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OF LATIN AMERICA

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## I. INTRODUCTION

### A. FOREWORD

In 1970 the General Assembly of the United Nations approved a plan of action to expedite the economic and social progress of the developing countries, which is known as the International Development Strategy (IDS).

"In essence, the International Development Strategy is an agreement by governments, drawn up at the highest political level of the United Nations, on the action which should be carried out systematically in various fields during the present decade with the immediate aim of stepping up the economic and social progress of the developing countries."<sup>1/</sup>

Paragraph 18 of the International Development Strategy reads as follows: "As the ultimate purpose of development is to provide increasing opportunities to all people for a better life, it is essential to bring about a more equitable distribution of income and wealth for promoting both social justice and efficiency of production, to raise substantially the level of employment, to achieve a greater degree of income security, to expand and improve facilities for education, health, housing and social welfare, and to safeguard the environment. Thus, qualitative and structural changes in the society must go hand in hand with rapid economic growth, and existing disparities - regional, sectoral and social - should be substantially reduced. These objectives are both determining factors and end-results of development; they should therefore be viewed as integrated parts of the same dynamic process, and would require a unified approach".

In brief, what has emerged is the concept of "integrated development", which acknowledges the equal importance and recognizes

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<sup>1/</sup> ECLA, Latin America and the International Development Strategy: first regional appraisal, E/CN.12/947/Rev.1, 1973.

the interdependence of such fundamental objectives as the raising of per capita income, more equitable income distribution, full employment, genuine equality of opportunities, more balanced social development, respect for human dignity, and the real development and cultural integration of the individual human being.

The "unified approach" means that this set of values and objectives must be the guiding principles for plans and action alike, not only in the economic sector but also in the educational system or the field of social progress, since otherwise distortions will inevitably be generated which, in the last analysis, slow down progress or halt it altogether.

There are many factors which, in different ways and with varying degrees of intensity, influence this process. Increased saving and investment, expansion of exports, foreign investment and external credit, industrialization and land reform, internal inflation and international price fluctuations are among those which have been analysed in the greatest depth from the economic standpoint. From another point of view, emphasis has been placed on the need for planning, structural changes and institutional development, education, health and housing programmes, wholehearted national support and international and regional co-operation.

In recent years, to concern with these and other factors has been added increasing comprehension of the role of science and technology in development. The traditional economic development models projected income growth as a function of the labour and capital input in the production process, and of a global parameter for the measurement of "productivity", to which was assigned a value calculated on the basis of empirical data, with the aim of using it to measure that part of economic growth which could not be explained in terms of the sum total of investment and the increase in the labour force.

Owing to the many studies of various kinds carried out in recent decades, technical progress is no longer a merely implicit

/factor in



factor in global economic projections, and recognition is now accorded to its preponderant influence both on the spectacular development of the industrial countries and on the progress achieved by the countries of the Third World. For example, Solow estimated that between 1909 and 1949 the contribution of technical progress - defined in its broadest terms - to per capita production in the United States amounted to 87.5 per cent.<sup>2/</sup> Denison and Poulhier have assessed the participation of technological change in the improvement in productivity per worker at the following rates for 1950-1962 in the European countries listed: Belgium, 34 per cent; Denmark, 20 per cent; Italy, 30 per cent; United Kingdom, 46 per cent.<sup>3/</sup>

Again, according to studies prepared during the 1960s by the Agency for Science and Technology and the Ministry of Industry and Foreign Trade of Japan, technological innovation made the following contribution to the expansion of production in that country: manufacturing industry, 41 per cent; chemical industries, 72 per cent; metal products, 46 per cent; pulp and paper, 60 per cent; electrical machinery, 38 per cent; transport equipment, 60 per cent; and textile industries, 38 per cent.<sup>4/</sup> Lastly, estimates for Brazil show that between 30 and 46 per cent of Brazil's economic growth since the end of the Second World War is attributable to technological innovation.<sup>5/</sup>

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- <sup>2/</sup> R.M. Solow, "Technical Change and the Aggregate Production Function", Review of Economics and Statistics, August 1957.
- <sup>3/</sup> "La recherche et le développement contribuent-ils a la croissance économique?", Rev. La Recherche, N° 38, October 1973.
- <sup>4/</sup> Juan Tampier B., El desarrollo tecnológico del Japón, Report for the Board of the Cartagena Agreement, 1973, p. 100.
- <sup>5/</sup> ECLA, The transfer of technology in the industrial development of Brazil. General aspects of the problem, E/CN.12/937, September 1972.

Whatever degree of inaccuracy may be involved in the procedures followed to determine the foregoing values, the figures are high enough to bring out the preponderant role of the technological factor in economic growth.

Moreover, it is needless to reaffirm the radical changes in the way of life of the peoples of the world and the consequent social and cultural impact produced by the spectacular technological progress which mankind has witnessed. The speeding-up of this progress in the course of the twentieth century and its relative concentration in the more advanced countries have widened the gap between these and the Third World, and its effects on man, society and the environment have become an increasing source of concern, giving origin, mainly in the industrial countries, to a new field of study, that of the "evaluation" of technology.

From the more specific standpoint of economic development, the speed with which technological innovations are produced in the world of today has notably shortened the "useful life" of many products. This varies, in the case of pharmaceutical products, for example, from two to six years, and is even shorter in the electronics industry, while for computers it is estimated to average five years.<sup>6/</sup> Thus, the pace of technical obsolescence tends to be a good deal faster than that of the physical wear-and-tear of production equipment and plant.

In Latin America, explicit interest in science and technology found its initial expression in the economic sector in relation to the problem of the payment of royalties, viewed from the standpoint of its effect on the balance of payments, and, to a more marked degree, in the cultural field with respect to the development of scientific knowledge and research. To this was subsequently added political concern at the power and influence of the transnational corporations and the phenomenon of "technological dependence".

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<sup>6/</sup> Erich Jantsch, La prévision technologique, Organization for Economic Co-operation and Development (OECD), Paris.

Little by little, the work of various institutions and personalities in the region, and, in particular, the studies and other activities of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Organization of American States (OAS), the Board of the Cartagena Agreement and other international agencies have given countries a better understanding of this question and extended their relevant action, while at the same time helping to promote the gradual integration of the various original points of view.

One of the most valuable of the recent contributions made in this connexion is the "Latin American Plan of Action for the Application of Science and Technology to Development". This was, prepared by the United Nations Advisory Committee on the Application of Science and Technology to Development (ACAST),<sup>7/</sup> on the basis of the World Plan of Action, and with the collaboration of the Economic Commission for Latin America (ECLA), of the specialized agencies of the United Nations and of OAS. The whole undertaking was related to the International Development Strategy, paragraph 60 "Concerted efforts will be made by the developing countries, with appropriate assistance from the rest of the world community, to expand their capability to apply science and technology for development so as to enable the technological gap to be significantly reduced".

As is common knowledge, at the fifteenth session of ECLA, held at Quito in March 1973, the secretariat was requested to go more deeply into the analysis of these problems in their relation to economic and social development and to disseminate the Latin American Plan.

This regional plan contains a valuable body of background data, opinions and suggestions bearing on policies and institutions concerned with science and technology and on scientific and

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<sup>7/</sup> Henceforward this will be referred to as the Latin American Plan.

technical education. It also includes an exhaustive list of problems and of priority areas of research in the various sectors of economic activity and social development.

"The objective of the World Plan of Action for the Application of Science and Technology to Development is to provide a framework for the combined efforts of developed and developing countries as well as of the United Nations system ..."<sup>8/</sup>

In its turn, the Latin American Plan of Action "is to be considered ... a set of guidelines for the application of existing knowledge and the development of research on a large number of basic problems that have been identified in Latin America by the United Nations agencies and by inter-American agencies. Some of the problems are common to all regions in the less developed world; others are particularly important in Latin America".<sup>9/</sup> In a later section of the present study special consideration will be given to the implementation of the Latin American Plan, in the light of the analysis made in this document as well as of the responsibility incumbent in this field on ECLA and the Latin American Institute for Economic and Social Planning (ILPES) and on international co-operation in general.

The purpose of the present document is to give an integrated picture of the problems of science and technology in relation to the development process, and to identify mechanisms, instruments, and specific lines of action required at the national, subregional and regional levels to secure the more harmonious development of science and technology as part of a unified approach to development, thus making for the effective implementation of ACAST's recommendations, and, in general, of the policies formulated in the Latin American countries. To this end, it was

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<sup>8/</sup> United Nations Advisory Committee on the Application of Science and Technology to Development (ACAST), "A Latin American plan of action for the application of science and technology to development", E/CN.12/966, 1973, p. 1.

<sup>9/</sup> Ibid., p. 9.

thought desirable to centre the analysis upon the process of technological change. All the factors calling for study will therefore be considered in relation to the way they affect that process, which from the standpoint of economic and social development is the phenomenon that it is of most direct interest to understand and evaluate.

The approach formulated above should be taken to cover the various sectors and forms of economic activity, including not only production technology but also administration and management technologies in general. It involves the study of problems relating to education, to the development of science and to the creation of technology in the Latin American countries, as well as of those deriving from the transfer of techniques from abroad.

## B. TECHNOLOGICAL CHANGE IN LATIN AMERICA: PROBLEMS AND PROSPECTS

### 1. Obstacles to technological change

In the first place, it seems useful to sum up the main difficulties and obstacles in the way of the harmonious development of science and technical progress that have come to the fore with the evolution of Latin American thinking on the subject. Most of those listed below derive from the inter-country differences in levels of development, and, therefore, both from the predominant characteristics of the advanced countries and from the structural weaknesses of Latin America.

#### (a) Historical characteristics of development

(i) The concentration of nineteenth century industrial development in Europe and the United States established at that initial stage the well-known international division of production whereby the Latin American countries became exporters of raw materials. It was in the export sector chiefly that a systematic process of incorporation of new techniques took place. Moreover, the relative isolation of export activities restricted the spread

/of such

of such techniques to the other economic activities, which continued to develop at a rudimentary level. The exploitation of raw materials, furthermore, largely took the form of extraction of easily accessible resources, a process which could be carried out with relatively simple technologies, while there were no significant incentives to reduce costs in view of the ownership relations and market conditions in which it was effected.

Briefly, technological progress has been concentrated in the developed countries, thus originating what has come to be called the "technological gap", which for many reasons tends to constitute a cumulative phenomenon.

(ii) Accordingly, when Latin America embarked upon its industrialization process, mainly by way of import substitution, it had to resort to the technologies existing in the developed countries. The result was the gradual generation of a "modern" industrial sector using advanced technologies, and forming an enclave in a traditional economy in which low-productivity activities predominate. The urgent need to relieve the desperate balance-of-payments situation resulting from the depression of the 1930s, combined with the small size of domestic markets, in which the middle and upper income groups were manifestly the main sources of demand, led through high levels of tariff protection to the creation of monopolies or oligopolies in the new industrial structure, and to the prevalence of high costs and low productive efficiency.

