UNITED NATIONS

ECONOMIC AND SOCIAL COUNCIL

LIMITED

ST/CEPAL/Conf.66/L.2
July 1978

ENGLISH
ORIGINAL: SPANISH

C E P A L

Economic Commission for Latin America

LATIN AMERICAN REGIONAL MEETING FOR THE UNITED NATIONS CONFERENCE ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

(Panama, Panama, 16-21 August 1978)

SCIENCE, TECHNOLOGY, DEVELOPMENT AND COOPERATION IN LATIN AMERICA

78-7-413-150

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INTRODUCTION

In 1976, the Economic and Social Council of the United Nations recommended that a world conference be held for studying and determining new modalities of cooperation in the field of science and technology.[1/] This step was taken in response to the oft expressed desire of the international community that efforts be made to foster closer and better relations between countries in order to facilitate their social and economic development.[2/] It was stipulated in the recommendation that in earmarking the resources of science and technology, priority be given to mitigating, on the one hand, glaring overall and localized imbalances by removing obstacles to the free flow and appropriate application of knowledge which might otherwise solve critical problems and, on the other hand, to improving the capability of all the developing countries for selecting and absorbing the technical and scientific innovations that might be most useful to them.

In this way, international rapport would be favored and the basic needs of broad sectors of humanity would receive due consideration.

Attention has already been given to the study and adoption of an overall, unified scientific and technological development program which has received encouraging support from Latin America. Over the last decade and a half, governments and regional organizations of this continent have been expressing their desire to organize and promote scientific and technological activities in an effective manner by making them compatible with development and cooperation criteria.

Certain of such criteria have already been studied.[3/] Generally speaking, they comprise responses to the inadequate and sometimes contradictory nature of recent Latin American development experience and to the

1/ ECOSOC, E/RES/2035 (LXI) and 2035, August, 1976.
2/ United Nations, Declaración sobre el establecimiento de un nuevo orden económico internacional (A/RES/3201-3202) (S-VI), May, 1974.
3/ See the Informe final de la Reunión Intergubernamental sobre Ciencia, Tecnología y Desarrollo en América Latina (ST/CEPAL/Conf.53/L.5/Rev.1), Mexico, November, 1974.

/expectations

expectations that technological advances might make it possible to overcome obstacles of a structural nature.[4/]

This document contains a number of ideas that have been expressed in the region with respect to scientific-technical advances and the policies that have been applied in relation to them in order to help define for Latin America the philosophy and objectives of the activities that are the subject of this Conference.

After having looked into activities related to trade, financing, economic integration and internal structural changes of the region, it seems pertinent now to consider the significance of technology, thereby complementing and enriching the topics touched upon previously. Strictly speaking, interest in this topic has always been latent in Latin America; it was underscored in previous studies on the disparate effects of technical progress in countries of the center and those of the periphery; of the growing incidence attributable to external financing in conditions of balance of payments difficulties, and most clearly so on substantiating the insufficient dynamism of the economies and the inappropriate or undue use of funds which are scarce, to boot.

It would appear, then, that the time has come to delve more deeply into these aspects - general as well as specific - of scientific-technical dynamics from three standpoints.

The first would be that of cooperation and negotiation between the industrialized countries and Latin America since the wish for untrammelled access to the flow of knowledge possessed by the former is shared by all as a means of fostering fruitful good relations.

The second would involve the opportunities that are opening for greater cooperation among developing countries, all equally concerned about the inadequacy of their respective economic progress and the limitations they come up against in the development process. As a series of relatively

4/ See the Report of the Latin American Meeting of Governmental Experts on Science and Technology for Development (CEPAL/MEX/ELCT/5/Rev.1), Mexico, October 31-November 2, 1977 and the suggestions of the Latin American Group of ACAST which met in Mexico on June 1-2, 1978 (CEPAL/MEX/ACAST/RGLA/1/2).

/similar

similar factors indicates, it would seem that joint technological-development programs might contribute to enabling all such countries to overcome the indicated limitations. Furthermore, Latin America's relative advancement in comparison with other developing regions would make it possible to provide technological-cooperation mechanisms and programs between regions.

The third standpoint would concern specific problems that the Latin American countries meet both in their relations abroad (in connection with imports of capital and technology) and with domestic innovations required for their respective development.

In this light, the present document - which follows upon other studies and experiences already taken up on various occasions - is submitted for consideration to the Regional Preparatory Meeting of the United Nations Conference on Science and Technology for Development.5/

Consequently, it has been sought here to analyze certain aspects of scientific-technical development under current conditions in the Latin American countries with a view, essentially, to contributing to a program containing ideas and mechanisms that would make it possible to utilize science and technology for dealing with some of the structural inadequacies to development that exist. This document also aims to contribute, from a Latin American viewpoint, to the identification of the factors responsible for the disparity in technological knowledge among the various countries and to the establishment of a degree of cooperation and solidarity among them that could eliminate or attenuate those differences.

This secretariat document parallels and is complementary to the forthcoming national and sub-regional reports. Together, they present a picture of the problems, priorities and tasks that the Regional Meeting must consider.

This document has been divided into five chapters. The first contains an outline of the problems that prompted convening the Conference for which the document is intended, as well as of the implications of those

5/ In addition to documents presented by CEPAL at the Intergovernmental Meeting on Science, Technology and Development in Latin America (Mexico, December, 1974) see the pertinent chapters in América Latina y las relaciones internacionales (E/CEPAL/1024), Guatemala, 1977.

/problems

problems at the regional level. In the second, the characteristics of the region's scientific-technical development are taken up, relating them to those of recent Latin American economic and social evolution. In the third, an overview is provided of the policies that have governed that development with reference to those aspects that have been bypassed or ignored in the past. In the fourth chapter, an analysis is made, for purely illustrative purposes, of some aspects of the development and characteristics of the five areas selected by the member countries in order to highlight the possibility of applying scientific-technical knowledge precisely to their common problems. Lastly, in the fifth chapter suggestions are put forward for an action program which contains various proposals that it is thought could contribute to improving the current status of the issues identified.

I. PROBLEMS AND SCOPE OF THE CONFERENCE

There are three basic problems that call for the attention of the United Nations Conference on Science and Technology for Development (UNCSTD).[1/] In the first place, the stock of useful knowledge, unprecedented in history, that is available today has barely served to provide for the basic needs of broad strata of humanity. Secondly, research and innovations tend to be concentrated in certain geographical areas (industrial countries) and agents (multinational corporations), and in addition they appear to stunt the vitality - and, in some cases, the viability - of the scientifically less-developed countries. And, thirdly, the institutions and mechanisms that form part of the international community - including the United Nations - play only a fragmentary and obviously inadequate role for solving these problems.

Various studies conducted for the purpose of elucidating the determinants of economic growth confirm the positive nature of building up scientific knowledge and of the inter- and intrasectoral transfer of the results of this stock of research. Science and technique join the classical factors of production (natural resources, capital and labor) lending them new potentialities easily identifiable in industrial societies. In addition to broadening and diversifying supply, technological progress has given that supply and the comparative advantages offered greater scope and importance which, furthermore, grow in proportion to the increment of available information and of the possibilities of putting it to productive use. This brings about significant changes in the context and terms of economic competition, as well as in the nature of sectoral and international interdependencies. Thus, productive activity and technology mutually reinforce one another, but, at the same time, they give rise to intermittent cycles of expansion and structural breakdown.

1/ For a detailed study of UNCSTD's background, see United Nations Conference on Science and Technology for Development: Background, objectives and regional implications (CEPAL/MEX/ELCT/2), September, 1977.

/The vast

The vast store of knowledge accumulated over the past two hundred years, whose social utility is obvious, has conditioned the levels of life in industrial-societies, but those benefits have been restricted to certain geographical areas and certain segments of society. In others, basic food, clothing, housing, and job needs have not been met and dire poverty has become even more acute at the same time that scientific information has increased.

Two relatively widespread attitudes have arisen in the developing countries as a consequence of this contradiction between the growth of scientific knowledge and its irregular and fragmentary spread which has produced the basic imbalances described. One is a radical skepticism regarding the application of modern science which, as some think, is responsible for the undesirable effects indicated. The other is a kind of "technological populism" which, according to some, will make it possible to introduce the "proper" innovations (the problematical nature of this adjective will be discussed further on) to overcome long-standing disorders, and foster self-determination.

In any case, the paradox of the scientific potential available and the needs being observed can apparently be attributed to the interdependency that has been created, which gives rise to the inequalities that characterize the modern world. The approach to this problem will have to be studied by the Conference and considered in its longer-range outlook.

This contrast involves the second key problem of the Conference. Reference has been made to the form in which research workers, research, and economic innovations tend to be concentrated. Over 90% of the world's researchers work in less than ten countries; the concentration of research projects in leading centers and industrial laboratories is even higher; and, technicoeconomic innovations are absorbed largely by the advanced countries.

There is evidence that this concentration of scientific and commercially useful knowledge entails - apart from the economic effects - political advantages implicit in the links between nations and that technological superiority is turned into greater possibilities of control over developing countries.

/The spinoff

The spinoff from technological progress received by the developing countries has been tenuous. The reasons for their relative bypassing are complex and have deep historical and cultural roots, this phenomenon resulting either from the modalities that characterized their relation to the industrial centers or because of the slow (if not circumscribed) nature of their internal transformations. In any case, these countries have not created internal capacity - or that which has been created meets with serious obstacles - for interpreting, absorbing, and selecting the tangible manifestation of a technical progress that usually resembles an artificial graft, which is subordinated to investment programs whose results are barely perceptible but which nevertheless impinge upon national options and the manifestations that development produces in those results.

Regardless of the indicator used - supply of scientists and engineers in relation to total population; share of research and development in national expenditure; technological content of exports -, it will show this distressing contrast between the world potential of scientific-technical resources and the slim national possibilities of creating them.

These phenomena are manifested in the form in which recognition of scientific achievement (the Nobel Prizes, for instance) is geographically distributed. They are almost invariably awarded to scientists of industrialized countries in which close to 2% of GDP is devoted to research while in the underdeveloped countries this item accounts for only 0.2% to 0.5%.

With time, the advantages accruing from this situation tend to be cummulative. It is understandable that advanced societies enjoy a series of advantages that build up when the productive processes and world trade depend to a significant degree upon technological capacity - an availability for the public and private entrepreneur of the industrial country that antecedes his decisions - and when it is, in turn, sensitive to investment capacity and scale economies. This does not occur in the backward societies. Their modest scientific potential is coupled with precariousness and financial restrictions that impede firm progress in industrialization and business transactions. This is another vital problem that must be faced.

/These considerations

These considerations on the disparities in scientific availability, the concentration of technical progress, and the restricted application of knowledge lead into the third problem which arises from the limitations of multilateral mechanisms for increasing the proliferation of scientific knowledge. As is well-known, the international community has established forums and procedures for coping with problems related to the monetary system, financing, and trade. Technology has been relegated to the background for the most part except in certain bilateral modalities of cooperation. The United Nations, for its part, has put a number of organizations and programs into operation over the years that have dealt with disparate features of technical assistance in order to cover certain aspects of knowledge. Fora have also been supported to examine general aspects related to the transfer of technology and the management of commercially useful knowledge. It has been impossible, nevertheless to arrive at a unified concept of world technological development nor is a satisfactory system of coordination yet available.[2/]

The efforts of the Advisory Committee (ACAST) which were crystallized in the World Action Plan for the Application of Science and Technology to Development and in the corresponding regional versions of it, have made it possible to go about unifying viewpoints while the United Nations has sought to put the joint programming of scientific-technical tasks into effect. In any case, all the interested parties appear to be in agreement that the Conference should try to channel scientific and technological activities in a coordinated way without neglecting the possibility of reorganizing the economic and social sectors of the United Nations system and other components of the international community.

These are the problems that prompted the holding of the Conference. Nor are they unfamiliar in Latin America; they have arisen there in various guises throughout its development process. For this region, the alternatives

2/ See recent discussion on the topic in the Comité de Ciencia y Tecnología para el Desarrollo, Informe del cuarto período de sesiones (E/1978/33, E/C.8/58), February 6-10, 1978.

are not between the indiscriminate transplantation of knowledge on the one hand and self-segregation from world technological flow on the other. It is rather a matter of combining intelligent selection of those technologies with increased internal potential. In this manner, it will be much easier to meet the needs of dynamic activities and to find specific solutions for the sectors and strata by-passed by development.

This flexibility should in no way be considered a fortuitous matter. It reflects the characteristics peculiar to regional evolution and is an expression of the role that science and technology must play in removing stubborn obstacles. In this sense, Latin America is called upon to formulate an agreement of some kind regarding the criteria and mechanisms that should be applied to mobilize those resources either internally or within a framework of reorganization of its external connections. Such an agreement could be reached in the course of the preparations for the Conference which would not preclude that in time it might take on a dynamic of its own in keeping with the region's characteristics and priorities.

To be sure, responsibility for the actions that should be launched devolves upon the national entities and processes. The consensuses will take on vitality and be realistic to the degree in which resistances and distortions - which originate in the modes in which technical progress was absorbed - are overcome.

A number of circumstances conclusively indicate that it would be advisable to convert the UNCSTD into an international consultative mechanism and a political act of paramount significance. The first of these is that the considerable fund of knowledge amassed during two hundred years of scientific and industrial revolution is hardly brought to bear upon remedying the situation of the less-developed countries and that not only the governments, individually, but also the complex interdependence of the international system whose structures and mechanisms seem to create inequality, may be considered responsible for this.

The second is that the gap between the countries that have scientific resources and those that do not tend to be perpetuated instead of decreasing, since those resources seem to be definitely concentrated in the space and

areas of interest of the advanced countries. Dependant upon those countries, and lacking mechanisms of their own for learning and creating, the peripheral countries are limited, in the best of cases, to superficial imitation and minor innovations; with technological passiveness as an irreversible limiting factor, characterizing no small number of them.

