: the basic difference between them is that in the case of the North the selected future is the continuation of the present tendencies with the minimum possible degree of change, while in the case of the South it is assumed that continuation of the present trends is neither viable, nor desirable, and a viable and desirable scenario is selected among a multiplicity of possible options.

There are not "objective" visions of the future, because there is not a predetermined future, there are only options. Prospective is as much a tool for shaping the future, as it is an instrument for exploring it. This means simply that prospective is not merely a theoretical exercise, but is always performed - implicitely or explicitely - as a guide for action.

Finally, we do not want to leave the impression that we believe that only in the Third World is questioned the viability and desirability of the present

world order. In the previous analysis there are unavoidable simplifications. the most importantone being the apparent clear cut division between the North and South visions of the world. The attitude towards the future embodied in the North studies is far from being universally accepted in the developed countries. There is an important part of the population - particularly significative in the young generations and among intellectuals - that strongely questions the vision of the world implicit in those prospective works. In a more general level, that contestatory attitude is one of the basic elements of the ecological, peace and feminist movements - and as we also know, a most important part of the literature on alternative futures is being produced in the developed countries. We used those studies as representatives of the North, at the risk of oversimplification, because they reflect the position of a great part of the upper levels of political decision making, the ones that have a central responsability in the shaping and maintenance of the present world order.

The Methodology of the Project

The central feature of the adopted methodology is that the frame of reference for the formulation of the scientific and technological strategy is the R and D demand of the desirable society. This means that the R and D policy should not be determined solely by specific problems, or areas of problems, posed by the technologies *per se* but also, and mainly, by the socioeconomic, political and cultural goals proposed by the chosen society.

The approach implies the following sequence of steps:

a) definition of the character of the desirable society ; b) identification of the obstacles to the attainement of the proposed society; c) formulation of a socioeconomic and political strategy for the overcoming of those obstacles d) determination of the scientific and technological demand of the strategy.

To solve the difficult problem of reaching a general agreement on what means a "viable and desirable society" we decided to define the desirable society on the basis of a few normative characteristics which can be called "invariants", in the sense that if any one of them is not present, the society is not desirable. This allows for a multiplicity as societies which are desirable, within a wide spectrum of cultural and organizational differences.

The invariant characteristics we adopted for the desirable society are the following.

- Essentially equalitarian in the access to good and services.

- Participative: all member have the right to participate in the social decisions at all levels.

- Autonomus (not autarquic).

- Intrinsically compatible with its physical environment .

The exact meaning of those invariant elements, and their form of implementation in the proposed society, will be clarified later on in this report.

The above characteristics may seem too general, but they are enough to define a basic type of society and, more important, they represent goals shared by the majority of mankind. They are what can be called first order long term goals which constitute the frame of reference for the formulation of the short and medium term objectives. Those objectives could vary greatly, depending on the national or regional conditions and on the selected strategy, but they should fullfil the requisite of contributing - or at least not hindering - the final attainement of the first order goals.

An important point, finally, is to see to what extent the proposed society is compatible with the type of society that could emerge from the process of world transformation.

We cannot describe that possible future society, but we can, at least, have a general idea of which could be their main conditionants. In our opinion they would be the following:

- The concientization that the natural resources and the environment constitute absolute limits to economic growth implies the need to put a ceiling to material consumption in a not distant future. In a reasonably equitable world society that limitation does not mean a "poor" society - in the present meaning of the term - but rather a society austere and careful in the use of material goods.

- The existence of an upper limite to material consumption implies that only an equalitarian society can be stable, because that restriction would show clearly the fallacy of the present illusion that inequality at the social and international levels can be corrected simply trough indiscriminated economic growth.

- The combination of a limit to material consumption with a wave of technological innovations whose main consequence is that every day we need less labor to produce the same amount of good and services, leads to a society

with increasing creative freetime, the gradual obsolescence of salary as the central mechanism of distribution of the social product, and to a reformulation of the relationship between employment and work.

- The need to control the environment at a the planetary level, the growing internationalization of the economy, and the technological advances - particularly in the areas of informatics and communications - imply a dynamic process of world unification.

The society proposed by the MED - equalitarian, participatory, non consumerist, intrinsically compatible with the environment, with creative utilization of the free time, autonomus - not only does not contradict the above determinants, but is the type of society best adapted to them. It is a desirable society, but it is also the society necessary to confront creatively the present crisis.

The fact of the proposed society being possible, desirable and necessary does not mean, obviously, that its implementation would be easy It could predominate the alternative represented by the present trends, with an increasing aggravation of the social and international conflicts. The most probable outcome would be a nuclear catastrophe in the near or medium term future, or an ecological colapse in a somewhat more distant time horizon. However, the growing awareness at world level that the society implicit in the present trends is not viable, suggest that trajectory is not as unavoidable as sometimes it seems to be.

For the formulation of the R and D strategy we consider two stages in the evolution of the proposed society.

I) The period of transition: the objective in this stage is to create the necessary preconditions for the access to the new society. Those preconditions are referred to two basic areas:

a) The insertion of Latin America in the international context.

As we have already seen, one or two central elements of the present crisis is the dynamic acceleration of the process of world unification which began with the expansion of the western powers. This unification is not only unavoidable but also desirable; it is a necessary condition for the creation of a viable world order. As we also know, however, it is a *necessary* but not a *sufficient* condition.

The present trends in the capitalist world are not towards an equitable world unification, but rather towards the construction of a world order based on an international division of labor whose main beneficiaries would be the developed countries. A central task of the countries of the region, therefore, is to create the conditions that could allow them an equitable insertion in the new word order.

b) Creation of the internal conditions necessary for the access to the new society. Those conditions are basically related to the characteristics we have called invariants.

The time horizon of this period is of the order of three of four decades. The effort of the project is concentrated on this stage.

II) The new society: the time horizon is open. We have tried to define only the basic characteristics of the new society, in order to determine, in very general terms, the type of scientific and technological challenge it will have to confront.

The temporal division between the two stages is obviously, to a great extent, arbitrary. The transition to the new society is gradual; it is possible to say that it has been completed when the values and the forms of organization and social action of the new society clearly predominates over those of the present one.

As we have already seen, in the first two steps of the sequence implicit in the adopted methodology - definition of the social goals proposed by the desirable society, and identification of the obstacles to their attainment - the scientific and technological dimension does not appear specifically: the central elements are social, economic, political and cultural. It is only in the step of the formulation of the socioeconomic and political strategies that the scientific and technological dimension enters as an explicit variable.

II - TRENDS IN SCIENCE AND TECHNOLOGY

The studies carried out in the Trends in Science and technology research area can be broadly divided into two categories a) studies whose objective is to have a general view of how the new technolgies are being generated and disseminated, and of their present and prospective socioeconomic impact; b) on the basis of the information generated by the above studies, to perform case studies which could help to have a deeper understanding of the impact of the new innovations.

The first group of studies are centered on the following main subjects.

- The main recent scientific and technological developments related to the new wave of technological innovations, and identification of the centers where those developments are generated.

- The mechanisms of dissemination of the new knowledge in the productive system.

- The R and D strategy of the great multinational enterprises on these new fields.

- The socioeconomic impact of the new technologies in the developed countries.

- Present and possible future socioecomonic impact of the innovations in Latin America.

- Discussion of some recent hypotesis and theories on technological change in relation with the socieconomic context.

In the selection of case studies it was impossible - due to obvious financial limitations - and, in our view, unnecessary to, cover the whole diversity of the region. Most of the case studies were performed in the countries with the highest degree of industrialization. In our view, however, they are reasonably representative due to the following reasons: a) those countries are the ones that show the highest degree of diffusion of the new technologies, and so

are the most appropriate to observe the impact of the new technologies in the region; b) the sectors selected for the studies show a considerable degree of homogeneity at world level; c) the main objective of case studies is not to apply directly the results obtained - above all in processes that are in their initial stages, as the ones under study - but to use them to formulate general hypothesis that can help to forecast the possible impact in different socieconomic contexts.

In what follows we will present some of the main results obtained, above all those which are particularly relevant for the formulation of the socieconomic and R and D strategies.

MICROELECTRONICS

The Social Impact of Microelectronics

A. The debate: Employment, qualification and management style.

The present crisis and the new trends of technical progress have been influencing entrepreneurs, workers, governments, grassroots social movements and scientists to reconsider the possible positive and negative effects derived from those new trends. There has also been a growing concern so as to influence S&T policy-making in order to give those policies an as wide as possible social control.

The debate going on about microelectronics automation effects on the Brazilian society, leads to a discussion about the way capital accumulation, and the changing labor organization and industrial relations have been taking place. Thus the entrepreneur's are particularly interested in the increase of productivity and reduction of costs which allow them to participate in better condition in the internal as well as in the internation markets, while the workers are worried about the risk of technological unemployment (which would add up to the existint structural unemployment) and the possible degradation of the working conditions. Finally, the government considers the necessity and opportunity of a technological adjustment in the economy, so that it might improve the country's foreign trade conditions and consequently the external debt situation.

Here we are referring to the Brazilian case. Perhaps it should be

worthwhile to point out that Latin America's contribution to the theme is very poor. We have made a bibliographical survey comprising about 1000 titles from our files, and leaving aside the Brazilian related works, there are scarcely more than 10 titles from other Latin American countries, practically all of them from Argentina, Venezuela and Mexico. That might well be just a sympton of the poor integration among Latin American research institutions, but it might also reflect the slower diffusion of the new technolgies in the other countries of the region. In any case, we consider that the analysis of the Brazilian case can be useful to discuss more deeply the possibilities of a new development model for Latin America. Brazil has made some significant concerted efforts in order to set up a national computer industry since the early seventies.

Although the Latin American literature on the subject is recent and scarce, there is a vast international literature characterized by a great diversity of approaches and conclusions.

Those approaches range from "post-industrial society" to "labor degradation", including Kondratiev-Schumpter's "long cycles", the "regulation school", and the "new capital accumulation strategies". They differ from each other in relation to the determinants of the process of social change and on their treatment of the technological dimensions, as well as on their conclusions about the possible consequences on the labor process.

Nevertheless, the recent literature seems to agree on some points:

- The present crisis derives from the exhaustion of the model of economic growth and socio-political relationships, which was adopted on a worldwide basis in the post war period. Such a model pressupposes a certain techno-economic "matrix", "pattern" or "paradigm";

- It implies a deep re-structuring process of the productive system and of the social and political relationships, and cannot be analysed from a purely economic perspective. The social, political and cultural variables must be also taken into account;

- In order to avoid technological determinism, it is necessary to develop an appproach which takes into consideration the genesis and the history of the social production of science and technology;

- In this process of change is emerging a new techno-economic pattern, matrix or paradigm, centered on the incorporation of information intensive technologies based on microelectronics.

- This new pattern reinforces the capitalist tendency to increase the technical composition of capital;

- This re-structuring process alters the international division of labor, as well as its social and sexual divisions, modifying the social relations of production and those related to human reproduction (family structures).

In relation to the possible effects brought about by information technologies, those studies present a wide spectrum of contrasting possibilites: leisure-time societies versus unemployment societies, greater labor qualification versus greater labor disqualification, decentralization versus centralization, autonomy versus greater control.

Recent empirical studies show that the introduction of microelectronic technologies produce effects heterogeneous and often contradictory, that depend on the non-linear process of technological change, and on how it is articulates with the recipient society. In general terms the following points could be stressed in relation with the introduction of microelectronic based technologies (Acero , 1984)

- The effects are differentiated according to specific characteristics of the production processes at the country,region, and economic sector, levels,and even according to the different segments in the same productive unit;

- The form new technologies are introduced depend of the specific patterns of competitition and on the comparative advantages of each country, region or sector;

- The displacement of workers does not occur necessarily at the point of entrance of the new technologies;

- The new qualifications required do not depend only of the characteristics of the technologies, but also of the products and labor markets and of the organizational structures and trade union policies;

- It is necessary to articulate the direct and indirect effects of the process of transformation, analysing the interrelationships between the formal and informal labor makets.

Based on the above, and leaving aside the polarization of the debate between "positive" and "negative" effects, it is possible to identify some more general trends, at least as far as mass-production industries are concerned.

In relation to employment, the trend is a reduction of the workplaces, specially those related to direct production, associated to great increases in productivity. During the periods of technological stability, employment rates follow more or less those of production, but in periods of technological change as the present one, production rates are much higher than employment rates. Such a phenomenon is no new in the history of capitalism. The difference now is the speed of dissemination and the pervasiveness of the innovations.

Facing a rapid increase of productivity the proposal of the trade unions is a reduction of the working time and the implementation of compensatory policies in relation to labor displacements (labor market policies). Falabella (1985) discusses the effects of microelectronics over the employment level, qualifications and working condictions in five European countries, from country to country, sector and companies. He stresses the importance of more wide ranging policies by the State and the participation of trade unions in the process of technological change, in order to keep low unemployment rates in a period of crisis and rapid technological change.

At the company level, we performed a study about the automotive industry in Brazil between 1980 and 1985. It showed that the most modernized enterprise increased its workforce, in absolute terms, but the increase of production was much higher than the relative increase of the working force. Taking the whole automotive industry the curves of employment and production were similar, due to the general low level of introduction of the new technologies.

In the USA the modernization of the automotive industry in the period 1970-1984 was responsible for about 170.000 job less.

The structure of qualifications is changing rapidly, as new qualifications and skills are substituted for old ones. It is important to note that the content of the qualifications is frequently related to the characteristics of productive processes which were not altered significantly for long periods, leading to a whole social process of validation and hierarquization of professions with consequences that included from the reorganization of the labor processes, to the curricula of the technological schools.

Here again, the behavior of the several actors involved, and the social, cultural and political characteristics of the host societies are fundamental in the determination of the character and orientation of the process In similar productive processes, it is possible to identifie not only situation of greater fragmentation or "petering out" of jobs, but also situations in which "recomposition" of occupations and tasks were produced. This is an extremely complex

process and it cannot be studied under the usual Labor X Capital bias only. The conflict, both within the labor collective and the management sector is extremely intense.

Our surveys about the metalworking industries have shown a proportional increase of the occupations deemed as qualified by the workers' collective, simultaneously with the creation of very restricting and boring jobs.

Considerations about the change of qualifications associated to employment are not only important to grasp the strategic importance related with the process of recombining the several sectors of the workforce, but also because of the impacts they certainly have on the present educational system.

It is very important to consider not only the insertion of Latin American countries in the current international division of labor in a fast changing context, but also how those countries are able to work together so as to promote development strategies which can be more favorable to the whole society. Policies aimed at the internalization of the electronics industry complex can be important elements to stimulate the creation of new jobs as well as to have some participation in the process of change. That will be possible if associated with more open policies aimed at the re-structuring of the educational system as well as towards social aspects (i.e., better income distribution, as well as enlarging markets for products and sevices).

Finally it is worthwile to pay attention to the changing managment practices referred to the use and control of labor. In order to discuss these points, it is interesting to retrieve a consensus position posed by the specialized international literature: the association of growth periods with different techno-economic matrixes, patterns or paradigms. With the exception of the "degradation theses" or "Bavermania" which points to a continuum, the other approaches picture the present moment as a turning point and try to explain the process of change from some form of counter-argumentation between the preceeding period and the current trends. We consider the notion of "pattern" or "paradigm" change very useful for the analysis we are conducting.

To Perez (1984), the idea of paradigm is associated with a cohort of common sense principles, aimed at technical and investement decision making procedures. Expressed in a more sociological jargon, that means a group of social practices that are mandatory during some time, as the most efficient and rational ones. These ideas are part of a broader analysis, but are referred basically to the changes in the industrial sector.

Björkman's work (1981), on the other hand, is based on an empirical survey done during the seventies, comprising swedish metalworking industries . He attempts to characterize the methods and strategies of capital accumulation in order to better discuss the changes of working conditions being produced.

To Björkman, what might be happening would be a change of strategy: from "Max" or maximization of the use of machines associated with space saving (fixed capital rationalization) to PIW strategy (speeding up the flow of products at work). In other words, to make use of process industry features (circulating capital savings) in mass-production industry. The former is appropriate to mass production in large industrial facilities. Some of the resulting consequences being: workshifts, the speeding up of work paces, little diversification and an increasing fragmentation and standardization. Labor organization would be based on what has been called "scientific management" or "Taylorism". The latter would be that of flexible, small-scale, decentralized production, even inside large companies. As a result, there would be a greater level of automation and time control, a reduction or virtual elimination of stocked raw materials and finished products (ideally production would start from a consumer's order) and a change in the structure of qualifications so as to shape up the multi-skilled worker. Here it is essential to make use of a flexible lay-out with parallel units and new forms of labor organization such as semi-autonomous groups, "just-in-time" systems, etc.

According to C. Perez we are at present in the midst of a transitional period. From the paradigm characterized by high energy and materials content products, by mass production based on economies of scale, by manufacturer's design and minimum change strategies, to a paradigm based on fast technological change: products with high information content, flexible production followed by specialization economies based on flexibility and the customer's definition of systems and products. Such a change implies new notions of management efficiency in which the company organization would not be based on an analytical model any longer, with sectors and departments and control systems based on hierarchical bureaucracies. A new type of organization would consider connections and inter-relationships, with control systems based on decentralized networks. In relation to the adaptation of production to the demand, period planning would be replaced by a dynamic "on line" follow-up.

Comparing the two works, it's possible to determine the similarities and the differences between them.

For our work, we consider that the idea of a technological pattern associated to a competitive one and to a management pattern, to form a

"techno-economic paradigm", can be useful because it associates social, economic and technological elements within one concept.

Microelectronics based technologies were introduced in Brazil in the mid-seventies along with the beginning of the economic recession and the crumbling of the prevailing labor relations model. The prevailing authoritarian model began to be challenged by different social strata (workers, entrepreneurs and bureaucrats) but without a consensual position as to the new forms to be adopted. Within such a context, there appeared - from inside the productive units - new methods and practices of labor management (QC circles, Kanban, semi-autonomous groups) along with new company - union relationships, e.g. internal commissions (Ford, VW, etc). At the same time technological changes were introduced at a faster than usual pace. Our surveys about the metal working industries indicate a clear correlation between the new forms of management and the introduction of new technologies, which in some cases indicates the possibility of a new relationship pattern between companies and unions. Here it is interesting to point out some emerging elements, such as the decrease of worker turnover rate, initiatives to achieve a greater worker involvement, the demand of formal schooling for relatively simple tasks, and the re-evaluation of careers and salaries.

It is important to point out that the new pattern leads to a greater company dependence on the workers, a feature the Federation of Swedish Metalworkers was aware of, as can be learned from the proceedings of their 1985 Congress. For them this fact could be used to influence joint company-union policy making ventures (Sveska Metallindustri - Arbetareförbundet, 1985). Incidentally the same pattern was found in our case studies about the theme in Brazil.

B. Social Consequences Brought by New Technologies in the Brazilian Metalworking Industry.

The seventies, in Brazil, can be considered a period of great industrial growth. Even though the first symptoms of the coming crisis and economic recession already appeared in 1974, it was not until 1981 that they become evident in relation to industrial employment. The evolution of the industrial employment level challenged some Latin American authors' statements related to the impacts produced on employment characteriscs, job qualifications, and female labor force, by the introduction of technologies in the fifties.

During that time there was a great increase in industrial activities and in the offer of industrial jobs, specially for skilled and semi-skilled workers. Another important element was the massive incorporation fo female labor into production activities, chiefly in the metal-working industry.

Such a process took place under the framework of a competition pattern aimed mainly to expanding the domestic market and protected by restrictions on imports. The capital goods sector was developed from the growing demand of the state sector (i.e., large public works concerning several activities) and from the consumer durables industries also in expansion.

As far as labor management is concerned, we found in mass production industries: what has been characterized by some Brazilian authors as predatory forms of labor utilization, extreme task fragmentation, the extensive use of unskilled labour, the high and induced labor turnover rate, and higher wages than in other industries. New labor legislation as well as the career and salary structures practiced by large corporation were also considered. The relation of the authoritarian prevailing labor regime within the enterprises with the political context, were not neglected either.

However, the crisis in the beginning of the eighties and the process of political liberalization undermined the assumptions of the model. From the competition pattern viewpoint, the stiffling of the domestic market and the foreign debt problem, pose a challenge for the involved companies as new competition patterns and markets are being redefined at eh international level. From the "quantity" production in the seventies, to the "quality" production in the eighties, an increment of the exports and of the domestic competition forced companies to increase theor productivity and eficiency. As to the technological pattern, it can be observed that microelectronics based new products and processes were introduced at a fast pace to counterbalance the economic crisis. On the other hand, the change of management pattern is difficult to observe, even by the responsible agents within the companies. However, we found some awareness within the most innovative companies, the ones which had a faster recovery of the employment after the crisis of the early eighties.

The social consequences brought about by the advent of the new technologies can be measured by the impacts caused both on the involved industries and on the educational system. The latter expanded during the last decade, but downgrading the educational level in general. At the same time that "islands of excellence" were created, working conditions worsened for most workers. Another question is the capacity several social sectors may have to influence the transformation process so as to make social, economic and technological policies aiming at a new model of development, a less exclusive and vicious one.

Trends in Microelectronics. Some implications for the R and D policy of Latin American countries.

1. The movements towards integration, concentration and verticalization by the main manufactures in the field of microelectronics increase drastically capital requirements and the minimum scales of production. They create strong barriers for new companies and countries to enter those markets, affecting directly the strategies of the countries of the region. Moreover, that process leads to a decrease in the opportunities to fill the gap represented by the ongoing technological transition. Although such a technological transition might enable the ascent of some countries able to positively confront the technological challenge , it seems that chances are continuously decreasing due to the growing control by large oligopolistic concerns of a broad range of activities geared to information technologies.