(b) Technology generated in the industrial countries

The technologies imported from the developed countries and generated in these in accordance with their own needs and conditions, are usually unsuitable for the Third World in general and for Latin America in particular. In this respect, the following are the main factors to be noted:

(i) The advanced technologies are created in relation to much bigger scales of production than any that are justifiable for the relatively small consumer markets of the developing

/countries. The

countries. The growth rate of per capita income in Latin America has not been high enough to reduce the difference in market sizes, which, on the contrary, is tending to increase in absolute terms. Moreover, the slow pace of the regional and subregional integration processes, and the insignificant effects of income redistribution policies, have prevented the markets in question from expanding faster.

On the other hand, a predominant characteristic in at least some important branches of world manufacturing industry is the trend towards the development of technologies which produce economies of scale; thus, as the volume of production increases, both the capital and the labour inputs per unit of output decrease, so that as production expands the unit cost diminishes, whatever the relative price of the factors of production.

There is nothing surprising about this phenomenon if it is borne in mind that a high proportion of technological innovation is the product of research and development activities carried out in the corresponding departments of enterprises in the industrial countries. For reasons of power and prestige, these enterprises not only aim at increasing their profits, but are also constantly seeking to expand their volume of operations, with the result that a significant proportion of their research work is designed to discover ways and means of effecting economies of scale.

(ii) In any event, the technologies originating in the developed countries are created to be applied where capital is relatively plentiful and labour is costly and in short supply, a situation diametrically opposed to that prevailing in Latin America and the rest of the Third World.

In other words, the more advanced technologies tend to save labour, while in the great majority of the developing countries there is a high degree of structural unemployment and under-employment.

Evidence of this is afforded by empirical studies carried out in the region. In Peru, between 1961 and 1970, employment in

/industry rose

industry rose from only 13.2 per cent to 14.5 per cent of the economically active population, but the whole of the increment was concentrated in artisan-type industry.<sup>10/</sup> Similar conclusions are to be drawn from a study of the same kind relating to Venezuela;<sup>11/</sup> this research also shows that even where significant changes take place in income distribution the consequent change in the structure of consumption and therefore of production does not bring about a marked increase in employment.

There is, no intention here of course, to formulate an assertion of general validity, or to deny that sufficiently dynamic and/or appropriately oriented industrial development may lead to a significant increase in employment. Nevertheless, the studies quoted, referring to given countries and periods of time, bear witness to the existence of a problem that claims preferential attention.

(iii) The advanced technologies have been created in view of the levels and types of skilled labour existing in the industrial countries, which are usually higher and other than those prevailing in the developed countries.

(iv) Technological development in the advanced countries naturally seeks to replace raw materials which they do not possess by synthetic products and, in general, by the use of raw materials to which they have surer, easier and more direct access. This has been repeatedly evidenced by the progressive displacement of natural resources indigenous to Latin America and the rest of the Third World, such as textile fibres of animal and vegetable origin, nitrate and rubber. It is a common observation that the recent world petroleum crisis may set afoot a new process of an unpredictable nature.

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<sup>10/</sup> Víctor Tokman, Tecnología y empleo en el sector industrial del Perú, (OAS/ILPES), 1972.

<sup>11/</sup> Víctor Tokman, Distribución del ingreso y empleo en el sector industrial de Venezuela, 1972.



(v) Moreover, the empirical studies carried out in Latin America reveal that no significant correlation is apparent between changes in the structure of production and employment opportunities. This calls in question the validity of the classic distinction between traditional labour-intensive consumer goods (textiles, footwear, food, etc.) and capital-intensive intermediate goods. On the whole the evidence goes to show that any industry undergoing a dynamic modernization process tends to save labour per unit of output, while employment increases to a larger extent in branches of industry which for one reason or another are not renewing their equipment or replacing their lines of production.<sup>12/</sup>

(vi) The terms on which the transfer of technology from the industrialized countries is effected are often unfavourable to the Latin American countries. The increasing part played in this process by the great transnational enterprises, which, backed as they are by enormous power, naturally endeavour to channel it along the lines that best suit them, does much to bring about such a situation. Only when they take solidary action at the subregional or regional level are the Latin American governments (with the exception of a few relatively more influential countries which can successfully act on their own account) able to stand up to the transnational enterprises on a fairly equal footing. In any event, however, there is an additional factor of weakness deriving from the vague or conflicting character of their objectives and priorities, in contrast with the clearly-defined aims of the great corporations operating under a single authority.

More generally speaking, the cost of transfers of technology is apt to be high because of the Latin American countries' lack of bargaining capacity, which is reflected not only in heavy direct payments, but also in the familiar limiting clauses relating to purchase of inputs, exports, etc., which frequently represent a high indirect social cost.

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<sup>12/</sup> Victor Tokman, op.cit.

(vii) Foreign investment, especially that effected through subsidiaries of a parent firm, usually constitutes an enclave which does not disseminate the imported technology to the rest of the national economy, and in which the successive adaptations and/or innovations are the product of the parent firm's research and development activities, a modus operandi that is generally much more to the advantage of the foreign enterprise.

(c) Structure of the Latin American economy

Generally speaking, the Latin American countries are characterized by a dual economy in which a "modern" sector, concentrated in medium- and large-scale manufacturing industry and in a few agricultural and mining activities producing primary commodities, exists alongside "traditional" activities in which productivity is very low and which, distributed throughout all sectors of the economy, constitute the major source of employment. In contradiction to what happens in the industrial countries, absolute levels of productivity in a large proportion of these activities are so low that their capacity to absorb more efficient technologies is usually extremely limited; the mere dissemination of "example" of progress in the modern sector is therefore not enough to speed up their development.

In support of this statement, reference may first be made to a study recently carried out by ILPES in the six countries of the Andean Group. It shows that in the area in question 60 per cent of the manpower employed in manufacturing is to be found in artisan-type activities, this sector being defined as the group of establishments employing fewer than five persons.<sup>13/</sup>

Table 1 below shows the great differences in productivity between sectors of production in Latin America and their unequal relative growth rates in more recent decades.

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<sup>13/</sup> ILPES, La pequeña y mediana industria en los países del Pacto Andino, provisional text, 1973.

Table 1

STRUCTURE AND TRENDS OF LABOUR PRODUCTIVITY  
IN LATIN AMERICA

Sector	1950	1960	1965	Annual percentage growth rates	
	(Dollars at 1960 prices)			1950-1960	1960-1969
Agriculture	450	555	633	2.1	2.5
Mining	3 617	5 404	6 103	4.1	2.0
Manufacturing	1 294	1 831	2 206	3.5	3.6
Construction	889	1 017	1 058	1.4	1.0
Basic services	1 663	1 814	2 049	0.9	2.0
Trade	2 261	2 494	2 623	1.0	1.0
Other services	1 393	1 295	1 282	-0.7	-0.1

Source: ECLA.

/In contrast,

In contrast, the following figures for annual productivity per worker in the United States may be quoted: agriculture, 3,352 dollars; mining, 7,583 dollars; industry and construction, 7,140 dollars; and services, 7,151 dollars.

More deserving of attention than the differences in absolute terms, which are obvious, are the variations in the relative figures. Whereas in the United States the ratio between the average productivity of industry and that of agriculture is 2.1:1, the corresponding figures for Latin America in 1965 are 3.5:1.

In short, the region's structural duality, the great differences in relative productivity and, in particular, the low absolute levels of the more traditional sectors, constitute a formidable stumbling-block to technological change and dissemination in Latin America.

(d) Education and scientific and technological activity

(i) Despite the significant progress achieved in the last two decades, Latin America's educational base is still inadequate, as can be seen from the data presented in table 2.

The figures for Latin America are not the most unfavourable, but they differ so greatly from those of the advanced countries as to make it easily understandable that the educational level of the region puts an obstacle in the way of more rapid absorption of technology or technological change.

Furthermore, in the educational profile of Latin America great differences between countries are observable, while in the internal disparities within any one country the dual structure remarked upon in the context of economic activities is reproduced.

Table 2

SCHOOL ENROLMENT RATIOS BY LEVEL OF EDUCATION,<sup>a/</sup> 1967-1968

Major regions	1967-1968			
	Percentage of children of primary school age attending school at any level	Percentage of children of secondary school age attending school at any level	Percentage of children of primary and secondary school age (combined) attending school at any level	Third-level enrolment as percentage of population aged 20-24
<u>World total b/</u>	<u>68</u>	<u>39</u>	<u>56</u>	<u>10.1</u>
Africa	40	15	28	1.3
Northern America	98	92	96	44.5
Latin America	75	35	55	5.0
Asia <u>b/</u>	55	50	45	4.7
Europe and USSR	97	65	85	16.7
Oceania	95	60	80	15.0
(Arab States)	(50)	(25)	(38)	(3.1)

Source: Fauré, Herrera and others, Learning to be, UNESCO, Paris, 1972.

a/ Provisional figures.

b/ Not including the People's Republic of China, the Democratic People's Republic of Korea and the Democratic Republic of Viet-Nam.

/"The educational

"The educational structure of Latin America around 1960 can be summed up by saying that between 15 and 80 per cent of the young population, depending on the country, was outside the educational system or below the minimum educational level, while enrolment in secondary education, including courses lasting more than 9 years, has expanded to include a very considerable percentage of those theoretically eligible for it. In other words, the peculiarity of the educational system in Latin America has been its inability to create a course of strictly basic education going above the minimum level necessary for the integration of the individual into contemporary society and covering the whole of the school age population. Although this goal has not been achieved, secondary and higher education in Latin America have been developed to a point where they include percentages of the eligible population that are comparable and in some cases superior to those of the developed countries.<sup>14/</sup>

Lastly, the foregoing statements are borne out by comparison of the figures for primary school leavers in Latin American countries and in Europe (1960 to 1970 cohorts).<sup>15/</sup>

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<sup>14/</sup> Secondary education, social structure and development in Latin America, E/CN.12/924, document presented jointly by CEPAL and ILPES at the Conference of Ministers of Education and those responsible for the promotion of science and technology in relation to development in Latin America and the Caribbean, convened by UNESCO (Venezuela, 6-15 December 1971).

<sup>15/</sup> Data taken from Secondary education, social structure and development in Latin America, op. cit.

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Country	Number of leavers after 6th course
<u>Latin America</u>	
Argentina	593
El Salvador	433
Mexico	384
Uruguay	669
Venezuela	394
<u>Europe</u>	
Bulgaria	891
Greece	933
Sweden	993
Yugoslavia	750

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(ii) There is also some under-utilization of the scientific and technical capacity already created through the secondary and higher education systems, which take in a considerable and rapidly increasing fraction of the school-age population. The "brain-drain" to the United States and other industrial countries, and likewise, in recent years, to some Latin American centres which offer better opportunities on account of their greater dynamism or relatively higher stage of development, is a phenomenon to which attention has repeatedly been drawn.

A similar point to be stressed is that the existing human capacity is only partly utilized inasmuch as, for a variety of reasons, some of the scientists, professionals and technicians at a country's disposal discharge functions in which their knowledge and talent are not fully turned to account, or, worse still,

/prefer to

prefer to engage in activities which have nothing whatever to do with their speciality, or are compelled to do so for want of suitable opportunities.