Lastly, the international community - including the United Nations - must become aware of the importance of these issues and problems for preserving general well-being and peace. Neither physical resources nor unilateral actions are sufficient any more. Because of its localized and, at the same time, profound impact, the scientific store is leading the advanced economies into postindustrial stages. New concepts and mechanisms are called for - which will have to put forward at the Conference - to spread the benefits of that fund in such a way as to reach the lagging nations.

Latin America occupies a leading position in this panorama fraught with concern. Technical-economic dualism, ambivalent internationalization, and pertinacious backwardness are no strangers to it. At the same time, however, achievements inherent in industrial maturation, in the regional organization of activities, and negotiations with third-party nations make up part of its historical and contemporary background. Latin America, at a point midway along the road between the industrialized and least developed regions, must fully realize the nature of the situation in which it actually finds itself and bring its own experiences to bear upon the rest of the world.

II. SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT IN LATIN AMERICA: GENERAL BACKGROUND

This chapter presents a general picture of the background against which science and technology is applied to the development process in Latin America. Beginning with a very broad analysis of the main features of the economic evolution of the region during recent years,[1/] it goes on to compare those features with the way in which technological innovation has actually taken place in Latin America. Lastly, because of the diverse national situations in the region, an attempt is made to typify their respective capacities for absorbing and developing technological innovation.

1. Nature of the economic evolution

The subject of technological change has not been adequately integrated within the framework of the development policy but, notwithstanding, less and less it is considered as an exogenous variable. In fact, the possibility is being accepted that the pace, nature, and orientation of technological change in a given society, the social and political process and the general operation of the respective economy are closely inter-related. Consequently, there is no doubt that the type of technological policy that should be fostered is decisively influenced by the style and strategy of development. In each case, the roles and participation of the state, foreign investment, and public or private enterprise will differ as will incentive and control policies and the relative priorities assigned to the various sectors of economic activity and social development.[2/]

1/ For a more detailed analysis see El desarrollo económico y social y las relaciones externas de América Latina (E/CEPAL/1024/Rev.1)

2/ See Progreso científicotécnico para el desarrollo de América Latina (ST/CEPAL/Conf.53/L.3), México, 1974.

/For example,

For example, a development model or style that favors maximization of the rate of economic growth, the accelerated advance of production of manufactures and their export will call for a process of technological change that gives priority to the utilization of "advanced" technology; if, on the contrary, the development style tends to concentrate attention on the solving of problems of critical poverty, underemployment, and disparities of income and consumption, it will place greater stress on the use or creation of autoctonous technology and the adaptation of external technology to conditions that require a greater labor input per unit of capital and production. In that case, technological policy will seek also to attain an effective absorption and internal dissemination of the technical knowledge necessary for raising the levels of productivity of traditional small-scale activities and, particularly, of agricultural production.

To be sure, none of these options, or others like the, appear in practice as exclusive routes. The relative level of development attained by the great majority of the countries of the region, the growing complexity of their development policies, the evident relative weight - varying from country to country - of the public sectors, and the noteworthy advance implied by the adaptations of policies aiming simultaneously to growth and transformation objectives, are being translated into diversified demand upon the scientific-technical apparatus ranging from flatly incorporating technology to the adaptation, creation, utilization, and improvement of traditional technics peculiar to the respective milieu.

Today, Latin America is a region in which modern industry prospers that penetrates increasingly into vanguard sectors and acceeds to markets of the economically more advanced countries. However, there survives together with this industry, a stratum - whose relative weight in terms of number of establishments and employment surpasses the foregoing one by far - composed of medium-size, small and handicrafts establishments of very low efficiency, barely articulated with the modern sectors because,

/instead

instead of there existing a complementary relationship with respect to them, it is, rather, a competitive one. A similar and perhaps even more marked condition is to be found in other sectors, particularly agriculture and commerce.

In fact, it the productive structure is studied taking the technological strata into account, the familiar problem of structural heterogeneity that characterizes Latin America comes to the fore.[3/] Taking the region's economy as a whole, quite a small percentage of the population works in the modern sector (a little over 12%) and that it, nevertheless, generates over half the production of goods. Some of these (and certain services) that directly or indirectly satisfy certain types of demand are produced especially or exclusively by this stratum.

In the mining and manufacturing sectors, the modernized sphere bears a greater relative weight; particularly mining because of the large exporting establishments involved. Outstanding in agriculture, on the other hand, is the scarce absorption of labor by its modern sector, which gives rise to a most uneven ratio among the variables selected in this sector.

The so-called "primitive" sector lies at the other end of the spectrum. Despite the fact that it contributes only 5% to material product it still accounts for more than one-third of regional employment.

A large part of agricultural employment (about 65%) and not inconsiderable portion of agricultural product (almost 20%) is connected with the "primitive" sector. It appears evident that a considerable amount of rural self-consumption is involved in this. This is not the case with manufactures which provides 1.5% of the product while accounting for nearly 18% of industrial employment.

The intermediate stratum is most "in balance" from the standpoint of the employment-product ration, with half the number of jobs and somewhat

3/ See Aníbal Pinto, "Notas sobre los estilos de desarrollo en América Latina", Revista de la CEPAL, 1st half of 1976.

/over 40%

over 40% of the product derives from this stratum. Its role is particularly important in manufacturing which provides 65% of industrial jobs and generates over one-third of the product. It has a very small share in mining production, although more than one-third of those engaged in this occupation belong to that level which establishes a more unfavorable ratio between the sectors under consideration.

The type of external relationing is another characteristic aspect of the region, that is to say, of its degree of foreign dependence which, in turn, is indicative of the measure of integration into the scheme of international labor division. As is well-known, the region shows relatively low export and import coefficients, on the average, basically because of the situation with respect to the larger countries. These coefficients range from about 10% for Brazil, Mexico, and Argentina to over 30% for certain Central American economies. Most of these coefficients increased during the past decade and the situation accentuated even more throughout the seventies.

This trend has been reinforced by other phenomena which contributed to creating a different structural situation. On the one hand, in the sixties, the importance of external financing increased in the coverage of the also larger trade-balance and current-account deficits. On the other hand, external "relationing" was likewise reinforced by the increasing gravitation of the transnational companies in the regional economy.

The changes undergone by exports and imports must be added to the foregoing. With respect to the former, there was a small decrement in the concentration on primary export while there was an increase in the share of sales of manufactures. It should be recalled that in 1970, about 36% of those regional efforts came from transnational companies, a percentage that does not appear to have varied much.

As far as imports are concerned, the most marked change, although not spectacular, was the lesser participation of consumer goods and the corresponding increase in that of capital goods.

It will not be sought in this section to provide an exhaustive enumeration of the Latin American characteristics that condition the type

/of policies

of policies and technological inputs, but only to point out those that seem most salient. Along these lines, in addition to the modalities of external relationing and the structural heterogeneity already mentioned, stress should be placed, on the one hand, on the high rate of population growth in the region - and its effect upon absorption of labor, underemployment, and the search for adequate technologies - and, on the other, on the relative abundance of natural resources that enables it to assume, in some cases, a privileged position in the world context with respect to the supply of certain minerals and tropical agricultural products. Concerning the former, it is being increasingly accepted that their optimal utilization will be attained to the degree in which the most modern technologies are applied, an effort that should even include research and development in vanguard technology in certain priority areas.

The region's economic evolution over the last decades which has been relatively dynamic in terms of productive-sector growth has, on the other hand, not been able to bring the benefits of that progress to the majority sectors of the population. In fact, most of the countries have not reduced the high-income concentration that prevailed three decades ago, a situation that appears to have become more acute in no few countries of Latin America.

Even though this evolution is not confined to the region, it is even more serious there because it has the highest population-growth rate in the world. Income concentration brings about the well-known distortions in the productive apparatus, considerably limiting, thereby, its development potential and that of the fuller utilization of available resources, by being unable to place them at the service of mass, diversified demand. Thus, scale economies cannot be attained nor perceptible advances made towards better integrated productive structures.

The difficulty or impossibility of the productive systems to absorb their labor forces in a direct consequence of this situation and is responsible for the high indices of open and hidden unemployment so often shown up in national and regional studies of the subject.

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This is perhaps the most serious challenge faced by technological policy as an inseparable component of general economic and social development policy. It is a matter of finding techniques which, without sacrificing productivity levels - or, should this happen, it would be due to intentional policy fully cognizant of social cost-benefit - would permit increasing incorporation into production of the vast human resources that are seeking to survive on the basis of activities that contribute little or nothing to broadening supply of productive goods and services.

Furthermore, a long-term view of Latin America's economic future shows up the complex and changing role that the technological variable will play. In fact, the dynamics of Latin American development have depended basically upon an interplay of stimuli and pressures activated by internal demand, foreign trade, and the regional market, against the background of realities and shifts in the level and distribution of income.

During the seventies, the region was characterized by a period of "internationalization", particularly of the relatively more-developed countries. As a matter of fact, the exogenous factors that foster and orient the development stand out. There was a combination of strong demand for primary products and clear-cut improvement in terms of trade between 1971 and 1973; growing and dominant participation of transnational companies, particularly in the sectors, which means greater diversification of the industrial spectrum; circulation of substantial financial flows in a variety of modalities; and, even a growing participation of exports of manufactures which will take on an important role in the expansion of certain activities.

Furthermore, stimuli from the internal market and regional demand are increasing. It should be taken into account with respect to the latter that Latin America absorbed almost one-third (32.8%) of its own industrial exports in the last five years, the value of which rose from some 850 million dollars in the first year to over 2 billion dollars in the last.

The productive structure underwent a profound change as a consequence of the above process. The region quadrupled its product between 1950 and 1975, quintupled its production of manufactures, multiplied its cement

/production

production by a factor of six, its energy production by eight, machinery and equipment by nine, and steel by fifteen. These important changes of scale were linked to substantive changes in the structure of supply. Latin America became industrialized and capable of increasing its self-supplying transportation, communications, and building sectors, as well as a consumption structure that covers non-durable industrial goods and important durables. Certain sectors of basic inputs like steel and petrochemicals, symbols of the early stages of heavy industry, are already in operation in many countries of the region.

However, avidness to consume, fanned by modern publicity, is present in broad groups of the population. The accumulation required to meet this demand surpasses the region's capacity by far. Consequently, if the industrial structure is considered in relation to the sophisticated levels of demand aspired to by the high and medium-income groups and other social strata reaching towards them, it can be seen that factors of imbalance are still strong between hopes and real possibilities of fulfilling them that have so strongly influenced the political attitude of the middle groups and in the dynamism of the consumer's demand.

The magnitude of production while significant in absolute terms is something more than inadequate compared to the amount needed to solve the problems of acute poverty. Advances are magnified when measured against the population making up the modern sectors but shrink when placed against the population as a whole.

The scales, structure, and relative importance of foreign trade were changed by the productive transformation. The growth over the first fifteen postwar years, based largely upon imports substitution on a national scale, prevented the region from participating in the dynamic world trade in manufactures. Furthermore, the Latin American share in world trade in important agricultural and mineral products declined. The two factors together caused the region to reduce its share in world trade from 9% to 5% between the middle of the decade of the fifties and the early sixties.

/In the

In the seventies, however, the countries have been trying to open their economies to foreign trade and to diversify their exports, projecting the industrialization process beyond the scale of the national markets.

The composition and volume of imports also changed as a result of the internal productive transformation. The region became an important customer of many countries for intermediate and capital goods thereby showing up a negotiation potential that Latin America had not yet fully put to use; besides which, it created a potential for intraregional trade substitution and expansion of the utmost importance.

Regardless of the context in which the analysis may be placed, it is undeniable that the public sector and transnational enterprise have been the most dynamic factors of production and that they have shown a capacity for mobilizing resources for large-scale activities that should be considered one of the most important features of this period. National governments and public enterprises in key sectors of the infrastructure and basic resources have been particularly successful. The state's managerial capacity is much greater now than it used to be. Cadres have been developed that are capable of instrumenting policies that mobilize very large amounts of economic resources, and the biggest public enterprises in some countries have reached the point where they are able to compete at the world level.

It should be stressed with respect to Latin America's incorporation into the world economy that its foreign sales are becoming more diversified; protectionist policies of the countries have become more selective in order to adapt to competitive conditions of the international market; in addition, the technological content has risen and the quality of exported goods has improved.

What is more, a certain shift of productive units away from industrial centers brought about by differentials in labor costs has become evident. This usually takes the form of subcontracting in highly labor-intensive activities oriented mainly to export. They are generally subject, however, to the decisions of big companies. Their impact is spread in the tecnhology and management fields, and in the financing programs; they are

/governed

governed, however, by overall long-range policies sometimes divergent with national interests. And, although the governments have acquired experience in regulating the conduct of the multinationals, the flexibility these firms have shown in adapting to the most varied restrictions without significant loss is noteworthy.

Latin America is at a higher stage of development in comparison to many countries of Asia and Africa, despite the existence of large deprived groups - situation that varies from country to country - whose extreme poverty is comparable to that of strata of the populations of any Asiatic or African nation. For example, life expectancy here is 61.7 years as against 54.9 in Asia and 45.3 in Africa. The protein-calorie deficiency in the two continents amounts to 30% and 25%, respectively while in Latin America it is 13%. Government intervention in this area is broad and varied. Industrialization coefficients - which are also indicative of more complex internal economic relations in the region -, are also contrasting, namely, 24.1% against 13% in Asia and 10% in Africa.

This disparity in regional situations gives rise to various topics that have an important place in the present discussion on the insertion of the region in the world economy and its connections with the developing world.