2. There is a growing integration among manufacturers of components and manufacturers of final systems reflecting a more general trend towards a technological convergence within the several industrial sectors directly affected by the development of micro-electronics. The final result, would be the integration of several sectors into a single one dubbed "the electronic complex". Microelectronic based digital electronics provides the common technological basis for this kind of integration process.

3. There is an urgent need to adopt an integrated policy for microelectronics comprising as much of the technological cycle as possible, i.e., raw materials - capital goods - final products. Such a policy is necessary, considering the process of internalization to which the production of capital goods in the field is being submitted, and the mounting restrictions on the trade of micro-electronics based technology due to political reasons.

4. The analysis of the technological trends shows, on the one hand, a growing sophistication of the know-how demanded by the most advanced electronics component manufacturing techniques; on the other, a rise in the required investments to develop them.

5. Microelectronics is a science intensive technological field and, consequently, scientific knowledge is continously being incoporated into the

final products. As a result of the high scientific sophistication of micro-electronics based technologies it is increasingly difficult to transfer technological knowledge by the well known process of "opening" the technological package.

6. It is necessary for the Latin American countries to establish long term scientific and technological strategies aimed at the creation of scientific and technological capability in the main areas related to the development of micro-electronics. That strategy can only be adequately implemented through the joint effort of universities, research centers, governments offices and industries.

7. As far as software is concerned, the present world situation indicates the existence of an important bottleneck responsible not only for a considerable rise in the costs of the final products, but also for a slowdown in the pace micro-electronics based applications permeate the economy. On the other hand, the attempts to change the software production process have not yet been fully successful. In this situation the key element to the development of software is human resources. There is here an important gap that the Latin American countries could close, at least in relation to their basic strategic priorities, through the development of a software industry, which is a key element for any autonomous scientific and technological strategy. It should be taken into account that the barriers to enter this field, are lower than in the case of hardware.

8. It should be a regional joint effort in relation to the construction of the electronic industrial complex. First, because at the national level the R and D capability, economies of scaly , and financial resources are clearly insufficient for such a complex and expensive enterprise. Second, and most important, because a regional cooperative effort in the field of informatics could be a dynamic element to stimulate a real process of integration which is vital for the Latin American countries to confront sucess fully the present process of world transformation.

9. Informatization is beginning to change the very nature of the required skills both for indsutry and the service sector. However, we still do not know enough about this new structure of skills and how it is related to the "traditional" structures. Thus, it seems important to study the process of change of the

qualifications with two main objectives: a) preserve those "traditional qualifications which might be adapted to operate in the new structure; b) identify the obsolete ones in order to promote "reconversion" to the qualifications requires by the new technologies.

MATERIALS

1. Science of materials: its role.

There has been a considerable progress in the understanding of the relationships between properties, structures and processing of materials due to the progress in the science of materials during the last four decades. Thus, "custom" production of materials became a reality, enlarging almost unlimitedly the variety of supplied goods. The expansion of the scientific basis on which the technologies related to the production of new materials depend, allows a more accurate forecasting of the expected results within a given time span, thus helping to attract financial resources for the development of new materials.

2. New materials as part of the advent of new technologies.

The rapid development in the science and technology of materials has accompanied the significant changes being produced internationally in the industrial system (largely conditioned by computer based technologies and biotechnology). Frequently, the advent of new materials (which are intermediate goods, i.e., basic inputs for the production of other goods) is an essential condition to innovate in other industrial sectors. In general terms, changes in the productive structure lead necessarily to changes in the sources of inputs, basically materials.

3. The integration of new materials in the final product conception.

The development of new materials in increasingly being lead by those products which are going to include them. Instead of starting from a stock

of given materials and of adapting them to the intended uses, there is a tendency to go the other way around; new materials are specifically created so as to meet the demand of a given final product. In other words the development and production of inputs is incorporated to conception of the final product. As a result there is a specialization process in the making of new materials, which in turn speeds up their diversification. The substitution of new materials for traditional ones, becomes a less important feature than it was in the past. The emergence of new materials is relatively independent from the displacement of traditional ones.

4. Changes in the nature of economic activities and their effects on new materials.

Changes in the productive structure of goods and services on a worldwide scale also affects the demand significantly and as a result the production of new materials. The growing participation of the service sector in the GNP in relation to industry, and the orientation of the manufacturing industry to the production of goods requiring a relatively lower quantity of materials are examples of factors which reduce the demand for a considerable number of traditional materials. On the other hand, the demand for high performance and specialized new materials is continously increasing. The amphasis is shifting from quantity to quality, from stardand materials to special ones.

5. Changes in the energy picture and its effects on new materials.

A great deal of the efforts directed at the development of new materials is related to problems created by rising energy prices, and to an increasing concern about the depletion of conventional energy sources. Thus a favorable balance between the energy used in the production of a given material and that used in the consumption of the products incorporating it, becomes an important conditioning factor for its adoption. In this way, the substitution is strongly influenced by the increase of energy efficiency obtained in the process of production and consumption.

6. **The role of recycling.**

Recycling is strongly conditioned by the energy balance involved in the process, and for that reason tends to be stimulated by high energy prices.

Another factor that stimulates recycling is its positive effect on the environment. Recycling allows a reduction in the usually high level of pollutants which come from the primary processing of materials, and contributes to the preservation of natural resources. Moreover, recycling can be an economically and environmentally sound solution to the problems represented by industrial and domestic refuse, an increasingly pressing issue in densely populated areas. The growing cost of the disposal of urban refuse, and its environmentally adverse consequences make recycling increasingly attractive.

However, the increasing complexity of both manufactured products and new materials, poses a serious limitation to the expansion of recycling, due to mounting technical difficulties and involved costs. Contamination by unwanted substances is a critical problem in the recycling of materials, demanding an stricter and more diversified chemical control than in the production of primary materials.

MAIN IMPACTS OF THE TRENDS DISCUSSED ABOVE IN LATIN AMERICA

1. The production of new materials covers a wide array of activities ranging from petroleum based chemistry to steel production. Therefore it cannot be considered solely as an industrial sector, nor even as a specific industrial complex, as is the case in other new technological areas such as, for instance, informatics, where it is possible to identify a sector with a clear internal articulation. There is no such equivalent sector for new macrials. The producers of new materials are much more strongly articulated to the consumers of their products than to their fellow counterparts. Therefore, it is necessary to formulate a global industrial policy in order to identify priorities which might orient the production of new materials.

2. Most of the emerging new materials are high technology products thus requiring an industrial and technological capability which is not still sufficiently developed in Latin America. Nevertheless;there are still some favorable conditions for investments in the area of new materials. Many of the

technologies are not yet consolidated and, most important, capital outlays for setting up and operate the plants are relatively modest.

3. The development of new materials is much more determined by the cost and performance requirements of the final products which incorporate them, than by the availabily of raw materials. Another factor which reinforces this situation is that the cost of the raw materials is a continuously diminishing fraction of the total cost of production of new materials. The main consequency of these tendencies for the countries of the region, is the reduction of the dependency of the industrialized countries on the raw materials which still constitute an important fraction of their exportations.

BIOTECHNOLOGY

The studies performed on trends in biotechnology and on the potential of this field concerning food production, have resulted in the identification of some aspects that can be relevant for the formulation of a scientific and technological policy for Latin America. Such aspects, obtained either from empirical sectorial studies, or from theoretical inferences derived from the process of development of modern biotechnology, will be described here in the following sequence: a) the general conclusions that can be extracted from the evolution of biotechnology as a whole; b) aspects relative to the interaction between biotechnology and food production.

From the current process of biotehcnological development on a worldwide basis, the following main conclusions can be discussed:

a. From the point of view of science policy, it would be convenient to consider biotechnology as a biologically based set of techniques for the purpose of obtaining goods and services, and not to reduce the field to only the most advanced biotechnological techniques, as it is the case now in most of the current specialized literature. This is justified for basically three reasons: i) there is a broad spectrum of opportunities in the field of biology based technologies that have to do with traditional and intermediate stages of technological sophistication and that can be developed in the Latin American countries; ii) the most advanced biological technologies will have substantial impacts on production only at the beginning of the next century; iii) the multinational

corporations involved in biotechnology are investins heavily on "intermediate" technologies, as tissue culture, continous fermentation, etc.

To facilitate the study of such a wide technological field, two basic analytical criteria were used: the first one refers to the division of the vast set of techniques into three levels of technological sophistication: the traditional level, which includes already known and rather popularized techniques, such as fermentation in general, classical genetic improvement and the production of inmunotherapeutic drugs (vacines and serums); the intermediate level, fundamentally represented by genetic and protein engineering.

The second one is concerned with the need to consider the impacts of biotechnology according to the specific features of each field of utilization: health, food production, agriculture, energy, environment. This is due basically to the great heterogenity of each fields of application, and to the peculiarities of those fields in each country or region;

b. From the viewpoint of the factors which determine the development of biotechnology, it can be observed that the analysis of the trajectories at the world level indicates a rapid expansion in the seventies up to the beginning of the eighties, when there appeared hundreds of biotechnology firms, and a slow down on productive investments and R&D from 1983 on, iniciating a stage of greater awareness of the real possibilities of modern biotechnology, of consolidation of a few small enterprises, and of a growing participation of chemical corporations based more on the development of intermediate level techniques, than on the most advanced ones, especialy food and agriculture. This change can be explained by four conditioning factors: (a) the technical and basic knowledge limitation detected during the period of exponential growth, when the difficulties concerning both the short and mid term returns of the investments in genetic engineering became clearer; (b) the process of industrial restructuration at the international level, specially of those industries dealing with science based fields such as chemistry, which entered biotechnology as a strategy of diversification, and opted for continuity rather than for discontinuity trajectories in order to make full use of biotechnology to increase the potential of their already consolidated markets, such as for instance, the development of corn and soybean varieties resistant to massive herbicide applications; (c) the difficulties related to the enforcement of legislation aimed at protecting biotechnology based industrial property, either due to the technical difficulties inherent to the patenting of living organisms, or because of the limitation imposed by the "imperfection" of the legislations on industrial property in different countries, be they developed

or not, and (d) by the pattern of state intervention and support of scientific and technological development in the field of biotechnology

c. In relation to the effects of the new biological technologies in Latin America, they are still small and it is expected the their full impact will be felt in a time horizon of the order of ten years. Prospective studies show that the impact will probably be greater in the food production sector (i.e. agriculture + agro-industry).

That trend is indicated by the changes which are currently taking place in agronomical R&D, pointing towards an active development of techniques of plant tissue cultures which change the technological basis of vegetal improvement, so as to optimize them through the introduction of a new set of instruments which opens entirely new possibilities for the creation of varieties, as well as important economies of scale through the shortening of the required time to obtain new varieties.

A direct extrapolation of present tendencies shows the important negative impacts that biotechnology might have on Latin American countries, by accelerating the loss of comparative advantages, as in the well known case of isoglucose vs. sugar. Another negative element is that the agents that lead biotechnological research at world level are the same who presently control Latin American markets, mainly the health and food production related markets, which implies a development trend disconnected from the specific needs of the countries of the region.

Nevertheless, within the normative scenario of the TPLA, and considering the way biotechnology is evoluing internationally, it is possible to identify important opportunities for Latin America. The following ones can be given as examples: a) The present R and D capability of the region allows a rapid mastering of intermediate level technologies, particularly in the field of generation of new vegetal varieties and species, and in the obtainment of products for the diagnosis of vegetal, animal and human diseases; b) As modern biotechnology is still in the process of consolidation, there are important gaps that can be explored, specially in the case of specific regional problems, as the development of vaccines for endemic diseases typical of certain region, and the generation of vegetal species adapted to local conditions; c) Latin America has a great comparative advantage in relation to the genetic pool. It is estimated that between 74 to 86% of all living species are in the wet tropical forest, and 46% of those forests are located in Latin America.

The interaction between biotechnology and food production will be exposed in the following ideas:

a. Concerning the food area the first point to be taken into account is that the main cause of widespread hunger and malnutrition in many countries of the region is related to insufficient income for a considerable part of the population, rather than to food production problems. There are other factors, however, that although not the central determinants of the situation can play an important role in this *problematique* as the unfavorable relations of production of staple foods, and the technical bottlenecks found in some countries of the region in several staple crops.

As to the first problem, the production of basic foodstuffs has faced unfavorable market conditions for the last 20 years in the majority of Latin American countries. The greater dynamism of the market of agro-industrialized products, associated to the entrance of great multinational corporations, determined a greater expansion of those products, and of the associated crops, in relation to basic food products. Besides, the crops for export received special treatment in the government policies.

The process of agricultural modernization - even though with unequal degrees of intensity in different countries of the region-was generalized during the last 25 years, and although it was responsible for important improvements in the productivity of labor and in the physical productivity of the Latin American agriculture as a whole, it was excludent in terms of products, producers and regions. The export products and those directly connected to agro-industrial businesses have had a great improvement, whereas small producers and more backward regions were left out of the process, increasing regional disparities and stimulating the rural exodus.

Although there is presently a greater emphasis for modernization of crops closely related to agro-industry and to the chemical and biological input ind tries, rather than to crops for export, such a move is not necessarily favorable to the production of basic food crops; on the contrary, as more agro-indsutrialized products displace traditional ones, there is an increase in family food expenses.

The lack of dynamism of export crops production, in addition to the increasing food self-sufficiency of most advanced capitalist countries, specially in the EEC, has produced loss of traditional comparative advantages for Latin American countries.

Nowadays, the production of basic foodstuffs in Latin America can count on considerable technological capability. Nevertheless, there exist some bottlenecks in certain regions, specially those characterized by inadequate climatic and rainfall conditions like bush regions, the Venezuelan savannas ; and

the northeastern backlands in Brazil. Moreover, most of the existing technologies have been developed exogeneously, showing a lack of understanding of the local conditions. Therefore, there is a strong demand for more adequate technical solutions for Latin American conditions, so as to make such technologies more efficient, less costly and less damaging to the environment.

b. Concerning the relationship between biotechnology and food production, biotechnology is expected to affect most seriously the food production sector, including agriculture and the processing industry, from the turning of the milennium on. At present the human health market accounts for the largest share. Some forecasts estimate that by the year 2000, food production related biotechnology might represent about 45% of the total market for biotechnological goods.

Techniques with an intermediate level of sophistication, show the most promising possibilities of successful achievements in the short and midium terms. They refer specially to plant tissue culture applications which could enhance enormously the traditional genetic improvement procedures, and open countless possibilities for the engineering of new hybrids and varities. The scientific and technological competence Latin America has in these areas of agronomical research, is significantly greater than in other fields of knowledge.

The interaction between biotechnology and food production should consider at least two issues: the first one, refers to the overcoming of existing technological bottlenecks in the production of basic food, and the second one is concerned with the general advance of biotechnology in order to achieve both internal and external capability, to fill existing gaps in the present international division of labor.

In programmes or strategies of development in this field, it is of fundamental importance to formulate integrated policies - including production and distribution - in order to make compatible the scientific and technological priorities with the overall problematique of the food sector.

ENERGY

1. Present and recent past situation

Ending now the 1980s' decade, and after 15 years of strong changes in

in the world and Latinoamerican energy situation, there are many authors considering that the so called "energy crisis" that outbursted as from 1973 has been overcome.

Although this can be partially true in industrialized countries and with relation to commercial energy sources, the situation is not so in most of the developing countries, particularly Latin American ones, which are still submerged in a deep socioeconomic crisis, partly related to the present evolution of their energy systems. On the other hand, they have not still been structured in such a way as to allow to satisfy adequately the energy needs of each and every one of their inhabitants.

Particularly in rural areas and marginal urban sectors, the crisis of wood supply and other biomass fuels subsists and is even getting worse, and is in some cases accelerating deforestation processes.

To this situation must be added the effect of strong price increases of conventional energy sources, which took place in recent years in most countries, as well as the stoppage or diminution of investments allocated to increase and improve energy infrastructure. This was due, among other facts, to the impact of the external debt . Both factors have restricted the supply and availability of conventional energy sources in the mentioned areas.

Within the sectors of medium and high income and of productive activities there remain also important problems of energy supply owed to maladjustments between: the structure of known energy reserves and supply structures; between levels of generation and production of energy and transport and distribution systems; between some transformation systems, such as refineries and power stations, and the new consumption or supply structures produced by substitution processes among sources; between the level and struture of prices and supply costs; between expansion and reestructuration requirements of the energy system and the present investment programs, limited by the external debt; between the requirements of human resources for planning and managing the system and its availability both quantitatively and qualitatively.

Other problems must be added to the above mentioned maladjustments, such as the lack of technological, human and capital capacities to implement effective programs for energy conservation and technological development; the crisis of the institutional systems that have been developed in Latin America centered in national public enterprises, and which are today strongly questioned, basically from outside the region.

2. Main basic premisses

Taking into consideration this tight conceptual synthesis of the actual energy problem situation in Latin America and the Caribbean countries, it is now considered necessary to establish the main basic premises on which the future proposals for development shall be based.

It is considered that the energy system of the region and of each one of their countries must be oriented towards satisfying the basic needs of the whole population, adequately covering the non-basic ones, based on the level of development reached and ensuring energy supply for the productive system of goods and services of each society.

For attaining this goal, the greatest efforts must be done, within reasonable technologic and economic conditions, towards making the most balanced use of energy reserves of local type, adequately identified, so as to ensure constant supply.

As related to the consumption side, a more rational use and conservation of energy must be stressed; these measures are in general compatible with an integral socioeconomic development process, and constitute the best answer in the short term.

In all cases it must be taken into consideration from the begining the need to minimize negative impacts on the natural and social environment and maximize the positive ones, which normally are produced by the development of the energy system.

From the institutional viewpoint, the role of national public organizations must be recovered and promoted, within a participation scheme at local and regional level, including, among other factors, the kind of ecoperative schemes which have had much success in some countries and sectors.

For fulfilling the above conditions, it will be necessary to promote research activities and local technological developments so as to generate the required new adequate technologies, and also adapt the ones already available or to be developed at international level.

3. Medium term options

Bearing in mind the present situation of the regional energy system, the requirements of the population and of their socioeconomic system, and also the present knowledge of Latinamerican and Caribbean countries energy reserves, it is considered that the strategies to be developed in the medium term (10-15 years) should be centered on the following ideas:

a) to increase the availability of useful energy of the system and at the same time to reduce requirements of primary energy through the application of adequate techniques for the rational use and conservation of energy.

b) to continue making a rational use of known renewable energy sources, particularly hydroelectrical and biomass potentials (as regards biomass, specially in rural areas).

c) to set up descentralized systems for energy supply based on the use of non-conventional energy sources (solar, biogas, colic, minihydro).

d) in the countries where natural gas reserves have been discovered, to promote its integral utilization in coordinationa with the use of oil derivatives with the purpose of supplying not only the big concentrated consumers (power stations, industries, raw materials), but also to other disperse requirements such as those of the residential, services and transport (CNG) setors.

e) in the case of oil and its derivatives, to promote exploration activities so as to obtain a better knowledge of available resources; to develop the exploitation of those reserves; to increase cooperative and exchange activities within the region; to adequate the refineries' structure to the newly structured demand of derivatives resulting from the foreseen substitution.

f) as regards coal, nuclear and geothermal energy, it is difficult to give general criterion, as their possible development at medium term will only be feasible in some particular countries, and in that case they should be integrated in their special energy equation following above mentioned basic premises.

4. Long term options

To be able to define exactly the energy system's long term options, it is necessary to take into consideration the impact of the foreseen changes on the socioeconomic system, since energy is not an end on its own sake, but only a tool to satisfy the populations' and economic and social development's requirements.

Bearing in mind this projects' position in that sense and viewed from the energy angle, we think that, for an alternative long term vision (20-30 years)

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it is important to make a concentrated effort as regards utilization of the basic energy flow which ensures the physic-biological functioning of our planet: solar energy.

Further to the caloric uses at low temperatures that can already be utilized in descentralized systems, the transformation of solar energy into electrical energy through photovoltaic systems, constitutes the main perspective and challenge for deep structural changes for energy supply at long term.

In more developed countries, particularly USA and Japan, an accelerated research and development program has already been started. which could lead to transform (even before the year 2000) photovoltaic solar energy into a competitive source, not only applied to special cases and remote regions, but also for massive uses.

Developing countries, and particularly Latin American ones, have favorably natural conditions for this kind of development which can be profitable if the adequate technologic and economic efforts are made.

The modular characteristics ofphotovoltaic equipments favour the structuration of highly decentralized systems in rural and urban areas, and may contribute to create institutional structures of a more participative and human character, avoiding concentrated and monopolic schemes normally required by the other energy sources in use today.

On the other hand, the foreseeable way for technologic development of this kind of systems make us think that they could be used in the first place in isolated and/or decentralized areas,an afterwards to introduce them gradually into more concentrated areas and into more specific uses, as their cost diminish and becomes more competitive in relation to the centralized systems now un use.

This process, which goes from the periphery towards the center, is also more compatible with the general development premises of the present project, that in the case of other energy souces.

From the viewpoint of the impact on the natural environment, the studies made up to now show that solar photovoltaic energy might have the lowest impact by unit of supplied energy.

In relation to its impact on the social environment, we consider that in most cases it would be positive, since its use implies more diversified and participative social and urban schemes that those normally generated by other energy sources.