Lastly, since the acceleration of educational progress is a recent phenomenon, its effects will be felt only after a relatively long time. Educational levels and the "quality" of training in the various strata of the existing active population are unquestionably far below what might be inferred from the analysis of the school population. The only way of raising these levels rapidly over the short term is through mass training programmes, an activity which - save for a few exceptions - has not been developed on the scale required to bring about a significant change in the situation.

(iii) The capacity for basic and applied scientific research is also limited, except in some of the relatively more developed Latin American countries and in certain disciplines (biology, for example). Another criticism frequently voiced is that its orientation is influenced more by the links which Latin American scientists maintain with their colleagues in the advanced countries than by consideration of their own countries' problems.

(iv) Lastly, the capacity to create technology is extremely limited in Latin America. An overwhelming majority of research and development activities are carried out in the developed countries, and an appreciable proportion in the appropriate departments of those countries' producer enterprises themselves. This assertion is valid in terms both of absolute figures and of percentages of the gross national product. Thus, in the United States, the Soviet Union, the European countries, Japan and Canada, expenditure on such activities ranges from 2 to 3 per cent of the GNP, whereas in the Latin American countries it does not even amount to 0.5 per cent. This situation is all the more critical in view of the fact that Argentina, Brazil and Mexico are responsible for 60 per cent of total expenditure on research and development activities in the whole region.



The implication is not only that Latin America's capacity to generate technological change is minimal, but also that it is an obstacle to the absorption and adaptation of imported technology, which calls for thorough understanding and assimilation of its various component elements of know-how. This can be deduced, for example, from specific studies carried out in relation to the textile and machine-tool industries in Brazil.<sup>16/</sup>

(e) The Latin American entrepreneur

Setting aside the relatively more advanced countries of the region and, in general, some of the medium- and large-scale enterprises, Latin America is short of entrepreneurial capacity both in the public and in the private sector. This deficiency is no doubt linked to the historical characteristics of the region's economic evolution, which is marked by the predominance of an agricultural and, in some cases, a commercial tradition. Education and environmental handicaps have also much to do with it, especially where small-scale economic activities are concerned.

These limitations are aggravated in countries affected by chronic inflation, where economic rationality steers the entrepreneur towards commercial or speculative activities. The lack of continuity and stability in the "rules of the game" with respect to tax, exchange, tariff, credit or wages policies and to incentive and control mechanisms in general is manifestly discouraging to technological innovation and, in particular, capital investment. Lastly, there is a sizeable proportion of industries which are not rationally organized, and in which their traditional character is a decisive factor, in relation not only to the ownership of the enterprise but to the allocation of tasks and responsibilities: technical, administrative and financial

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<sup>16/</sup> See Franco Vidossich, La transferencia de conocimiento técnico en la industria de máquinas-herramientas del Brasil, E/CN.12/633, 1971; and Luigi Spreafico, La transferencia del conocimiento técnico en la industria textil y del vestuario del Brasil, E/CN.12/623, 1971.

functions are often concentrated in the hands of a single person. Small-scale enterprises usually belong to people who have the necessary know-how for production purposes, and who pursue the activity in question because it gives them personal independence and in so far as it enables them to obtain a steady income higher than any they could receive as wage-earners, with which result they are fully satisfied. In such cases, they cannot be said to fulfil a genuine entrepreneurial function, and technical change seldom enters into the interests of the producer.

There are also many cases in which the passive or inadequate behaviour of the small-scale entrepreneur is imputable to the limitations imposed upon him by the hard facts of the economic conditions in which he carries on his activity.

## 2. Latin America: a heterogeneous region

Complementary to all this is the region's internal heterogeneity, by reason of which the problems described above affect the various countries in widely differing ways and degrees. The distribution of the gross domestic product by sectors of economic activity and the percentages of urban and rural population shown in the tables 3 and 4 below bear eloquent witness to this fact.

It will be noted that the rural population figures range from 82.7 per cent and 72.3 per cent in Haiti and Honduras, respectively, to 20.1 per cent and 21.1 per cent in Uruguay and Argentina.

The contribution of manufacturing industry to the gross domestic product amounts to 37.7 per cent in Argentina, 26.2 per cent in Chile and 25.3 per cent in Brazil, whereas in Bolivia and Guatemala, respectively, it reaches only 13.5 per cent and 13.9 per cent; the figures are reversed in the case of agriculture. The influence of these facts on the composition of the "modern" and "traditional" sectors in each country, and, therefore, on the characteristics and possibilities of technological change in each case, is too obvious to need further comment.

Table 3

LATIN AMERICA: STRUCTURE OF GROSS DOMESTIC PRODUCT  
BY SECTOR OF ECONOMIC ACTIVITY, 1972  
(Percentages)

Country	Agriculture	Mining	Manufacturing	Construction	Basic services <u>a/</u>	Other services
Argentina	11.6	1.8	37.7	4.3	9.8	34.8
Bolivia	21.0	13.6	13.5	4.8	10.3	36.9
Brazil <u>b/</u>	19.1	0.8	25.3	1.1	10.4	43.3
Colombia	28.5	2.6	19.5	4.5	9.0	35.9
Costa Rica	22.2	-	20.0 <u>c/</u>	5.1	6.6	46.1
Chile	9.3	9.5	26.2	4.2	11.7	39.1
Ecuador <u>b/</u>	27.7	2.0	18.0	5.8	7.9	46.5
El Salvador	27.2	0.1	17.1	3.7	7.8	44.2
Guatemala	26.9	0.1	13.9	1.6	6.0	51.6
Haiti	48.3	0.9	13.8	1.9	4.8	30.4
Honduras	34.5	1.9	14.2	5.4	10.1	33.9
Mexico	11.2	4.3	23.9	4.9	5.2	50.5
Nicaragua	27.7	0.9	17.7	3.5	8.5	41.7
Panama	18.4	0.3	17.4	7.3	10.9	45.8
Paraguay	33.5	0.3	18.5	3.5	5.6	38.7
Peru	16.3	5.9	23.5	4.8	6.2	43.3
Dominican Republic	21.6	4.5	16.1	7.4	8.2	42.2
Uruguay	19.0	-	20.9 <u>c/</u>	3.5	8.8	47.2
Venezuela	6.9	16.1	12.6	2.9	7.6	53.8

Source: ECLA, Economic Survey of Latin America 1972, E/CN.12/954/Rev.1, 1973

a/ Including electricity, gas, water, transport and communications.

b/ 1971.

c/ Including mining and quarrying.

Table 4  
LATIN AMERICA: URBAN AND RURAL POPULATION, 1970 a/  
(Percentage composition)

Region or Country	Urban	Rural
Latin American(average)	54.4	45.6
Argentina	78.9	21.1
Bolivia	35.5	64.5
Brazil	47.6	52.4
Colombia	57.7	42.3
Costa Rica	33.6	66.4
Cuba	53.4	46.6
Chile	70.4	29.6
Ecuador	45.7	54.3
El Salvador	37.9	62.1
Guatemala	30.8	69.2
Haiti	17.3	82.7
Honduras	27.7	72.3
Nicaragua	40.0	60.0
Mexico	62.3	37.7
Panama	50.2	49.8
Paraguay	36.0	64.0
Peru	49.2	50.8
Dominican Republic	36.9	63.1
Uruguay	79.9	20.1
Venezuela	71.9	28.1

Source: Latin American Demographic Centre (CELADE), Boletín Demográfico,  
January 1969.

a/ Mid-year estimates.

### 3. Prospects

The problems expounded in the preceding paragraphs are unquestionably of enormous magnitude, and constitute a formidable obstacle to the more rapid and harmonious development of the Latin American countries. No attempt is made in presenting them to contribute anything new to what is already known on the subject. The aim pursued is simply to emphasize the need for consistent action in widely varying fields so that the bottlenecks hindering more satisfactory progress may be gradually and jointly eliminated. Another object is to show that the mere projection of present trends into the future holds out no prospect of an adequate solution for many of the problems mentioned, unless in the very long run, and that in some cases the differences between Latin America and the advanced countries might become greater still, and the internal disparities at present characterizing the region might be intensified.

In this context, there are facts and figures which are hardly short of catastrophic. For example, the concentration of research and development activities in the industrial countries and the existing disparities in levels of education clearly show that unless very much more is done to remedy the situation than has been achieved to date, the technological gap will be widened and the capacity to assimilate new world technologies will continue to be limited. This is an important consideration to take into account in determining priorities and seeking to overcome technological dependence.

Dependence is not a purely political concept, for it emerges here as a very real problem of increasing inequality in decision-making and bargaining power, and in the capacity to opt for the most suitable alternative or to influence, even to a modest extent, the main direction of technological change with the aim of adapting it to conditions in the Latin American countries. In the words of the Assistant Administrator for Latin America of

the United Nations Development Programme,<sup>17/</sup> "changes are taking place in Latin America with varying degrees of rapidity. Under the impetus of the modernization process, the social body is adapting itself to new conditions, demanding technological change and creating the requisites for its adaptation and generation. The direction of these changes is important. It is essential that societies should evolve along lines which will make their real modernization possible by establishing an environment propitious to continuing creativity".

On the other hand, it must be recognized that in recent decades Latin America has made great strides in dealing with most of the above-mentioned problems. School attendance has increased rapidly throughout most of the region, and the scientific infrastructure has received considerable support and is becoming progressively consolidated. Thanks to a steadily growing appreciation of the nature of the transfer of technology and to greater communication with the rest of the world, governments and enterprises have been able to take steps to speed up the absorption of imported technologies and to improve the conditions in which it takes place.

The progressive introduction of modern management techniques, the increasing use of computers and, in more general terms, the gradual improvement in agricultural productivity and the emergence - even in the relatively poorer countries - of high-productivity nuclei (at least in the export sector and in many cases in the sector producing for home consumption as well), not only bear out this statement but also indicate that neither the problems set forth above nor those to be discussed in subsequent paragraphs by any means constitute an impassable barrier.

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<sup>17/</sup> Gabriel Valdés, "Desarrollo científico y tecnológico", Estudios sociales, Corporación de Promoción Universitaria, April 1974. (Unofficial translation.)

It must also be taken into account that the emergence of subregional associations and of various mechanisms for joint action on the part of the Latin American countries has made more solidary action possible, and has thus also helped to strengthen the political pressure which is exerted by the Third World in all the international forums, and which now gives a place of eminence to the problems of science and technology.

What is needed, therefore, is a bold and sustained policy backed by a national and regional political will to assign the requisite priority to scientific development and technological change: a decision which, of course, must be reflected in the allocation of resources on a corresponding scale.

It is important to point out that a coherent and realistic policy in this field must set up short-, medium- and long-term targets, since the achievement of some objectives may call for a longer lead time or may prove more costly, while in other cases it will be possible to obtain very effective short-term results through specific policy instruments or institutional mechanisms.

The heterogeneity of the region likewise precludes the formulation of a single policy for Latin America. Goals that can be achieved within two or three years in one country may take several decades to reach in the relatively less developed countries or may have no chance whatever of attainment in those of smaller size. The fewer the resources available, the greater the need to concentrate efforts - at least in an initial stage - on a small group of well-defined targets, in order to secure maximum utilization of the resources in question.