The first of these concerns the eventual rise of a new international division of labor whose characteristics and implications are yet to be assessed. Secondly, the degree of coincidence or disparity between the situation foreseen in this respect and the arrangements or prospects contained in the New International Economic Order the world community is seeking to introduce should be ascertained.

It would also be advisable to advance in the formulation of policies for strengthening and taking advantage of the potential implicit in closer "horizontal" linkage of Latin America and the developing regions of Asia and Africa. Lastly, in close relation with the above, it is of interest to assess adequately the desirable and feasible development goals for the region itself considering the special features of its present stage of evolution, matters that should be re-examined in the light of the modalities

assumed in various levels by the technological process. This has a profound effect upon external relationing at the same time that it charts uncertain courses for the region's major problems. Observations will be made later in this regard.

To summarize, the regional situation is complex in those countries that differ as to the degree in which they have been penetrated by technical progress, are simultaneously facing long-standing structural problems. Among them are lack of equity in social participation in the fruits of that progress - shown up in underemployment and urban-rural deprivation - and the high degree of external dependency which, although it varies from one country to another exerts a determinant influence on the pace of development and the possibility of progressing towards more complex productive structures. Together with these characteristics, there arise - factors - the increased value attached at the world level to the natural resources that are more or less plentiful in the region and finally, a certain awareness there of the potentialities derived from intra-Latin American cooperation if semimaturity and complementation already attained by the productive systems of the various countries is considered.

These and other characteristics place demands upon the design of technological policies -, national, regional, and vis-a-vis third-party countries -, which must, in addition be flexible enough to be adapted to a milieu whose productive systems and institutional frameworks are swiftly transformed.

2. The lineaments of scientific and technological development

The forms in which technological innovation makes its appearance in the region are affected by the general features of development. Some of the modalities of incorporation of science and technology that are inherent in the styles of development will be taken up below. Reference will be made to certain retardation and deficiencies in order to point up the distance that remains to be covered in solving basic structural problems.

Latin America was relatively passive in this area for a long time. It appeared that technical change was considered an exogenous variable independent of economic policy and, at the same time, it was assumed that the processes of accumulation and industrialization were capable of spontaneously generate at the opportune moment the local ability to absorb, disseminate, and create technical knowledge.

The fact did not support these hypotheses. It is correct that through migrations, trade, investments, and loans, manifestations of the scientific-technical revolution taking place in industrial centers were transplanted, but it occurred in limited and not very selective amounts. Frequently, cultural imitation accompanied a regressive distribution of income to create a favorable climate for ostentations forms of luxury consumption supported by technologies that barely contributed to necessary productive change.

Within this general framework of limited dissemination and absorption, technical advances were incorporated at very different rates in accordance with the productive and social heterogeneity that characterizes the area. Generally, the urban segments, linked to services the industrial sector and foreign trade activities, adopt styles of behavior that are relatively adjusted to what prevails in industrial society. This is not so in the strata that have been bypassed by development. Technical change reaches them irregularly, decompensating life and work habits.

The conditions underlying these processes are highly complex. Three hypotheses have been put forward to explain the nature of the regions's scientific-technical development. One stresses the over-restrictive nature of the technological policy implicit in the industrialization strategy that has taken shape since the thirties. As is well-known, this strategy was based on the substitution of technically simple imported goods; the demand for knowledge was satisfied from abroad without the assertion of local effort for absorbing, selecting, and producing discriminatively - in accordance with availability of productive factors and common interests - the manifestations of technological change. They undoubtedly penetrated the economic systems but in a piecemeal and irregular manner.

/Comparative

Comparative studies show that this evolution was not an inevitable effect of economic growth. Countries that simultaneously fostered growth and research during the decades before World War II, do not face at the present time the problems of technological dependency and anarchic transmission of innovation that are troubling Latin America. To be sure, this lack of foresight could be explained to some extent it it is considered that the industrial countries themselves became aware of the scope of technology as a variable and mechanism of growth only during the course of the war. Previously, any idea of the importance of this factor was purely intuitive.

In any case, substitutive industrialization continued on the rise - now encouraged by regional transactions, expansion of internal markets, and foreign trade - without opening the way - or only moderately - to the complex of policies, instruments and institutions required for technological development. What is more, the increasing weight of multinational companies upon dynamic activities implies that the mechanisms and consequences of technological change operate on the fringe of public policy. The root of the asymmetry between technological apprenticeship and industrial progress is to be found in these facts, an asymmetry that includes all elements of scientific-technical supply (academic research centers, extension services, consulting and engineering firms, and legislative, financial, and institutional supporting instruments).

A hypothesis of a second kind refers to instruments -largely short and medium-term - of economic policy whose effects would favor an atmosphere inhibitory to independent technological development. The limited anticipation of the impacts of substitutive industrialization - linked in some degree to over-formal planning policies -, the scope and nature of the changes in development style suggested by those effects and, in short, the relative conformity vis-a-vis a process of underdevelopment that was successful in terms of growth, tends to favor and prolong the application of the instruments of economic policy mentioned. Thus, it is argued that measures concerning industrial protection, factor costs, public expenditure, internal

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prices, and primary-exports incentives have turned into elements of discouragement for local supply of knowledge. This also would have called for basic investment and a long-range planning outlook. Economic policy would not have known how to cope with these requirements.

If its scope were not limited to the economic realm, this hypothesis on the contradictory and inadequate nature of the instruments would be more plausible. After all, attention to the scientific-research systems, to modalities of investment in human capital, and, in general, to the eduation and university field has also resulted in errors that affect the scientific-technical potential. To summarize, economic and social policy would have involved adverse consequences for scientific and technological development even though it might have had constructive effects in certain specific segments.[4/]

A third type of hypothesis points to the circumstances that shape the transnationalization of the Latin American economy and society prompted by technical progress itself. This view does not deny the initial disadvantages created in this realm by substitutive industrialization without endogenous technical change nor the ambivalent effects of the instruments of economic policy. Rather, it fixes on a new interplay of factors - industrialization of scientific research, oligopolistic competition between industrial centers, transnationalization of the ecnomic cycle and decision-making centers - which has found a receptive atmosphere in certain countries of the region at this stage of development.

These factors would have three tangible expressions that make up part of the Latin American discussion of the subject. One is the reduction of technological options on processes and products that follow the dominant line of the big research-and-development-intensive economic conglomerates. Despite the fact that the local learning process is important, it is usually limited to the passive or peripheral absorption of prevailing technical-economic

4/ See A. Nadal, Instrumentos de política científica y tecnológica en México, El Colegio de México, 1977.

modules or to minor innovations that do not mitigate basic dependency. Another is the deficiency of national policies in this area since they would lag behind the guidelines provided by the industrial laboratories of the big companies as to the pace and content of innovations. And, in short, this confluence of factors would reinforce the inadequacies of recent Latin American development indicated at the beginning of this chapter. The limitations shown by present development would become more marked with time if the predominant technical style is capital-intensive and, in addition, if assumes consumption patterns for some groups similar to those of the industrial countries. Objectively, the transnationalization of decision-making, links, and innovations would worsen this syndrome of initial and accumulated disadvantages which, in general, is shown by the region's technological evolution.

It should be stressed that these three hypotheses on the lag - an industrialization strategy without technological independence, the limited nature of the policy instruments in general, and the growing transnationalization of the economies - are complementary. Taken jointly, they offer valid explanations on the nature and limitations of the region's technological progress.

3. Differentiation and convergence

A situation that must be kept clearly in mind is that the degree of technological lag in the region differs from country to country. Each has potentialities and comes up against particular restrictions and, under certain circumstances, the advantages and disadvantages may turn out to be more important than the common features of their general development processes. Historically, these differences originated in the specific circumstances and modalities under which each country began to overcome the primary-exporting stage. The importance of those conditions was increased with time by the unequal endowment of resources among them, their institutional and political development, and the course of their economic policies.

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These are especially significant facts in the technological domain because the differences in the availability and organization of resources are in large measure the main facts conditioning the absorption and dissemination of technical change.

Various criteria are put forward that may serve to better illustrate that situation of science and technology policies, with a view to establishing a provisional typology. The need is confirmed of exploring priority areas - an aspect that will be developed later on for illustrative purposes - so as to relate to the structural heterogeneity. Of course, a more detailed analysis would have to distinguish between each of the criteria proposed in order to relate them exclusively to the scientific and technological development indicators. Various observations will be made in this regard.

Size appears to represent, in the first place, a significant conditioner of national options over the long-term. It could refer exclusively to population, per capita income or even territorial dimensions and the endowment of resources. Historical and comparative analysis shows, ceteris paribus, that size affects the productive structure (small countries generally stress primary activity), capacity for providing and mobilizing resources, and the degree of complexity of the economic system. To be sure, the influence of intermediate variables in the links between size and these phenomena are not disregarded. The topic has been little studied but data are available to suggest that size is a parameter of technological development not only on the microeconomic plane (where proof is abundant) but in the broader one of national policy.

In the second place, the importance of the industrial stage must be realized. From a general standpoint, all the countries of the region have increased their contribution of secondary activities to the product; the degrees and orientations of this expansion, however, are disparate. The major countries have reached a stage of "semimaturity" which is characterized by a significant industrial contribution (over 30% of the product); considerable diversifications with recent emphasis on capital goods; export-mindedness;

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and, an increase in expenditure on activities of learning and industrial extension, characteristics that place them in a different position from less-developed countries. The scope of "semimaturity" allows them to initiate a cycle of cumulative advantages on the technological plane which will eventually cause regional gaps in trade and in the technological transactions if proper care is not taken.

In the third place, access to and participation in integration schemes are aspects that condition the development of the member countries by neutralizing to some extent the limitations arising from size and the industrial stage. Thanks to these schemes, instruments of complementation and cooperation may be implemented as experiences received from Central America and the Caribbean have proved.

Lastly, the pace and nature of economic internationalization are criteria that qualify national situations. It is not the same thing if that process affects strategic or marginal sectors; if it is concentrated in the production phase or in that of marketing; if it is linked to forms of ownership or not; if it forms part or not of oligopolistic relations; if it shows rising or declining tendencies. Generally, meaningful internationalization would imply the transfer of capital and resource-intensive techniques besides a situation of considerable dependence on suppliers and standards established abroad. To be sure, this does not exclude cyclical short-term expansions brought about by favorable external fluctuations.

These factors of differentiation do not necessarily accentuate the dispersion among the countries of the region. On the contrary, they open the way to a constructive convergence of societies at disparate levels of development, an outlook that is particularly valid for launching technological programs and projects that need economies of scale of certain importance. As will be seen, there are broad prospects for cooperation and reciprocity in research, joint utilization of infrastructure (including industrial laboratories), information, and the training of human resources.

However, national disparities and the increasing fragmentation that may arise would be neither underestimated nor disregarded, since in the

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same way that the indicated situation would foster the regional solidarity needed by the countries to overcome structural limitations through scientific-technical knowledge, the technicoeconomic superiority of a given country left to its own devices could affect regional coexistence unfavorably.

It would be opportune at this point to make some inquiries into the nature of the technological development that predominates on the Latin American scene.

III. SCIENCE AND TECHNOLOGY POLICIES

1. Scope

The importance and manifold impacts of scientific knowledge in the Latin American countries has been recognized by their governments. Consequently, they have established specialized institutions and mechanisms for the purpose of coordinating and promoting their respective scientific-technological systems insofar as possible.[1/] As a result, there are many research centers that deal with sectoral aspects and train experts in specific subjects.[2/]

The institutionalization of certain policies is a process that has begun to gain importance in this decade throughout most of the continent, although it was initiated earlier in some countries (Brazil and Mexico). The objectives sought thereby are, in the first place, to make the rational selection of imported technologies possible and to reduce the drawbacks of the technology market. Secondly, to encourage innovation and adaptation at the national level particularly for the benefit of the most underpriviledged sectors of the population and the smaller productive units. This would have to be completed by imports of capital goods and managerial and administrative know-how. Thirdly, to disseminate the applications of science for the solution of the most pressing problems of the various countries (food, health, jobs, housing, energy, exports, etc.). And, fourthly, to foster the internalization of scientific culture, that is, collective recognition of the importance of scientists and science.

1/ For further information see Consideraciones sobre algunas experiencias recientes en la promoción del desarrollo tecnológico de América Latina (ST/CEPAL/Conf.3/L.4), November 1974.

2/ In the Dominican Republic, for example, over half the specialized institutions were founded starting in 1962. University entities were likewise expanded and diversified during this period, particularly in Mexico, Central America and Peru.
See OAS, Inventario del potencial científicotécnico de la República Dominicana, Washington, D.C., 1974.

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In an attempt to achieve these aspirations institutions have been established (science and technology councils, industrial-information centers), laws and regulations passed (standards for the regulation of foreign investment, including patents and trademarks), and other measures taken (fellowship programs, incentives to local engineering and consulting firms).

The activities of the public sector in this area were expanded when a new type of problems and procedures connected with technology began to be faced. A concerted effort was also made to increase expenditures oriented to research and development in line with more selective criteria than in the past, seeking at the same time to establish mutual relations between the various instruments of technological policy.

All of the above was unquestionably inspired by the efforts of the industrialized countries to regulate the pace and direction of scientific-technical activities. By the end of the twenties, entities and programs designed for this purpose were already in operation in the United States, Great Britain, Germany, the Soviet Union and Japan,[3/] and the effort was stepped up during World War II and at the end of it when specific experiences and detailed studies demonstrated the economic, social and military importance of scientific research.

The formulation of guidelines for science and technology in Latin America has been affected by various factors; for example, reciprocal influences - ranging between rivalry and complementation - in relation to the industrial countries over recent decades. The enormous burgeoning of technical progress determined sometimes by substantial investment[4/] and sometimes by the unparalleled expansion of world production and markets

3/ See T. Hiroshige, "The Role of the Government in the Development of Science", Journal of World History, Vol. IX,2,1965.