Besides, this long term energy strategy is also coherent with the proposal towards using, at medium term, renewable energy sources such as biomass and hydroelectricity, thus minimizing the impact on the regional and the world's ecosystem produced by combustion of any other non-renewable fuel (coal, oil, natural gas) through irreversible generation of CO_2 and other polluting materials (SO_2, NO_x, etc).

To obtain an effective penetration of this technology in Latin America adequately adapted to its socio-economic requirements and avoiding an excessive foreign dependence, it is of fundamental importance to promote research, development and commercial production of this source as soon as possible and with the maximum use of available resources.

In the same way as in the past some countries of the region promoted massive and successful programs for development of hydroelectricity or nuclear energy, it is today necessary and urgent to start a programme for development of solar photovoltaic energy.

Complementary to this central option, it will be necessary to continue studying and developing techniques of rational use and conservation of energy, ensuring always the highest availability of useful energy for the socioeconomic system with the lowest utilization of primary energy sources, which provides, at the same time, for the reduction of negative impacts on the natural environment and the minumum requirements of scarce economic resources.

Both as regards development and utilization of solar energy by photovoltaic means and for the rational use of energy sources, particularly electricity, it is important to explore and bear in mind the recent developments related to superconductivity of ceramic materials. The temperature at which these experiments have been performed, similar to that of liquified nitrogen or liquified natural gas, made us think of multiple applications in the energy field, as well at levels of energy captation (solar photovoltaic), energy transmission (specially electricity), or stockage and final utilization (electric, magnetic and electronic equipments).

As related to the nuclear options, nuclear fision or fusion, we think that this will only be feasible in some Latinoamerican countries, such as could be, at medium term, Argentina or Brazil as regards nuclear fision.

On the contrary, nuclear fusion will not have a significant role in Latin America in the period considered, since this option has still not been established even at laboratory level.

As regards hidrocarbons and coal, they could have a specific and complementary role at long term, for those uses where they can not be substituted

by electricity, as could be the case in the goods and/or human transport, and as raw material for the production of chemical products of diversified kind.

5. Institutional aspects

Simultaneously with the energy systems development and as a fundamental policy tool, it is necessary to structure an adequate institutional framework.

With a very participative and democratic perspective, and with a development style oriented towards the satisfation of spiritual and material needs of all and every one of the region's inhabitants, we think it is necessary to promote structures of coo rative and descentralized kind, integrated to the regional and national public organizations and acting within a global planning scheme, leaded by the State with an adequate participation of all social actors (public and private producers, users, workers, technicians, suppliers, etc).

The institutional structure should be a bottom-up process, starting from local and regional levels and reaching national and international ones.

The energy system, adequately used, could be a concrete factor towards Latinoamerican integration: through building up of common projects along or through the borders; transport nets and distribution systems of electricity and natural gas; mechanisms for commercial exchange of energy products; integrating processes for the provision of equipment, materials and construction of energy projects; mechanisms for cooperation in research activities, training of human resources and financing energy systems development of every one of the countries and of the region as a whole.

III- THE URBAN DIMENSION OF TECHNOLOGICAL CHANGE IN LATIN AMERICA

During several millenia cities have been at the centre of changes and innovations, but until the present urban - driven change, the world population was overhelmingly rural. Even Europe and USA during the industrial revolution and well into the XIX century, were predominantly rural.

The situation has now changed dramatically and in the XX century the population of the world will become, for the first time, mostly urban. The change include not only the rapid growth of the percentage of urban population, but also its concentration in large metropolis, and the increasing relative weight of the urban population of the Third World. This change in pattern of population distribution should be taken into account when considering the socioeconomic impact of the new wave of innovations.

Cities are increasingly not only the locus where technological innovations are produced, but also their main place of application. This subject has been a recent and increasing concern in developed countries and urban researchers forecast important changes in employment patterns, in growth and decay of urban centres, and in urban design and land use patterns.

in June 1987 the research group on urban problem of the OECD starting its programme on Technological Change and Urban Development reached the following conclusions:

"Five principal components of urban change can be identified. These components are global economic restructuring, which involves the rise of the multinational company, the concentration of decisions and capital in world cities and shifting centres of production; automation of manufecturing; the rise of information technology which influences processing and communications, the demographic phenomenon of ageing populations; and household fission which results in smaller, single parent households."

Although most of the problems identified in the developed countries are also matter of concern for Latin America, they must be placed in a different framework. The urban problem is a clear example of the difficulties in direct extrapolation of issues and trends from the ind trialized countries to the Third World.

The first point to be taken into account is the foreseeable effect of accelerated growth and urban concentration of the population of the region. By the year 2025 the general level of urbanization in the region will reach 84%. Argentina, Chile and Uruguay (temperate South America), with urbanization percentages of more than 90%, will even exceed the average figures in industrialized countries. The cities with more than four million inhabitants (21 at that date) will include 30% of the urban population, as compared with 10% to 20% in industrialized countries. At the same date the population of the region will reach 786 millions (362 millions in 1980).

Considering those demographic trends, a simple projection of accumulated urban deficits plus new demands makes it obvious that they cannot be removed and satisfied with either public or private funds given present technologies of urban development. Whether we express them as volume of necessary investment, or as numbers of families in need, housing and related facilities are the highest deficit in Latin America. It can be estimated that public and private investment in commerical housing represents around half of what is required every year. A massive increase of investment in this sector is not probable, especially in a period of restricted public expediture .

The urban population in the labour market wil increase even faster than the cities. Between 1980 and 2000, the urban working force will increase more than 3,4% per year. This rate is almost seven times higher than in industrialized countries (0,5%).

The evolution of urban labour markets in Latin America between 1930 and 1980 has recently been the subject of research and discussion. Most authors arrived at the conclusion that even in the post-war period of very rapid economic growth, the capacity to absorb the urban labour force was limited in the most productive economic sectors. There were various reasons for this limitation, among which income distribution, pattern of demand, and the technologies introduced in the more dynamic productive sectors, should be stressed. As a result there was a relatively larger increase of employment in areas of low productivity, with foreseeable economic and social consequences.

If this happened during the period of post war expansion, it is not difficult to forecast what will happen now, when a new wave of labor saving technologies is spreading through the world in a period of economic depression. The OECD countries, with a labor force growing at a rate of 0,5%, high capacity of accumulation of capital, and no structural unemployment until recently, cannot cope with the problem of unemployment (even leaving aside

the part of the so called informal sector of the economy, composed of workers who hardly survive, deprived of any protection from the state of from trade unions). It is obvious that in the Latin American countries with a labor force growing at a rate seven times higher than in the indsutrialized countries, low capacity of accumulation of capital, and chronic structural unemployment, the employment situation will deteriorate much faster than in the advanced countries. The social consecuence of that deterioration will also be much more dangerous, as the Latin American countries cannot afford to give the unemployed the degree of economic protection provided by the industrialized countries.

Taking urban social needs, and not technology as starting point, one immediately finds imposible to limit the analysis to new technologies. Rather the interplay between new technologies and other technologies must be addressed. This includes transfer and adaptation of current well established technologies; appropiate or intermediate technologies (in relation to specific social groups or natural environments) and the spread and upgrading of traditional technologies.

In spite of the great variety of urban activities and forms, it can be identified in the modern history of cities, periods where urban innovation is generalized and accelerated. The last years of the XIX century and the begining of the XX century is one of such periods where urban innovations tends to cluster (electricity, elevators, generalization of water and sewage sistems, automobile, etc)

Those clusters of innovations can be broadly divided into two distinct categories:

- active technological innovations, with great pervasive potential;
- passive technological innovation wich spread in close association with general socio-economic development and change, or through specific public or private investment policies.

Automobile at the begining of the century,, and microelectronics at the end of it belong to the active type of technological innovations, while housing or basic urban services are more of the passive tipe. The challange is how to combine both of them in a research and development policy for the region.

It is also useful to distinguish between the general technological change taking place inside the city (industry, services) and the technical change in the construction and organization of the city. We will concentrate mainly on the second type of technological change. It is a well known fact that even in the advanced countries expenditures for research and development in the building sector are much lower than for other industrial activities.

Building has been the industrial activity with least technical progress since the Industrial Revolution. Furthermore, technical changes have tended to be concentrated in the industries providing elements for the construction of facilities (transport, communication, water provision, climatization) or in ancilalry activities, rather than in the construction of dwellings.

The main obstacles to the development of innovations for the construction of dwellingswere not scientific or technological, but social and economic. Urban researchers in USA report a considerable number of new building materials wich are not being used because of traditional regulations or lack of economic relevance, since building materials make up only 20% of USA house costs (site, kitchen and bathrooms being more important cost items). This is not the case for poor Third World urban dwellers. In self-help housing, for instance, walls and roof materials are the main monetary expeditures.. How can the new technologies contribute in this areas of urban problems? Up to know current building technology, oriented to homogeneity, concentration ,and massive production, has not been able to innovate in the field of housing, especially housing for low income groups. New technologies,particularly in manterials and microelectronics, with promise of high efficiency on small scale production,greater product differenciation. descentralization and autonomy, may perhaps face this challenge better. The enormous variety of urban habitats which contitute a barrier for the introduction of standard technologies, may become a rich field for experimentation which the new innovations. Some examples can be given.

Low density urban areas are expensive to provide with public services (longer networks, low energy efficiency, low demand). High density downtown commercial areas are also costly and high energy consumers. Intermediate densities in multifamiliar buildings are not accessible to individual self-help builders,even if it is the least costly and more efficient solution. Multipurpose public cooperation, based on careful studies of the regional and local conditions,could greatly reduced the private and public costs of urban development, making possible for poor urban dwellers to benefit from technological innovations not available in a house by house approach, for instance.

A great variety of new materials have been tested for low cost buildings in recent years (earth, earth+cement, local woods, cement+polimers, cement+agricultural by products). The difficulties in disseminating these new technologies are related to comercialization problems, cultural barriers and difficulties to the on site replication of the original designs. An adequate

combination of social science and technological research could be a great help in the field.

- Prefabrication, and standardization of building component has been hampered in Latin America by lack of a steady and reliable demand, necessary to pay for the initial high investments required. Recent research however, shows that in latin American cities standardization and prefabrication of components could be a very important way to innovate in building design and materials at lower costs, provided those market constraints are removed. It is obvious that the solution to this problem rest on a redistribution of income, and on the new forms of social organization proposed by the Model of Endogenous Development.

- Drinking water and sewage sistems. In the last two decades there have been important improvements in low cost alternatives. Biotechnology could make significant contributions reducing costs, increasing the quality of the product and particularly enlarging the environmental carring capacity, which currently hinders the utilization of those technologies in other than very small cities.

- Maintenance and administrative costs. Two interrelated issues which are of special interest, are the environmental and administrative deterioration of large cities. In many cities of the region there is a growing conflict between the city and its supporting environment, due to pollution, overload of carrying capacity, and increasing vulnerability of all types of flows that enter and leaves the city. This is an important field in which to speculate about new technologies and the city. At the same time, as cities grow older, the costs of maintenance, including personnel, absorb the greater part of local budgets, greatly reducing the possibility of investments to improve living and environmental conditions. The net result is a continous deterioration of the urban environment in all its dimensionss.

The more affluent dwellers make up for the deficiences of the public sector by means of their greater capacity to spend (exclusive urbanizations, country clubs, shopping centres). The gap between rich city and poor city inevitably widens. Do the new technologies offer any hope for alleviating this situation ?

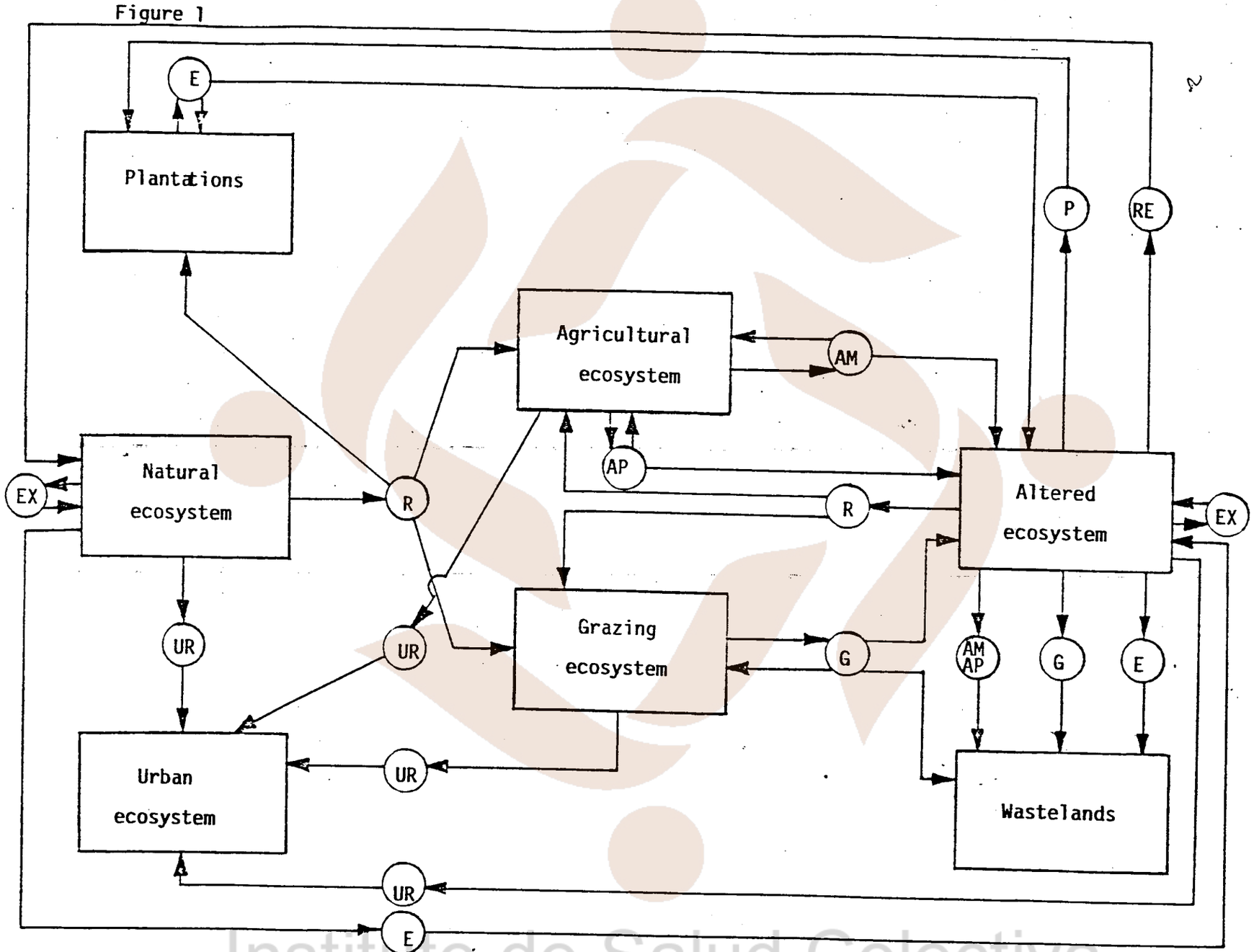
There is no doubt that the new technologies can play an important role in the improvement of the living conditions of the cities of the

region. It is also obvious that for this to happens to only innovative technologies, but also innovative social, economic and political arrangements should be introduced.

One of the paradoxical elements of the present situation is that, at the same time that cities are deteriorating due, to a great extent, to the lack or deficient implementation of measures which have to do with the behaviour and actions at the individual level - such as environmental protection, preventive health care, rational use of available resources and services, community organization, violence prevention and control, informal education, etc - a considerable part of the labor force is maginalized deprived of any social useful task.

The participative society proposed by the Model of Endogenous Development allows the creative utilization of all human resources, and the full implementation of the communitary activities mentioned above. It is also in this context that the new technologies associated to information and communication can help by rationalizing maintenance and administrative tasks, and informed participation.

Figure 1



RE = spontaneous regeneration
R = reconversion
AP = permanent agriculture

AM = shifting agriculture
UR = urbanization
P = plantation

EX = extraction of products
G = ranching
E = forest exploitation

Table 1

Distribution of World Consumption, Averages for 1980-82

Commodity	Units of per capita consumption	Developed Countries (26 % of population) Share (%) in World Consumption	Developed Countries (26 % of population) Per Capita	Developing Countries (74 % of population) Share (%) in World Consumption	Developing Countries (74 % of population) Per Capita
Food:					
Calories	Kcal/day	34	3395	66	2389
Protein	gms/day	38	99	62	58
Fat	gms/day	53	127	47	40
Paper	kg/year	85	123	15	8
Steel	kg/year	79	455	21	43
Other metals	kg/year	86	26	14	2
Commercial Energy	mtce/year	80	5.8	20	.5

Source: World Commission on Environment and Development. 1987. "Our Common Future", Oxford Univ. Press, Oxford.

Table 2

Population and Natural resources available for different regions

	Latin America	Africa	Asia	Developing Countries	Developed Countries	World
Population 1980 (10^6 persons) (1)	361	398	2526	3281 **	1169	4450
% of the world	8.1	8.7	56.8	73.7	26.3	100
Population 1985 (10^6 persons) (1)	405	451	2765	3627 **	1210	4837
% of the world	8.4	9.3	57.2	75.0	25.0	100
Potentially arable lands (10^6 Ha) (2)	736	732	627	2095	1093	3188
% of the world	23.1	23.0	19.7	65.7	34.3	100
Cultivated lands in 1980 (10^6 Ha) (3)	170.9	150.5	466.7	788.1	672.1	1460.2
% of the world	11.7	10.3	32.0	54.0	46.0	100
Cultivated/potential	23.2	20.6	74.4	37.6	61.5	45.8
Permanent pastures in 1980 (10^6 Ha) (3)	546.4	634.9	717	1898.3	1268.9	3167.2
% of the world	17.3	20.0	22.6	59.9	40.1	100
Forests and woodlands in 1980 (10^6 Ha) (4)	1084	1152.2	366.8	2603	2341	4944
% of the world	21.9	23.3	7.4	52.6	47.4	100
Tropical open and closed forests in 1980 (10^6 Ha) (4)	885.5	703.5	331.3	1920.3	0	1920.3
% of the world	46.1	36.6	6.7	100	0	100
Total runoff (Cu.Km/year) (5)	10380 *	4225	9544	24149	14671 *	38820
% of the world	26.7	10.9	24.6	62.2	37.8	100
Stable usable freshwater runoff (Cu.Km./year) (5)	3737 *	1479	2291	7507	4633 *	12140
% of the world	30.8	12.2	18.9	61.8	38.2	100
Livestock (10^6 heads) (6) (ca.1980)	435	520	1020	1975	960	2935
% of the world	14.8	17.7	34.8	67.3	32.7	100

Sources:

(1): FAO Production Yearbook 1986.

(2): Gallopin, G.C. & I.G. Gomez, 1978, p.8

(3): FAO Production Yearbook 1984.

(4): FAO 1981, Lanly 1984, Lugo 1988,1987.
(5) GAIA p.108
(6): GAIA p.36; includes cattle, sheep, goats, horses, mules, asnes
*: Figures for South America; Central America and Mexico included in North America (hence in Developed Countries)
**: Includes "other developing" (5.1 and 5.8 millions for 1980, 1985)

Table 2.1
Tendential Scenario: changes in land use by life-zone.
(% of total area of Latin America)

	BROAD LIFE-ZONES							
LATIN AMERICA	T&sTWF	T&sTDF	TeWF	TS&G	sTS&G	Ma&De	D&SD	Pu&Pa
Area (10^3 Sq.Km.)	20417	9375	4747	339	1066	1038	186	2744	922
%	100	45.9	23.3	1.7	5.2	5.1	.9	13.4	4.5
Natural								
%(1980)	40	63	22	15	40	1	28	21	19
%(2030)	26	44	10.5	7	27	1	14	12.5	12.5
Altered								
%(1980)	22.5	16	33	44	12	15	43.5	28	27
%(2030)	20	18.5	19	40	13	16	51.5	28	24
Wasteland								
%(1980)	2	.1	2	5	0	.2	.5	8	5
%(2030)	5	.5	7	10	0	.5	1	15	14
Agricultural								
%(1980)	7.5	8	8	6.5	3	22	4	4	2.5
%(2030)	13.5	16	15	8	6.5	22	5	6	5
Grazing								
%(1980)	27	12	34	27	45	60	23	38	46
%(2030)	33	19	44	26	53.3	58	27	38	47
Plantations								
%(1980)	.3	.3	.5	2	0	.3	0	0	0
%(2030)	1.5	1	3.5	8	0	.5	0	0	0
Urban								
%(1980)	.7	.6	.5	.5	.1	1.5	1	1	.5
%(2030)	1	1	1	1	.2	2	1.5	1.5	1

T&sTWF: tropical and subtropical wet forests (montane, premontane and basal); T&sTDF:tropical and subtropical dry forests; TeWF:temperate wet forests; TS&G:tropical savannas and grasslands; sTS&G:subtropical savannas and grasslands; Ma&De:mangroves and tropical deltas; D&SD: deserts and semi-deserts; Pu&Pa: Puna and Paramo.

IV - ENVIRONMENT AND DEVELOPMENT

The research carried out in the area of environment and development was centered in the following major subjects: 1) characterization of the current environmental situation in Latin America, actual trends, ecological potentials and restrictions; 2) analysis of ecosystems behavior; 3) identification and characterization of the principal traits of the scenarios in terms of ecological implications; 4) implementation of the regional simulation model for ecological forecasting.

In what follows the main results obtained are summarized.