This consideration also underlines the decisive importance of intra-regional co-operation, in the sense of the formation of associations by those who cannot solve given problems on their own account, and the collaboration that the relatively more developed Latin American countries should extend to those in a

/less privileged

less privileged position so that the disparities between Latin America and the industrialized world may not be reproduced, more or less intensively, within the region.

The less developed countries are handicapped at the start; they have fewer resources with which to tackle the tasks involved in technological change and the improvement of productivity in general, and as far as the use of technology in the modern sector is concerned, they are faced with almost insuperable difficulties as regards scales of production in relation to their domestic markets.

Unquestionably, co-operation is the natural answer when individual action cannot suffice to solve a problem. Its effect is multiplied when integrated use is made of resources in short supply. Clearly, in all the respects touched upon in the present paper and in relation to the national and regional priorities concerned, there are many opportunities and needs for inter-Latin American co-operation, either at the subregional level or at the level of the region as a whole. As has already been pointed out, the necessity for such co-operation becomes much more pressing in the case of countries with fewer resources and at a more incipient stage of development. In the following chapters mention will be made of specific areas and mechanisms for collaboration to serve this purpose.

Lastly, it is essential to stress that the heterogeneity within individual countries which finds expression both in the "dualism" of the economy referred to above, and in the manifold differences existing between the various sectors of activity, such as agriculture, mining, industry, construction, health or transport, makes it imperatively necessary to formulate specific policies for each sector, with due regard to the need for overall consistency. Admittedly, most of the studies carried out, the policies proposed and the action undertaken relate mainly to medium- and large-scale manufacturing industry. However, according to tentative projections prepared by ECLA experts in 1973,



45 per cent of the active population of Latin America will still, on an average, be employed in the low-productivity traditional sectors by the end of the present century (an estimate based on relatively optimistic assumptions). This projection is enough to give a clear idea of how high a priority is merited by any efforts that may be made to raise the productivity of the sectors in question.

In the light of all the foregoing considerations, the present document takes as a frame of reference the diversity and consequent individuality of the development strategies and policies of the Latin American countries. An attempt will be made to keep the analysis and the relevant recommendations in line with this situation. Nevertheless, it is understood that many common objectives also exist, and for the purposes of the document it has been assumed that raising the economic growth rate, improving income distribution and increasing employment opportunities are aims which fall into the category of special priorities.

The topic of technological change will therefore be dealt with in relation to the considerations and priorities indicated and with due regard to the various problems set forth in earlier paragraphs.

## II. TECHNOLOGICAL CHANGE AND ITS AGENTS

### A. GENERAL REMARKS

It was stated in an introductory paragraph that the object of the present document is to analyse the development of science and technology from the standpoint of technological change.

The justification of this approach lies not only in the specific aims of the present paper but also in the nature of scientific and technological phenomena.

According to a UNESCO study as yet unpublished, scientific activity has its motivation and centres its interest in knowledge, which is in itself a "social end" of the highest value. Consequently, from the point of view of science, the possibility of putting knowledge to practical use is normally a secondary matter. This attitude is shared even by scientists working on applied research.

Technology, in contrast, is valueless without a user and a consumer, and is essentially an ingredient of the process of producing goods and services. Consequently, in technology, as distinct from science, attention is always focused on both creation and use; in other words, technology is created because someone wants to use it.

The bond of union between science and technology is knowledge and the creation of technology, whereas the application of technology in the production process belongs to the domain of economic decisions, and depends upon the decision of a public or private user for whom technology is an input which he appraises in accordance with his own motivations and interests. Technological change, therefore, is not a phenomenon which can be brought about either by a mere arbitrary decision or by the generation of a supply of technology. There must also be a demand for technology. This concept, already almost a truism, has not been sufficiently taken into account in the designing of policies and institutions, so that the problem of technology has been bandied to and fro "between production and science", and the division of functions that must result from the dual nature of the technological phenomenon has not been stated with the necessary clarity.

Again, without for the moment going more thoroughly into this problem, it should be pointed out that from the standpoint of the evaluation, adaptation or creation of technology, the institutions or individual persons who devote their energies and talent to such work need the support of science, but that technological change must be tackled specifically at the level of each sector and subsector of production.

This consideration is a basic practical limitation which must be taken into account in the analysis of overall scientific and technological development plans. As regards the supply of technology, the dominant relation is between science and technology in the process of creating this latter, whereas when existing technology is to be "sold" or transferred, the essential link is established between technology and economic activity, since in that case, the problem is analysed from the standpoint of a particular line of production.

In short, technological change will occur when an existing and available technology which constitutes the "supply" finds a user with the requisite technical and financial capacity who decides to apply it. The user in his turn can only be induced to introduce a technological change if he possesses or acquires adequate knowledge of the existence of such a possibility, and he will do so to the extent that he thinks such a move to be necessary or sufficiently profitable from his own point of view.

Accordingly, technological change is a process, involving the participation of agents who act on the demand and the supply side respectively, and who need information and communication in order to fulfil their function. The generation of this process necessitates both adequate motivation on the part of the agents, and promotion of such potential opportunities and policies as may enable and induce the said agents to behave in a way that will bring about the desired result. To meet all these requisites various mechanisms and instruments will be used. Lastly, technological change will be effected through one or more alternative channels for the creation and/or transfer of technical know-how.

## B. THE AGENTS OF TECHNOLOGICAL CHANGE

By agents of scientific development and technological change are meant the various institutions which in one way or another participate in that process. The analysis of their composition and and behaviour has been aptly systematized in terms of the now familiar "triangle" which was defined by Dr. Sábato, and whose vertices are the production sector, the scientific infrastructure and the government.

The clearest inference to be drawn from the "triangle" idea is that the institutional network thus described should constitute a system which, as such, must be closely interrelated. The first and most obvious handicap revealed by Latin American experience is the isolation in which, as a rule, each of the sectors listed above have carried on their activities. What is more, with a few recent exceptions, most of the efforts made by one or other of the "vertices" to establish a flow of communication have been far from successful.

It is impossible to make a more specific analysis of the problem stated without first stressing the fact that each of the "vertices" of the scientific-technological triangle is characterized by the heterogeneity of its internal structure, which is made up of a varied set of institutions differing in their objectives, motivations and interests.

In other words, for the purposes of a more specific study it is necessary to "break down" the basic triangle and make a separate analysis of the functions, structure and behaviour of each individual agent. In addition, separate attention must be devoted to the information, communication, promotion and dissemination functions, which are of fundamental importance.

In brief, the institutions involved may be classified as follows:

(a) The government, inasmuch as the planning, orientation and policy-making functions are its province, together with activities relating to promotion, co-ordination, provision of incentives and establishment of controls, all of which it performs through the appropriate public agencies;

/(b) The

(b) The production sector or user of the technology, which is responsible for production decisions and is, therefore, ultimately responsible also for deciding what specific technology is to be used. This must be taken to apply both to private and to public or mixed enterprises;

(c) The scientific and technological infrastructure, which creates and transmits knowledge and technical know-how, and which is constituted by the scientific community working in universities and in academic institutes of basic and applied research, by technological research institutes, by engineering firms or enterprises providing consultant or other services, by extension services and technical assistance agencies, and by the research and development departments of the producer enterprises themselves. The bodies listed may be State agencies, autonomous public institutions or private undertakings, and are grouped and analysed here from the functional standpoint. They constitute the sector providing the national supply of technical know-how. When technological change is introduced through the importation of a purchased technology, this role is performed by the supplier or "owner" of the technology transferred, but even in such cases, as will be stressed later, an important part has to be played by the local agencies on the "supply" side;

(d) Information and dissemination services which may be organized by the production sector, set up as public institutions, used to supplement the action of the scientific and technological infrastructure or established as a many-sided and flexible network involving the participation of all the agents listed above.

## C. THE SCIENTIFIC AND TECHNOLOGICAL INFRASTRUCTURE

### 1. The importance of the human factor and of education

Education is a vital element in an integrated development process and its basic social function is to serve as a mechanism for the transmission of culture and an instrument of the democratization of society. All this is beyond question, and is not germane to the purposes of the present paper.

It is likewise generally agreed that education is an agent of development, since it is also a means of attaining other social ends. From this standpoint, and in the context of a process of technological change, it is worthwhile to indicate at least some of the urgent responsibilities incumbent on the educational sector, leaving those questions which are more directly related to the scientific infrastructure to be dealt with in a later section.

Nor will reference be made here to general educational problems. Suffice it to reaffirm that the rapid rise in productivity calls for considerable capacity to absorb new knowledge of the most widely varying kinds, and that such capability depends essentially upon the population's level of education.

Japan's impressive capacity to absorb, copy and imitate the most advanced technologies and the dizzy speed with which it has climbed to the position of a leading industrial power, are closely linked to the fact that as from 1868, the date of the Meiji restoration, Japan devoted itself to the task of educating its people as fast as it could: a process which took place over the subsequent fifty years at a rate which was initially much higher than that of the country's economic growth.

With respect to questions more directly related to technological change, the following remarks are intended to draw attention to some priority fields of action:

(a) The efficiency of producer enterprises, government agencies, technological research institutes or firms of consultants obviously depends upon the qualifications of their staff. The basic functions of bodies of this type relate to the handling of the technology itself

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in its various aspects, and to the work of organization and administration. They entail respectively, ability to understand, evaluate, operate, adopt or create technology, and possession of the necessary attitudes and training to organize, to weigh the merits of alternative courses of action, to take wise and well-timed decisions and to direct the execution of the measures deemed appropriate.

While it is essential that interdisciplinary teams including various types of social scientists should be available, as well as adequately qualified intermediate-level personnel, the functions described above point to the strategic importance of engineers, administrators and economists.

It is necessary, therefore, to augment the region's supply of professionals of this type, properly oriented and trained to serve as dynamic agents of a process of technological change. This necessitates, in addition to sound scientific and technical training, the development of creativity and the critical faculty and full understanding of the scope of scientific and technological phenomena and of their relation to economic development and social change;

(b) The work of these professionals needs, in its turn, to be supported and complemented by that of intermediate-level technicians, if producer enterprises, research institutes and, in particular, the public agencies concerned are to be satisfactorily organized. It is a question of setting up the necessary "teams" and ensuring a division of functions which will obviate under-utilization of the high-level professional talent referred to above;

(c) It should also be recalled that the training of professionals is a lengthy process, so that the impact of any new programme takes six years or more to begin to make itself felt. Hence it is of special importance to give systematic opportunities to working professionals for deepening, updating and diversifying their knowledge. What is meant is not a mere "refresher" once and for all, but a continuing activity designed to prevent professional obsolescence;

(d) In small-scale economic activities - manufacturing, mining, construction, etc. - capacity for absorption of technology necessitates a major effort in the direction of training the entrepreneur both

/in dealing

in dealing with technological problems and, above all, in administration and finance. In this task the initial educational level of such producers will have to be taken into account;

(e) Where agriculture is concerned, the levels, orientation and content of professional training need to be thoroughly overhauled in those countries where the application of agrarian reform programmes has led to significant changes in land tenure, and has thus brought into being a sector of peasant entrepreneurs, who need systematic support in many directions if they are really to become efficient producers. Similar problems are faced, as a rule, by the small family farm and all the more by the minifundio.