4/ Expenditure for research and development in the industrialized countries expanded considerably after the last war, at rates of over 20% a year. Gross domestic product in each of those countries exceeded 2%.

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has been an influence in this interdependence. As far as Latin America is concerned, this circumstance has signified the growing influence of multinational corporations which, on the one hand, impose their desires regarding production and marketing of goods and services and, on the other, impede the transfer of technology.

It should be noted that in the first five years of this decade sales of technology by these companies rose from 2.7 to 11 billion dollars. Despite the fact that developing countries accounted for only 10% (5% for Latin America), it is estimated that these countries will be paying 6 billion dollars in 1985 if present trends subsist.5/

The technicoeconomic inferiority of the area has been rendered more acute and evident by these external circumstances not only because of the fact that research workers there are small in number (1 per 10 000 inhabitants in comparison to the United States and Western Europe where the ratio is 40 and 30, respectively), but because investments in such activities are notably disparate. For example, the United States spends 115 dollars per capita on research and development while in the countries of the region outlay for this item runs from 0.40 dollars to 2.00 dollars. The same difference holds true for all aspects making former and current disadvantages of the region explicable.

In addition, there are other drawbacks of internal origin. The public sector, in the responsibilities it would be willing to take on in this field, comes up against the paradox that technological factors have never been assigned a special importance in the region's basic problems (decelerated industrialization because of technological barriers, unemployment, underemployment exacerbated by lack of technical training and the indiscriminate selection of technologies, and agriculture in need of secondary inputs) while economic policy and overall planning have scarcely taken these circumstances into account.

It should be added that this discrepancy reflects a flaw among the many to be found in Latin American planning and not only asynchronization between economic policy - of widespread tradition - and

5/ See United Nations, Transnational Corporations in World Development: A Re-examination, New York, April 1978.

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the recent application of technological policy as an endogenous variable. Something deeper explains these inhibitions on the part of the public sector in deciding upon technical change that is not limited merely to a mechanical process that can be applied without problems. The adoption of technology involves a new formulation of objectives and the use of new instruments for the public sector. It would help very little, for example, for scientific policy to be oriented towards the formation of resources and the study of technical requirements for producing capital goods if economic policy were to continue being directed to the importation of those goods.

All these contradictions and asynchronizations must be eliminated, since the risks and costs of overall and prolonged technological dependency are huge.

2. The bases for the discussion

The institutionalization of a policy whose goal is the utilization of science and technology is giving rise to far-reaching discussion. Intergovernmental fora[6/] and many experts[7/] disagree in this area, even on substantive aspects, which is an indication of the lively interest that has been aroused by these questions in Latin America.

Discussion generally centers around the degree and quality of technical change. For some, numerous innovations are needed in Latin America; they believe that economic modernization was prematurely halted and that

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6/ These forums are indicative of a growing awareness and of the outcropping of ideas for action. The following should be recalled in this regard: the presidential meeting of Punta del Este (1957); the Conference on the Application of Science and Technology to Latin American Development (CACTAL) in 1972; and the Intergovernmental Meeting on Science, Technology and Development of CEPAL in 1974. Also, the specialized meetings of directors of scientific policy and experts in the various facets of the subject, sponsored by UNESCO, UNCTAD, WIPO, OAS, etc.

7/ In addition to the studies indicated in the CEPAL document see Consideraciones sobre algunas experiencias recientes en la promoción del desarrollo científico y tecnológico de América Latina, op.cit. Note should be taken of the Regional Action Plan on Science and Technology for development prepared by experts of ACAST and research within the framework of the Scientific and Technological Instruments Policy sponsored by the International Center for Research and Development (Canada).

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this is not the time to criticize the transfer of knowledge. Insofar as they feel that there would be no technological options over the short-term, they consider that growth should follow the same paths. They believe that the drawbacks of external transfers would be offset by the vigor of the economy in the long run. Others consider it preferable to look into a technological style that would provide technosocial guidelines more in line with the elements and interests of the regional economy. According to this school of thought, it would be advisable to check the technological flow in certain cases if this would lead to progress in other underdeveloped activities. That is, they appear to be convinced that the prevailing technological system inevitably conditions a situation of backwardness that tends to be perpetuated. Consequently, options must be sought not only for meeting a temporary shortage (for example, unemployment in a given activity) but for crystalizing development in other sectors.

At the same time that this type of controversy goes on, others argue the advantages and disadvantages of internationalization. In the opinion of some, the world economy is entering a phase of complementarity and interdependence (provoked by the technological dynamics and trade within a period of prolonged global peace) that cannot be challenged. It constitutes one of the characteristics of the times. As a consequence, each country's strategy would have to consist of identifying the advantages that might accrue to it from this headlong process and in likewise identifying some subsector, branch or activity in which geoeconomic factors of size and location were not decisive and could be the pivotal point for their development. Meanwhile, the transplantation of knowledge would be devoted to clearing away internal blockages.

However, others are of the opinion that the complementation and interdependency process on a world scale would primarily benefit the industrial countries and that, at best, it would give rise to a new division of labor that would give the developing countries small margins for growth. As far as the defenders of this viewpoint are concerned, the only positive outcome to this state of affairs would be the gradual and

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selective reduction of external links (investment, trade, imported technologies, technical assistance), as the sole form of developing internal aptitudes for development. It is argued that this strategy of "decoupling" from industrial centers would be the proper response to their intented domination.

A third approach - in relation to the two others mentioned - would be that of stressing the rectification of the regulations governing international transactions, particularly those involving technological items (patents, industrial property, trademarks and technological information). According to this viewpoint, a change in the international position in this field to bring it into line with the postulates of a new international economic order would be the prerequisite for independent technological development. Other analysts, however, believe that arrangements of that nature are only symbolic. The cause of technological backwardness is internal, according to them, and if there is no change at that level, international rectifications would continue to have little effect upon it.

The discussions also impinge on the content of the problem. Some will have it that scientific-technical backwardness is no more than an administrative-institutional problem arising from the fact that there is no communication between the leading elements in technological development (government, research centers and users, in general). Thus, the divorce between the needs of governments and the scientific and technical preparation offered at the universities; the preference shown by users for imported technology; the limited use of public measures to encourage the development of technology, and the use of imported schema on the part of universities. The solution, then, would consist of building bridges for facilitating communications between them which would give a more solid base to the activities each tries to carry out alone, in precarious fashion.

Other students of the problem believe that the solution lies in economic policy. If said policy were to consider the long-term outlook and the immediate needs of technology, in addition to modifying shifts in the prices of the factors and certain tax provisions - it is argued -, it could bring about conditions favorable for technological self-determination.

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To be sure, all these positions are not mutually exclusive. Some refer to a special aspect of scientific-technological underdevelopment, some to another, in particular, and all of them, as a whole, offer quite a complete picture of the main obstacles to be faced. Besides, the existing situation in Latin America is so complex and the flexibility that it lacks is so necessary that it would be an error to adopt any of these extreme positions. External transfers in itself is not the main obstacle; rather, it consists of the actual orientations that technical change gives rise to within the national systems. Similarly, the interdependencies that are sprouting in the international community - admitting their present negative aspects - include, at the same time, certain opportunities, and a radical severance from that community might signify the loss of stimuli that give rise to them. And, most important of all, it is just as necessary to change the climate and external conditions of the marketing of technology as it is to obtain dramatic changes at the national level. The lack of scientific streamlining, in the final analysis, is not merely an administrative, institutional or economic problem; it involves aspects of the greatest diversity which must be dealt with in a coordinated fashion.

In any case, discussion of these topics is heated in Latin America and has spread over most of the developing world. At the same time, it has served to bring out the main concerns of regional scientific and technological policy.

3. The problems

Some of the Latin American concerns in this area will now be looked at.

The fact that supply of investigators is weak has already been mentioned, and some of the reasons for this should now be indicated. Their level and orientations are the same. For the moment, one difference comes to the fore - which is not always apparent in available statistics - between professional groups (including teachers) and active research workers, devoted respectively to different activities, of course. The former provide technical and dissemination services and the later

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acquire and create knowledge which they exchange at the international level. In 1974, for example, approximately one-fifth of the 8 500 scientists, engineers and technicians in Bolivia belonged to the first group.[8/]

Such a low availability as that indicated above may, in the first place, be attributed to the fact that the majority of those investigators hold a first academic degree and, less often, a higher one (master's or doctor's), either because postgraduate institutions are weak or non-existent or because local demand has not yet called for more. The educational level of investigators is therefore lower in many cases than might be required by international standards and the type warranted by the research.

In the second place, the scarcity of these graduates is due to the fact that research as a full-time occupation is not a generalized phenomenon. Part-time work, which reduces the productivity of the scientists more than proportionally, is common. By way of illustration, it might be recalled that there were about 1 500 engineers in Uruguay in 1971-1972 devoted to research and development and that their number shrinks to 1 100 if full schedules are considered.[9/] In the third place, the activities of the investigators do not correspond to specific demands from the public or entrepreneurial sectors, but rather to individual interests that do not always coincide with the collective interests of the country. Thus, for example, two-thirds of the projects prepared by research institutions are not covered by external contracts in Argentina nor are they applicable directly to any industry.[10/]

Investigators generally work in small groups which barely constitute a critical mass; it is thus understandable that projects prepared by two or three investigators (and there are cases in which the projects outnumber the investigators) are limited in scope and are concerned with

8/ See Ministry of Planning and Coordination, Informe de Bolivia a la Quinta Reunión de la Conferencia Permanente de Dirigentes de los Consejos Nacionales de la Política Científica, UNESCO, Quito, March 1978.

9/ See R. Brezzo Pardes, La problemática de la transferencia de tecnología en el Uruguay, OAS (SG/P.1, PTT/37) September, 1975.

10/ See A. Araoz-C. Martínez Vidal, Ciencia e industria. Un caso argentino, OAS, Washington, D.C., 1974.

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narrow issues. These circumstances aggravate problems and substantially cushion the impact that investigators could have in the scientific and economic sphere.[11/]

Apart from supply problems, there is that of expenditure on research and development which is very low in Latin America in comparison to other countries. It is fundamentally of a public nature (private participation barely amounts to 10% in comparison to 60% for various advanced market economies). Besides, coverage is largely earmarked for current costs and its allocation is not very selective.

In addition, financing for research involves special problems that are different from those found in that for other activities; in the first place, with regard to the mobilization of additional funds for that purpose (Peru and Brazil have applied innovative systems of their own in this regard); secondly, in budgetary organization and programming;[12/] thirdly, in the particular criteria applied to the selection of projects (which should differ from those for physical infrastructure, for example); and, fourthly, in the methods of evaluation of the cost involved in very complex methodological questions. It appears that highest priority among activities to be carried out should be given to in-depth studies of these aspects.

A third type of problem - after those enumerated dealing with supply of scientists and expenditure - is of an institutional nature. It has already been pointed out that the links between the main actors involved in technological exchange (universities, productive sector and governments) have drawbacks, but additional impediments to communication arise in the course of the various phases of the cycle which cover the gamut from basic research to pilot plant. Deep divisions are to be found between scientists and technologists, and such divisions

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11/ A rough indicator of scientific backwardness is the very small number of Latin American recipients (2) of the Nobel Prize out of the total of 313 awards.

12/ See a study in this relation by Alfonso del Toro, El proceso de programación presupuestaria para ciencia y tecnología en Colombia, COLCIENCIAS, Bogotá, 1977.

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may also be found within the public sector itself. The insufficient coordination between ministries of education and labor, and between these and academic centers, for example, are classic. For all these reasons, scientific and technological policy must cope with "disconnected units" which conform to traditions and interests peculiar to them although they all affect the buildup and dissemination of technological change.

Another body of problems is to be observed on the external front: consider, for example, the limitations and ambivalences of the transnational corporations as vehicles for the transfer of technology. Apart from the effects they produce from the economic standpoint, there appears to be a consensus of opinion that these entities have advantages due to the technological and organizational vigor that characterizes them and due to local inferiority in this field. To be sure, they transmit innovations, but less important ones than those developed within the firm. Apart from the above, the burden of these enterprises is usually counterproductive seen from other vantage points. They often impose restrictive practices in supplying materials and in marketing; they affect consumption patterns by inducing artificial differentiation in supply and, in some cases, inadmissible interference in the local political system is tolerated.

Furthermore, the effects generally forthcoming from public and private international cooperation - notwithstanding its good intentions - are often debatable, particularly with respect to the lack of clarity concerning national needs. External cooperation can be a valuable instrument only to the degree in which technological policy determines and selects the real areas of interest. The second National Science and Technology Plan of Brazil (II PBDCT-1975/1979) is a good example of the exactness with which objectives and instruments should be specified in order to obtain maximum benefits from international scientific resources. It stresses substitution of basic inputs and capital goods; the checking and replacing of demand for certain petroleum derivatives (use of alcohol obtained from vegetable products as a gasoline additive, for example), and the diversification of exports.[13/]

13/ See in this regard CNPq, Informe Nacional de la Reunión de Directores de Política Científica, UNESCO, Quito, 1978.

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And, as if the above were not enough, an additional problem arises through the movement of skilled personnel across national boundaries. Information in this regard is inconsistent, usually referring to only one country (the United States), mentions "professionals, technicians and similar workers", and does not specify the original immigrants who later return to their country of origin. With these reservations considered, the total number of migrants for the period 1960-1970 amounted to approximately 47 000 persons.[14/] More exact estimates for a given country and its scientific resources, in particular, show that migration is broader in scope in some countries than in others, is prompted by economic factors and in some cases to political turmoil.[15/] Migratory movements of scientists within the region also appear to have grown.[16/]

4. The instruments

The Latin American experience in the development and handling of various instruments of scientific and technological policy has been noteworthy. Some have had considerable exposure as a consequence of having been involved in steps taken by academies of science, university centers and certain government entities; others are new and emerged as the outcome of a critical review of the legal and practical regulations governing the transmission of technical knowledge. The instruments concerned are both national and regional in scope and in line with the respective context of action and the recent evolution of Latin America.