1. The current situation

1.1 The changing global environment

Ecospheric degradation is proceeding at an alarming pace. Every year 6 million Ha of productive dryland turns into worthless desert, more than 11 million Ha of forests are destroyed (most of it converted to low-grade farmland unable to support the farmers who settle in it). In Europe, acid rains kill forests and lakes, and produce soil damage beyond reasonable hope of repair. The burning of fossil fuels is causing global warming which may lead to a shifting in climatic and agricultural production areas, a raise in sea levels flooding coastal cities, and disruptions in national economies. Other industrial gases threaten to deplete the planet's protective ozone shield to such an extent that the frequency of human and animal skin cancers will rise sharply and the ocean's food chain would be disrupted. Industry and agriculture put toxic substances into the human food chain and into underground water tables beyond reach of cleansing.

All peoples of the Earth share the benefits of the functioning of the ecosphere, all share the costs of ecological degradation, all share responsibility for its maintenance. But this sharing is uneven. The more affluent industrialized countries use most of the world's metals and fossil fuels, as well as the food products that are more resource-intensive (Table 1).

Two major sources of environmental degradation in the world can be distinguished: those associated to prevailing patterns of economic growth

in the affluent societies (and the affluent sectors within the poor countries), and those associated to poverty. Those two types of situations (unsustainable development and unsustainable lack of development) often differ in the prevailing associated processes affecting the quality of life and the ecosphere, but they are not disconnected. At a higher level of analysis, affluence and poverty are complementary sides of the prevailing pattern of economic growth at the world level, an uneven growth characterized by increasing inequality and growing asymmetry between rich and poor countries, and between the rich and poor sector within many countries.

We share with the World Comission on Environment and Development the deep conviction that a new development path is both required and possible, one that sustains human progress "not just in a few places for a few years, but for the entire planet into the distant future". The urgent need for global solidarity is exceedingly clear, and (even if still weak) signals of its possibility are, we believe, growing. They need to be translated into political will.

1.2. The Latin American relative situation

The region as a whole is relatively well endowed in terms of natural resources. With about 8% of the global population, Latin America has 23% of the potentially arable land, 12% of the cultivated land, 17% of the rangeland, 23% of the forests (and 46% of the tropical forests), and 31% of the stable usable freshwater runoff. (Table 2)

The contribution of Latin America to the global climatic warming due to carbon dioxide is small. Deforestation in Latin America contributes with 7,7% of the global carbon dioxide emission. Its total contribution to emission from fossil fuel consumption, can be estimated as a maximum of 11,7% of the total planetary man-made emission of carbon dioxide in 1980.

The acceleration of the rate of species extinction is a serious irreversible global problem. Only about 1,7 million species of organisms have been so far identified, out of an estimated total ranging between 5 to 10 million. About 35% of the identified species occur in the tropics, which are estimated to contain 74 to 86% of all of the species existing in the planet, concentrated particularly in the wet tropical forests. Predictions of the extinction rates vary wildly. According to some authors, extinctions will reach between 20 to 50% of all existing species by the end of the century, essentially due to habitat

destruction in the tropics. The latest forecasts of species extinction in the tropical forests of Latin America by the year 2,000 could be about 10% of the total biota. Still, this figure implies the loss of between 30,000 and 100,000 tropical species, many of them unknown to science.

During the current decade, air and water pollution in some industrial countries receded, due to control measures. However, for the world as a whole, the situation worsened. Air pollution in many Third World cities has reached very high levels. The industries most heavily reliant on environmental resources and most heavily polluting are growing most rapidly in the developing world. Also, a number of transnational corporations are relocating their polluting plants in the Third World, as a response to tighter environmental controls within the industrial countries.

Acid rains associated mainly to industrial pollution are affecting Europe and North America, with potentially serious consequences upon the forests, local climatic change, soil erosion, siltation and floods. Those problems are likely to arise locally also in some areas of Latin America.

Deforestation is perhaps the most pressing land use problem. In tropical America it has been driven by pressure to clear more land for farming, land speculation, the development of commercial ranching, and population growth. In developing regions annual rates of deforestation range between 0,53% and 0,61%, except in Central America where the rate increases to 1,34%. Shifting cultivation is responsible for 33% of South America deforestation; figures of 49% and 70% are reported for Asia and Africa respectively. Even small amounts of cropland conversion in tropical forests generally have severe and immediate impacts, resulting in high levels of erosion, floodings and nutrient loss. On the other hand, reforestation is very low in all developing areas. The reforested to deforested ratio is 1:10,5 in Latin America (1|15,5 in the tropical areas), 1|29 in Africa and 1:5,5 in Asia.

Preliminary forecastings of the effects of unchecked soild erosion over the long term suggest severe decreases in rainfed potential croplands. It would reach 36% of cropland in South East Asia, 30% in Central America, 20% in South West Asia, 16% in Africa and 10% in South America.

Desertification is another major hindrance to production. About 61% of the total productive drylands of the world are moderately to very severely desertified. In Latin America the percentage is 71%, in Asia 72%, in Africa 84% and in developed regions, 36%.

Poorly designed and implemented irrigation systems have caused waterlogging, salinization and alkalinization of soils. Estimations indicate that 10 million hectares of irrigated land are being abandoned each year.

Pastures are in general poorly managed and their productivity is declining. Some countries, particularly in Latin America and Africa, are pushing rangelands to their ecological limits.

1.3. The current ecological situation in Latin America

A number of analysis of the recent history of Latin America clearly indicatesvery high and accelerated rates of ecological deterioration, expressed as deforestation, desertification, soil erosion and depletion, agricultural, industrial and domestic pollution, accumulation of wastes, increased vulnerability to catastrophic landslides, droughts and floods. The problem lies not on the transformation or alteration of the natural ecosystems, but on the actual modality and result of those transformations, implying a degradation of the ecological basis for production, a veritable impoverishment and destruction of the renewable natural resources and vital ecological processes of the region. Many of those alterations, such as desertification and soil erosion, are irreversible in practical terms. The major ecosystems where those problems are more acute have been identified.

A number of broad areas implying major regional or subregional environmental opportunities/constraints for sustainable development have been identified. The most important are:

a) the fertility limitations of tropical red soils (covering 50% of South America) for agriculture; b) sustainable utilization of the deserts and semideserts (covering 15-20% of South America, 35-40% of Meso America) and of the superficial and undeground freshwater stocks and flows; c) sustainable management of the tropical forests and of their ecological functions; d) management and protection of the regional germplasm, and of wildlife; e) sustainable increment of agricultural yields, and sustainable livestock management; f) valorization and utilization of the regional empiric cultural experience in agroecological management; g) management and conservation of fragile ecosystems; h) management and restoration of degraded and/or overcharged regional environments (Andean zone, coastal and island areas, deforested, desertified and overgrazed areas, metropolis, etc); i) knowledge and management of the stabilized neo-ecosystems generated by human actions; j) knowledge and treatment of the regional and sub-regional bio-geo-chemical cycles, and

implementation of inter-country co-ordination regarding human activities affecting them.

1.4. Reasons behind ecological degradation

A comparative analysis of more than 20 case-studies of utilization of renewable natural resources in Latin America (including projects of planned colonization, colonization promoted by the construction of roads and highways, massive high-tehcnology exploitations, and "spontaneous" ocupations) shows that almost all of them resulted in serious ecological degradation with important negative social and economic consequences upon the populations supposedly benefitted from the developments. In the majority of the cases, the immediate causes of the failures were due to human factors: improvisation, gross planning and management errors, neglect to consider known ecological variables, economic rationality of the companies peasant poverty, etc. Most of the problems could not be attributed to a "perverse" or unpredictable behavior of the ecological systems, but to a seemingly irrational behavior of the social agents.

In terms of deeper causes, the ecological deterioration of the region is mainly a product of the functioning of the prevailing socio-economic structures, with their internal dynamics and contradictions, but clearly associated to a style or pattern of development which, even before the current crisis, was becoming less and less viable. This style is: imitative and consumerist; dynamized by the transnational enterprises; leading to an increasing external dependency; with trends towards the concentration of income as well as to the marginalization of large sectors of the population; leading to the spatial concentration of the population, the financial resources and the production; leading to the homogenization of the production, consumption, commercialization and cultural patterns; favoring indiscriminate imports of technology; intensifying the exploitation of the natural resources for exports; allowing the externalization of the environmental costs by the enterprises; and tending to the uncontrolled artificialization of nature. This style is the great macrodeterminant of the acceleration of ecological degradation in Latin America.

1.5. The trends previous to the new industrial revolution

Forecasts made in the early 80's anticipated that agricultural lands (including fallow) would change from 9% of the territorial surface to 14% by the year 2000. Most of this land will come from teh Brazilian Amazon, but a relatively higher proportion will originate from the High Amazon (eastern Andes) with catastrophic ecological consequences because of the fragility of the soil. A similar situation is expected in Central America, with an expansion of the agriculture encroaching the protection forests. The grazing lands will probably grow from a 26% of the total surface to 34%, essentially at the expense of the natural forests, which will diminish from 49% to 33% or perhaps even 20%. The non-utilized, urban and useless-land will change from 16% to 18-20%, the increase being mainly due to desertification. The trends lead to anticipate that for the whole region the ecological problems will aggravate and they could lead to a collapse in the first decades of the XXIth Century, associated to the incapacity of the prevailing, ecologically degrading, forms of agriculture (and particularly of ranching), to feed the population existing at that time.

Those predictions do not take into consideration the current additional pressures towards the overexploitation of the ecological productive basis directed to exports for the sevice of the external debt, nor the pressures associated to the present deterioration of the international terms of trade. This suggests an exacerbation of the trends towards regional ecological degradation, while at the same time, the large development projects are being reduced or cancelled.

2. The tendential scenario

2.1. Characterization of the scenario

On the basis of the starting situation, and the visible trends, a likely scenario has been specified as a frame for the anticipation of the future ecological changes in the region in the next 50 years. This scenario implies a partial continuation of the current stagnation followed by a moderate increase in economic growth, but lower than before the current crisis. The pattern of development would be fundamentally unchanged, with an expanding influence of the transnational corporations. The new technological wave will enter essentially under exogenous determination, with the region maintaining its present passive and defensive attitude.

associated to the general redefinition of the comparative advantages are hard to anticipate because of the likelihood of new, unexpected advantages.

Equally (or more) important than the ecological impacts of the new technologies will be those arising from the diffusion of the already existing ("modern") technolgies and from the changes in products. The recent history of Latin America exhibits impressive product and technology shifts in the agricultural sector. This shows that the ecological effects of the new technologies will not replace in the region those associated to the "modern" and "traditional" technologies, but they will add to them, at least in the next decades.

As it has been shown, many of the foreseeable ecological effects are linked to the logic and behavior of the transnational enterprises and the large organizations of the advanced countries. This is clearly recognized by the World Commission on Environment and Development.

2.2. Modelling ecosystems and land use

The general hypothesis related to land-use are the following:

- a regional initial population growth rate around 2.4% per year, diminishing to 1.2 after 50 years.
- a general growth of total per capita agricultural production around 0,5% per year.
- general crop yields similar to those of the 80's in shifting and subsistance agriculture.
- a moderate increase in the yields of permanent agriculture, essentially for cash crops and cereals.
- a general increase in livestock yield due to technical improvements.
- a general increase in land-use intensity and in agricultural inputs intensity.
- a general increase in the degradation of the agricultural, altered and natural ecosystems due to the intensification of land-use and to forest exploitation.
- a continuation of the advance of the agricultural frontier for land colonization following the sequence agriculture-ranching, but with a slow-down due to the economic crisis and the exhaustion, in some areas, of the potentially arable lands.
- a process of crop diversification in peasant agriculture.
- a general increase in the lands allocated to export crops.

Simulation models have been implemented for the 18 major terrestial ecosystem types existing in Latin America. Each ecosystem is modelled as a set of compartments represented by areas under different regimes and with different

structural, functional and productive characteristics. Every year, land can shift from one category into another according to the intensity and nature of the human activities (depending upon the assumed scenario), and antural processes. The general categories are:

a. Natural ecosystem: undisturbed areas with primary vegetation, but also including areas that have been perturbed in the past and having today a vegetation similar to the original.

b. Altered ecosystem: areas with coexistence of portions of the original ecosystem and secondary vegetation and fallows resulting from forestry and shifting cultivation, areas with soil and vegetation altered by livestock, areas with light and moderate erosion.

c. Agricultural ecosystem: areas annually sown and havested, including permanent and annual crops and non-traditional plantations (coca and marihuana). The fallow of shifting and peasant agriculture appears under "altered ecosystem".

d. Grazing ecosystem: areas with natural or atificial pastures, currently used for ranching.

e. Plantation ecosystem: areas reforested for waterhed protection or for production of timber, paper pulp, charcoal, etc. Includes industrial and non-industrial plantations.

f. Wastelands: areas with severe human-accelerated erosion and desertification processes with irreversible changes in their structure and function (it excludes the natural original deserts).

g. Urban areas: urbanized areas(essentially cities).

According to the scenario and the ecosystem, each year fractions of land shift from some categorias into others. The major processes including ecosystems changes are:

a. Reconversion (for agriculture, ranching or plantations).
b. Permanent agriculture.
c. Shifting agriculture.
d. Ranching.
e. Forest exploitation.
f. Extraction activities (recollection of wild plants, hunting, fishing, etc)
g. Urbanization.
h. Plantation production
i. Natural regeneration.

The general pathways of trasnformation appears in Figure 1.

2.3. The new trends

The results from the simulation runs indicate, for the whole region, the following gross ecological changes, under a reasonable "tendentical scenario":

Ecosystem	Initial 1980	Scenario (2030)	% Total Change
Natural	40,0	26,0	-35,0
Altered	22,5	20,0	- 10,0
Wasteland	2,0	5,0	160,0
Agricultural	7,5	13,5	76,5
Grazing	27,0	33,0	23,0
Plantation	0,3	1,5	450,0
Urban	0,7	1,0	95,0
Total	100,0	100,0	

Table 2.1 shows the expeted changes in the scenario by broad ecological life-zones.

For the whole region those figures imply the transformation of 6.6 million hectares per year of virgin and semi-virgin ecosystems. A fraction of 78% of this surface will come from the tropical areas, 19% from the subtropical areas, and only 3% from the temperate areas. As much as 45% of this transformed areas will become agricultural (30% under shifting agriculture, 15% under permanent agriculture); 30% will be used for grazing and 22% for forest exploitation.

Two major driving processes account for a large part of the dynamics: 1) The advance of the agricultural frontier, translating into a decrease of the natural ecosystems and the growth of the agricultural, grazing and altered areas and 2) The intensification of the use of the land which, in the dry zones, increases the wastelands at the expense of the altered ecosystems, and in the humid zones increases the areas of altered ecosystems, within which subsistence agricultural activities intensify.

Soil erosion problems originated from deforestation, inappropriate agricultural techniques, overgrazing, and overexploitation, will particularly affect the tropical and subtropical mountain rainforests and the subtropicaL rainforest of Central America, the Andean countries, and Brazil. To a lesser degree, the Argentinean pampas will continue to suffer from erosion.

Watershed degradation due to deforestation and damming will affect mainly the tropical and subtropical mountain and lowland rainforests in Central

America, the Andean countries, parts of South America, Brazil, and Mexico, as well as the temperate rainforests of Chile and Argentina.

Floods due to watershed degradation, deforestation, and natural processes, will mainly affect the tropical and subtropical mountain and lowland rainforests in Central America, the Andean countries and Brazil, and some of the savannas, subtropical forests, and pampas of the Andean countries, Argentina, Brazil and Bolivia.

Desertification, associated to overgrazing, excessive extraction of fuelwood, and cyclic droughts, will advance mainly in the Patagonian steppes, the Puna, the dry tropical forests, the tropical and subtropical desert shrublands, and the temperate thorn scrublands in the Andean countries, Brazil, Argentina, Chile, Peru, Mexico and Central America.

Whole region, and agricultural, industrial and urban pollution will increase in the deltas and mangrove forests of Central America the Caribbean, and parts of South America.

The deficit of fuelwood will continue to increase in most of the ecosystems.

By the year 2030, average caloric supplies will increase to more than 3,000 calories per capita/day. Consequently, relative levels of undernutrition will decrease, but absolute numbers of people under this condition will increase.

3. The new proposal

3.1. The endogenous sustainable scenario

A possible and desirable scenario for endogenous development of the region was identified. This endogenous development pattern will be directed to reach an adequate satisfaction of the fundamental needs of the whole population, to provide a better distribution of wealth, and to be intrinsically sustainable in environmental terms. A central emphasis will be a greatly increased participation of the population and a de-centralization of decisions.

The envisaged society would be, in comparison with present advanced countries per capita consumption of resources, austere in terms of material consumption, with consumerism not conceived as a value per se.

In terms of environmental sustainability, the issues of technological pluralism (complementary use of traditional, "modern" and high-technology) and of technological blending (constructive integration of new and emerging technologies into traditional or modern technologies) will assume paramount importance, requiring new forms of organization and an integral strategy for technological development and diffusion. The revalorization and upgrading of traditional technology and of the empirical knowledge existing in the region will become specially important for the medium and small-scale sectors of the rural areas. Many traditional technologies are already better adapted to the local conditions and ecological cycles than the expanding "modern" technology. Technological blending could improve the yields and avoid some of the limitations of traditional techniques. Such a technological integration would permit a reduction in conflicts, could promote self-sustainable technological innovation, could be easily absorbed and adapted to local situations, and would favor social, cultural, economic and environmental sustainability.

Special emphasis will be allocated to the development of new systems of production based on the utilization of the ecosystems already altered including the "neoecosystems" generated by past human activities upon virgin and abandoned lands, as well as to the modernization and yield improvements in the better lands that are already under exploitation.

Strategies will be developed concerning allocation of ecological areas for protection (and in some cases management) of large-scale ecological functions and processes (i.e. watershed regulation, bio-geo-chemical cycles, etc) often involving cooperation among different countries.

The valorization of cultural diversity and participation includes of course the respect for the indigenous cultures, their mode of production and their life-styles.

Food production should cover the needs for an adequate nutrition of the demographic evolution of the total population, and be capable to increase exports when the international demand increases (without jeopardizing internal self-sufficiency).

MAJOR RURAL PRODUCTIVE ACTIVITIES

When appropriate, integrated production systems (agriculture, animal raising. forestry) will be favored. A particular emphasis would be laid upon the development of the productive activites according to ecological suitability zoning.

AGRICULTURE

A general criterion is the maintenance (at least during the period of transition) of productive pluralism, with the coexistence of different major types of agriculture, integrated through sub-national, national and regional policies.

1. **Modern, capital-intensive agriculture.** This type of agriculture will be located in the lands with higher comparative ecological advantages (fertile and stable soils, optimal climate, irrigated lands, etc). This activity should not necessarily adopt the form of large monocultures, but it would include diversified crops, biological control of pests, crop rotation, soil conservation measures, etc. The production will be mostly directed to urban food consumption, industrial crops, and cash crops.

2. **Pesant agriculture.** It requires the implementation of structural reforms and technological innovations directed to the transformation of the present subsistence agricultural sector into a effcient and sustainable peasant agriculture. The production will provide local food self-sufficiency as well as a number of products of high unit value possibilited by the local ecological conditions. It will consists of multi-purpose integrated or mixed farming, carried out by small producers with access to credits, land and means of production. The activity will be labor-intensive, as well as intensive in technologies appropriate for diversified and small scale production. Technological blending will be significant here.

3. **High-technology diversified agriculture.** This agriculture would be directed to the selective exploitation of the local genetic resources for food, medicine. industry, etc. It would imply the development of technologies for a new efficient recollection agriculture in diversified ecosystems, viewing ecological,

diversity, heterogeneity, variability and singularities as resources rather than as hindrances or constrains.

4. **Indigenous farming systems.** Consistently with the respect for cultural diversity and participatory emphasis of the scenario, indigenous communities will be given the opportunity (and means and lands) to maintain their life-styles and production systems if so they choose.

MEAT PRODUCTION

1. **Modern intensive livestock-raising.** It will consist of capital--intensive animal husbandry, either in herds or in barns including also the intensive raising of wildlife with high food or commerical value.

2. **Extensive livestock-raising.** It would imply a modernization and rationalization of the present extensive ranching, including also the harvesting and utilization of native species and wildlife management. Most of the current subsistence or nomadic pastoralism will become transformed into this activity or, alternatively, into peasant agriculture.

3. **Modern and High-technology wildlife management and harvesting.** It implies the management, domestication and harvesting of wildlife in captivity, semi-captivity or wilderness, for the production of meat, fur, fine wool, skins and hides for internal consumption and for export. Major initial candidates are camelids, capybara, otter, alligator. With appropriate management, they can produce higher economic yields than cattle.

FORESTRY

This activity will imply a re-valorization of the forests as multi-purpose producers (wood, energy, wildlife, special products, ecological functions).

1. **Integrated forestry.** Carried out by companies, and by cooperatives linking distributed households. It will be based on the sustainable management of the natural and altered forests, mainly in the tropical rainforest zone, and implying the rational use of most of the species (not only of a few as in current practice). The products, for internal consumption and for export, would include: timber, agglomerates, hardboards, paper pulp, wood flour (for animal

feed), chemicals, raw materials for the plastics industry, fertilizers, soaps, charcoal and fuelwood, plus hunting and fishing products.

2. **Recollection forestry.** It will be an artisan forestry, socially organized and provided with scientific research inputs and it would be mostly located in the forests, savannas and shrubby semi-deserts. This activity would be complementary of the peasant agriculture, with communal organization of turns and zones of extraction. Some of the products, according to the local ecology, could be palm sprouts, rubber, mushrooms, nuts, palms, etc.