Education is unquestionably one of the sectors in which the largest quantity of resources is needed for the implementation of programmes on a significant scale, while the quality of the teaching, which depends upon the availability of suitably qualified teachers, is also of vital importance. Accordingly, this is a field in which the relatively less developed countries of the region need considerable support, and in which, more generally, increasing co-operation at the regional and subregional levels takes on decisive importance.

## 2. Priority action in the educational field

In more specific terms, the following lines of action may be suggested in face of the problems listed above:

(a) University study programmes for engineering, administration and economics should include subjects with a bearing on policies for scientific development and technological change, to which end the copious literature already in existence could be used as teaching material. International, regional and subregional agencies might offer joint courses designed to train an initial nucleus of teachers specializing in this field.

In any event, the first step would be to introduce the subjects in question into the region's existing post-graduate programmes in the fields of study mentioned above. As the available supply of teaching staff increased, these courses would be extended to post-graduate training programmes for high-level scientists who also need to possess a general understanding of the question under discussion.

/Specifically, teaching



Specifically, teaching on systematic concepts relating to the importation of technology and to negotiations for its transfer in general should be introduced into training programmes in administration, together with other techniques and practices customarily taught under this head;

(b) University curricula in general, and in particular those relating to the above-mentioned areas should be revised with a view to gradually securing full interchangeability of students and professionals within the region.

A realistic way of tackling this task is to confine it at first to a small number of selected universities in each country or subregion, as the case may be, for which purpose a working group composed of representatives of each of these universities could be formed. The universities in question would act as leaders, setting the standard to which other institutions of higher education would gradually have to rise;

(c) At the same time, post-graduate studies should be strengthened by the establishment of regional or at least subregional systems so as to arrive at some division of labour between various Latin American countries, in accordance with their present or potential relative development in different areas. These systems would give special consideration to the co-operation which the countries endowed with greater capacity in each respect would provide to the less privileged countries with regard to admission of students, facilities for professional practice or graduate theses, and progressive training of teaching staff so that similar programmes could subsequently be established in the countries concerned;

(d) In the specific field of engineering and kindred professions, working groups could be formed at the subregional or regional level, as the case might be, and by branch or sector of industry, with the participation of university teaching staff, technologists from institutes of technological research and high-level experts from the

/production sector

production sector. The aim would be to introduce a wider range of subjects relating to certain technological questions, to establish systems of professional practice in enterprises or research institutes, to take advantage of the teaching potential of such agencies' technical experts for the purposes of higher education, and to encourage the preparation of graduate theses on technological subjects;

(e) A network of permanent and systematic programmes of continuing education might be established for professionals exercising their calling, for which purpose use could be made of the post-graduate courses, and the higher-level subject programmes in general, existing in the regular curricula;

(f) One or more regional or subregional working groups could be set up to review the content of teaching programmes for agronomics, veterinary medicine and similar professions, with the object of determining the types and levels of professionals required in agriculture, given the conditions existing in Latin America's rural sector and their probable future evolution;

(g) Requirements in respect of intermediate-level technicians in engineering and other professions should be determined, taking into account not only functions connected with medium- and large-scale manufacturing, but also, in particular, the probable operational and technical assistance needs of small-scale industry and small-scale economic activity in general.

The intermediate-level personnel needed in various social areas such as health and education, and, in particular, hospital and educational administration, should also be included here.

All this certainly involves a systematic overhauling of intermediate-level technical education, the development of which is far from satisfactory in most of the Latin American countries. The obstacles that have constantly had to be faced are a matter of common knowledge: they include such widely differing factors as the values prevailing in society (aspirations to enter the "liberal professions", contempt for manual labour, etc.), the limitations

imposed by an insufficient rate of economic growth, the shortage of resources to meet the needs of a branch of education in which costs are high because of the facilities required, and the relative lack of contact with the production sector which has prevented the use of its physical and human resources for teaching purposes, besides militating against the possibility of channelling vocational training along lines more consistent with national requirements.

Furthermore, it is necessary gradually to strengthen and/or launch training programmes at different levels and for various sectors of activity with a view to raising the workers' standards of skill in particular in the case of specialized skilled labour. As regards timing, precedence will have to be given, of course, to training in particular areas which are identified as being of special importance for securing a rapid and substantial rise in productivity.

With a similar end in view, training of intermediate-level civil servants needs to be intensified, as well as that of entrepreneurs and technicians working in small-scale activities. In both cases the corresponding programmes should include the teaching of basic notions of administration.

Unquestionably, the gradual attainment of these objectives calls for an intensive intra-regional co-operation effort and steady international support. In this connexion, stress should be laid on the importance of conducting systematic and joint educational research, by means of which the programmes can be constantly reformulated and improved upon, adapting them to the conditions peculiar to the various countries of the region.

The widespread opinion that in this field it is impracticable simply to imitate what is done in the industrial countries has been highlighted in a recent empirical study carried out by a specialized agency of the United Nations.<sup>1/</sup>

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<sup>1/</sup> United Nations Research Institute for Social Development, Vocational Training in Developing Countries: A Survey of Expert Experiences, Geneva, 1973

This study points out that the problem of vocational training in developing countries lies chiefly in the adoption of methods or styles of work which signify the combined development of technical comprehension, attitude to work and specific skills. It adds that as far as the grasp of concepts goes, the greatest difficulties arise in connexion with language limitations affecting assimilation of the content of textbooks or manuals, and with the handling of diagrams, graphs, models or other symbolic forms of representation. Among its recommendations, it strongly urges the priority of polyvalent training which makes it easy to switch from one occupation to another and facilitates constant adaptation to future technological change. It also lays stress on the importance of maintenance and repair functions and the need to train people to fulfil them; on the necessity of precision, continuity and systematization of work; and on aspects in which the survey reveals major deficiencies, such as planning of work, technical terminology and spirit of initiative.

### 3. The Universities and the development of science

Latin American universities are the main center of scientific activity in the region, although a limited number of basic and applied scientific research institutes do exist in both the public and private sector that have been set up as autonomous corporations to study specific branches or aspects of science.

The rapid expansion of higher education and the permanent influence of social conflicts on the universities themselves, in addition of course, to a chronic shortage of resources, has restricted their capacity to play a really major role in scientific progress. It has therefore proved difficult to formulate a corresponding policy capable of promoting a sufficiently satisfactory level of scientific activity for the infrastructure thus created to acquire the kind of firm foundation that is needed to ensure a process of self-renewal.

/It is

It is in any case in the university departments, institutes and schools that the majority of Latin American scientists work. They therefore have to assume a fundamental responsibility for scientific development that they share with the National Research Councils, whose activities are largely geared to creating and strengthening university bodies and encouraging the work of their scholars. The Regional Scientific Development Programme of the OAS has served a similar purpose.

The primary and essential objective of a national scientific development policy is to achieve a certain minimum scientific capability.

This is a basic requirement that covers most of the spheres of knowledge; it consists of creating the kind of situation where there can be an adequate supply of human resources and a suitable material and financial infrastructure to permit permanent and stable scientific activity, so that the country is kept fully informed of the advance of knowledge in the world and the scientific system is equipped to tackle or help to tackle the various scientific and technical problems that arise as a result of the exigencies of national development.<sup>2/</sup>

The concept of scientific activity is particularly significant in that it reflects the idea that the initial and most important step in science is "to be present" and "to be functioning", although this does not necessarily imply a pretension to be "scientifically creative" - a point which is also made in the unpublished document of UNESCO already referred to.

The largest and relatively more developed countries of the region have gone beyond this stage, possess a substantial number of high-level scientific centres and could, in fact, claim to be adequately integrated in the mainstream of world scientific progress. The situation is quite different in most of the other less favoured

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<sup>2/</sup> Corporación de Promoción Universitaria, Universidad e integración andina, (Seminario Internacional 1973), p. 96.

countries, which should therefore adopt - individually or under subregional co-operation programmes - a series of measures carrying them to the threshold referred to above. An effort in this direction requires continuity and the adoption of such measures as will develop a minimum number of priority basic disciplines, which should at least include biology, mathematics, chemistry and physics.

Accordingly, the implementation of a process of planning requires an initial phase of analysis and evaluation of the "state of the art" in the various disciplines, so as to detect which of them are insufficiently developed in absolute or relative terms. Once this information has been obtained, there exists a planning procedure that can be extremely profitable. It involves convening a small group of unquestionably qualified scientists for each discipline and, with the advisory services of experts on administration, planning and budgeting, creating a working group to formulate a development programme for the discipline concerned which, on the basis of a diagnosis of existing shortcomings and obstacles, can propose a set of appropriate measures to overcome them. A programme of this kind would undoubtedly involve the training of a certain number of high-level scientists over a given period of time; it would entail both studies in the country and further training abroad and, as far as possible, would include the establishment of post-graduate training programmes in the country and the gradual improvement of the level of those already existing. It would also contemplate the creation of specialized magazines, the systematic organization of scientific meetings and seminars, the creation of adequate resources in the form of libraries, equipment and laboratory material, the creation of a minimum number of new research posts each year in the respective field in the corresponding university departments and the identification of the academic units that should serve as central nuclei or top-level centres in the discipline concerned. It would likewise be responsible

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for setting adequate levels of remuneration for the academic staff and for the creation of a special research development fund in the respective area, in addition to making specific proposals for budgetary allocations and identifying persons to be placed in charge of the execution of the programme - this can either be done by making a direct allocation to specific academic units or be entrusted to an ad hoc development committee set up for the sole purpose of ensuring its more efficient and rapid realization.<sup>3/</sup>

Secondly, an effort will be made to identify and, by means of the allocation of special budgetary funds, give priority to areas and problems that are of prime interest from the standpoint of national development. Special interdisciplinary committees may accordingly be created and the administration of the resources allocated to specific objectives may be entrusted either to these committees themselves or to academic units more directly concerned with the area or problem involved (Faculties of Agronomy, Engineering, Medicine, etc.).

Another form of promotion is the direct allocation of lump sums to certain academic units with a view to encouraging scientific activity in a specific branch or area; for example, agricultural research could be entrusted to the Faculties of Agronomy and Veterinary Science and educational research to the Faculty of Education following an evaluation of their ability to carry it out.

It is also important to allocate special resources for their exclusive use to provincial academic units that have not had an opportunity to engage in research and are therefore initially not in a position to compete in quality with groups of a higher level. It should be made quite clear that a fairly large-scale programme for

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<sup>3/</sup> Corporación de Promoción Universitaria, Universidad e integración andina, op.cit.

achieving this objective is a medium-term investment that is essential if it is really intended to promote more harmonious and balanced development.

Finally, the development of scientific activity requires the explicit consideration of the machinery and resources that are needed for the country to establish a series of post-graduate training programmes at the highest level. In most Latin American countries it would be impossible to contemplate the existence of more than one programme at the doctorate level in a given discipline; programmes of this kind should be undertaken by the university system as a whole, at the same time establishing appropriate institutional machinery to ensure that the individual autonomy of each university in respect of diplomas and grades and individual preferences is respected.