For facilitating study, distinction will be made between institutional, legal and administrative-financial instruments. In practice, a

14/ According to the OAS, II Seminario Metodológico sobre Ciencia y Tecnología, Bogotá, Colombia, 1972.

15/ See UNCTAD, Principales cuestiones que plantea la transmisión de de tecnología. Estudio monográfico sobre Chile (TD/B/HC.11/20), May 1974.

16/ See Colombia, Informe Nacional, presentado a la Quinta Reunión de Directores de Política Científica, UNESCO, Quito, 1978 and R.Brezzo Paredes, La problemática de la transferencia de tecnología en el Uruguay, op.cit.

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certain amount of overlapping - and conflicts, as well - arises between the mechanisms reviewed.

It should be noted at the institutional level that national councils of science and technology with relatively similar areas of competence have been established. For example, a council of this kind was created by presidential decree (December, 1970) in Mexico which "signified an important structural change in the science and technology system".[17/] Without altering the autonomy of its various components, the new organization made every effort to identify and classify in order of importance objectives, goals, policies and programs for scientific and technological development. The National Research Council of Peru, on its part, is an organ of "coordination, promotion and assistance under the Office of the President of the Republic". Its main objective is to establish a national and technology system.[18/] Cuba has founded a specialized organization - the State Committee of Science and Technology - "in charge of directing, coordinating and supervising the application of state and government policy" in the field of science and technology, including matters related to industrial property and national systems of scientific and technological information.[19/]

These councils do not constitute the only institutional formulae known in the region. In Ecuador, for example, the National Planning Board includes promotion and organization of scientific-technological activities within its area of competence. Furthermore, various of such functions have been assigned to the National Institute of Technology

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17/ See Monografía Nacional de México for the UNCSTD (draft version), May, 1978.

18/ See Peru, Informe nacional, presented at the Fifth Meeting of the Conference of Directors of Scientific Policy, UNESCO, Quito, March, 1978.

19/ See M.A. Fernández Finalé, D.O. Fernández Rodríguez and J.A. Hernández Revelo, Resumen de la política e instituciones relacionadas con la planificación y transferencia de tecnología en la República de Cuba (UNCTAD/SIDA/III/DT.22), April, 1978.

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and Standardization in Paraguay, an autonomous entity connected with the executive branch through the Ministry of Industry and Trade.

The objectives of all these entities usually coincide. One of them is to coordinate and inter-relate the various components of the scientific and technological system. Another is to strengthen the infrastructure and general support services, mobilize internal and external resources, broaden fellowship programs, disseminate significant research. Recently a special effort has been made aimed at specifying priorities, an indispensable requirement for designing strategies and plans.

The technological research institutes (industrial and agricultural) are an institutional arrangement that has sprung up in some countries that complements that of the councils. They provide specialized sectoral services with a view to engaging in trouble-shooting on occasion and at other times to facilitating advice and information needed by productive units. The Industrial Research Institute (INTI) of Argentina and the Institute of Industrial Technology and Technical Standards (ITINTEC) of Peru are examples of such arrangements. It should be noted that at this time an attempt is being made to check over the functions and powers of these institutes in the most thorough fashion. Institutions also function at the sub-regional and regional level. This is the case of the Central American Institute of Industrial Research and Technology (ICAITI), the Institute of Nutrition of Central America and Panama (INCAP) and the Interamerican Center for Tropical Agriculture (CIAT).

Finally, various modalities have been established for regulating the transfer and marketing of technologies. In a number of cases these have taken the form of national registries (Mexico, Argentina); in others, of royalty committees (Ecuador, Colombia). Nevertheless, the purposes are usually the same: promote the standardization of payments for royalties, reducing the restrictive clauses in sales contracts, and advice to local entrepreneurs on their dealings with suppliers of technology. These organizations operate within the context of more

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general policies that orient industrialization, foreign trade and foreign investment and, as a result, are subject to contradictory guidelines depending upon the variance of pressures in each situation.

In short, the institutional instruments for science and technology have been expanded and diversified in the region. Although differences may be seen in their form of introduction into the public sector and in their respective areas of competence, they share the intention of providing flexibility to the process of creation, transfer and selection of socially useful knowledge. They nevertheless involve severe problems that will be examined later.

With respect to the legal instruments, each of the organizations mentioned receives legislative support that defines its purposes and areas of action, considerations that indicate new attitudes on the part of the countries with respect to sources and mechanisms of technical progress. Apart from those mentioned, other specific instruments regulate different aspects of the problem. For example, the Law of Inventions and Trademarks (1976) of Mexico regulates the issuance of patents on inventions and improvements, certificates of invention, registration of models and industrial drawings, trademarks and indications of origin. This law is in answer to the generalized concern over the large number of registrations of foreign patents and trademarks, the unfair competition that may be implied, and the abusive transfer of payments that is frequently involved. The Intellectual Property Law of Costa Rica, currently under review, was passed for the same reasons.

The influence of various measures taken by the Board of the Cartagena Agreement is also noteworthy. Decision 24, in particular, was at the time of issuing a significant attempt to deal in an organized manner with the various mechanisms of the transfer of technology for the benefit of the receiving countries; it has been supplemented by other instruments that clarify matters related to industrial property and trademarks.

Another type of instrument to deal with the problem is of an administrative-financial nature and in this respect mention should be

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made of three measures which reveal the intent of establishing complementary bases for self-propelled technological growth.

The first consists of forming liaison units between Ministries of the Treasury and Councils of Science and Technology for deciding upon the level of expenditure and corresponding distribution criteria. Advances have been made in this direction by Mexico, for example, which proposed setting up an interinstitutional science and technology committee to be composed of the Ministry of Programming and Budget and the National Council of Science and Technology. This committee would study the financial aspects of the programs in the field, including preliminary drafts of federal budgets, with a view to their coordination.

Along the same lines, it is opportune to recall Colombia's recent attempt to set up a budgetary mechanism for programs financed through the General Budget. It is divided into two phases. The first identifies science and technology actions to be carried out by public institutions based upon the specifications of preliminary draft budgets and the second sets goals and programs, defines implementing institutions and allocates the funds agreed upon.

The second measure concerns new methods for mobilizing funds based upon the activity of enterprises. Relatively small percentages - many of them significant, nevertheless - are deducted from their books to support research and development projects that the companies themselves would be unable to carry out. This has been done in Peru, for example, with encouraging results.

Lastly, the establishment of financing agencies specializing in technological studies and projects should be mentioned. In Brazil the contacts that have been established between the National Council (CNPq), Industrial Studies and Projects Financing Agency (FINEP), and the National Development Bank (BNDE) within the Ministry of Planning is undoubtedly of interest.

In conclusion, it is clear that the analysis and evaluation of each instrument calls for detailed studies still to be made. At the moment, certain observations may be offered that might contribute to arriving at a provisional balance of the experiences obtained.

/5. The balance

5. The balance

It appears that there is a clear intention of having a critical examination of science and technology policies in the region. Few persons deny the value of such an exercise. The objections raised to the idea of "planning for science" - which were weighty in their day - faded with time after it became evident that if technological development were to remain exclusively in the hands of the forces that introduce it from abroad it would not contribute either to strengthening internal aptitudes or to overcoming critical limitations. This realization must in large measure be attributed to the successful public discussion of these policies.

The recent efforts to create new technologies in line with specific needs should also be recalled; for example, the production of rubber from the guayule, of steroids from yucca, and of pharmaceutical products from coral. Also, the utilization of sugar cane and of alcohol as a source of energy has been perfected.

Furthermore, the pioneer work initiated by the Central American Institute for Research and Industrial Technology (ICAITI), the Nutrition Institute of Central America and Panama (INCAP), and the Inter-American Institute of Agricultural Science (Costa Rica) has continued at the regional level.

The impression nevertheless exists that the lines of action and instruments available for attacking them barely conform to the magnitude and urgency of the problems. In not a few cases, the creation of new institutions (councils, registries, research centers) seems to have been a response to sectoral demands: academies of science, protectionist trends of industrial policy, and the accidental rise - although strong at the moment - of a group of scientists and public officials. It has not yet been possible to project an overall, long-range view of scientific and technological development nor to organize the available tools of public policy to operate smoothly in this area. It is also true that the lack of a clear idea as to what type of development would be desirable together with substantive and instrumental flaws in overall planning

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have, in some cases, sharpened the difficulties and restrictions confronting science and technology policies. These become meaningful and are fostered only to the degree in which national priorities - and the role technical progress plays in this respect - are established and put firmly into practice.

Furthermore, short-term pressures - external and internal - which reveal special intensity in the Latin American context, have resulted in less attention being paid to long-range measures. For example, investment in scientific and technological research has not been freed from the limitations that usually beset public finances; they have been trimmed in accordance with their uneven development. Also, the intensification of local research and development capacity is usually in disaccord with liberal import policies on equipment and technical assistance. This sort of asynchronism tends to be perpetuated.

Along another line of thinking, there are reasons to believe that the emphasis placed on increasing expenditures on science and technology has been limited to its quantitative aspects; slight attention has been paid to criteria on allocation, unnecessary duplications, underutilization of resources and equipment, and obstacles in the way of converting knowledge into useful innovation. What is more, many cases can be cited in which sight apparently has been lost of the fact that universal literacy and changes in the direction of traditional educational policy come before the effects anticipated from increased expenditure.

This reflection is coupled with another of a more general character. Historical experience indicates that technological progress and the impetus arising from it depend very largely on the collective solution of the problems of ingrained insufficiencies. In this regard, it should not be forgotten that there was an agricultural revolution prior to the industrial revolution; that scientific research takes on impetus in an atmosphere of struggle and assertion of human rights; that the flow of innovations was fostered to satisfy basic needs of the majority strata of industrial society, including the expanded coverage of elementary and secondary education; and that the dynamic introduction of countries into world

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markets is conditioned, in the final analysis, by the generalized increase in productivity.

These observations cannot be left unheeded in the day-to-day operation of policies for science and technology nor do they deserve only formal recognition. They must always be kept in mind in the light of both the unquestionable achievements of these policies and of the shortages that must still be overcome.

IV. AREAS OF STUDY: SOME ILLUSTRATIVE EXAMPLES

1. Background

The selection of areas of study has been based on two considerations: the wide variety of inter-related topics related both to the scientific-technical progress and its backwardness existing in present-day Latin America - features which should be adjusted to the practical limitations that must be considered in the Conference on Science and Technology for Development and its preparation - and the coincidences and contradictions that may arise between the particular priorities of the member states and the subjects that make it possible to build and coordinate a regional and international program of common actions. It will be necessary to find the best way of combining them on the understanding that the organized and equitable transfer of technical progress within each country and between countries is a long, dynamic and contradictory process.

If it is accepted that science and technology influence strongly the economic and social life of a country, the criterion for selecting categories of topics cannot be narrowly sectoral. There are three serious disadvantages to choosing a productive branch as a subject for international attention: it unjustifiedly limits both the real and the potential effects of scientific-technical knowledge; it sharpens the discrepancy between particular options and overall interests and it duplicates the content and the concerns of other international meetings at which specific subjects have been discussed. Indiscriminate attention to one sector or branch (i.e. "agriculture", "industry", "capital goods", "fertilizers") may lead to limited formulations that would detract from the scope and aims of the opportunities and resources that the Conference should promote.[1/]

1/ For further information on the selection of areas, see The Question of Subject Areas (CEPAL/MEX/ELCT/3) and Further reflections on the question of subject areas (CEPAL/MEX/ELCT/4), October-November, 1977.

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It is necessary, therefore, to link the technological content of the productive sectors - including trade, of course - with the factors that regulate the technological market. That is, there is a need to examine those questions that concern both supply of scientific-technical knowledge (training of resources, data networks, sufficient funding, institutional incentives) and its demand (makeup of the social product, engineering and consulting services, control and selection of techniques, guidelines on foreign investment and industrial property) within a national framework that would define their development style in clear-cut fashion.

The Latin American Meeting of Government Experts on Science and Technology for Development (Mexico, October-November, 1977) delineated the exact nature and scope of the "spheres of study", thanks to which the potential applications of science and technology would be exemplified.[2/] They do not necessarily reflect national priorities; rather, they constitute inter-related aspects that are vital for the development of countries of the periphery.

These suggestions were adopted at the second meeting of the Preparatory Committee of the Conference (Geneva, January-February, 1978) where five areas were specified for purposes of illustration: food and agriculture; natural resources; human settlements, environment and health; transportation and communications; and, industrialization, with emphasis on capital goods.

Research efforts will have to be initiated or strengthened in many of the fields examined below with the aim to characterize and specify national and regional problems and experiences in order to establish a common position to be taken at world forums where the direction and content of international cooperation is discussed.

Also by way of illustration, certain problems will be mentioned that are indicative of the priority nature of certain areas and the technological aspects that should be taken into account. In the light of the above considerations, the following material is presented on issues concerning agricultural development, human settlements, health, and capital-goods production.

2/ The Question of Subject Areas, op. cit. and Further reflections on the question of subject areas, op. cit.

2. Areas and problems

a) The agricultural situation

The technological progress of Latin American agriculture over the last twenty years can be said to have been remarkable. Among others, it has the following characteristics: application of improved techniques for cultivation and cattle handling; better farm management; utilization of new varieties of seeds; use of mechanical power and equipment; application of herbicides, pesticides and chemical fertilizers; and, better utilization of water. Nevertheless, it cannot be denied that there have been very slight increases in average yields of many farm products, particularly if compared to those obtained in other parts of the world. Modernization has brought with it the proletarianization of the farmer, development of new forms of social stratification, increased rural unemployment, and expansion of farm limits as the main resource for increasing production.