3. **Productive plantations.** Carried out by companies or cooperatives; in tropical rainforests, and in dry tropical and subtropical forests with scientific research inputs regarding local fast-growing species. Mostly for the production of paper, fuelwood and charcoal some for timber.

3. **Protective Reforestation.** For watershed and highland protection directed to restore ecological regulation of floods, reducing the silting of reservoirs, etc.

FISHERY

1. **Intensive marine industrial fishing.** Restricted to the open seas, by companies or large cooperatives. For internal consumption and for export, exploiting many species.

2. **Modernized marine artisan fishing.** In the coastal zones. Implies rescuing and improving existing techniques (some of them neglected today) and the utilization of most species. It will require research and technical assistance (mainly to reduce post-harvest losses). For internal consumption (assuming changes in the pattern of consumption) and for export.

3. **Marine aquaculture.** In the coastal zones and estuaries; some in fishponds. It implies priority for the management of local species, and the protection of estuaries as breeding grounds. For internal consumption and for export.

4 **Modernized freshwater artisan fishing.** Similar to its marine counterpart, but directed essentially to the internal and local consumption.

5. **Freshwater aquaculture.** In dams, fishponds, etc. Similar to its marine counterpart. For internal consumption and for export (i.e. trouts).

3.2. The Model of Endogenous Development

Under the endogenous scenario, the region is capable of satisfying the agricultural, livestock, fishing and forestry internal requirements in a sustainable manner within the considered time-horizon of the next 50 years, with a substantial surplus for exports.

Three major processes account for a large part of the dynamics in this scenario: 1) Emphasis upon productive rehabilitation of deteriorated and altered ecosystems (which covers 22% of the total land area) because it represents the most realistic strategy for dealing with many of the complex tropical and subtropical ecosystems; 2) Integrated rural production systems (agriculture--animal husbandry-forestry-aquaculture) are favored whenever appropriate; and 3) Integration of the new technologies into traditional and modern technologies is actively pursued.

The first calculations indicate that the partern of land use would change roughly as follows:

Ecosystem	Initial 1980	2030	% Total Change
Natural	40.0	35.0	- 12.5
Altered	22.5	20.0	- 11.1
Wasteland	2.0	1.0	- 50.0
Agricultural	7,5	15.0	100.0
Grazing	27.0	25.0	- 7.4
Plantation	0.3	3.0	900.0
Urban	0.7	1.0	95.0
Total	100.0	100.0	

Besides the quantitative differentes with the pattern derived from the current trends, the qualitative changes in the modality of rural production imply a drastic reduction of the ecologically degrading processes discussed in Section IV.

For the whole region those figures imply the transformation of 2 million hectares per year of virgin and semi-virgin ecosystems (most of them in tropical areas)

Protected areas represent 35% of the remaining natural ecosystems. Altered ecosystems will cover 20% of the area, the same figure as the tendential scenario. However, in this case most of the altered lands become productive lands (14% under forestry and 6% in rehabilitation). Cultivated lands increase to 15% (8% under intensive agriculture, 4% under agro-forestry, and 3% under shifting cultivation). Rangelands decrease because of increments in carrying capacity (18% is under intensive and semi-intensive grazing systems and 7% is integrated with forestry). As a consequence of the rehabilitation and restoration activities, wastelands are reduced to half their initial surface.

By the year 2030, the average caloric supply will be more than enough to feed the population of that time. Undernutrition will be erradicated.

4. The new proposal and science and technology

4.1. Basic criteria

The concept of sustainable development adopted here does not postulate the conservation of nature in its original state as a primary goal. It implies, however, a pattern of development minimizing the degradation or destruction of its own ecological basis of production and habitability. The goal of sustainable development is the long-term amelioration of the quality of human life, and this implies the management (even the transformation) of the structure and function of the ecosystems in order to benefit from the goods and services provided by them, while minimizing the conflicts inherent to their exploitation, maximizing the mutual support between the necessary actions and activities, and distributing the ecological costs and benefits among the involved populations.

The results from the research indicate:

1. There are no important ecological constraints (at the level of the region as a whole) for the sustainable satisfaction of the human needs and for sustainable development (including food production). The sacrifice of the conservation areas needed to maintain essential ecological functions and services is not required. However, the currently prevailing pattern of development is ecologically unsustainable and is leading towards ecological collapses, showing increasing rates of deterioration of the ecological productive basis.

2. Today, there exists no critical lack of available technologies which could impede the sustainable management of the Latin American ecosystems (in the sense that they represent a bottleneck at the region level). Even when more research is needed, and knowledge for the management of some ecosystems is seriously incomplete, there exists a large number of socially, economically and ecologically sustainable management techniques for a wide variety of ecosystems. There are many needs that can be fulfilled by the existing technologies, often culturally and socially more acceptable than the new technologies. Even if the potentials of the new technologies were not considered, there exists a battery of adequate technologies which, if applied, could make a significant contribution to solve a large portion of the serious current ecological problems.

3. Regarding the new and emerging technologies, the ecological analysis allows the identification of broad regional priorities for R&D, taking into account the major ecological opportunities and constraints for development.

4. The ecological future of Latin America, and the possibilities for benefiting from the ecological opportunities while minimizing the constraints are much more directly tied to the great social options adopted in the region, than to the search for new knowledge and new ecosystem management techniques (although those are also needed).

4.2. **Basic ecological criteria for technology selection**

The fundamental factors that any sustainable technology must take into account to insure ecological sustainability and ecosystem renewal were identified in broad terms. The same factors are considered valid for the sustained management of either natural ecosystems or altered, degraded or artificialized ecosystems. However, the technologies would have to include, in the latter cases, specific measures to restore deteriorated ecological flows, mechanisms or resources.

1. Levels and rythms of input and output flows which determine the maintenance of the ecosystem. Those flows be altered within certain limits by human actions. However, in all ecosystems tolerance limits exist for upper and lower levels of perturbation in the flows with the external world; when these limits are exceeded, structural ecological changes take place. In some cases, the natural

flows can be replaced by human subsidies. For example, the flows of water entering and leaving the wetlands and mangrove forests are critical for their survival.

2. Stock, source or major reserve for renewal. When this stock is reduced below certain levels, vulnerability increases and the renewal capacity is lost. In some cases, human subsidies can replace the natural reserve. For instance, in tropical rainforests the critical reserves of renewal are the understory, the vulnerable soil, and diversity and heterogenity.

3. Ecological supply (stock, flow or ecological functions exploitable by man). Their supply and quality is affected by the other factors, and it may include many unperceived opportunities. For instance, mangrove forests can supply not only wood and other products under sustainable shifting agriculture, fishing and extraction of aquatic fauna, but they provide ecological functions such as nutrient regeneration and dilution of organic wastes and pollutants.

4. Basic internal homestatic mechanisms. All ecosystems posses regulatory or homestatic feedback mechanisms that tend to preserve their functioning and renewal, and those must be taken into account. In some cases, certain parts of the mechanisms could be replaced or artificialized. For instance, intermitent and scarce precipitations in hot deserts inhibits salt and toxic concentration in the soils due to capilar ascent and evaporation. Often, irrigation interferring with this mechanism generates alkalization and soil toxicity problems. Another example is the common population explosion of plagues following the simplification of some complex ecosystems, due to the elimination of natural regulatory mechanisms.

4.2. Environmental R&D priorities

4.2.1. By major new technological areas:

Biotechnology: emphasis on development of sustainable food-production systems (commercial and subsistence), and sustainable management of renewable natural resources adapted to local environments. Exploitation of the regional germoplasm. In some countries where mining is abundant, biometallurgy may be a priority.

Computation: emphasis on education, on micro-computer endogenously developed systems for rural communal units (for medical diagnosis, agricultural management), and for planning of resource development, and management and administration of complex systems of diversified production, commercialization and distribution.

Telemetry: emphasis on natural resources detection and evaluation, monitoring of erosion, crop condition, pollution, forecasting of weather and natural disasters, monitoring of the amount and condition of the national renewable natural resources stock.

Telecommunications: emphasis on access to information (prices, products, weather, pests, alternative agricultural management methods, etc), education, participation,decentralized inter-connexion, tele-diagnosis of problems and maladies, emergency plans of alert, etc. Efficient systems for linking remote and isolated areas.

New sources of energy: emphasis on energetic self-sufficiency of rural communities, benefiting from local conditions (wind, biomass, hydro, sunshine). Development of small-scale energy systems.

New materials: utilization and improvement of locally available mineral and biological materials for house-building, tools, roads, dams, etc.

4.2.2. By kinds of environmental problems for scientific research (none of those are widely researched today).

a) The study of the functioning of most Latin American natural ecosystems including their responses to human actions and natural perturbations. Most of the ecological studies in the region are highly descriptive, shedding little light upon ecosystem dynamics, evolution and resilience limits, and particularly about sustainable and alternative management schemes.

b) The study of the perturbed and the degraded ecosystems, as well as the stabilized neo-ecosystems which have been generated by man-made transformations, in order to recommend appropriate management or reclamation techniques. Those new ecological configurations do not necessarily have low productivity; in many cases they offer new potentially useable resources.

c) The study of the concrete forms taken locally by the relationships between society and nature in a comparative basis in Latin America. Those studies are

essential for the proposal of realistic and acceptable solutions to the problem of ecological degradation, by taking into account both the ecological dynamics and the rationality and conditions of the social actors.

d) The study of the interactions between major ecosystems of the region, which are likely to result in effects taking place at long distances and with long time-lags. This includes aspects such as the regional effects of the transformation of the Amazon basin. the relationships at the continental level between the Andean range as the great donor of water, sediments, nutrients and species, and the lowlands which receive, accumulate and distribute materials and energy; the regional or sub-regional impacts of the growing re-design of the hydrological systems; the impact of changes in land use upon climatic catastrophes across national boundaries, etc

5. Environmentally significant atributes of a strategy for science and technology.

A list of traits of the scientific-technological strategy having environmental importance follows.

1) Definition of needs and development of a basic scientific capacity in relation to the central problems (sustainable food production, sustainable renewable natural resources management, etc).

ii) Development of mechanisms and incentives for articulating the existing and new basic capacity with applied research and technological development.

iii) Development of mechanisms for linking the R&D system with the production sectors, their demands and resources (incentives, channels of communication, etc).

iv) Emphasis on R&D focused around great problems, not disciplines or sectors. Hence, reinforcing of interdisciplinary and intersectorial R&D. For instance, the attack to the food problem would involve ecological, agronomic, economic, social and cultural studies. Biotechnological solutions should interact with informatics, telemetry, telecommunication applications, as well as with the use of new energy sources and possibly of new materials. The final solution could involve a balanced mix of new and old techniques.

v) Reinforcing of co-operative research, involving different centers within countries, and often between countries. Involves the possible development of new research styles and management.

vi) Development of efficient mechanisms for the communication and transfer of results and experiences within the region (today much weaker than the center -periphery communication).

vii) Development of mechanisms for full utilization of local creativity (implies re-defining the application of international criteria for excellence and of the international mainstreams of research; the recuperation and revalorization of local traditional knowledge and technologies; the participation of the local population in the definition of problems and acceptability of solutions, etc).

viii) Development of an institutional capacity for management of technological pluralism, optimizing the installed human and capital capacity (blending new technologies, "modern" technologies, and traditional technologies).

ix) Emphasis on accesibility of the technology to the low-income rural producers and on local self-reliance (avoiding the Green Revolution effect), together with the large sophisticated production systems. Mechanisms for articulating large scale homogeneous agricultural production with small scale, diversified production (minimizing expulsion of rural labour to marginal lands). Decentralizing and deconcentrating approaches.

x) Emphasis on flexibility and adaptability to local conditions and to changes in priorities and directions.

V- RESEARCH AND DEVELOPMENT CAPABILITIES IN LATIN AMERICAN

Introduction

R and D activities in this study are not considered in their strict sense, but on the contrary, the problem of capabilities is placed in a broader context, which comprises several types of activities linked to innovation. Thus we prefer to speak of different types of capabilities, related to different relevant social actors, which provide the foundations for the eventual emergence and/or consolidation of R and D in the future of the region. In this way, within the TEPLA project framework, several studies have been made, oriented to explore the specificities of: scientific, technological, entrepreneurial, management, and labour capabilities. Emphasis has been placed in deepening the understanding of the nature and modalities of each of these capabilities in the Latin American region; and in exploring the complex interactions between them and other relevant dimensions of the socio-economic reality, both within and beyond regional boundaries.

The purpose has not been to produce another inventory, task for which are better prepared the governmental agencies of the region. On the contrary, the attempt has been to produce interpretative analyses of areas of knowledge identified as having crucial importance for our main purpose, the construction of an S and T strategy.

S and T indicators have been one of the topics that concerned us in this exercise. But they do not exhaust the breadth of the intellectual territory we attempted to cover in the project. Thus we try to raise the public awareness about the need of an institutionalized effort in the field of S and T indicators as a useful tool for measurment for policy ends, but also to understand and assess in a more qualitative vein and at a more micro level, specific areas of institutional concern, specific scientific disciplines, publications, etc., about which there is still little empirical evidence in Latin America. Case studies, as the ones carried out within this project, are deemed useful although the data thus obtained were not systematic and showed great variation between fields, sectors, firms, countries and times.

Admitting that in such conditions to generalize from individual experiences would be dangerous, it may nevertheless be recognised that it is necessary to define the problems and understand the processes before measuring them. This is what we have tried to do.

THE IMPORTANCE OF THE TRANSFER OF TECHNOLOGY

For many years students of economic development, political and administrative development, and technology transfer have been trying to figure out what factors make possible the effective assimilation of foreign technology in developing countries, and what factors explain the development of indigenous innovative capabilities. More recently, students of international business have begun to analyze the fact that the predominance of multinational firms with centralized direction and research might restrict the national learning based on practice and use, as well as on other informal skills. This literature indicates that the motivation for and performance of technology transfer varies greatly by type of industry and by individual corporation strategy. Indeed, the very concept of technological transfer is not likely to be the same for enterprises in different industries. Neither will it be the same for different countries.

In economies that are net importers of technology, which is a common condition of the underdeveloped world, when a country imports industrial technology linked to an investment project, its production capability increases; however, this does not necessarily means that the country has achieved any significant growth of its technological or scientific capabilities. Therefore, a central problem for a country that imports technology is to acquire not only the tangible elements of production capability, but also the intangible ones of technology capability (the resources of knowledge and skills) that will allow it to adapt, assimilate and improve the imported technology.

In this sense, the process of technology transfer has obvious interest and cannot be taken to be contradictory with the development of technological self-reliance, as has been depicted often in the past. Since this is often the only way by which less developed countries can acquire and develop their own technological capabilities, it involves the need of identifying the different factors which allow to carry out a process of accumulation of technological skills and abilities (learning) linked to the process of technology import. Thus it becomes indispensable to have indicators useful to

know to what extent such process helped to increase the technological capability and not merely the production capability. It is within this conceptual framework of the technology transfer that the TEPLA analysis of technological and scientific capabilities has been developed.

THE SCIENCE COMPONENT OF THE R AND D CAPABILITY

Students of development, especially economists, have tended to dismiss the importance of indigenous scientific capabilities, regarding them as a misuse of scarce resources. They have maintained that the issues in the developing world are usually more technological than scientific, and that these cannot be understood apart from an understanding of the "technology flows" which have come to characterize world affairs.

Science, however, does not have one single meaning and may refer to a wide variety of activities and fluid definitions. It is regrettable that one-dimensional thinking, on one or the other end of the S and T relationship, prevails in current debates. Clearly, an approach is required that admits both the importance of the indigenous scientific development issues and the international technological linkages.

The disregard of the importance of scientific capabilities for economic development in Latin America is largely responsible for the weak participation of scientists from the region in activities related to the new frontier areas of science. The people in charge of defining the development strategies for the particular countries and for the region as a whole, do not seem to be sufficiently aware that our stark inadequacies in basic science constitute a strategic liability for the growth of competitive industries in the world markets and for an active participation of our countries in the expanding frontiers of knowledge.

It is not necessary to discuss here all the arguments given to justify to attitude to science we are refering to. We will briefly consider those which are specially relevant for the objectives and the philosophy of the project.

A first and old one is that science is a "cultural luxury" in countries with hunger. It is not profitable to invest in research and in areas of knowledge which at best can manage to contribute to the mainstream

of international science but which surely will not result in material benefits for the poor countries that would finance such an activity. This argument implies assuming a perverse view of the less developed world, denying it the possibility of actively participating in the creative human experience. Science is culture, and culture is as a vital a part of humanity as material subsistence.

Another objection is that the construction of scientific communities in the region has been irrelevant or useless, for the process of industrialization and economic growth. This argument, which goes against world experience, could only prove at best, that the amount and orientation of the present scientific effort in the region is not sufficient to produce detectable results. Besides, it is not easy to "prove" the direct social and economic benefits accruing from investements in science. This task, which is so difficult to carry out in industrialized countries, becomes much more intrincate and arduous in developing nations, where the linkages are more complex and less transparent. We made a critical review of the literature on indicators of science and technology for development, trying to show the limitations of available indicators and the prior need of more appropriate approaches for the interpretation of current processes.

The lack of integration that the scientific activity carried out in our countries has with industrial and agricultural production - according to some authors - would be due to the lack of interest by the local scientists and the little usefulness of their products. In our view the root of this difficulty is the lack of an effective demand by a local industry which is deformed, weak and highly subsidized. The post-war economic development of Latin America was based on import substitution, requiring a limited growth of the technological and scientific capabilities. But more recently, it became clearly import-intensive in the most advanced technological areas, redering increasingly superfluous the small and weak national scientific capabilities. Given the irrelevance of scientific research to the style of economic growth adopted, it could only result in the discouragement of the national efforts to build up the required scientific capabilities observable today in most countries in the region.

The problems of scientific capabilities are often phrased in terms of the old distinction between "basic" and "applied" science, equating the former with "superfluous" or "luxury" and the latter with "useful" science. This is to a large extent a false antinomy, and the problems of science in the region today have more to do with the inherent weakness and poor quality of a large portion of the efforts, than with its being

"basic" instead of "applied". The need to identify strategically important areas of basic research has emerged in the 1980s as a central concern in all the major industrial societies. Broad areas of what was known as "basic" science are thus being transformed into what has come to be called "strategic research", more obviously linked to long-term technological and economic criteria (along with the usual scientific ones). Thus, Latin America needs urgently "strategic" (basic) science embedded in a strategy of social and economic development.

- While in the most industrialized nations basic research is accorded great prominence within national and international reports on science and technology in the "new economic context" of the late 1980s, the rest of the world is subjected to a message geared to make them good buyers of "new technology". Views commonly advertised and assimilated in Latin America call for an industrial development and the construction of a technological capability which do not share any of the crucial ingredients of industry and technology in the advanced industrial countries, as if there were two such new technologies, one for the developed world and another one for the under developed one.

By accepting that the advanced technologies be generated and produced elsewhere, what can be expected for Latin America is that it assumes once again a subordinated role with regard to the most industrialized countries.

THE TECHNOLOGY COMPONENT OF THE R AND D CAPABILITY

The previous discussion indicates the need of a dynamic clear strategy to update and expand scientific activity in the region, as a pre-requisite for industrial development. But scientific capability, even if strategically oriented, is not enough. The region has shown a remarkable incapacity to absorb, innovate, develop and incorporate technological knowledge in productive activities. So, we need to improve dramatically the technological capability of Latin America, meaning by it the set of resources used for exploiting the technical knowledge potential and for transforming it into: new production units (incorporating or not new technical knowledge), improvements in the existing production units and the creation or modification of products.

R and D is only one of the sources from where technological capability can be measured. Technical change has a multiple origin.

R and D only produces new knowledge, not technical changes, which in order to occur needs of other activities besides those of R and D. Among them, learning by doing, reverse engineering, small technical improvements, cost reduction by improvements in maintenance and reliability, and quality control, stand out.

We reviewed the main approaches to this subject, organising the literature as placing the emphasis on:

a) A "scientistic" way of assessing technological capability which is the most frequent and better known. Some effort of TEPLA consists in a critical review of major approaches in the production of indicators of technological capabilities.

b) An apppproach that sees technological capability as different from scientific capability. Here the emphasis has been on the nature of technical change at a micro level, and a distinction can be made between the literature related to the developed countries and that related to underdeveloped ones, particularly Latin American.

Although the latter approach has the merit that it acknowledges the specificity of technical change, its overall concentration on the micro level ofthe firm must be supplemented with more macro approaches that allow to analyse other crucial dimensions of the national technological capability.

However, given the state of knowledge in the region, it is necessary to develop indicators for measuring adequately the process of accumulation of technological skills and abilities taking place in the local firm when it acquires and uses foreign technology, and for the country as a whole in connection with its national decisional autonomy. An exercises was made within the framework of TEPLA to propose of a set criteria and categories for the elaboration of indicators in the area of microelectronics. The underlying idea here was that it is important to measure not only the internal capabilities of a country for the generation of technology, but also its capabilities for facilitating the process of diffusion of such technologies in the rest of the economy. The study analizes a number of widely held assumptions in the field of microelectronics which are particularly relevant for the formulation of an R and D strategy. We will briefly refer to some or the most important ones.

One of the accepted general premises of any R and D policy is that the microelectronic based industries present problems which are very different from those of the electro-mechanical ones.

Although the pervasiveness of microeletronics makes sometimes difficult to differenciet clearly between microelectronic and eletro-mecanic based industries, there are sub-sectors which are really highly specific, such as the components and softwere industries. It should be taken into account, however, that the problems they present, from the point of view of R and D policy, vary widely. In the components sub-sector the difference lies in the high rate of technological change to which the sub-sector has been subjected since the innovation of the punctual contact transistor in 1951. For the developing countries, such feature becomes a strong barrier for entrance. The production of the world eletronic industry is highly concentrated in the developed countries, and is heart is the components industry.