The foregoing suggestions should make it possible to formulate a scientific development plan for the university or for the national university system, as appropriate. Consequently, and in order to promote the harmonious participation of the academic community in the formulation and execution of the plan and its constant review and appraisal and to maintain the indispensable liaison with the rest of the university system and State scientific development agencies (national research committees, etc.), a specialized academic technical body is absolutely essential. It was for this purpose, for example, that the University of Chile created the Technical Office for Scientific Research (Oficina Técnica de Investigación Científica).

It is of course no easy task to implement a programme of this kind successfully, and it is therefore extremely important to establish clear and realistic targets and not to yield to the temptation of being scientifically creative in every respect at the world level, particularly in more complex areas and branches that have only recently been embarked upon in the more advanced countries.

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To be realistic, it is also necessary to emphasize the need to establish time horizons for achieving various objectives, their sequence and the preliminary requirements in each case. It is likewise necessary to identify the regional and international co-operation that is needed, especially the kind of permanent co-operation that is called for in areas where the desired national objectives are only feasible in the very long term. This is particularly relevant to the smallest and least developed countries of the region which are far from possessing the minimum scientific capability referred to here.

In such situations as these, the concept of minimum scientific capability should be taken, in the short or medium term, as applying to the subregion as a whole, with due attention to supranational programming and all kinds of co-operation in respect of the training of scientists, joint research and the common use of material resources that such an undertaking implies.

Moreover, the purpose of this study is to suggest a concept and specific method for planning scientific development. As envisaged here, the aim is to promote a coherent set of simultaneous measures designed to create or increase the opportunity for training the necessary scientists and for placing them in an environment that is conducive to the development of their activities. Although the measures are deliberate and, consequently, planned, they do not interfere in any way with the freedom of the person conducting the research whose specialization in certain areas or problems of priority national interest may be stimulated by means of certain incentives without its being in any sense compulsory.

In the relatively more developed countries, the emphasis is already tending to switch to the greater involvement of academic circles in specific national problems of immediate interest whose

/solution requires

solution requires the support of science. Obviously, because of the very nature of their particular branch, this is the attitude of social scientists. A major effort is also being made in the fields of nutrition, agriculture and certain branches of engineering.

The presence of scholars on the boards of technical research institutes, the recruitment of university groups to carry out specific projects, the financing by State institutions or national research councils of technological research projects with the participation of university departments or scientific bodies in general are initiatives that naturally contribute to the achievement of the desired objective.

It would be particularly desirable to strengthen relations between the university and the productive sector by means of professional apprenticeships for advanced students, the provision of technical advisory services to enterprises and the holding of seminars and lectures by company experts with a view to informing specialized students of specific experiences in the field of technology. Activities of this kind would also undoubtedly help to facilitate the access of persons responsible for taking decisions in the production unit to new productive and managerial techniques.

In addition to the factors already referred to, it must be borne in mind that the possibility of achieving more effective scientific development in Latin America has also been hindered by the fact that progress has been held up or prevented by various government policies. A limited import capacity, for example, has often meant that the Central Bank or other ad hoc agency has controlled the importation of equipment and material for science, in spite of its obvious ignorance of the subject, instead of a global budget being established in foreign currency for the purpose, in accordance with its high priority, and its administration being entrusted to the research councils. Furthermore, government wage policies have rarely assigned any

/real priority

real priority to scientific activities, with the result that the salary scales of universities and research institutes tend to be inadequate and, incidentally, to encourage a "brain drain". Obviously, scientists cannot claim a level of income that is divorced from national reality, but there can only possibly be progress in science if it is established as a basic criteria that their salary scales shall be at least equal to the highest prevailing scale in the country's public sector. Furthermore, as a phenomenon, the "brain drain" is not only a question of emigration but also occurs within a country, in so far as people are induced to transfer from one branch of activity to another and, consequently, from one function to another. This internal migratory flow often occurs at the expense of scientific activities.

#### 4. Technical research institutes and consultant firms

As already pointed out, most of the potential supply of local technology in Latin American countries is to be found in technological research institutes and consultant engineering firms, together with technical information centers quality control laboratories and similar bodies.

The fact that they have been conceived and developed from the standpoint of "supply of technology" has limited the effectiveness of public technological research institutes whose priorities, work programmes and budgetary distribution usually reflect the preferences individual field and intuition of their researchers without any real appreciation of the productive process entering into the picture and without there being any systematic system of communication to inform them of the preoccupations and problems of the users and to enable them, in turn, to influence their decisions. The research institutes that have made the most headway and had the most impact in relative terms are in the agricultural sector, where the problems of applying

/technology are

technology are of very special and therefore dealt with in another section of this document. It must also be borne in mind that, as far as industry is concerned, the technological research institutes and consultant firms are concerned first and foremost with the problems of the medium and large-scale manufacturing sector, that is to say, with the so-called "modern industrial sector".

Because of the importance for Latin American countries to become sufficiently capable of selecting, adapting and creating technology and in view of the poor immediate prospects of developing such activities within the enterprises themselves - except for some of the larger enterprises in the relatively more industrialized countries of the region - the need for such institutes and firms is unquestionable. The initial gap which, for these reasons, exists between the productive activity and technological research makes it essential to define carefully, in each case, the sphere of action of the latter and to establish the aforementioned communication channels if the venture is to be successful and if the original isolation is not to become a permanent divorce.

First of all, the point should be made that, although during an initial stage of organization and consolidation the objectives of a research institute or consultant firm may cover a wide range of subjects and problems - as has happened for example with the Industrial Research Institute (Instituto de Investigación Industrial - III) of Colombia, the National Industrial Technology Institute (Instituto Nacional de Tecnología Industrial - INTI) of Argentina, the Technological Research Institute (Instituto de Investigaciones Tecnológicas - INTEC) of Chile and the agricultural research institutes in general - the need to communicate with the productive sector and the technical requirements of the task at hand tend to steer their subsequent evolution towards a decentralization or division of a sectoral nature. Moreover, since not all sectors are equal or have the same priority from the standpoint

/of development

of development, the few human and material resources available must be concentrated in a limited number of agencies at the level of specific productive sectors.

The work of the consultant firms at the national level has mainly involved the provision of advisory services to enterprises, wherein their function is principally one of domestic dissemination of known technology to which access is freely available. In some countries of the region, their work has had more to do with problems of administration, financing and marketing than with specialized aspects of production, which should be no surprise considering that these fields are more or less similarly applicable to all activities and that the consultant firms have therefore been able to acquire a permanent clientele and a satisfactory volume of work.

Gradually, Latin American consultant firms - either on their own or in association with foreign firms - are also participating more and more in the various stages of development of industrial projects: feasibility and pre-engineering studies, design and assembly of plants, installation of various types of services (electricity, air conditioning, etc.), organization of production, quality control standards and management and administration of enterprises. In this respect, the consultant firms are an important factor in the national assimilation of imported technology. Similarly, they may operate efficiently as conveyors of external technology being transferred to the country by serving as liaison with foreign suppliers or "sellers" of technology.

The performance of the aforementioned tasks moreover equips the consultant firms to assist efficiently in the adaptation of imported technology to local conditions, a field in which several countries have already managed to make a really creative contribution that may eventually represent a strategic source of technological progress. In the light of the priorities laid down in other sections of this document, this point highlights the desirability of extending the

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work of dissemination and creation to small-scale economic activities, which requires the adoption of a systematic policy by the extension, technical assistance and training agencies involved. This aspect is dealt with further on.

The list of functions given above is sufficient justification for priority policies to be adopted to encourage the development of consultant activities in Latin America, with an eye to regional and subregional association and co-operation so as to permit adequate specialization and the rational use of meager human resources.

As far as technical research institutes are concerned, they can only develop and operate effectively if they fulfil certain conditions, of which the following must be borne in mind:

- (i) The most highly qualified professional personnel, consisting of an appropriate minimum permanent nucleus;
  - (ii) Easy access to specialists who can be recruited for individual projects or to outside bodies with which they can collaborate or enter into subcontract arrangements for the same purpose;
  - (iii) Minimum regular volume of work in the case of institutes that have to finance themselves exclusively out of their own revenue, as is the case of private consultant firms. Regional associations should accordingly be formed of bodies specializing in related or complementary fields of work that are in a position to make themselves known and inspire the client or public or private user with the necessary confidence;
  - (iv) Adequate financing, which means that the technological research institutes need to carry out a significant proportion of their activities on the basis of contracts concluded with and financed by productive enterprises, which presupposes the existence of a constant demand on the part of the users.
- However, the institutes must at all costs be free to tackle

/problems under

problems under their own initiative, just as there must be a set of basic items of expenditure and services that cannot be charged to the contracts and which must necessarily be financed out of State funds or, if the field of action relates to a specific sector, out of contributions from the the corresponding enterprises. Another possible way of sharing the financing of contracts is to have the State and the productive enterprises participate in them, or to list them as items of expenditure for tax purposes;

- (v) Direct access to similar activities being conducted in the the rest of the region, to information and to the international technology market;
- (vi) Participation in their boards of directors of representatives both of the productive sector and of government bodies connected with the sector and researchers themselves.

Support from international credit institutions has mostly taken the form of encouraging investment in accordance with priorities established by their executive bodies, with particular emphasis on the quality of the work involved in preparing projects, including technical and economic feasibility studies. Although, generally speaking, there has been no apparent policy to promote local consultancy services specifically, the requirements of such bodies have contributed to their development. These institutions are mentioned here because both the International Bank for Reconstruction and Development (IBRD) and, more specifically, the Inter-American Development Bank (IDB) and, at the subregional level, the Andean Development Corporation (CAF) are in a particularly suitable position to contribute to the development of Latin America's capacity to supply technology and to mobilize part of the tremendous accumulation of technological know-how available in the industrialized countries on behalf of the region.

/These organizations

These organizations could actually establish provisions for the minimum participation of Latin American consultants in Latin American project studies, carry out an analysis of possible alternative technologies where relevant, and recruit Latin American research institutes for specific technological studies.

With regard to this last point, it is of some interest to cite a major undertaking of the OECD involving joint action by the Scientific Policy Division, Technical Co-operation Service and Development Centre.

A programming and study committee, specially created for the purpose, has undertaken to detect problem areas where there is not enough know-how available to improve the technology being used in the countries of the Third World. In other words, it set out to identify gaps in technological research that have a negative effect on the development of such countries. Following a period of analysis and consultation, a list of nine areas was drawn up that appeared to be in this situation. Subsequently, two of these areas were chosen for more detailed study and appropriate action. As a result, an institution of great scientific prestige undertook an analysis of the technology being used in the developing countries in prospecting for natural resources. Similarly, a study was requested on the supply of drinking water to rural areas suffering from extreme poverty. With regard to prospecting for minerals, the reports received by OECD indicated that there really were gaps in the technology being used and that sustained research in the field offered substantial possibilities of success. The intention of OECD is to prepare a specific work programme, for which purpose it has convened a special group of experts and intends to recruit appropriate research institutes in its member countries to carry out the programme, as far as possible in association with similar bodies from the developing countries.