Exhaustion of "easy" ways of bringing new lands under cultivation in most countries of Latin America has made it necessary to find alternative technologies for more intensive use of existing lands or the incorporation of others for which available technology is inadequate or inappropriate (damp tropics, desert zones).

The problem calls for thorough study of the experience the countries of the periphery have had in the application of science and technology to agricultural development to ascertain if the results were satisfactory (employment, rising income for producers, increased production and productivity, etc.) or if other methods should be used.

The studies made by the United Nations Research Institute for Social Development (UNRISD) on the socioeconomic effects of the "green revolution" in Asia, Africa, and Latin America[3/] should be kept in mind

3/ The socioeconomic impact of the introduction of high-yield strains of grain is dealt with in the GLOBAL-2 Project. It includes general studies and analysis of countries (Mexico, Philippines, Sri Lanka, Indonesia, India, Morocco and Tunis) and by regions (Asia, Africa, and Latin America).

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for that purpose. They show, with numerous examples, that the use of high-yield strains of seed (particularly, wheat and rice), for which there were such high hopes in the sixties, benefitted especially a small minority of producers in almost all the countries where they were utilized. It did not succeed in solving the food problem as had been supposed. What happened is that the "technological packages" called for by the "green revolution" - relatively high density of capital, inputs, machinery, and irrigation per unit of exploitation - were beyond the reach of the vast majority of rural producers, regardless of the spectacular yields per hectare, and as far as the production of certain articles is concerned their effect upon other key objectives of rural development (employment)[4/] were negligible or even negative (income distribution in the rural areas). In this sense, the "green revolution" contributed to aggravating the social-polarization processes characteristic of agriculture in most of the countries involved. Government policy itself is not free of blame in this respect because the spectacular nature and rapidity of the yields prompted the allocation of funds to the new farmers able to apply the new technology to the detriment of the vast majority and, in some instances, at the expense of the population's basic diet.[5/]

The shift that took place in agriculture research in the tropics, largely in the peripheral countries, is another example of this phenomenon. A sharp difference has been noted in them between the many scientific-technological research efforts in the field of agriculture aimed at export and the inordinate scarcity of studies on the production of basic foodstuffs, despite the obvious crisis in the traditional systems of tropical subsistence farming (splash and burn) which lead to the progressive deterioration of the man/land ratio.

The application of scientific-technical research has, thus, not been socially neutral and, therefore, a conscious effort should be made

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4/ In some cases in which commercial farming expanded at the expense of peasant farming, in taking advantage of increased yields, the net effect on employment was even negative.

5/ Along the same lines, it is still surprising that the major research efforts financed wholly or in part with public funds in the not very distant past were systematically channelled into commercial farming and not, except when it was the same, into the most important elements of the national diet (wheat, in Mexico where the basic product is corn; corn, in Chile where it is wheat; coffee and soya, in Brazil where they are beans and mandioca, etc.)

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to orient it in the direction of its potential for social transformation and to find technological alternatives that will serve the majority.

If the objective of the application of science and technology to farming is to increase not only production but the income and employment of the majority of those engaged in that pursuit, in other words, rural development, the goals set should consider the needs of that majority, its real or potential resources, the ecological framework in which its activities are carried on, the forms organizing production and the logic underlying its management and, in general, the aspirations, motivations, and living conditions, of the people, besides the activities to which they are devoted.

Since most of the production units of the countries of Latin America are peasant-type small holdings, technology should find alternative forms of exploitation which, without increasing the capital requirements per person engaged or raising them slightly, would make it possible to improve yields per hectare and per labor-time invested in the unit. This does not assume relegation of top-level research; quite the contrary, conditions are so serious that simple production techniques must be found that arise from the most painstaking scientific research possible.6/

Examples of possible lines of application of scientific and technological research to agricultural problems that will illustrate the indicated approach cover fields as diverse as balance of energy consumed and generated in the sector; reduction of hazards of crop loss and increase of nutritional content; utilization of the tropics for producing basic foodstuffs; improvement of rational food systems; building of rural physical infrastructure; and others.

With respect to energy balances, agricultural development has absorbed increasing energy inputs per unit of energy generated in the form

6/ For example, genetic research on somatic cells which drastically reduce the gestating time of new strains in comparison to that needed by hybridization and selection procedures utilized in the "green revolution", based upon selecting peasant-farming products and generating strains that adapt to techniques the growers are able to absorb.

/of agricultural

of agricultural production, and with the shrinking supply of fossil fuels in most of the countries of the area, it is becoming increasingly difficult to resort to agricultural or food systems that are common in the industrialized countries. In fact, if the world population had to be fed by a productive system like that of the United States, 80% of the energy resources consumed annually throughout the entire world would have to be devoted to this purpose alone.7/ This fact, in addition to those already pointed out, show up the limitations that generalization of the "green revolution" suffered from its inception.

The cost and growing scarcity of fossil fuels calls for research into ways of cutting down needs for calorie inputs per unit of product generated, that is:

1) Alternative energy sources: wind, solar, biogas (methane from waste matter);

2) Natural instead of chemical fertilizers (reduction of calorie input by over 400 000 kilocalories per hectare, besides improvement of soil conditions).

3) Substitution of pesticides by biological forms of pest control; by their selective application ("treat as needed") or by more intensive cleaning practices;

4) Substitution of commercial fertilizers by crop rotation which includes nitrogen-fixing agents as part of the rotation (thereby making it possible to reduce energy needs by half a million kilocalories per hectare).

In regard to the need for reducing the hazards of crop loss, to increase the nutritive value of farm products, research in hybridization or the most advanced studies in somatic-cell genetics would have to be directed towards obtaining strains more resistant to pests, with higher

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7/ J. and C. Steinhart, "Energy use in the U.S.Food System", Science, V. 184 X 41 34, April, 1974. Until about 1910, United States agriculture consumed less energy than that generated in the form of food. At the present time, over ten calories are consumed in various forms for each calorie of food produced. (Page 311).

protein content, and with lower water requirements, even at the sacrifice of yield (which must cease being the main old fashioned objective of the new strains created).

The utilization of the extensive tropical areas of Latin America (plains and grazing lands to the north and south of the Amazon, the coastal plain of the Gulf of Mexico, etc.) as a source of basic foods and the checking thereby of the deterioration and crisis of migrant agriculture depends upon scientific and technological progress in that area. Up to three crops a year could be obtained in spite of the climate of these zones if problems of lack of water in some areas or periods and of excessive leaching in others can be solved. This would imply shortening of the lapse, sometimes enormously, between planting and harvesting which would call for not only the introduction of appropriate seed but of instruments, machinery (not necessarily complicated)[8/] and cultivation practices needed in those activities.

The development of new forms of production organization (or the improvement of existing ones) which, by utilizing the complementary potentials of integrating small family holdings (as in rural communities) into more efficient structures of social division of labor, would permit the manufacture of the basic equipment for such communities, reduce the need for importing it,[9/] and favor the design of tools and simple machinery that would be easy to make.

The coordinated study of the complex social relations and the technical-material and institutional factors that enter into the realm of food from its production to its consumption, that is, food systems,[10/]

8/ "It has been seen in experimental stations in India and Pakistan that such farm machinery, together with pumps, motors, and well casings can be built by small machine industries with steel and other metals supplied by central shops." R. Reveille, "Recursos disponibles para la agricultura", Investigación y ciencia, November, 1976.

9/ "Recursos disponibles para la agricultura", Investigación y ciencia, op. cit.

10/ By food systems is meant the social relations involved in the process of production, manufacture, distribution, change, appropriation, and consumption of food in a given country or locality. UNRISD, Food System and Society, March 2, 1976.

/is undoubtedly

is undoubtedly the point of departure for determining the potential contributions of science and technology for solving the food problem. Research into alternative solutions of another kind might not only hamper the possibilities of establishing the most appropriate priorities of needs but would lead to senseless waste of effort.

b) Human settlements

The secretariat considers human settlements another of the pressing problems that requires continuing attention from national development policies and the regional and international cooperation system, particularly in view of the fact that concern about environmental deterioration has developed very slowly even though the population of Latin America will amount to almost 610 million inhabitants towards the end of the century.[11/] It is extremely urgent, therefore to adopt technological policies that can be adapted to the available resources for meeting the basic needs of the settlements. In any case, the lack of concern for preservation of the physical environment may complicate and aggravate deficiencies observed in the region.

Human settlements and their implications in relation to social and economic aspects constitute a most complex subject but it is of interest at this time, nevertheless, to stress the point that present technologies applied to solve the habitat problems for the majority groups have had little or no success.

It should also be kept in mind that activities connected with the building of the habitat in Latin America and the Caribbean have resorted largely to imported technologies[12/] whose application has had to be restricted particularly because of the high costs in relation to the low incomes of the majority of the population. Consequently, the low-income groups have been forced to develop their own modes ("informal") of organization and "empirical" technologies because of their limited access to the goods and services market.

11/ CELADE, Boletín demográfico, Año VII, No. 13.

12/ UNEP/CEPAL Program on Human-Settlements Technology, Tecnología de asentamientos humanos en América Latina y el Caribe, preliminary version, Mexico, D.F., May, 1978.

/Inasmuch

Inasmuch as most of the land, materials, and financial resources is absorbed by the "formal" system anyway, it is necessary to devise a different system for the sectors of the population whose weak purchasing power prevents them from solving their housing needs through the regular market mechanisms. In the absence of another alternative, this new "informal" system of production and distribution of environmental goods and services would have to resort to other forms of organization with different resources and empirical techniques. Such a system would also differ from the usual one in its decentralized nature since the function of building would have to be defined in terms of the persons carrying it out, who are generally the users of the product themselves. The "formal" system, on the other hand, operates independently of the ultimate users and, in the case of governmental management, the setting up of priorities and the decision-making involved are clearly centralized.[13/]

Technological research on human settlements in Latin America has always been oriented towards two main fields: building materials and techniques and the design of low-cost housing.

Although the national science and technology organizations have recently begun to show more interest in human-settlements technology, they have not yet become fully cognizant of the needs and potentialities of empirical technology. Only as an exceptional case has attention been paid to the techniques that have been applied for a long time to the more precarious urban settlements and in rural communities. One of the few exceptions is the PREVI project implemented in Peru with United Nations support. The interest shown in this regard by various centers operating in the region, however, raises hopes that research in the field will be oriented in that direction.

c) Health and the pharmaceutical industry

The achievement of integrated development brings up, among other requirements, the implementation of policies that would tend to universalize the provision of basic services to the entire population. The question

13/ Tecnología de asentamientos humanos en América Latina y el Caribe, op. cit.

of health is of paramount importance because of its influence upon the well-being and the creative and productive capabilities of the population. Resources are channelled in ever greater amounts for the purpose by all the countries of the region but the form in which the services - considered in the broadest sense to include administrative organization, etc. - are organized increases their cost inordinately and for that reason the only ones who have really benefited from them - and only up to a certain point - are the middle and upper urban groups.

Supply of these services suffers, therefore, from a technology that is inappropriate for the needs and possibilities of the countries of the region. To make it generally available would signify such a huge cost that its feasibility becomes dubious. More accessible options in terms of both quality and cost will, therefore, have to be contrived.

Programs on science and technology for development have apparently paid insufficient attention to public health. They have been concerned particularly with research in pharmaceutical products and the training of personnel for some medical and biochemical activities. For example, among the issues that have been covered is the rationalization of the consumption of drugs through the formulation of master lists which contain a limited schedule of products and thereby prevent the proliferation of the use of brand-names and patent medicines thereby reducing costs to the consumer. Efforts towards introducing the use of indigenous medicinal plants contributes to the same end.

These master lists have been utilized almost exclusively by social security institutes that provide medical services and have been able to save considerable sums because of them. They have been of little use, on the other hand, to the new organizational and management systems that channel medical attention to broad sectors of the population in an effort to make health programs more effective.

One of the main reorganizational efforts in this regard will, therefore, have to be aimed at finding a solution to the problems affecting large masses of the population, particularly the economically, socially, and geographically underprivileged. In this respect, ministries of health should not restrict themselves to coordinating services for disease

prevention and eradication. They should also tackle problems that directly affect health such as those of nutrition and food production, and the construction of potable-water and sewerage systems. They should also cooperate with scientific and technological research institutes in their research programs in the indicated areas.

Technological changes in food production are of decisive importance particularly when it is considered that nutritional and dietary deficiency in Latin America is the leading cause of infant mortality and of many infectious and parasitic diseases.

Primary medical care is another area in which it is urgent to improve the organization. For that purpose individuals and community groups should be trained for mutual help; a process that means teaching the population to identify and solve their own problems.

The technical progress that would be achieved by providing primary medical care would make it possible to control many health problems of Latin America with certain celerity and to make better use of the human resources available for that activity.[14/] This implies not only a revision of health policies but also the development of proper technologies and the training of specialized personnel. Experience has shown that it is possible to reduce the incidence of transmissible diseases like malaria and those controllable by vaccination through providing the community with rudimentary ideas of medicine and environmental sanitation.[15/]

The health conditions of mothers and children, the most vulnerable group with respect to mortality and morbidity, can be improved in this way. In short, the participation of an organized community would render hygiene and preventive medicine programs effective.

The development of suitable technologies in the health field - in its broadest sense - must be coordinated with activities directly related to it, such as those involved in nutrition and the improvement of environmental conditions.

14/ In 1975, Latin America had 214 000 doctors, 86 000 nurses and 286 000 nurse's aids for a population of over 320 million inhabitants.