As far as the software sub-sector is concerned, there are differences depending on the generic functions that the software may fulfil: systems software, applications and data bases; or according to the degree of standardization: custom-made or packages. The production of systems software is directly linked to hardware producing firms. It is very difficult to fragment the market, which reduces the possibilities of penetration by local firms. The production of applications software is transferred to independent enterprises under arrangements of exclusive distribution, with scale economics and therefore it is highly concentrated.

However the need to give an answer to the requirements of the local adaptation of systems, with a direct understanding of the needs of users and environment, has resulted in the proliferation of local applications software enterprises to respond to this need. The design capability is identified with the production capability, and thus large manufacturing capabilities are not required; the exploitation of market niches is made feasible, which allows to obtain advantages of the economies of localization and especilization.

An important area of discussion refers to the difference in the character of the problems confronted in the generation of technologies in microeletronics, as compared to the ones confronted in the electromechanical technological field.

In this case the differences between the old and the new technologies are sometimes overemphasized. Concerning the design capability it is necessary to distinguish between having a pure design capability (the capacity to generate new technologies starting from knowlege generated from basic research), and effective design capability, which produces commercially successful designs and depends, among other factors, on the knowledge of the market and the manufacture capabilities of the enterprise. This means that

besides the design capability, in order to enter successfully the eletronics field it is required, as in any other industrial sector, production, marketing, financial, and management capabilities. Therefore, an adequate combination of these capabilities with an effective design capability, can greatly contribute to overcome the obstacle posed by a limitation in pure design capability.

Another assumption is that micro-electronic technologies are, on average, in the initial phase of the life cycle, i.e , that they are not mature technologies, which would imply that entrance barriers are less than for established technologies. However, the electronic complex presents variations in the life patterns of the technologies for specific products and sub-sectors. Such diversity of patterns of behaviour in the life cycle of products reflects the degree of maturity of sub-sectors. Thus it cannot be generalized that the products of this industry are in the initial stage of development.

Entrance barriers have too frequently been subestimated. There will be entrance barriers in the early phases of the life cycle of some products, due to the very complexity of the technology and the scale of the required investiments. And on the way towards technological maturity there appear other barriers to entrance (financial, scale, marketing), which if not necessarily insurmountable for developing countries, should be seriously taken into account in the design of an R and D strategy.

During the Fifties and Sixties, in different parts of the world, including Latin America, quantitative measures of Research and Development began to be made, starting from what was more immediately measurable: research expenditures on basic, oriented and applied science; research expenditures by source of funds (government, industry); scientific manpower by socioeconomic objective or discipline; total R and D personal per thousand labour force; supporting staff per researcher or university graduate; and/or R and D services provided by libraries, information agencies, etc.

These statistics afforted essential data. From them a number of indicators began to be built, reflecting variations of a common theory, to which criterion levels were related that stood for the health and good balance of the R and D infrastructure of the country. Usually available indicators have

been more appropriate for the most industrialized countries, than for the majority of the countries in which science and technology sre not so tightly embedded in the social frabric. Thus, for instance, after three or four decades of tradition in the elaboration of inventories of R and D personal and material resources in the Latin America region, we now know that this kind of information is in need of serious revision. Many of the people administratively registered as researchers because they belong to the universities, do not qualify as such in terms of the relevance of their scientific technological or pedagogical contribution. "Body counting" of the people in the payroll of universities and research institutes is no substitute for technical and "strategic" evaluation and this is long overdue. Therefore, since the problem of less developed countries is to apply scarce human and material resources to do something new, using established procedures of asseement as a tool for policy-making may be a necessary starting point but not a sufficient one. We need indicators that seriously reflect the directions that the national scientific and technological effort follows. A significant part of the TEPLA project effort in this areas was spent on re-thinking the problem of indicators of R and D capabilities for development, and on showing the need of very particularized sets of indicators according to well defined social and technical objectives.

It is a truism to say that R and D in the region continues to be weak and fragile. However, conditions today are quite different from what they were twenty, thirty or forty years ago. Problems, needs, challenges and opportunities differ in significant way from those of the past. At present there exists already an R and D capability which must be expanded, assessed, re-defined and re-oriented, and where the weight of the existing systems constitutes in itself a challenge, since in not a few cases they have become powerful obstacles to further changes in this field.

The economic, cultural and political heterogeneity between the countries is perhaps the salient feature of the region as a whole and this is reflected in R and D characterisos as well, both in terms of size and complexity. There has been a significant institutional differentiation at the national level, and universities are no longer the almost exclusive loci for research. To it have been added the public enterprises, the private productive sector and private R and D institutions, all of them alsc internally differentiated by functions and rank.

Although scientific activity constinues to be a practice

of small groups in almost all the countries of the region (with the partial exception of Brazil, Argentina and Mexico), there are indications that traditional "academic science" is diversifying and a version of "industrial science" has emerged in several places. A current transformation under way in the most advanced countries in the region, is that science is being forced to subject to the particular rules of capital and commercial dynamics in which their national economies are involved, and this does not happen without friction on the national scientific community. But contrary to frequent criticisms aimed at a supposedly conservative behaviour of scientists, uninterested to participate in industrial development, our results point to a different line of interpretation. Scientists justly resent their lack of influence to make their opinion heard at the relevant political levels, in order that the technology transfers could reinforce the national capabilities and therefore the national autonomy. Despite the fact that less developed countries sometimes have low cost well trained researchers, transnational companies have shown little interest in facilitating the growth of R and D in them. Besides, very few governments of these countries have attempted to link the technology transfer to the national R and D by means of permits, fiscal incentives or their instruments.

In the necessary social and economic transformation, the State have a crucial role. It is obvious that in Latin America it is only the State that can sustain a large proportion of the existing science, be it academic or industrial. It is only the State that can make the required long-term and risky investments, and support the basic, strategic and applied research that the solution of social problems demands.

All trends indicates that the products in the world market will have an increasingly higher R and D content. A most valuable international resource will be the researchers. The global distribution and productivity of human resources in R and D will become an important variable in international commerce. The prospects of international migrations suggest that throughout the world competition for the scarce talent of scientists and engineers will intensify. Latin American countries should revert their "brain drain". The R and D capability will be a key variable to determine the regional political and economic balance, particularly with regard to the possible emergence of some industrial centers that may define new forms of intra-regional cooperation.

Informal learning skill, rooted in the national culture and less subject to external transfer, are as important as the formal criteria of R and D, be it expeditures, human capital or local research. And they are closely linked to the general education base of the country, and the presence

or not of a broad scientific culture. This is a pre-requisite for having informal learning skills, and these enormously facilitate the development of formal R and D capabilities.

Despite all the changes, it is good to remember that the universities will continue to have a central role in the region. Therefore, its critical problems of today are part and parcel of the R and D agenda, and cannot be solved separately. Massification and lowering of quality standards require deep and extensive administrative and other institutional innovations.

Stability, continuity, descentralization, flexibility and inter-linkages with the various sector of the economy, must be defining features of R and D planning.

Basic Needs: The Health Problem

One of the fields of special interes for the project is basic needs: food, education, helth and housing. The problems concerning food have been treated by the Trends in Science and Technology (biotecnology) and Environment and Development research areas, and housing by the Urban Development research area. As for education, the interest has been centered in its content in relation with the proposed society.

We concentrated part of our work in the health problem, a subject of special interest, not only by its social relevance, but also by the conceptual revolution produced in the last years.

In recent years there has been a conceptual renewal in the health domain, mainly around the program of Health for All in the Year 2000. Now health is no longer measured only in terms of morbility and mortality, and prevention is not limited to vaccines and environmental sanitation. It is conceived integrally as quality of life.

These conceptual changes have deep implications for the redefinition of the lines of action in the health sector, among them in the aspect of human resources. Health ceases to be only care of disease and therefore it ceases to be a strictly medical problem, to become a social problem, with several manifestations in the individual and in society.

In Latin America, the countries concerned have insufficient knowledge about the real condition of human resources in this area. The available information was collected with a conception of health different from the one being proposed, and therefore it is not very useful to help in the definition of policies for the sector.

We made a study that contributes descriptive data of the situation of health human resources in five countries: Argentina, Brazil, Cuba, Mexico and

Venezuela, as well as a discussion of the indicators used for its description and evaluation. Its limitations are identified and recommendations are made.

According to conventional indicators, there is an apparent over-production of some categories of professionals in the area of health human resources, which has been tried to be solved by proposing to cut down the numbers of medical doctors graduating from university in the region. But in fact, what we have is an absence of appropriate information and adequate indicators that may lead to the design of efficient policies in this field.

The available information emphasizes the production of human resources aspect. Thus for instance, the indicator of the number of graduates and its relationship to existing positions shows that absorption is low, with saturation of the employment market. But it says nothing with respect to which employment market, whether it is that corresponding to the health of the entire population,or that of the State, which restricts the social expenditure in health as part of its programme for re-negotiating the external debt.

The medical doctor/inhabitant ratio is said to be adequate because in its measure are used the global figure for medical doctors and the global figure for inhabitants, assuming that all the population is homogeneous. But it so happens that the population does not have equal opportunities of access to the services. Therefore, this indicator does not say much with regard to the need or not or more personnel.

The geographic distribution indicator is insufficient without the analysis of to whom and how it is distributed. It does not inform as to the accessibility or equality of the service.

Utilization of health services is an information only subjected to underemployment and unemployment considerations, but the population and its real use of the servicesare not taken into account. Utilization as an indicator, without taking into account the user, says nothing.

Specialization as an indicator evaluates a particular trend of the organization of health services, revealed by the increasing specialization of medical doctors and the freezing of public positions.

The foregoing was presented to suggest that the package of indicators available to public decision-makers, reflects the dominant conception in the organization of health. As such it is coherent with a practice of restriction of public expeditures and increasing privatization, which is legitimated by way of the available indicators which do not reflect the real social dimensions of the health problem.

In no case (except for Cuba) the indicators that are coventionally used contrast their data with the general health situation of the population. Thus helth (a social phenomenon) ends up being the grand absentee in the literature about human resources in the health sector.

There is no contrast of the information on helath human resources, with income distribution, increase of unemployment, etc.

The current batteries of indicators do not allow to measure processes of change, but only quantitative results of the programs themselves. They do not allow to know the progress made in the implementation of the goals of the Health for All in the year 2000 programme, as far as social aspects are concerned, there is no evaluation of the services and their limitations.

Combined with this critical study of indicators in the area of human resources capabilities, we made another on the achievements of the strategy of primary health care in Latin America. The main trends in the written production about this topic were identified and analized, as well as the proposals and results of some concrete Latin American experiences, taking as indicators the following: conceptualization, community participation, intersectoriality, and orientation towards sectors of the population.

We conclude that there exists a contradiction between the policy advocated, and the strategy developed to put the primary health care program to work. Traditional ideas and concepts continue to be used, and of course indicators continue to be the traditional ones.

The philosophy of the Panamerican Health Organization is oriented to conceive of primary health care as a set of actions addressed to improve the quality of life of the population. But in 50 per cent of the cases analyzed in Latin America, this program is limited to a set of actions carried out at a first level of care. This conclusion is redimensioned with the results of the study, which show that in 50 per cent of the cases, primary health care is second rate care for second rate people.

POLITICAL ECONOMY OF SCIENCE

This research has analyzed the recent historical evolution of the science and technology systems of Latin America. The interactions between the institutions and actors involved in the generation and diffusion of technology and the productive systems of the countries of the region were studied.

During the first phase of the project the local R and D systems were studied in four types of national environments:

1. Countries with a relatively high degree of industrialization, and with a significant scientif capability, such as Brasil, Argentina and Mexico.

2. Countries belonging to the Andean Pact.

3. Central American Countries.

4. Cuba, the only country of the region with a planned economy.

In the second stage of the project the research was centered on the following subjects:

1. Models, objectives and strutures for the institutionalization of science and technology institutions in Latin America.

2. Systems of Scientific and Technological research in Latin America.

3. Instruments and mechanisms in the support of R and D activities.

4. The role of the universities in the development of scientific and technological research.

5. Regional cooperation in science and technology.

The results of those studies are a valuable contribution for the institutional dimension of the R and D strategy.

VI - THE SCIENTIFIC AND TECHNOLOGICAL STRATEGY FOR THE REGION

As already stated, the central feature of the adopted methodology is that the basis for the formulation of the R and D strategy is the R and D demand of the proposed society. This approach implies a sequence of steps: a) definition of the character of the desirable society; b) identification of the obstacles to the attainment of that society; c) formulation of a socieconomic and political strategy for the overcoming of those obstacles; d) determination of the R and D demand of the strategy.

The selection of the viable and desirable society proposed by the project starts by characterizing, through key variables, the possible regional and international scenarios. There basic scenarios are considered:

The first one, the "rupture scenario", assumes the continuation of present trends under the American hegemony with its monetarist policy. It is considered that this scenario does not have long term viability, and most probably leads to a reformulation of the international situation. The second scenario - which is considered more viable then the first - emerges from that restructuration of the international system. A new international economic order is established through an agreement between the advanced countries, which ensures the continuation of the control of the Third World countries by the central powers. The possible future development of the Latin American societies is explored in the context of this scenario in relation with the following aspects: international trade, distribution of income, employment, regional and subregional development, urbanization, energy model, and pattern of industrialization. No significant changes are envisaged in the North South relations, and in the internal social conditions of the countries of the region.

A third scenario represents an alternative to the second scenario, on the assumption that the advance of the process of democratization going on in the region, and the action of new social alliances determined, at least in part, by the social impact of the new technologies, could lead to the choice of a more autonomus and socially equitable style of development. This option called "Model of Endogenous Development (MED)" is the equalitarian, participative, intrinsically compatible with its physical environment, and autonomous society that was briefly described in the first part of this report.

Using those basic characteristics as a frame of reference, it is possible to identify the short and medium term objectives - second order objectives - which attainement constitute preconditions for making possible the desired society. In very general terms, the main medium term objectives would be the following :

- The satisfaction of the basic needsof the population - nutrition, housing, education, health - to the level required for a person to be completely and actively incorporated into his of her culture.

- the effective incorporation of the whole population into the market of good and services. It is estimated that more than forty percent of the Latin American population is outside, or almost outside, the non staple goods market.

- A restructuration and modernization of the entire productive system.

- The control of the negative impact of social activities on the physical environment. The final goal is a society intrinsically compatible with its environment. Intrinsically means that the compatibility is not obtained through *a posteriori* corrective measures, but due to the very nature of the style of development.

- The political democratization of the Latin American societies. Without this conditions there is no real possibility of attaining the above objectives.

The strategy to attain those objectives should consist of a set of specific socioeconomic measures or actions conducive to the implementation of the MED (Plan of action). Each of those measures or actions should be explicitely connected to the objectives and obstacles identified. In other words, the strategy should be translated into tactical moves. The strategy is in general terms constant; the tactical moves could vary considerably, depending on the initial conditions, conjuctural determinants, etc.

Some of the obstacles - basically the external ones - are very difficult to eliminate through the actions of individual countries. The policies should aim at: a) to explore the degrees of freedon left by those obstacles, and to devise socioeconomic policies which - as far as possible - minimize their influence; b) to try to eliminate totally or partially the negative effects of those obstacles through the joint action of the countries of the region.

The plan of action can be divided roughly into two stages. The first one sould deal with the problems which requires immediate attention, and

whose solution is essential for the implementation of the second stage. The second stage deals with the policies required for the attainment of the first order objectives of the MED.

First stage

The most immediate pressing problem of the countries of the region is the adequate satisfaction of the basic needs of a great proportion of the population. The key factors in this problems are the distribution of income, and the structure of production. The required policies can be grouped as follows:

a) Redistribution of income

There are direct and indirect policies for the redistribution of income. Some of the most important are:

- agrarian reform
- selective salary policy
- reform of the income tax structure
- reformulation of the state policy in basic services: education, health, housing
- protection for the unemployed

b) An economic development policy based on the internal market.

The main economic measure would be:

- tax reform aimed at the generation of financial resources for the solution of the most pressing social problems.
- a reformulation of the policy related to the external debt. Whatever the solution - moratory, or the establishement through an agreement of a fixed percentage of the external income to be devoted to the payment - it should allow a growth of the economy compatible with the social goals.
- a selective policy of economic growth based on social priorities.
- reestructuration and reorientation of the state apparatus in order to adapt it to the new policies.

Second stage

During this stage the conditions for the attainment of the first order goals of the MED should be created.

Central objectives of the policies to be impemented would be:

- To reformulate the socioinstitutional matrix in order to make it compatible with the creative incorporation of the new technologies, and with the first order goals of the MED.
- To reformulate the pattern of consumption and production. This transformation is also an unavoidable consequence of the redistribution of income.
- To increase the efficiency of the productive system in order to make it compatible with the new pattern of accumulation. It implies a better intersectorial integration, and a greater technological dynamism .
- To reformulate the criteria of economic efficiency in order to integrate the social and environmental dimensions.
- To regulate the spacial distribution of the economic activities.
- To implement an active policy of regional integration.

The two stages of the strategy do not imply a strict chronological sequence. Depending on the circunstances, and on the character of the specific policies, there will undoubtedly be a considerable overlap between the two stages.

The scientific and technological dimension

In the first two steps of the sequence - definitions of the goals of the MED, and identification of the obstacles to the attainment of those goals - the scientific and technological dimension does not appear specifically. It is only in the step of the formulation of the strategy for the implementation of the MED that the scientific and technological dimension enters as an explicit variable.

In what follows we present a synthesis of the basic principles that constitute the frame of reference for the formulation of the R and D strategy for the region. No attempt is made to cover the *content* of the strategy, i.e., the specific measures recomended for each area of interest.

The reasons for that option are basically two. The first one is that given the character and extension of this report, there is no possibility of making a systematic presentation of those specific measures and their justification; besides, a considerable part of those specific element of the R and D strategy are implicit in the previous chapters of this report. The second, and more important reason is that, in our view, the quality and relevance of planning depends primarily on the basic philosophical premises adopted; they determine, to a great extent, the character of the results.

The proposed R and D strategy for the region is centered in two interrelated objectives:

a) The creation of national or regional R and D systems of a level, diversification, and flexibility comparable to those of the R and D systems of the industrialized countries. As it is well known the Latin American countries have R and D systems totally insufficient and inadequate for their needs. Unless they correct this situation - and this require *long term* planning - their possibilities of an equitable insertion in the new world order will be strongly jeopardized.

b) To satisfy, as much as possible, the R and D demand of the socioeconomic strategy of the transition period to the new society. This objective requires a careful determination of scientific and technological priorities, the reorientation of the effort as a function of those priorities, and the institutional reestructuration of the R and D systems.

Those two objectives imply the necessity to compatibilize the policy *for* science - the policy aimed at the strenghtening and growth of the R and D systems - with the policy *of* science - the satisfaction of the scientific and technological demand of the socieconomic strategy. As it is well known, most countries of the region have had a policy of science. The failure of most of those policies is due not only to the structural problems already analyzed, but also to the almost total absence of a long term clearly defined policy for science.

Although the two objectives mentioned above are closely interlinked, we will consider them separately, in order to facilitate the analysis.

THE POLICY OF SCIENCE

Technological Dependency: the discussions about R and D policy in Latin America are almost always centered on the problem of technological dependency, the fact that the countries of the region have to import most of the technologies used in their production systems. A widely held opinion is that the incapacity of most Third World countries to whole incorporate the benefits of the postwar process of modernization - based on the incorporation of the previous wave of technological innovation - was due largely to their technological dependency.

We have to accept the fact that - in the short and medium term future - the region will have to import most of the technologies required for its development. Only in the long term future (two to three decades) -

provided that an adequate policy for science is implemented - will the region be able to attain a degree of technological autonomy comparable to that of the advanced countries. For this reason it is an essential prerrequisite for the formulation of any R and D strategy, to have a clear idea of the implications of technological dependency in relation with the objectives of socioeconomic development. In our view, the most important points to be taken into account are the following.

a) the main cause of the failure of the countries of the region in the incorporation of the postwar wave of innovation was not technological dependency, but the fact that the socioeconomic strategy applied was not geared to satisfy the needs of the majority, but rather to stimulate a pattern of consumption based on the model of the upper and middle classes of the developed countries, and only accesible to a small minority of the Latin American population. The weakness of the local R and D systems was only a secondary contributing factor, and more a consequence than a cause of the failure. The imitative style of development did not create a significant demand on the local R and D systems, and so there was no stimulus for the implementation of an active, systematic policy for science.

b) Technological dependency is not an all or nothing situation, there are degrees of dependency. Practically all countries have to import technologies in certain areas or sectors. The difference between the developed and developing countries is not only on the degree of dependency but also, and more important, in the policy they apply to import technology. The developed countries - capitalists as well as socialists - adapt the imported technologies to their own conditions and possibilities. On the other hand, most developing countries in the capitalist world introduce the technologies to create deformed copies of the societies where the technologies were originated, which in practice resulted in the socioeconomic marginalization of a great part of the population.

c) Although, as stated above, it will take two or three decades for the countries of the region to attain a technological autonomy comparable to that of the advanced countries, it should be stressed that they already have some degrees of freedom and that - if appropriate policies are implemented - the capacity to take autonomus decisions in the scientific and technological field will increase continously in the period of transition. To maximize the benefits accruing from that expanding capability, a central task of the strategy should be to determine R and D priorities based on the socioeconomic goals.