This is the kind of area in which real co-operation should be possible among the Latin American nations and where an important role could be played by such agencies as IBRD, IDB and CAF. In their respective spheres of action, they could in fact create funds for

/developing technology



developing technology suited to the requirements and conditions of Latin American countries and of the Third World in general. For this purpose, they could recruit research and development groups at the highest world level to carry out - preferably in co-operation with Latin American institutes - studies designed, for example, to modify a particular technology so as to make it more labour-intensive, reduce costs or find new uses for certain natural resources.

5. Analysis of cases of creation of technology  
in Latin America

Mention has been made throughout this document of the need for Latin American nations to adapt and create their own technology. Any conceptual analysis will agree on this point. Both Brazil and the Commission of the Cartagena Agreement assigned it the highest priority. The question therefore arises as to what real possibilities exist of technological innovation at the national level. It is generally agreed that the possibilities are meagre - insignificant compared with the impressive potential of industrialized countries - and that the gap between developed and developing countries will tend to increase despite all efforts that may be made in the region. It suffices to point to the fact that the annual expenditure of industrialized countries on research and development in connexion with the use of synthetic fibres is reckoned to be equal to the total volume of resources spent on research and development in the Third World.

On the other hand, it is also true that an innovation of modest technical significance in Latin America can often provoke considerable economic repercussions.

Although few empirical data are available on the subject, a number of conclusions and observations are listed below that have been taken from a valuable OAS document <sup>4/</sup> which, while not shedding any light on the extent to which the regional creative drive can be developed, helps to identify the criteria and mechanisms that can serve to encourage it.

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<sup>4/</sup> La innovación tecnológica en América Latina: Estudio de casos  
(Technological Innovation in Latin America: Study cases),  
OAS, 1972.

The study analyses 40 cases of technological innovation in all sectors of economic activity. For the purposes of the present document, the following points are of particular interest:

(a) Of the 40 cases studied only five relate to the manufacturing industry. This means that there are sectors in which, a certain dialogue has been established between producers and users of know-how and others where such a dialogue continues to be exceptional.

(b) In 92 per cent of the cases studied, it was found that the researchers were aware of the set of problems facing the user - a striking discrepancy with the findings of general surveys which suggest that most Latin American researchers are quite unaware of them.

(c) Some 87 per cent of the cases were derived from institutes that normally maintain contact with the productive sector, while a closer link between researcher and user was found to exist in 82 per cent. These findings contrast with the estimates of other OAS studies, according to which 80 per cent of total research work in Latin America is conducted in laboratories that have no regular contact with the world of the user. This comparison would indicate that there is considerable wastage of resources owing to the divorce of technological research activities from problems of production and from the failure to apply their conclusions or findings.

(d) Seventeen cases relate to projects linked to government programmes for development and social improvement, and in 15 there was a total absence of adequate technology; it can be deduced from this that the vast majority of the successful cases of innovation considered correspond to sectors where there is no "competition" with priority research and development studies in developed countries.

(e) The innovations detected usually originate from technological research institutes that are specially designed to solve problems of the productive sector, while the contribution of university-type institutes is insignificant.

(f) A total of 30 cases were found to involve the participation of a multidisciplinary group of researchers; no information was available on the other cases.

(g) The little demand that is expressed by the productive sector tends to restrict itself to "processes" whose fundamental characteristics are already known and understood. Where a new product is concerned, by contract, preference always seems to give to foreign sources that are already producing it.

(h) A classification of the 40 cases by country, sector of economic activity and origin of the initiative provides the following data:

- (i) 21 cases are to be found in Argentina, Brazil and Mexico and 19 in the rest of the region. Of the former, the initiative came from the researcher in 7 cases and from the user in 14, whereas of the latter 16 originated with the researcher and only 3 with the user;
- (ii) In the 5 cases taken from the agricultural sector the initiative came from the researcher, whereas in those taken from the food sector the initiative came from the researcher in 10 cases and from the user in 4; in those taken from the housing sector the origin of the initiative was shared, and in the 16 cases relating to industrial activities the initiative came from the user in 10.

Although essentially tentative in that the list of cases analysed has no statistical significance, the findings would seem to confirm the importance of the initiative of the user and of effective communication between demand for technology and its supply - a situation that is to be found principally in the industrial sector since in the other sectors, and particularly in agricultural activities, the picture is quite different. As far as the agricultural sector is concerned, the main problem is no doubt that of establishing machinery to permit an effective dissemination of the results of research among the various types of producer existing side by side in the sector;

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in view of the large percentage of the total represented by the rural population, this factor is of the utmost importance for Latin American countries and will be dealt with further in subsequent paragraphs.

The study referred to in any case shows that it is possible to conduct research in Latin America and apply its results to the production of goods and services. In other words, the progressive development of a useful creative capacity is within the grasp of the countries of the region, although in varying degree and with different time-horizons and, naturally, with different requirements in terms of intra-regional and international co-operation.

#### D. THE PRODUCTIVE SECTOR

##### 1. Behavioural analysis

The technological behaviour of an enterprise is determined by its motivations and interests and by the existing objective situation. The entrepreneur (at least in the "modern" sector) is motivated essentially by expected economic returns, although power and prestige are also considerations to be taken into account and tend to be measured more in terms of size than of profits - a particularly important point in the case of public enterprises, whose success is traditionally measured in terms of the quantity of services provided, volume of investment carried out and overall size rather than in terms of economic and social efficiency.

The characteristics and explanations of the conduct of entrepreneurs in this field are well known. In so far as it operates under monopolistic or oligopolistic conditions and is protected by high custom tariffs, Latin American industry does not face the kind of competition that obliges it to be more efficient and is able to pass on the cost of importing technology to the consumer, especially in view of the demand of Latin American markets for foreign products associated with trademarks etc., that receive ample publicity in the mass media.

If one adds to this the advantages of speed of decision and of its subsequent realization and the lack of knowledge or lack of confidence that exists in respect of the domestic capacity for supplying technology, one can understand that the general tendency is for the entrepreneur to purchase external technology by any of the known methods and to restrict his demand to that.

Foreign investment has been geared, on the one hand, to exploiting various natural resources in the region and this, because of its particular nature and importance, has given rise in several countries to a reaction that has taken the form of progressive nationalization and even drastic expropriation of foreign enterprises. From the standpoint of the investor, these developments have contributed to make the extraction of basic resources a highly risky activity and have therefore been partly responsible for the entrepreneur's reducing his expenditure on technological research to a minimum and provided yet another reason for the industrialized countries to develop synthetic substitutes.

In the manufacturing sector, the foreign enterprises tends to use the creation of a branch or subsidiary as a means of taking advantage of the protected or monopolistic market referred to above (tariff-jumping). The subsidiary has a logical source of technology in its parent company and takes its corresponding decisions in terms of the overall interests of the enterprise.

On the other hand, the importation of technology poses the problem of choosing between alternative where they exist, deciding how exactly to carry out the transfer and paying for it.

The range of available technology varies greatly from one sector to another as do the characteristics of the "spearhead" technology in each case. Although the knowledge of, and access to, the world technological market of Latin American entrepreneurs also vary, only the largest and most dynamic enterprises enjoy such knowledge and access to a satisfactory degree and make any systematic effort to increase it. Because it is quicker and apparently less expensive, they usually prefer to make arrangements with sellers of

/equipment or

equipment or to make contact with specific suppliers of technology that they consider reliable. In the long run, the price paid is usually higher owing, at least in part, to the lack of knowledge of available technologies.

This factor, combined with the limited technical advisory services that are available to the Latin American producer and his relative financial and technical weakness in general, places the seller of technology from industrialized countries in a highly favourable position vis-à-vis the Latin American buyer, with the result that negotiations for the transfer of technology usually lead to high costs and restrictive clauses that are detrimental to the importing country.

## 2. The case of Brazil

It is interesting to note some of the figures for the Brazilian economy taken from recent studies carried out in the country.<sup>5/</sup> The rapid industrial growth of Brazil, where a modern and extremely dynamic industrial sector is to be found, is well known. Even in this instance, however, the following data tend to corroborate the observations made above.

(a) Brazil's payment abroad for imported technology, as a percentage of the gross national product, are of a similar level to those of Japan calculated in the same way. However, Japan's expenditure on research and development inside the country, in the same percentage terms, is four times greater than that of Brazil - twenty times greater in absolute terms.

(b) Statistics show that 73.5 per cent of foreign payments for imported technology (licences, technical assistance) are made by foreign enterprises, three quarters of this, in turn coming from subsidiaries in Brazil.

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<sup>5/</sup> "The transfer of technology in the industrial development of Brazil", by Nuno Fidelino de Figueiredo (E/CN.12/937), ECLA, 1974; and "The transfer of technical know-how in the machine-tools industry in Brazil", by Franco Vidossich (E/CN.12/920), ECLA, 1971.

(c) As far as the number of contracts entailing payments abroad is concerned, the proportions are similar.

(d) The sectoral distribution of payments for imported technology is extremely uneven. Some 55 per cent of the total corresponds to the motor-vehicle industry whereas the steel industry, which is the next largest, accounts for only 4 per cent of such expenditure.

(e) In the machine-tools industry, only one enterprise out of a total of 71 analysed employs more than 500 workers, this being also the only enterprise, according to the study, that has a similar level of technology to that of sellers of technology and is in a position to assimilate directly a significant proportion of the 17 different factors of know-how taken into account by the author. Even so, eight of the said factors are thought to be still impossible to transfer to the Brazilian enterprise.

(f) From the foregoing data, an author deduces that the "capacity for absorption" of imported technology in the modern industrial sector of Brazil is limited and insufficient, since its expenditure on imported technology is comparable to that of Japan while its relative need for new technology is greater and its own capacity for creating it much smaller.

(g) A survey of the textile industry indicates that the price of synthetic textiles in developed countries stands at about two thirds of the prices of cotton textiles, whereas in Latin America the average cost of synthetic fibres is almost three times that of natural fibres, not allowing of course for the tariff factor.<sup>6/</sup>

(h) Fifty-two United States firms have invested in the Latin American textile industry, 42 of which employ synthetic fibres or a mixture in which the latter predominate.<sup>6/</sup>

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<sup>6/</sup> "The transfer of technical know-how in the textile and clothing industries in Brazil" (E/CN.12/919), by Luigi Spreafico, ECLA, 1971.

(i) It appears that there are no specialized consultant firms in Brazil or in the rest of Latin America capable of providing adequate technical advisory services in the textile industry. (There are none in the developed countries either, but there the problem does not arise.) Consequently, there is a vacuum that makes the choice of technology something of a problem.

Several other studies draw attention to the frequent existence of a variety of restrictive clauses in licence contracts.

A study conducted by the Regional Scientific and Technological Development Programme of OAS 7/ for the Andean Group, for example, notes that, of 451 licence contracts considered, 307, or 68 per cent, contained clauses prohibiting exports to other countries.

Another OAS study 8/ indicates figures that generally exceed 50 per cent of the cases examined in respect of other restrictive clauses in licence contracts, such as price control, control of the supply of raw materials and purchase of inputs, together with frequent over-invoicing of inputs imported by the licensee.