15/ See Apreciaciones sobre el estilo de desarrollo y sobre las principales políticas sociales en Cuba (CEPAL/MEX/77/22).

d) The secondary sector and production of capital goods

Capital goods hold an outstanding place in the endeavor of developing countries, particularly those of Latin America, to increase the effectiveness of their participation in world industrial production by the end of the century in accordance with the Declaration and Action Plan of Lima of March 1975.[16/] This is true because the achievement of this goal will be instrumental in large measure to the availability to the countries of those goods under satisfactory quality and price conditions.

Inasmuch as this type of goods is barely included in the industrial structures of the region, there is considerable potential for the substitution of imports by regional production. If this were to be realized, it would give vigorous new direct and indirect impetus to industry.

Some observations on the behavior of the secondary sector as a whole would help to clarify the issue. The indicators show that the importance of secondary activities in the formation of the national product has mounted sharply. Region-wide, it has risen from 21% in 1960 to 25% in 1977. The countries of greater economic scope participating in integration schemes have shown an accelerated pace in the more complex technical branches whereas the inter- and intrasectoral linkages have lagged behind, opening the way to significant impediments and preventing the system as a whole from receiving the benefits of the vigorous demand for final goods; the dependence upon external supply of capital goods is also evident here. Nevertheless, and in comparison to other countries of the developing world, Latin America has had evident successes and its experience in industrialization has been noteworthy.

It has been already said that the process lacked an explicit technological policy at its outset. Institutions and mechanisms for incorporating the sources and components of technical change within the process of substitution of imported goods were missing. Designs, equipment, specifications, technical assistance, and personnel training continued

16/ UNIDO, Declaración y Plan de Acción de Lima en materia de desarrollo industrial y cooperación, Second General United Nations Conference for Industrial Development, Lima, Peru, March 12-26, 1975.

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to depend upon external factors, a situation which, in the course of time, meant excessive royalty payments (rising lately to a rate of between 10% and 20% a year in various countries) and, mainly, the imposition of a structural "ceiling" on the development of industries.

Furthermore, industrial employment has remained unchangeable (about 14% of the labor force) and also displays a downward trend. This failure is attributable to restrictions of a general nature (such as size of markets, regressive distribution of income, and shifts in prices of factors) although technological aspects underlie them like the application of inadequate techniques, underutilization of equipment, and limited supply of skilled resources. The importance of these aspects increases as the industrial process moves into more complex activities (heavy and electronic precision machinery and the automotive sector), more highly capital-intensive of technical-organizational innovation, and dependent on more highly skilled labor.

To gear technical change to employment there is a need for complementary actions on the part of the public and private sectors and research centers; at the same time the policies of the transnational companies will have to adjust to these requirements.

There are additional reasons that make it advisable to promote the strong development of capital goods industries in the near future. Worthy of mention among them are: high degree of foreign dependency - including financing characteristics - for satisfying that demand with the consequent incidence on external imbalance; the special characteristics of the capital goods sector; the level already attained in the region for the production of machinery and equipment; and, lastly, the willingness of the countries of the region to achieve a significant growth of industrial production in order to reach the goals set forth in the Declaration and Action Plan of Lima.[17/]

The accrued importance of these goods is also due to the fact that its ultimate destination is investment and to the demand for them is closely

17/ Declaración y Plan de Acción de Lima en materia de desarrollo industrial y cooperación, op. cit.

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related to the total investment of the countries and, consequently, to the intensity of their development efforts. Furthermore, the manufacture of these goods is intimately connected with other productive activities may it be the supply of materials and parts or the strengthening of the linkage between internal productive processes.

In short, the capital goods industries are an important source of employment and their capital requirements are, at the same time, relatively small in comparison to other basic industrial activities. However, they require a certain level of skilled labor. As far as employment is concerned, the repercussion of these industries upon activities and services is also of some significance.

Likewise, the development of this sector is instrumental, to raise the technological level of the countries both for the need to meet technological demands of their own and of the constantly advancing sectors that use these goods, as for the dissemination of technical progress which forces the suppliers of inputs and parts - through the training of personnel and the demonstration effect - to adjust to specifications and standards.

To a greater or lesser degree, there is a technological component in every capital good through basic, design, detail, and/or production engineering. A limiting factor in the development of the sector is the lack of an engineering system of its own since this conditions its development to the possibilities for access to the technological changes that are taking place in the industrialized countries which are geared to productive needs and demands that are generally different from those of Latin America. However, if an endogenous engineering system is to be developed, particularly in design - which is the one that gives countries a greater degree of technological independence - it will be necessary to exert efforts to provide incentives for the creation and strengthening of national and regional engineering groups.

In short, a clearer understanding by countries of the region of the ways in which they must carry out the process of assimilation and development of technologies - conditioned by the peculiar problems and the capacity of each country - suggests that the policies implemented to foster production of these goods will endeavor to avoid the indiscriminate incorporation of technologies that - in general - characterizes the substitutive industrialization process that has taken place in the region.

V. OUTLINE AND SUGGESTIONS FOR AN ACTION PROGRAM

1. Basic criteria

A characterization of Latin America's evolution was offered in the previous chapters' which stressed two particularly outstanding features for the delineation of a scientific-technological policy. The first concerns the complexity reached by the regional economic system - in which sectors comparable in modernity to the economically-advanced regions and broad strata of the population involved in activities of the lowest productivity coexist; the second is related to the level intermediate to a certain degree, attained by the region in its economic and social development within the world context.

In the light of this general background it is considered that one of the basic concerns of the Regional Preparatory Meeting should be the formulation and implementation of a scientific and technological policy - embodied in the New International Economic Order - aimed at the integral development of its society. To this end, structural change at the national level must be strengthened and a change brought about in the relations between countries in an effort to obtain an increasing social justice at the international level. Policy in this regard should, therefore, seek to foster scientific and technological development centered around man, with special stress on the overall needs of the most deprived groups.

That is to say, the available knowledge, both at the world and local levels, should be directed to solve pressing problems - extensive poverty, underemployment, productive sluggishness - and, at the same time, to lend renewed vigor to the technically advanced sectors. To attenuate the geographical concentration of the flow of technology, the international community and internal resources must both be tapped at the same time.

As an immediate consequence of this approach, the conviction arises that the main effort must be forthcoming from the countries themselves through the search for an endogenous, self-reliant technological development that draws sustenance from full awareness of their own problems and locates the decision-making process in the developing countries by transferring to them the center of gravity of their technological evolution, at the same time avoiding the creation of new hegemonic centers.

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It is asserted in this document, consequently, that the mere transfer of external technology is not in itself the paramount problem facing Latin America. The way in which it should be obtained, its make-up, the actual orientation of the technical change, and the strengthening of internal potential are of greater importance.

Despite the efforts exerted by the great majority of the Latin American governments to set priorities, establish institutions and programs, and revise coordination guidelines with a view to accelerating scientific-technological development based on their own resources, these efforts have been insufficient for coping with the problems which are substantial and whose solution is pressing.

This insufficiency makes it necessary to supplement national activities with international cooperation through subregional, regional and world actions together with those by international organizations.

In the light of all the foregoing, five basic criteria are set forth below which should be considered in formulating the guidelines for an action program.

The relations at the subregional and regional levels should play a dominant role in cooperation in accordance with the spirit of self-reliance that animates the developing countries. In addition, the quest for a more equitable international order imposes the need for establishing preferential treatment in the area of science and technology for the relatively less-developed countries. Cooperation between industrialized and developing countries and that provided by international organizations should always support national, subregional, and regional efforts, seeing to it always that the decision-making center remains in the developing countries.

With this in view, such local training should be promoted that would allow selection and dissemination of technical advances, lessening of dependency - without seeking to attain autarchy - and rationalization and intensification of the use of natural resources of the region, supported by the greater public control over them that is possible under creative self-reliance that does not preclude interdependency when convenient.

/A second

A second key criterion of an action program is the need for giving technical change a social orientation. Neither science nor technology possesses intrinsic values: they are able to create and perpetuate deficiencies or they can remedy them. It all depends on the direction given to those forces by the political and economic system. Consequently, critical poverty, rural marginality, and environmental deterioration cannot remain outside of this concern about technological development.

In the third place, the activities must take into account the transverse nature of science and technology. That is, academic centers will have to relate with the industrial laboratories because technology cannot ignore teaching, information, and standardization entities; the findings of basic and applied research must be given careful consideration in agriculture and industry. Universities, public sector, and entrepreneurs could establish organic relations through mechanisms established for the purpose.

These actions that are part of the scientific and technological system must be linked, from another standpoint, to more general aspects of economic and social policy.

Actions must converge not only on the national plane. Cooperation between countries - within the region and outside it - have broadened and offer opportunities for joint projects and programs in basic research, common utilization of infrastructure, the training of human resources, and other related aspects. It should be kept in mind that scientific and technological progress allows for economies of scale as it does other capital-intensive activities. Not even the relatively more-developed countries can fulfill these requirements on their own.

Fourthly, it would be necessary to stimulate the social and cultural internalization of science and technology in order to develop awareness in broad strata of the population regarding the importance of this activity for their own well-being, encouraging them to take an active part in the design and implementation of scientific-technological policy.

Lastly, the actions decided upon would have to be congruent, likewise, with those that might be put into practice in other developing

/countries

countries and with the philosophy of the New International Economic Order. They would have to be aimed especially towards horizontal cooperation between similar developing economies on the basis of mutual problems. It should be remembered that the capacity of certain developing countries permits providing technical advice to others and that the availability of foreign exchange in various of them creates the conditions for a system of mutual solidarity.

From this standpoint, suggestions are presented below at the national, regional, and international levels, including, in the last one, horizontal cooperation, links with industrialized countries, and the functioning of international organizations.

It should be pointed out that there are specific responsibilities at each level. For example, problems of a structural nature would be the direct concern of the countries; negotiations with third parties, achieving and utilizing scale economies, and launching cooperative programs on resources and common problems would lie at the regional level; and, whatever might concern the transfer of technology, its financing, and related aspects would be situated at the international level.

2. Ideas for action

The suggestions put forward below are based largely on a group of regional and subregional meetings that were held in Latin America and the Caribbean over the last two years,[1/] at which the governments and experts of the

1/ Up to the time this document was prepared, the most important meetings for the evolution of regional meetings for the evolution of regional trends with respect to the Conference were:
- The Latin American Meeting of Governmental Experts on Science and Technology for Development (Mexico, D.F., October 31-November 2, 1977).
- The Caribbean Sub-regional Seminar on Science and Technology for Development, (Kingston, Jamaica, February 14-18, 1978).
- The First and Second Andean Sub-regional Preparatory Meeting of the UNCSTD (Lima, February 27-March 3 and July 3-7, 1978).
- The First and Second Sub-regional Meeting of Government Experts of the Countries of the Southern Cone (Buenos Aires, March 27-29, 1978 and Santiago, June 20-30, 1978).
- The Fifth UNESCO Meeting of the Permanent Conference of Directors of National Councils of Scientific Policy and Research of the Member States of Latin America and the Caribbean (Quito, March 13-18, 1978).
- The National Seminar of Brazil, preparatory for the United Nations Conference on Science and Technology for Development (Brasilia, March, 1978).
- The Meeting of the Expert Group on Science and Technology for Development, sponsored by SELA, (Caracas, May 15-19, 1978).
- The Meeting of the ACAST Regional Group for Latin America (Mexico, D.F., June 1-2, 1978).

region have been outlining their viewpoints on what concrete results might be expected to come out of the United Nations Conference on Science and Technology for Development. They are grouped in accordance with the level - national, regional, or international - to which they refer.

a) The national level

The activities and deficiencies at this level would undoubtedly determine the scope and practical consequences of the projects and mechanisms that would be suggested for the other two. For example, the carrying out of joint research projects - and the equitable distribution of its benefits - would depend upon the real possibilities of each country; and, furthermore, the international adoption of "codes of conduct" could have real force only in the measure to which they are embraced by the national juridical and economic systems.

Understandably, the diversity of national situations complicates the adoption of ideas adaptable to them all. Criteria have already been set forth (Chapter II) for assessing the possibilities in each country. Leaving the discussion of particular issues to the national papers, we can advance the following general aspects on which the majority of the countries of the region are in agreement: increase in internal potential and demand; integration of scientific and technological policy into sectoral and overall planning; revision of institutional procedures; rending them complementary and, the suitable selection of technological combinations.

With respect to needs, marked weaknesses have found in the local possibilities for fostering and absorbing technical change; their elimination would depend upon a series of actions related simultaneously to supply and demand. One action would be the broadening and reorientation of educational services with special consideration for modern science. Historical experience shows that universal literacy has gone hand in hand with scientific and technological development, permitting its assimilation by industrial society. Efforts in this direction have frequently been made and the results so far in some countries of the region have been important. However, literacy training and educational reform will have to be accelerated in the manner indicated, given the economic and social importance of training human resources.

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Besides, training must include - depending upon local needs - scientific dissemination and the preparation of personnel able to administer technical change in companies as well as in research institutes.

This effort must be supplemented by incentives for basic research on selected subjects. This is the kind of research which, in the long run, makes it possible to achieve international standards of quality and identify available options with greater clarity. This calls for division of labor since few countries of the region are able to meet basic-research needs on their own.

These activities, of course, involve a substantial increase in public and private financing of scientific-technological activities for which the Regional Program of Action had recommended the designation of 1% of gross domestic product, which few countries have been able to do.[2/] It is probable that even if such an amount were available, the governments would consider that a greater effort should be made. It should be recalled in this regard that the levels of expenditure of the industrialized nations during their period of expansion (the fifties and sixties) were two- or threefold greater.

On the demand side, the public sector is capable of inducing effective or potential utilization of local resources through its capital investments and purchasing systems. Such reorientation of expenditure would reinforce other public-sector promotional instruments; along these same lines, it is proposed that preferential treatment, on a reciprocal basis, be given to Latin American patents.