In other words, the problems is not to close the "technological gap" in absolute terms, but to gradually reduce it as a function of the demand of the socieconomic strategy.

Technological Space

A central problem, therefore, of an R and D strategy, is how to select technological solutions - endogenously generated or imported - adapted to the local aspirations and possibilities. A general frame of reference can be given by the concept of technological space.

The concept of technological space - developed in a previous UNU project: R and D Systems in Rural Setting - is simply the systematization of well known but often forgotten principles. It starts by stressing that technological problems that are identified as obstacles to development can only be understood in their true dimensions by taking as a starting point the socieconomic context in which they are immersed. In other words, a technological problem is always a component of a much wider "problem situation". From that point of view the problems we are concerned with can be broadly divided into two categories: those in which the technical solution is not presently viable owing to socioeconomic or political constraints, and those for which a technical solution is viable.

A typical case belonging to the first category is the problem of undernutrition or hunger in many countries of the region. The technological dimension is not determinant; the necessary technologies are available, and the local R and D system have enough capability to cope, at least, with the basic problems. The root of the problem is not technology but distribution of income. Another problem of this type is the deterioration of some agricultural productive ecosystems. The technologies required for a rational exploitation of those ecosystems are known, but cannot be applied unless a radical agrarian reform is implemented.

In the case of problems were the technological solution is viable - it includes obviously the first group when the socioeconomic obstacles are removed - all the aspects of what we called problem situation should be carefully analized.

With the information gathered in the previous process, a set of assumptions or paradigms will be derive which will be the frame of reference for the final step of developing the required technology. The set of assumptions - which will contain scientific, technological, environmental, economic, social,

psychosocial and anthropological information - will define a *technological space* which is basically the set of requirements and constraints that the technology has to satisfy.

In finally building the technology, all possible solutions that fit the technological space should be considered. As is well known, from a certain body of scientific knowledge many technological solutions to a given problem can be devised. The existence of an adequate frame of reference allows the exploration of a multiplicity of possible paths, and the selection of the one best suited to the particular situation. Another result of this procedure is to give coherence to technologies pertaining to different fields of activity.

It is obvious that once the set of paradigms has been built, in some cases the required technology will already exist, and there may simply be a question of adaptation and introduction. In other cases, it may be a problem of combining existing technological elements in a different way. Finally, in other cases it will be necessary to devise an entirely new technology. In most instances, however, it will probably be a problem of combining some of these alternatives.

It should be emphasized, finally, that in this methodology endogenous generation of technology refers to the process through which the characteristics that the technology should have are determined. The *endogenous is the process of definition* and not necessarily the technology itself, which can be imported, provided it is appropriate. In this way *the transfer of technology becomes an integral part of the process of generation of technology.*

Employment and Participation

We will consider briefly the policies adopted by the proposed society in relation to employment and participation, because they have very important implications for the formulation of the R and D policy.

As we have already pointed out, the most important social impact of the new technologies is the impact of microelectronic-through automation and robotization - on the organization of production, the labor process, and the social division of labor. The problem is not whether or not traditional forms of work and employment will be abolished - that change is inherent to the transformations induced by the new technologies - but rather the way in which they will be abolished.

The solution to the problem of employment applied now in the developed countries - the payment of a minimum for subsistence to the unemployed - creates a category, the unemployed, which represents, in practice, a form of social marginalization. In A.Gorz words "watever the amount of the minimum guarantee, its fundamental vice remains: it leads to a gash in society, to a dualist stratification that can amount to a southafricanization of the social relationships. The minimum guarantee is really the salary of the social marginalization and exclusion... The minimum guarantee is a way of accepting that gash, and of consolidating and making it more tolerable".

In the society proposed by the project the employment policy is based on the principle that every person has not only the duty but, above all, has the right to a useful task in society.

In the first stages of developmenmt of the MED, all the members of the working force without a place in the productive system will receive a state subsidy - as it happens now in the industrialized countries - that can ensure them an adequate access to all basic good and services. The diference is that they will have to fullfil some social useful task.

That conception means that it will be necessary to create new socially productive activities outside the traditional forms of employment. This policy will be greatly facilitated by the fact that the process of transformation activated by the socioeconomic strategy will certainly generate, or stimulate, social activities which have not a clearly defined role in the present employment structure, such as informal education, communitary organization, preservation of the environment, etc.

In more advanced stages of the process of change the objective will be the uniform distribution of the diminishing socially necessary work among the whole population. This will require a complete redefinition of the relationship work-employment - technology, and of the social role of salary.

The above policy, which implies the elimination of the category of unemployed, would greatly facilitate the social incorporation of the new technologies. As it is well known, one of the central elements being advocated for the R and D strategy of the developing countries, is the adoption of labor intensive technologies in order not to agravete the chronic problem of unemployment. That policy is unrealistic, because the rapid expansion and the pervasiveness of the microelectronic based technologies, together with the process of world unification, makes it practically impossible to avoid the penetration of the labor saving innovations in the context of present socieconomic

policies. Besides, in the case that policy could be implemented through the enforcement of a different socieconomic strategy, the result would be to convert the developing countries, at least for the foresseable future, in the marginal proletariat of the advanced countries.

The policy proposed by the project would allow the Latin American countries to incorporate the new technologies on the basis of their *overall socioeconomic effects* instead of conditioning their introduction to their capacity to preserv the traditional forms of employment. Besides, and most important, the employment policy proposed is the central precondition for entering the society that could emerge from the present process of world transformation, and is a policy that sooner or later, will have to be adopted by the developed countries.

In relation to participation there is a relatively wide consensus - at least at the level of declarations - that in a really democratic society all persons should have the right to participate in the social decisions in a more effective and direct way than the periodic election of governments. There is less consensus, however, in relation to the possible mechanisms of participation. In general, there is a tendency to subordinate that human right to the attainment of certain objectives which are considered preconditions for an effective participation: higher levels of education and social concientization, creation of adequate means of access to information, etc.

The implicit philosophy of the MED is that participation is not only a *means* for a more efficient social organization, but and *end in itself* In a process of social change persons are not liberated when certain specific goals are attained - as for instance, in poor countries, when the basic needs are satisfied - but rather when they feel that they are protagonists of the process, and not simply passive beneficiaries, or victims.

Starting from the principle that full participation is the result of a process, and that the only way to learn participation is by participating, the process should start at the very beginning of the period of transition through the participation at the community and place of work levels. This approach has two main advantages: a) at the community and place of work levels, all persons have, or can obtain easily, the information required to take decisions on matters that concern them directly; b) the decisions taken at those levels affect directly the participants; the well known mechanism of trial and error is the best school for learning a conscious and responsible participation.

It is very difficult to foresee which will be the character of the mechanisms that will emerge to allow participation at higher levels of decisions making. We want, nevertheless, to emphasize the following points: a) the decisions taken at the community and place of work levels, necessarily affect the upper levels; b) the type of decisions taken at the first level reflects clearly the general lines of thinking and opinions of the population; c) taking into consideration the previous points, it is difficult to imagine that the upper levels of decision making would try to impose policies in open contradiction to the tendencies expressed in the first level. That would generate conflicts - at the operational and implementation level - which would jeopardize the viability of those policies .

It would be very difficult to analyze all the possible implications of participation on the R and D strategy; we will refer briefly only to two areas of special interest.

Participation is not possible, above all in societies of the size and complexity of the modern nation states, without adequate information. The advances in informatics allow, for the first time in history, that the necessary information to take social and economic decisions could be available to the whole population. One of the goals of the R and D strategy should be to study which is the most efficient way - not only technically, but also from the point of view of how participation is socially organized - of making available the required information to the participants.

Another field where participation is essential for the implementation of the R and D policy, is the definition of the technological space. The appropriate technological solutions required for the building of a new society can only be generated through an active interaction between the R and D systems and the social demands expressed through the mechanisms of participation refered to above.

Global and sectorial R and D planning

As the work advanced it become clear that the traditional way of formulating an R and D strategy - the identification of the demand of good and services over the *productive system* and from that to deduce the demand over the R and D system - is not adequate for the objective of the project.

That approach, which is essentially sectorial, makes difficult the adequate identification and incorporation of the R and D demand of the *qualitative*

elements - such as participation, patterns of consumption, relation with the environment, descentralization of decisions and production, autonomy, etc - which characterize the new society.

The R and D strategy is not simply the addition of the sectorial demands, taking them in isolation; it is necessary to articulate them and to establish priorities. On the other hand, the interaction between the sectors and, consequently, also the factors wich determine priorities vary with time, in a process of transformation as the one proposed by the MED. This is particularly evident in relation to the qualitative elements. It is obvious in consequence, that essential components of the R and D demand cannot be identified through the sectorial approach, because they are condictioned by the global evolution of the society.

The above means that the formulation of R and D strategy for the implementation of the MED requires a reasonably clear conception of the possible global evolution of the society in the period considered. This approach has the following additional advantages:

That view of how the socioeconomic and R and D strategies affect the society as a whole helps to undestand, and consequently to anticipate, the behavior of the various social actors in the different stages of the process of transformation.

The speed, the rithm, and the way to adequately incorporate the new technologies depend to a great extent on factors - such as forms and degree of participation, employment policies, territorial organization, cultural characteristics, etc - which are not directly condictioned by the productive system, but rather by the general evolution of the society.

- The analysis of the global effects of the adopted policies through time, will greatly facilitate the comparison between the proposal of the MED, and the alternative options, particularly the tendential one.

The overall evolution of the society cannot be evaluated only as a function of the partial goals, even including the qualitative elements. In a process of transformation with many options open - even within the basic characteristics of the MED - it is necessary to establish global goals which can help to articulate the partial goals, and to evaluate their role in the attainment of the overall objectives.

In the period of transition to the new society - the period on which the effort of the study is concentrated - the overall objective is to create the conditions for the countries of the region to acced to the desirable society that the present process of world transformation, in which the new technologies

have a decisive role, makes possible. This is undoubtedly the most important message of the project.

The above approach means that the present dicotomy in practice between socioeconomic and R and D planning, should be overcome: *the scientific and technological dimensions should be an explicit variable incorporated to the whole process of socioeconomic planning.*

The integration of socioeconomic and scientific and technological planning in the context of a changing society, cannot be effectively attained unless there is a close interaction between social scientists, technologists and natural scientists. So the implementation of real interdisciplinary research-instead of the loose addition of knowledge from different disciplines that we often call now interdisciplinary research - is one of the most difficult challenges confronted by the social sciences to day. We cannot discuss this complex subject further; we only want to stress that the basic precondition for really relevant interdisciplinarity is to start by posing the problems in an interdisciplinary context, instead of the present common practice of defining a social problem in terms of a single component - economics, for instance - and asking afterwards the support of other disciplinary fields.

The conclusionsarrived at in the critical consideration of the relative merits of global and sectorial planning, does not mean obviously that the later should be abandoned. It means that in the formulation of the R and D strategy two levels should be clearly differenciated: the global level, whose main characteristics we described above, and the sectorial level, where most of the specific scientific and, above all, technological actions, are centered. In the relationship between the two levels, the guiding principle should be that the character and priorities of those actions-besides the intersectorial priorities which are unavoidable for operational reasons - should be determined primarily by the demands of the first level.

We will refers briefly to the general criteria to be applied to articulate the two levels we are refering to,by considering two central areas of production: basic needs and industry.

One of the widely accepted principles in relation to the development of the Third World countries, is that they should concentrate most of their R and D efforts in the area of basic needs (food, education, housing, and health). This policy is based on the fact that a great part of the population of developing countries do not have an adequate satisfaction of those essential needs.

The policy adopted by the TPLA project is based on different premises:

a) In most of Latin America the obstacles to satisfy the basic needs of the whole population are not technolgical, but socieconomic and political: the main cause of the deprivation is a deformed- in some cases at a level that can only be qualified as grotesque - income distribution.

The technologies needed to provide for the basic needs are available, and the R and D systems of the region have, with only minor improvements, the capability to use them adequately.

b) According to the socieconomic strategy adopted by the project, the basic needs of the whole population should be satisfied at an adequate level in the first ten years of the period of transition. Adequate level means the level which allows a person to be wholy and actively incorporated into her or his culture.

The main instrument to attain that goal should be redistribution of income. The technologies to be used, given the established time schedule, are the existing ones. Housing,from the point of view of financial resources and technology is for the reason given in a previous chapter, the basic need most difficult to satisfy; above all in the urban areas. It will require, besides resources and technology, new forms of communitary organization and action.

The proposed policy means that the region will direct most of its R and D effort to the technological areas which are crucial for entering the new society. To concentrate the scientific effort on the basic needs, besides being unnecessary for the reasons given above, would be to contribute to the preservation, in the new era, of the present situation of a world divided into first and second class countries.

The above does not mean that no research will be performed in the field of basic needs. On the contrary, the solution of the problem of the basic needs through an "emergency plan" based on the utilization of the available technologies - current or new - would allow the involved sectors of the regional R and D systems to concentrate their efforts in the explorations of the possibilities offered by the new wave of innovations.

As it was said at the beginning of this report, the pattern of industrialization of Latin America was conditioned by the demand of a burgeoisie and a middle class with a pattern of consumption equivalent to that of the developed countries. As a result it can be estimated that more than forty percent of the population of the region is outside, or almost outside, the non staple goods market, and a considerable partis even below an adequate level

of provision of staple goods. This tendency to produce goods not accesible to a great part of the population has been reinforced by the recent policy - above all in the more industrialized countries, as the case of Brazil - of exporting manufactured goods to the developed countries in order to obtain external resources to pay the service of the external debt.

The production policy proposed by the project is radically different, and will be centered on the internal market. The redistribution of income will allow the effective incorporation of the whole population to the market of goods and services. The main result of this process would be a change of the pattern of products demand. The *average* income, which conditions the market, will be different from that of the advanced countries, and consequently the pattern of consumption - at least in the transition period - should be different. It would be a process similar to the one that earlier changed the pattern of goods demand in the advanced countries through the redistribution of income induced by the emergence of the mass production technological style.

Another consequence of the process , by enormously expanding the productive system, would be increased employment by counter balancing - at least in the first stage of the transition period - the effect of automatization and robotization. This will allow a smoother transition to the policy of employment which will be one of the central characteristics of the new society.

One important point of the production strategy is that, given the international situation, the external resources required for development - inputs incorporation, technology, etc - should come through a favorable external balance of payments. This means a capacity to compete at the international level in certain favorable sectors. The exportation policy should be based primarily - as has been the case in the advanced countries - on the exploitation of comparative advantages in areas of production for the internal market. It should be also stressed that, although the traditional comparative advantages have been greatly eroded by the technological revolution, the wide spectrum of natural resources of the region still offers possibilities that should be carefully explored.

The industrial policy so sketchly presented above implies the compatibilization of two objectives: to concentrate on the production of goods and services for a market which is different from that of the advanced countries, and at the same time to introduce and master the new technologies which will play a central role in the attainment of the desirable society. This

compatibilization will require a policy of selective protection and opening which sould be carefully studied.

Environment

One of the characteristics of the proposed society is its compatibility with the physical environment. We are anot going to refer here to its implications for the R and D strategy, because the capter devoted to environment presents and exelent example of how the two levels we referred to above can be articulated

The policy for science

The central objective of the policy for science, is to create national or regional R and D systems comparable to those of the advanced countries.

The international experience does not offer "recipes" on which is the best methodology to create, starting from the present conditions of Latin America, an R and D system of that magnitude. There are, however, some criteria that should be taken into consideration.

The rate of growth of a scientific system, assuming no financial restrictions, *is given by the capacity to form researchers*. These reserches, on the other hand, can only be formed by other researchers (for this purpose we consider researcher the person capable of perform research independently, or under the general supervision of a high level scientist). Therefore, the growth of the system dependes basically on two factors: *the initial number of scientists, and its rate of growth.*

The only way to estimate the possible rate of growth of the researchers, is to examine the international experience. We cannot discuss here in detail that experience, but many experts in the developed countries consider that it is very difficult to exceed a growth rate of 10%. Although there are a few exeptions - Japan reached 14% between 1953 and 1964, and China greatly surpassed that growth rate in the period 1949-69 - it seems reasonable to accept the 10% rate as a limit. It should be taken into account that to obtain such a rate of growth the country should make a real "war effort" in the field of science and technology.

A most important problem is to determine which should be in the growth process the relative weight of the different disciplines or knowledge areas.

Taking into consideration that the present regional R and D systems - due to to their historical evolution - have serious deformations it is not advisable the simple solution of making them grow maintaining the present relative composition

The most appropriate criterion, in the short and medium term perspective , is to make the systems grow - particularly in the areas of applied and development research - as a function of the demand of the great problems that society has to confront. In the long term horizon, the objective should be to prepare R and D systems diversified and flexible enough to be able to cope efficiently with any new scientific or technological challenge that may emerge.

In the area of basic research *strictu sensu* the criteria for its development should be different from the ones applied in the other research categories. In this case the orientation of the research should be left to the scientists temselves, and the State should allocate to basic research a constant proportion of the total resources spent in the R and D system. On the basis of the international experience, the amount of those resources should be of the order of 15 to 20% of the total budget for science and technology.

The cost of developing an R and D System can be estimated with an acceptable acuracy. On the basis of the number of researchers it is possible to estimate the total personnel of the system - technicians, administrative staff, etc - in each stage of its development. According to the international experience, the cost of personnel represents between 60 and 70% of the total cost.

As to the overall resources that a country can allocate to science and technology, it depends on many factors that we cannot discuss here. Hewever, there is a general agreement that it should be of the order a 2 or 3% of its GNP.

Regional Cooperation

Preliminary estimates, and just common sense, show that it would be practically impossible for the countries of region - even for the largest ones in terms of human and material resources - taken individually to cope with the challenge represented by the present process of world transformation.

There have been several efforts at integration at the regional or subregional levels in latin America but the results, up to now, have been rather poor. There is now a growing awareness that without an effective economic and scientific and technological integration, there is little hope of an equitable insertaion of the region in the world order that will emerge from the world crisis. We hope the results of the TPAL project will contribute to reinforce that awareness.

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a. Attendance at seminars with presentation of results of the project or related to the project.

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LIST OF PUBLICATIONS NPCT/UNICAMP

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Seminario Nacional em Política de Ciência e Tecnologia (National Seminar on Science and Technology Policy) participation in the 1984 to 1986 meetings.

Seminário: "Oportunidades Imediatas de Desenvolvimento Científico e Tecnológico em Novos Materiais" (Present opportunities in Scientific and Technological development of new materials). Rio de Janeiro, 1987.

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Seminário sobre os Efeitos Sociais da Automação Industrial na Indústria Automobilística (Seminar on Social impacts of Industrial automation on the car industry) CEDEC, CNRH-IPEA, DIEESE, S.Paulo, August, 1985.

Seminário Inovação Tecnológica, Modernização Industrial e Trabalho (Seminar on Technological Innovation Industrial renewal and Labor) SEPLAN/IPEA/CENDEC, Brasília, november, 1986.

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II Seminario de Engenharia e Tecnologia de Alimentos (II Workshop of Food Technology) São Paulo, May 13-16, 1986. Promoção SBCTA.

III Ciclo de Debates sobre Ciência e Tecnologia de Alimentos (III Workshop ou Food Science and Technology). Brasília, october 13-16, 1987. Promoção SBCTA e FAO

II Simpósio Latinoamericano de Política Científica e Tecnológica (II Latin American Simposium on S&T Policy). Rio de Janeiro, april 1986.

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Seminario Nueva Estratégia de Industrialización para Colombia. (Seminar New Industrial Strategy for Colombia) Bogotá, July 1985.

Reunión sobre comportamiento de la Comunidad Científica en América Latina y en el Peru. (Scientific Community behaviour in Latin America) IDRC/GRADE, Lima, peru, June 1986.

Seminário sobre Estudos Prospectivos (Seminar on Prospective Studies) UNESCO. Caracas, February 1988.

Reunión sobre Impactos de la Revolución Tecnológica en el desarrollo de America Latina (Meetings on the Impacts of the Technological Revolution in the Latin American Development). Santiago, december 1987.

XIV International Congress of Latin American Studies Association New Orleans, March 1988.

MEETING OF Expert Group: "Gran Programme I. Reflexion sur les Problems Mondiaux et Éstudes Prospectives, UNESCO, Paris, Dec. 15-17, 1988.

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Seminar on "Prospective for the Formulation of Science and Technology Strategies". Paper presented: "Theoretical Background of the Prospective Methodology. The Case of the Technological Prospective for Latin America project, OEA, Universidad de Buenos Aires, Sept. 23-25, 1987.

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Meeting on the Applications of the New Advanced Technologies, Banco de la Provincia de Buenos Aires, B.A., Argentina, Oct. 29, 1985.

Regional Seminar on Science and Technology, UNDP, Bariloche, Arg., Oct. 21-26, 1985.

International meeting on "Prospective, Impact Evaluation and Social Participation in the Scientific and Technological Development". Presentation: The Impact of the New Technologies on Society: a Prospective Approach" CNPq-OER, Rio de Janeiro, May 24-26, 1988.

International Workshop on Advanced Technologies Alert Systems. Presentation: Two Latin American Experiences in Forecasting, German Foundation for International Development, Berlin, Dec. 1985.

Seminário: Biotecnologia e Desenvolvimento Nacional (Workshop, Biotechnology and National Development). Campinas, april 14 e 15 1986. Organização NPCT/UNICAMP. Apoio CNPq, UNU/IDRC, UNICAMP.

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AREA OF URBAN ENVIRONMENT AND DEVELOPMENT

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1. Articles in journals, books and congressess

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MEETINGS ORGANIZED BY CEUR WITHIN THE TPLA PROJECT

1. Workshop on "Urban growth & Technological Change" held at the Latin American Countries of Social Sciences (CLACSO). Buenos Aires, June 22, 1987.

2. International Symposium on urban growth and technological change in Latin America. Held in Buenos Aires, May 3-5 1988 with attendants from Argentina, L.America, Europe and USA, 22 papers presented, 4 round tables, 110 participants.

PRESENTATION OF CEUR/TPLA PROJECTS AT OTHER ACADEMIC MEETINGS

1. International Symposium-Latin America population, resources, environment, Quito, Ecuador July 1987.

2. International Symposium-Urban research in Latin America, Quito, Ecuador, September 1987.

3. XIV I.H.A.S. World Congress on Housing: Innovation in Sciences and Technology for the Future, Berlin October 1987.

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Morello, J.H. (1985) Reflexiones sobre las relaciones funcionales de los grandes ecosistemas sudamericanos. (Reflections on the functional relations of the great South American ecosystems.) Proyecto PTAL. Textos para Discusión Fundación Bariloche/04; 50 pages.

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Gallopín, G.C. (1985) Problemas del futuro ecológico de América Latina. (Problems of the ecological future of Latin America.) Presentation in the Regional Seminar on Global Habitability, Buenos Aires, August 5-8, 1985. (Bariloche: GASE/PTAL, 11 pages).

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Gómez, I. (1987) Superficie natural, alterada y cultivada en los grandes ecosistemas sudamericanos. (Natural, altered and cultivated surfaces in the great South American ecosystems.) Technical Report. (Bariloche: GASE/PTAL, 8 pages).

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Sant'ana Diegues, A.C. (1987) Ecossistemas marinhos e sua degradacao na América do Sul, Central e Caribe. (Marine ecosystems and their degradation in South and Central America and the Caribbean.) Preliminary Report. (Bariloche: GASE/PTAL, 162 pages).

Gallopín, G.C. (1988) Prospectiva ecológica de America Latina y revolución tecnológica. (Ecological prospective of Latin America and technological revolution.) Manuscript. (Bariloche: GASE/PTAL, 34 pages).

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Winograd, M. Memoria de la reunión Nuevas Tecnologías y el Futuro Ecológico de América Latina. (Narrative of the meeting New Technologies and the Ecological Future of Latin America.) (Bariloche: GASE/PTAL, 13 pages).

Winograd, M. (1988) Estimación de superficies y uso de las tierras en los ecosistemas de Suramérica, Centroamérica y Méjico. (Estimation of surface areas and utilization of soils in the ecosystems of South America, Central America and Mexico.) Internal Report. (Bariloche: GASE/PTAL, 26 pages).

Winograd, M. (1988) Clasificación de los ecosistemas de Suramérica, Centroamérica y Méjico por zonas de vida. (Classification of the ecosystems of South America, Centro America and Mexico by life zones.) Internal Report. (Bariloche: GASE/PTAL, 18 pages).

AREA ENVIRONMENT AND DEVELOPMENT

SEMINARS

a. Attendance at seminars with presentation of results of the project.

A Crise Presente e o Futuro de America Latina. Annual meeting of the SBPC. Sao Paulo, Brazil, 1984.

Regional Seminar on Global Habitability. Buenos Aires, Argentina, August 5-8, 1985. Columbia University, USA - Fundacion Bariloche - CONICET (National Council for Science and Technology, Argentina).

Expert group meeting on impact of new and emerging areas of Science and Technology on Developing Countries, Buenos Aires, Argentina, 8-12 December 1986.

Tenth Annual Scientific Conference "Alexander von Humboldt". Sociedad Científica Argentina. Buenos Aires, October 2 1987.

Third Latinamerican Congress about scientific and technological policy. "Science and technology in Latin America at the XXI Century". San José, Costa Rica. 1-4 March 1988.

International seminar. The environment between politics and economics. Latinamerican and european contributions. Mendoza, Argentina. 26-28 april 1988. CIEDLA - Konrad Adenauer Fundation.

Reuniao Internacional. Prospectiva, Avaliacao de Impactos e Participacao Social no Desenvolvimiento Cientifico e Tecnologico. CNPq e OEA. May 24-26 1988, Rio de Janeiro, Brazil.

b. Attendance at seminars related to the project.

Seminar on Biotechnology and National Development and Seminar on Agricultural Production and Natural Renewable Resources. April 14-18, 1986. Campinas, SP, Brazil.

c. Meetings coordinated by GASE.

Regional meeting of senior Latin American ecologists. Buenos Aires, Aug. 8-10, 1985.

Seminar on New Technologies and the Ecological Future of Latin America. Bariloche, Nov. 9-12, 1987.

d. Attendance to the meetings of the Executive Committee.

Campinas, Brazil, 1-3 Aug., 1983.
Campinas, Brazil, 21-26 May, 1984.
Caracas, Venezuela, 4-8 Sept., 1984.
Campinas, Brazil, 26-30 Nov., 1984.
Mexico City, Mexico, 2 July, 1985.
Buenos Aires, Argentina, 5-9 Nov., 1985 (hosted by GASE/FB).
Campinas, Brazil, 7-10 April, 1986.
Caracas, Venezuela, 13-16 Oct. 1986.
Campinas, Brazil, 23-26 March, 1987.
Campinas, Brazil, 24-29 August, 1987.
Campinas, Brazil, 1-9 April, 1988.

TRAINING ACTIVITIES

No special training activities were performed in relation to the project. Postgraduate students reshaped their research activities to include concepts developed for it.

AREA OF SCIENTIFIC AND TECHNOLOGICAL CAPABILITIES

LIST OF PUBLICATIONS

SCIENCE AND TECHNOLOGY AREA/CENDES

I. Articles in journals, books and congresses

Balderrama, R. (1987) Estado actual del esfuerzo de ID en fuentes alternas de energia en Venezuela y algunas opciones para su valorización (Current State of the R and D Effort in Alternative Energy Sources in Venezuela and Some Options for its Improvement) (Caracas: Cuadernos del CENDES nº 8).

De La Cruz, R. (1986) Venezuela en busca de un nuevo pacto social. Alternativas frente a la declinación del modelo socioeconomico actual (Venezuela in Search of a New Social Pact. Altenatives to the Decline of the Current Socioeconomic Model). Colloquium: Venezuela hacia el 2000. ILDIS-UNITAR-CENDES. Caracas, November Published in the book: Venezuela Hacia el 2000. desafios y opciones (Editorial Nueva Sociedad-ILDIS-UNITAR/PROFAL, Caracas) pp. 247-268.

Jaen, M.H. (1987) Atención primaria de salud: estudio de las tendencias en la producción de conocimientos sobre el tema y análisis de algunas experiencias en America Latina (Primary Health Care: Study about the Trends in the Knowledge Production about the Subject and Analysis of Some Experiences in Latin America) (AVEDIS-CENDES, Caracas), 57 pp.

Licha, I. (1987) La enseñanza de la ingenieria en Venezuela. Investigación o innovación ? (The Teaching of Engineering in Venezuela. Research or Innovation ?), Ciencia Académica en la Venezuela Moderna, H. Vessuri, editor (Fondo Editorial Acta Científica Venezolana, Caracas), pp. 77-102.

Pirela, A. (1984) La ingeniería eléctrica y electrónica en la trayectoria del cambio tecnológico - Un estudio de caso sobre

Venezuela (Eletric and Eletronic Engineering in the Trajectory of Technological Change - A Case Study about Venezuela), Ciencia Académica en la Venezuela Moderna, H. Vessuri, editor (Fondo Editorial Acta Cientifica Venezolana, Caracas).

Pirela, A. (1984) Aspectos definitorios de un programa nacional de desarrollo tecnológico e industrial en electrónica (Definitional Aspects of a National Technological and Industrial Development Program in Electronics) (Investigacion y Gerencia , vol 1, nº 3, July-September, Caracas) pp.151-161.

Plas-Power, I. (1987) La visión cientificista de la informática: el proceso de informatización de la literatura sobre el futuro.(The Scientistic View of Informatics: The Informatization Process of the Literature about the Future) (Cuadernos del CENDES, nº 8, Caracas).

Rengifo, R. (1984) La sociología en Venezuela: institucionalización y crisis. El caso de la sociología y la antropología en la UCV . (Sociology in Venezuela: Institutionalization and Crisis. The Case of Sociology and Anthropology at UCV), Ciencia Académica en la Venezuela Moderna, H. Vessuri, editor (Fondo Editorial Acta Científica Venezola, Caracas), pp.173-212.

Reyes, J. F. y Sutz, J. (1984) La computación en Venezuela: evolución de la actividad docente y de la investigación en la UCV (Computer Science in Venezuela: Evolution of Teaching and Research at UCV), Ciencia Académica en la Venezuela Moderna, H. Vessuri editor (Fondo Editorial Acta Cientifica Venezolana, Caracas), pp. 103-134.

Ruiz Calderon, H. (1987) El proceso de modernización, los especialistas y la prospectiva sociohistórica (Modernization Process, Specialists and Sociohistorical Prospective) Cuadernos del CENDES, nº 8, Caracas).

Texera, Y. (1984) La biologia en un contexto periférico: la Escuela de Biologia de la Universidad Central de Venezuela (Biology in a Peripheral Context: The Biology School of the Central University of Venezuela), Ciencia Académica en la Venezuela Moderna, H. Vessuri editor (Fondo Editorial Acta Cientifica Venezolana, Caracas), pp. 47-76

Texera, Y. (1986) Biotecnologia y agricultura. Cultivo de tejidos vegetales en Venezuela (Biotechnology and Agriculture. Plant Tissue Culture in Venezuela). Acta Cientifica Venezolana, vol 37, nº 1, Caracas).

Texera, Y. y Di Prisco, M.C. (1986) (Editors). Biotecnologia: Oportunidades para Venezuela (Biotechnology: Opportunities for Venezuela) (Fondo Editorial Acta Cientifica Venezolana, Caracas).

Uribe, G. y Lander, E. (1987) Acción social, efectividad simbólica y nuevos ámbitos de lo político en Venezuela (Social Action, Symbolic Effectiveness and New Political Domains in Venezuela), Conferencia Internacional XX Aniversario de CLACSO: "Identidad Latinoamericana, Pre-Modernidad, Modernidad y Post-Modernidad", Buenos Aires, october.

Vessuri, H. y Diaz, E. (1984) El desarrollo de la química científica en Venezuela. (The Development of Scientific Chemistry in Venezuela), Ciencia Academica en la Venezuela Moderna, H. Vessuri editora, (Fondo Editorial Acta Científica Venezolana, Caracas), pages 305-350.

Vessuri, H. (1984) Qué investigar en América Latina? (What research to do in Latin America?), Acta Cientifica Venezolana, vol. 35, nº 1, Caracas, pages 147-160.

Vessuri, H. y Diaz, E. (1984) La formación del investigador científico básico a través de los programas de becas. El caso de los químicos (primera parte) (The Training of the Basic Research Scientist Through Scholarship Programs. The Case of the Chemists. First Part), CyT (CONICIT Journal), vol. 2, nº 1, Caracas, pages 18-27.

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Vessuri, H. (1985) The Reception of Modern Science in Venezuela. Cross Cultural Diffusion of Science: Latin America. J.J. Saldaña editor. Symposium "Cross Cultural Transmission of Natural Knowledge and its Social Implications: Latin America. Vol. V, Acts of the XVIII International Congress of History of Science, (Berkeley: Calif., 31 July - 8 August), Cuadernos de Quipu 2 (Mexico, 1988).

Vessuri, H. (1986) Los roles culturales de la ciencia en los países subdesarrollados. (The Cultural Roles of Science in Developing Countries), El Perfil de la Ciencia en America, J.J. Saldaña editor, (Colección Textò y Contexto, SLHCT, Mexico), pages 7-17.

Vessuri, H. (1986) Universities, Scientific Research and the National Interest in Latin America. Minerva, vol. 24, nº 1, pages 1-38.

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Vessuri, H. (1986) La publicación científica y la capacidad científica en América Latina (Scientific Publishing and the Scientific Capability of Latin America). II Seminario "Jorge Sábato" de Política Científica y Tecnológica. (Consejo de Investigaciones Científicas de España and OAS, Madrid).

Vessuri, H. (1987) La evaluación de la capacidad científica de América Latina ante el desafio de las nuevas tecnologías. (The Evaluation of the Scientific Capability of Latin America in Face of the Challenge of the New Technologies), Acta Cientifica Venezolana, vol. 37, nº 4, Caracas, pages 351-362.

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Vessuri, H. (1987) El proceso de profesionalización de la ciencia venezolana: la Facultad de Ciencias de la Universidad Central de Venezuela. (The Process of Professionalization of Venezuelan Science: The Science Faculty at the Universidad Central de Venezuela). QUIPU, vol. 4, nº 2, Mexico, May-August, pages 253-282.

Vessuri, H. (1987) The Social Study of Science in Latin America. Social Studies of Science, vol. 17, nº 3, pages 519-554.

Vessuri, H. (1987) La orientación actual de la investigación científica en el mundo actual. Implicaciones para Venezuela. (The Current Orientation of Scienctific Research in the World Today. Implications for Venezuela). La Crisis del Sector Ciencia y Tecnologia en Venezuela. Propuestas y Posibles Soluciones. Libros y Monografías nº 1 (Asociación para el Progreso de la Investigación Universitaria - APIU-UCV, Caracas) pages 17-26.

Vessuri, H. (1987) Nuevas relaciones entre cultura y sociedad ? La cultura cientifica en el futuro de Venezuela (New Relationships between Culture and Society? The Scientific Culture in the Future of Venezuela) Venezuela Hacia el 2000. Desafios y opciones, J.A, Silva Michelena coordinator, (Nueva Sociedad - ILDIS-UNITAR-PROFAL, Caracas), pages 299-318.

2. Textos para Discusión (Discussion Papers)

Avalos, I. Y Viana, H. (1985) Bases para la elaboración de indicadores de medición de la capacidad technológica (Bases for Constructing Indicators of Technological Capability), Textos para Discusión nº 2, CENDES-UCV, Caracas, 54 pp.

Balderrama, R. (1985) El potencial científico-técnico venezolano en materia de fuentes alternas de energia (The Venezuelan Scientific-Technological Potential in Alternative Energy Sources), Textos para Discusión nº 4, CENDES-UCV, Caracas.

De La Cruz, R. (1986) La América Latina semi-periférica: un dato básico para la economía de la innovación y para el ejercicio de prospectiva (Semi-peripheral Latin America: A Basic Datum for the Economics of Innovation and for the Exercise of Prospective Analysis), Textos para Discusión nº 8; CENDES-UCV, Caracas.

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Pirela, A. (1985) La microelectrónica en Venezuela: una posibilidad de desarrollo tecnológico ? (Microelectronics in Venezuela. A Possibility of Technological Development ?), Textos para Discusión nº 7, CENDES -UCV, Caracas.

Rivera, M. (1984) La capacidad de ID en hierro, acero, aluminio y materiales cerámicos en Venezuela (R and D Capability in Iron, Steel, Aluminium and Ceramic Materials in Venezuela), Textos para Discusión nº 5, CENDES-UCV, Caracas.

Sutz, J. (1984) Informatique et Société: Quelques Reflections a partir du Tiers Monde (informatics and Society: Reflections from the Third World), Textos para Discusión nº 6, CENDES-UCV Caracas.

Texera, Y. (1984) Contribuciones al Estudio de la Biotecnología desde una Perspectiva latinoamericana (Contributions to the Study of Biotechnology from a Latin American Perspective), Textos para Discusión nº 3, CENDES-UCV, Caracas.

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Vessuri, H. (1984) The Universities and Scientific and Technological Research in Latin America, Textos para Discusión nº 9, CENDES-UCV, Caracas

3. Documentos internos (Internal Reports)

Arvanitis, R. (1987) Indicadores de capacidad tecnológica. Propuesta de primer listado (Technological Capability Indicators. First List Proposal). (Caracas: CENDES-UCV, mimeo), 26 pages.

Arvanitis, R. (1987) La capacidad tecnológica de los empresarios industriales venezolanos. Anexo: Indicadores para medir las conductas empresariales y la tecnologia en Venezuela (The Technological Capability of Venezuelan Industrial Entrepreneurs. Annex: Indicators of Measuring Entrepreneurial Behaviour and Technology in Venezuela). (Caracas: CENDES-UCV, mimeo) 7 pages.

Avalos, I. and Viana, H. (1986) Bases para la elaboración de indicadores de capacidad technológica en el área de microelectrónica (Bases for the Construction of Technological Capability Indicators in Microelectronics). Final Report (Caracas: CENDES-UCV, December), 157 pages.

Balderrama, R. (1984) La teoria de la dependencia: una visión retrospectiva y prospectiva de algunas de sus limitaciones metodológicas (Dependency Theory: a Retrospective and prospective View of Some of Its Methodological Limitations). (CENDES-UCV, mimeo, July).

Barrios, S. (1985) Capital monopólico, Estado y estructura centro--periferia en America Latina (Monopoly Capital, State and Centre-Periphery Structure in Latin America). (Caracas: CENDES-UCV, mimeo), 23 pages.

Bilbao, S. (1988) Indicadores de I y D en Tecnologia de Alimentos en America Latina (R and D Indicators of Food Technology in Latin America), 96 pp.

De La Cruz, R. (1985) Estudio sobre la viabilidad del modelo de desarrollo endógeno. Estudio sobre reajuste socio-institucional

(Study about the Viability of the Model of Endogenous Development. Study about Socio-Institutional Readjustment). (Caracas: CENDES-UCV, mimeo), 17 pages.

Franco, C. (1987) Reflexiones sobre las capacidades tecnológicas de la fuerza de trabajo y su vinculación con los modelos de gestión organizacional (Reflections upon the Technological Capabilities of the Labour Force and their Linkage with the Model of Organizational management) (CENDES-UCV, Caracas, mimeo), 27 pages.

Jaen, M.H. (1987) Revisión bibliográfica para evaluar los logros de la estrategia de atención primaria de salud, especialmente en América Latina. Resumen . (Bibliographic Review for Assessing the Achievements of the Strategy of Primary Health Attention. Summary). (CENDES-UCV, Caracas, mimeo), 35 pages.

Licha, I. (1987) Propuesta metodologica para la evaluación de la capacidad de gestión de las instituciones estatales de ID en el marco del proyecto PTAL . (Methodological Proposal for the Evaluation of Management Capability of Public R and D Institutions within the TPLA Project) (CENDES-UCV, Caracas, mimeo, June).

Licha, I. (1987) Capacidad de gestión de la Investigación y Desarrollo: el caso del Instituto de Ingenieria (R and D management Capability: the Case of the Instituto de Ingenieria), (CENDES-UCV, Caracas, mimeo), 20 pages.

PIRELA, A. (1984) Dependencia tecnológica versus prospectiva tecnológica (Technological Dependence versus Technological Prospective). (CENDES-UCV, Caraças, mimeo)

Pirela, A. (1986) La escuela latinoamericana del pensamiento económico y social. CEPAL-Dependencia (The Latin American School of Economic and Social Thought: ECLA-Depdendency). (CENDES-UCV, Caracas, mimeo), 79 pages.

Silva Michelena, J.A. (1984) Los intereses estratégicos globales y la problemática de la seguridad en el orden internacional: América Latina y Europa (Global Strategic Interests and Security Problems in the International Order: Latin America and Europe). (CENDES-UCV, Caracas, mimeo).

Sutz, J. (1985) Informe de avence del proyecto: "Impacto social de la informática en América Latina: la toma de conciencia de los técnicos" (Progress Report of the project: "Social Impact of Informatics in Latin America: the awareness of technologists"), (CENDES-UCV, Caracas, mimeo).

Sutz, J. (1985) Developpement et Informatique en Amérique Latine. Quel Developpement ? Quel Informatique ? (Development and Informatics in Latin America. Which Development ? Which Informatics ?) (CENDES-UCV, Caracas, mimeo), 51 pages.

Sutz, J. (1986) La informatización en el futuro de América Latina: una exploración de tendencias. (Informatization in the futureof Latin America: an Exploration of Trends), (CENDES-UCV, Caracas, mimeo).

Uribe, G. (1985) Contribución al informe de avance del Area de Dinamica Socioeconómica. (Contribution to the Progress Report of the Area of Socioeconomic Dynamics), (CENDES-UCV, Caracas, mimeo), 11 pages.

Uribe, G. (1986) Nuevos movimientos sociales, tejido social alternativo y desarrollo científico-tecnológico: algunas tesis prospectivas (New Social Movements, Alternative Social Tissue and Scientific-Technological Development: Some Prospective Theses), (CENDES-UCV, Caracas, mimeo), 28 pages.

Uribe, G. (1987) Segundo Informe de Avance. Aspectos Teórico-Metodológicos. (Second Progress Report. Theoretical-Conceptual Aspects), (CENDES-UCV, Caracas, mimeo), 14 pages.

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AREA OF SCIENTIFIC AND TECHNOLOGICAL CAPABILITIES

SEMINARS

a. Attendance at seminars with presentation of results of the project or related to the project:

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b. Meetings coordinated by the Science and Technology Area of CENDES:

TEPLA Executive Committee Meeting and Seminar on Scenarios. CENDES, Caracas, September 1984.

Simposio Taller sobre Nuevas Tecnologias. CENDES, Caracas, April 1986.

TEPLA Executive Committee Meeting and local team Seminar. CENDES, Caracas, October 1986.

Workshop on the R and D Capability of Latin America. Caracas, July, 1987.

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