Some suggestions based on the material in Chapter III can be put forward on institutional arrangements. The contradictions between the centralism necessary for giving consistency to actions and the decentralization that fosters enterprise initiative are usually solved in a quite unsatisfactory way. In many cases, the liaison between the councils and the registries of technology are very tenuous, as is the case between them

2/ A Latin American Plan of Action for the Application of Science and Technology to Development, United Nations Advisory Committee on the Application of Science and Technology to Development (E/CN.12/966), October, 1974.

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and the academic centers and between technology import policies and local research; at the same time, the various components of the scientific-technical system must still be geared to the general needs of development policies. This is not exclusively an administrative problem nor is it one that can be solved at once. It seems advisable, therefore, to undertake studies that will go deeply into the various modalities of the organization of science and technology systems, taking regional planning experiences into consideration.

At this point, it would be timely to bring up technological information and technical standardization. The former has been restricted to meeting the needs of large public and private organization and some research centers. The lack of trained personnel is noteworthy and inconsistency in the programs is common. For that reason, it is a new responsibility for the public sector to gear information systems to the needs of the small and medium-size production units which are the backbone of industrialization. To be sure, training and integration in systems may resort increasingly to regional cooperation.

Scant attention has been paid to technical standards in national technological policy. Basic principles have been decided on standards, weights and measures in accordance with the levels of industrialization of the countries and the guidelines given by imported goods. However, local effort has been meager towards adjusting the physical aspects of the product and its physical, chemical, and biological properties to the socioeconomic and environmental conditions of the region, including due selection of technologies and inputs. Standardization, from this standpoint, would unquestionably give production a new orientation, rectify cost structures, and promote competitive capacity. The training of human resources (in basic standardization, metrology, and quality control) and expansion of testing laboratories are urgent needs that are, however, relatively easy to meet both at the national and regional levels.

Consequently, actions that the countries should undertake and improve in the sphere of science and technology are varied. Sometimes,

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it is a matter of increasing the potential; on other occasions, of adjusting practices of the educational system and international flow of knowledge - including foreign investment - and, on still others, of introducing into national politics and culture the demands put forward at international forums and the innovating spirit of science. No sector should be exempt from these actions because all should contribute - so that they may be coordinated - policy statements and instruments within the framework of a consensus on the development style to be adopted.

b) The regional level

As has been pointed out at various times, many national actions call for complements and economies of scale that may be provided through cooperation with other countries. Apart from this, the evaluation and strengthening - where applicable - of industrial and agricultural research institutes and the expansion of sectoral investment programs arising from various integration schemes are also advisable.

Among the measures, it seems expedient to look into the establishment of regional consulting and engineering firms and, in particular, of "technology companies" devoted to gathering information and to answering requests at the sectoral level. Proposals have been made in this regard that have been favorably received, in principle, by the United Nations Development Program (UNDP). It is now in order to implement them in a group of strategic items (energy, steel, telecommunications, materials, forest industry, and food).

It is also possible that in conjunction with present integration of national economies, the private sector of some of the more-developed countries will establish such firms and companies in order to take advantage of investment and profit opportunities. In anticipation, it would be useful to put forward ideas of the type of standards that should regulate these activities.

The creation of mechanisms - beginning with public-sector companies - to facilitate the joint utilization of infrastructure, including laboratories and program series, is also advisable.

/The broadening

The broadening of the scope of research schemes has already been manifested in the establishment of cooperative institutions and practices in science and technology. Examples of these are the Latin American Physics Center (with headquarters in Rio de Janeiro), the Latin American Chemistry Center (Mexico), the Latin American Center of Biological Sciences (Caracas), and the Regional Sismology Center for South America (Lima). The Permanent Conference of Directors of Scientific Policy, sponsored by UNESCO, is also a very useful instrument of consultation and exchange. The Organization of American States, the World Intellectual Property Organization (WIPO), as well as the United Nations Industrial Development Organization (UNIDO) and the United Nations Conference on Trade and Development (UNCTAD) have put forward proposals and implemented projects within their respective spheres.

Measures regarding the joint establishment of science managers and planners, for example, on the basis of recent experiences in the region, would also be of interest. The Latin American Institute for Economic and Social Planning (ILPES) could take charge of these as part of its regular activities (courses and advisory services).

Also, the foundation of a Latin American School of Exact and Natural Sciences is also to be recommended, following the model, in its organization and financing, of the Latin American School of Social Sciences (FLACSO), such an organization would have various roles: the preparation of research cadres at the postgraduate level; study of problems concerning the region as a whole; and, determination of the scope of a system of scientific acknowledgment to compensate and reward research that leads to the solution of problems of regional nature without lowering accepted scientific standards.

Some institutions for strengthening regional cooperation have been proposed. Outstanding among them are the technological information network suggested by SELA and the Regional Center of Transfer of Technology by UNCTAD. One recommendation in this regard would be to foster ideas of such a kind within the framework of Latin American reality and interests.

/Another

Another might be that of the possibility of introducing reaarch and development programs on basic export goods (oil, bauxite, copper, coffee, cotton, grain) in order to identify problems and increase competitive advantages of these strategic products.

It would be expedient to take advantage of the facilities offered by the United Nations University (UNU) for launching research and scientist-exchange programs in a selected group of areas (nutrition, natural resources, arid zones, development in the damp tropics) and explore the possibility of a UNU study - with the effective support of regional institutions - on existing and potential contradictions between technological conduct of transnational companies operating in Latin America and specific policies of national governments on the subject.

One formulation that calls for immediate action on the part of the countries of the region is the setting up of an "early warning" system to study scientific and technological advances that are originated in the industrialized countries and could be of special value or benefit for Latin American countries or which might adversely affect their economies or their economic development.

All these proposals do not preclude or detract from others that have come up in regional discussion even though they may not yet have crystallized, such as the homologation of academic degrees; the agreement of common criteria on technical standards, the establishment of engineering and consulting firms; the training of groups of investigators in the historical study of science and technology.

c) The international level

Overall actions would come under the Action Program for the New International Economic Order. It contains recommendations on an international code of conduct on the transfer of technology, priority access to technology, and the regulation of trade practices.[3/] Modalities of cooperation between developing countries, which include the region, are also emerging.

3/ See Resolution 3202 (S-VI), March, 1974.

/Supplementary

Supplementary indications will be necessary, as well, that refer, respectively, to developing countries, underdeveloped countries, and the United Nations system.

Since scientific resources have accumulated significantly in the industrialized countries, they should make their contribution through special science and engineering programs for developing countries; providing equipment and information; eliminating technical barriers to imports of goods produced in the region; preferential financing; and other related aspects. Bilateral and multilateral means of cooperation could be utilized for concretizing these proposals.

The support of the industrialized countries is needed for approving codes of conduct on transnational companies and transfer of technology, which have been thoroughly discussed by the international community.[4/] It is being sought through these measures to reduce harmful effects on the development and the independence of the nations of the periphery and, in particular, to eliminate restrictive practices, distorsion of consumption patterns, and undue interference with national systems. Efforts to rectify agreements on patents and trademarks and to adapt them to the socioeconomic needs of developing countries are directed towards the same goal. Thanks to the work of the World Intellectual Property Organization (WIPO) and UNCTAD and various independent studies, it is known that these agreements have deficiencies that interfere with technological development and the competitive capacity of peripheral countries.[5/]

Likewise, broad prospects for exchange and cooperation between Latin America and the countries of Asia and Africa are opening in the realm of the principles of collective self-reliance. These principles imply, on the one hand, a better negotiating position vis-a-vis the industrialized

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4/ See, United Nations, Las corporaciones multinacionales en el desarrollo mundial (ST/ECA/190), New York, 1973, and UNCTAD, Informe del Grupo Intergubernamental de expertos sobre un código internacional de conducta para la transferencia de tecnología acerca de su quinto período de sesiones (TD/AC.1/15), February, 1978.

5/ For additional information see UNCTAD, Efectos de las marcas sobre el proceso de desarrollo de los países en desarrollo (TD/B/C.6/A.C.3/3), June, 1977; and C. Vaitsos, "Patents Revisited: Their Function in Developing Countries", The Journal of Development Studies, October 9, 1972.

countries and, on the other, expectations of establishing new links and options different from those prevailing in the present international division of labor.

Technical assistance between developing countries has been carried out so far largely through the United Nations system, but it is felt that it could be more direct and be complementary of the foregoing. Latin America has - in some sectors - skilled and semi-skilled personnel who could be very useful in the more backward regions, through agreement between governments and under fixed-term contracts. This contribution would be of mutual advantage and would facilitate the establishment of joint institutions and programs for training and the transfer of personnel (transfers could eventually include other development factors).

As far as the United Nations system itself is concerned, the governments could present five proposals which, if accepted, would provide tangible benefits for scientific and technological development of the peripheral nations, including Latin America.

The first would be the establishment of the Industrial and Technological Bank considered at the Second General Conference of the UNIDO,[6/] ad entity concerned with various aspects of technological information and the exploitation of resources, including suppliers, obtainment of licenses and potential utilization of wastes, and sectoral orientation of investment at the world-wide level.

This proposal is part of a broader concept on the establishment of an international network for the exchange of technological information which has already been discussed at various United Nations forums. The idea would be to integrate certain information programs carried out at present - without the congruence that would be expected - by various components of the United Nations system; to improve personnel training; promote national and regional information policies; and, identify, with the active cooperation of the regional committees, the requirements for establishing a worldwide information network.[7/]

6/ For additional information, see UNIDO, Establishment of an Industrial and Technological Information Bank (ID/B/C.3/52), August, 1976.

7/ See United Nations, Establecimiento de una red para el intercambio de información tecnológica (E/5839), June 14, 1976.

/These measures

These measures could be implemented at the regional level with the support of the corresponding funding organizations. The programs of the various regions could be linked up later.

The second proposal would be that the United Nations University should consolidate its training and research programs, as has been explained, and give them the desired selectivity.[8/]

The third would consist of attending to the issues related to the "appropriate technologies" in accordance with the work being done by the Advisory Committee (ACAST), the UNIDO, the ILO, and several nongovernmental institutions. These technologies imply, on the one hand, radical criticism of certain effects of the dominant technology (inequality, heterogeneity, bureaucratic centralization, environmental destruction) and, on the other, research on new combinations of inputs so as to create an alternative technological style. It would be advisable, in this sense to investigate the feasibility of instituting an overall program of registry, information, creation, and dissemination of appropriate technologies. It is understood, by definition, that appropriate technologies would have to be adapted to local needs, which explains why these ideas put into practice in a world wide framework will have to be adjusted to those requirements.

The fourth would be related to the need for having an international financing mechanism specialized in the promotion of scientific and technological progress of developing countries. As is well-known, the RIO report[9/] proposes the formation of a Technological Development Bank either as a new entity or as an additional function within a broadened investment bank. The purpose of this mechanism would be to support research on problems of the poor countries; mobilize supplementary funds for information networks; stimulate exchange and advanced training of scientists studying the problems indicated; cooperate in the publication of the studies; and, prompt the regional joint purchasing of technologies. In keeping with several

8/ See The United Nations University, Proceedings of the Ninth Session (UNU/C/9/L.4), Tokyo, December, 1977.

9/ See J. Tinbergen (compiler), La reestructuración del orden internacional, FCE, Mexico, 1977.

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of the foregoing observations, institutions of a regional character - such as the Inter-American Development Bank (IDB) - and the United Nations Development Program (UNDP) might anticipate studies of this kind.

The fifth, of great importance for the redistribution of the international technological effort, is the establishment of a list of experts and consulting and engineering firms of the third world which would be given preference by the international organizations.

3. Conclusion

Five criteria have been suggested that could govern the formulation of a regional action program in science and technology: 1) collective and self sustained self-reliance; 2) social redistribution-orientation; 3) the necessary convergence in the actions; 4) increasing participation of interested groups, and 5) cooperation with other developing regions. Ideas already discussed at various forums and, on the point of being given the final touches in some cases, were reconsidered in the light of these criteria; others have been added to them that arose in the course of verifying the importance of scientific-technical development and the obstacles it faces.

A few final observations are in order. Like other developing countries, those of Latin America will have to cope simultaneously and in a competitive international situation with a series of problems that present industrialized countries each solved separately and under more favorable conditions in their day. One of these is scientific-technical inadecuacy at a time when innovation, which is based on research, has become one of the main determinants of growth and social development at the world level.

Furthermore, the gap between some countries and others is unquestionably greater than the one that can be inferred from the economic and scientific history of last century. And, in addition, it is even wider than the technological gap between industrialized nations today. The lack of the technology required by the region creates new problems that complicate the long-standing ones.

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Without question, the technological challenge is serious. In contrast to physical and financial resources, whose mobilization and utilization can suffer delay without irreversible effects - albeit important - upon growth, the weakening of internal scientific capacity can spell the definitive segregation of the countries in which it occurs, affecting the factors that determine, at present, wealth, well-being, and power among nations. If that happens, national and regional progress would be impaired because technological dynamics in the industrial centers follow an exponential path, augmenting the disparities brought about by other circumstances.

It is unlikely that these trends can be halted. Paradoxically, general opinion on the physical limits of growth - as well as the relative dependence of the advanced countries on the supply of strategic materials from peripheral countries - hastens the pace of innovation.

These hazards of technological backwardness seeem to have been understood in Latin America as the specific policies put into effect in that regard and the concerns expressed by the region as various international forums indicate. Nevertheless, sharp discrepancies may develop between declarations of intent and the manner in which policies are actually carried out. Unfortunately, it would not be the first time this happened. It is not for lack of ideas - it should again be stressed - that a regional action program might be weakened; the danger lies, as in other aspects of development and cooperation, in a potential weakness of the collective will for putting these ideas into practice.