### 3. Private motivation and the interests of society

From another standpoint, the interests of the individual enterprises are usually conducive to patterns of behaviour that are undesirable from the social point of view. In other words, as has been repeatedly indicated, a divergence sometimes occurs between cost and private gain and cost and social gain. High tariff protection, oligopolistic or monopolistic domestic markets and the aforementioned structural shortcomings of Latin American enterprises are major factors in this kind of discrepancy.

The negotiation of licence contracts is a typical case where the conduct of the entrepreneur may be contrary to the interests of society, not only because he may be prepared to pay excessive

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7/ Pierre Gonod, La problemática de la transferencia de tecnología en América Latina, OAS, 1972.

8/ La transferencia de tecnología hacia los países del Grupo Andino, OAS, 1972.



royalties, but also because of his possible willingness to accept various kinds of restrictive clauses which, at least in the short term, do not affect his profits and future interests but are clearly unacceptable from the national point of view (export prohibition, compulsory purchase of certain raw material, equipment or components, etc.).

As regards the evaluation, adaptation or creation of technology itself, the discrepancy between the conduct of the individual enterprise and national interests is often even greater in Latin America. Both the explicit policies of Brazil and those of the Commission of the Cartagena Agreement emphasize the importance of promoting such activities as much as possible. By far the majority of the studies carried out by UNESCO and OAS and by various experts of the region on the subject have reached similar conclusions, which have been echoed by participants in meetings held in Europe under the auspices of the OECD <sup>9/</sup> to analyse the problems of the relatively less advanced member countries.

However, the demand of Latin American enterprises for such national activities is extremely limited. Part of the reason for this is their lack of confidence or their lack of knowledge of the country's scientific and technological infrastructure, as well as the limited capability that the latter in fact possesses. The possibility of importing technology at any price and transferring its cost to the consumer has a similar effect, as does the "operational speed" of purchasing technology and recruiting experienced and well-known consultant firms or other advisors from abroad for purposes of design, installation, etc. The advantage for the entrepreneur of using famous trademarks that ensure greater demand for a new product also inevitably has a negative effect in this respect.

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<sup>9/</sup> Edward P. Hawthorne, "The Transfer of Technology", OECD, Paris (Istanbul, 1970). This document summarizes the deliberations and recommendations of a seminar on the subject organized by OECD in Istanbul in October 1972.

To sum up, the absence of any real demand for technology among a large proportion of Latin American enterprises tends to perpetuate the initial meagreness of the domestic supply of technology.

#### 4. The "traditional" economy

The point must once again be emphasized that all these observations apply mainly to the medium- and large-scale enterprises of the "modern" sector of the economy. In small-scale economic activities and the "traditional" economy in general - including of course the agricultural sector - the factors of behaviour and motivation are substantially different.

These activities involve a vast number of producers, most of whom are not really entrepreneurs but know how to produce a specific good and, in exchange, obtain a personal income and a greater satisfaction than that afforded by alternative opportunities. A considerable proportion of them have an inadequate level of education: their most important limiting factors are lack of organizational and administrative capability, ignorance of marketing and supply machinery and a precarious financial situation deriving from their small net worth, their limited financial solvency and their consequent lack of access to credit.

Technological progress in these areas, therefore, does not depend on direct access to world technology, and the divergence between individual conduct and the interests of society has more to do with cultural, educational and environmental problems than with a different appreciation or calculation of economic gain.

In conclusion, it should be emphasized that the conduct of the enterprise, whatever its nature, responds - in the technological sphere as in other areas - to factors whose explanation is to be found in actual developments and circumstances. The problem then, is to find the means or create the conditions for adjusting individual comportment to the requirements of economic and social development. This is one of the fundamental challenges facing a scientific and

/technological development

technological development policy and one of the main responsibilities of governments, as shall be seen in greater detail in subsequent sections of this document.

#### E. THE GOVERNMENT

In the field of science and technology, the government operates through certain institutions and influences their development by means of various policies and the necessary machinery for implementing them. For the sake of clarity, the following classifications will be employed:

- General planning agencies;
- Institutions that are directly responsible for the planning and development of science and technology;
- Policies whose direct objectives is the development of science and technology;
- Policies that affect science and technology without this being their principal objective.

##### 1. General planning agencies

Reference must first be made to the national planning offices or boards with overall responsibilities that naturally include science and technology.

As far as these agencies are concerned, it is immediately apparent that the technology variable has not been allowed for explicitly in national or sectoral development and that their staff does not include specialists in the subject. In growth projections, the technology factor is implicit in the presumed increase in productivity, and the same is true of specific investment projects that are included in the corresponding plans.

Planning must inevitably reconcile such strategic development variables and parametres as the growth rate of the product, the distribution of income, employment, the balance of payments, public revenue and expenditure, the productive structure by sector and, of course, technology. Moreover, any serious attempt to look ahead must

entail a global view of the probable trend of certain fundamental aspects of progress in world knowledge and of its effect on development. In other words, unless an effort is made to predict how technology will develop, it is impossible to anticipate with any degree of accuracy the pattern of production that will prevail towards the end of the century, and this in turn limits the effectiveness of long-term global planning. Hence the need to provide planning offices with a small but highly qualified nucleus of scientists and technology experts and to include this variable explicitly in medium and long-term projections.

The same can be said of the preparation of plans by sector and by geographical area which must make allowance for more specific technological aspects and for problems arising in connexion with particular human and natural resources. The preparation of industrial development plans is undoubtedly particularly complex, in view of the very wide differences between individual branches of industry in terms of the number and characteristics of the technological alternatives that are theoretically available and economically feasible and of the probable future evolution of such technology.

It must likewise be stressed that, at the sectoral or area level, the preparation of plans naturally entails the identification of projects, and this means carrying out much more detailed technological studies as well as establishing priority criteria arising from the State's global planning and general policies, so as to ensure the selection of socially efficient projects.

In other words, it is necessary for planning to incorporate systematic analysis and technological forecasting, situating such activities at the subregional level wherever it is not feasible or desirable to do so at the level of the individual country (for example, in Central America or the Caribbean).

/Of course,

Of course, further study is needed for the preparation of methodologies that allow the technology factor to be taken into account in planning.

It is also extremely important to collect information and study the opinions and criteria of people who are directly involved in the process; it is therefore desirable for industrial development plans and programmes to be prepared in close contact with the corresponding producers, whether public or private, and with the experts from the "technology supply" sector. In other words, at the sectoral and area level - according to a generally accepted principle of planning - the formulation of plans must include the participation of those who are responsible for their subsequent execution. Use can therefore be made of such working groups or ad hoc consultative committees as may be necessary to serve as advisors to the corresponding planning offices.

Special and separate attention must be given to programming the development and consequent technological evolution of small-scale and artisan-type industry and other small-scale and low-productivity activities, and special working groups must be established in the corresponding planning offices to deal with such problems.

Finally, planning agencies must study the problems of employment, technology and distribution of income systematically and in conjunction, both at the global level and at the level of specific sectors. The working groups established for the purpose could make use of all kinds of research already carried out on the subject, including studies prepared under the joint OAS/ILPES programme.<sup>10/</sup>

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<sup>10/</sup> Victor Tokman, Ingresos, tecnología y empleo en la industria del Ecuador, 1973, and Distribución del ingreso, tecnología y empleo. Un análisis del sector industrial del Ecuador, Perú y Venezuela, 1973.

2. Institutions that are directly responsible for science and technology

A growing interest in science led governments to create national research councils. These councils have contributed greatly to an awareness of the importance of the science factor and to the promotion of research by financing projects and scholarships, encouraging meetings and publications and other similar initiatives. Their influence on the formulation of a policy and consequently, on the more integrated development of the scientific infrastructure has been less apparent. Their directors, who are normally taken from scientific circles, have in fact been extremely zealous in defending the necessary freedom of investigation, and this would seem to have had a bearing on the emphasis that is placed on financial support for specific individual or working-group activities, which in practice have usually been their most outstanding function. It is being increasingly recognized, however, that formulating scientific policies does not mean restricting the freedom of the man of science, but taking a series of measures to ensure the harmonious development of a sufficiently wide selection of spheres of knowledge. For this it is necessary to adopt a realistic attitude towards the shortage of human and material resources - for example, the time horizons required for the training of a sufficient number of groups of a minimum size at the doctorate level - and to understand that the prime objective of a policy is not the accumulation of original creations having a major impact but the possibility of conducting high-level scientific activities on a systematic basis.

Furthermore, despite their formal participation in the State structure, research councils in Latin America have operated with a considerable degree of autonomy; although this in itself is a positive factor, it has resulted in an evident lack of communication with the rest of the State apparatus, which means that the councils have not served as a sufficiently effective link between the scientific

/community and

community and the governments. Their boards should therefore perhaps be a place of meeting, confrontation and co-ordination of government representatives, particularly from planning agencies, with university authorities and members of the scientific community, so as to ensure the adequate participation of all sectors and the real possibility of formulating and implementing coherent policies.

It should also be pointed out that the formal link with the rest of the State administration is usually provided by the Ministry of Education; though logical, this poses a real problem in that education is such a vast and complex field that the heads of such ministries, who are in any case rarely experts in scientific matters, find it impossible to carry out their task properly. Alternatively, therefore, they are frequently attached to the Office of the President of the Republic - a solution which is equally feasible but which once again can only be effective if intersectoral guidelines of the kind already indicated are laid down.

Finally, and particularly important from the point of view of this study, the work carried out by the national research councils reveals that they are the product of an idea and a concern expressed in terms of education and culture; save a few recent cases that have evolved in a different direction, therefore, they have no real contact with the productive sector and have no influence whatsoever on the process of technological change. This is not just incidental but the inevitable outcome of the dual nature of the scientific and technological phenomena referred to earlier in this document.

In other words, except in countries whose State apparatus is on a small scale or at an early stage of development, it is difficult to imagine a centralized system of scientific and technological development planning under a single command. If this is accepted, the State apparatus must here be conceived in terms of administrative agencies that are separate but duly and formally interconnected for purposes of information, consultation and co-ordination. On the

/one hand

one hand, decisions regarding problems related to the productive sector or, in other words, to the use of technology, would be the responsibility of agencies of the economic sector. On the other hand, specific problems of science and know-how would be dealt with by such bodies as the national research councils. The Ministries of Education would have no jurisdiction over such bodies, their authority being restricted to the field of education as such.

At all events, it would be preferable to make any institutional adjustment by strengthening or re-orienting existing agencies, since the creation of new institutions would tend to start a process of "bureaucratic growth" characterized by overlapping, disputes over jurisdiction, high costs and wasted efforts.

It should, moreover, be made quite clear that, if one accepts that education, science and technology are so different in nature that they justify the existence of three separate groups of administrative agencies at a similar level and, at the same time, the close and manifold interrelationship between them, the responsibility for the adequate functioning of the State apparatus in this area belongs to the communication and co-ordination machinery which is established.

At least as far as certain matters are concerned that must naturally be identified with sufficient precision, the concept of co-ordination here includes the right to take decisions, which would be granted to intersectoral collegiate bodies, although the final word in the matter would belong to the head of the Executive power in accordance with the institutional structure of each country.

This does not, of course, mean that a strict sphere of action must be established for each of these co-ordinating entities. Since both the problems and the solutions considered most suitable to solve them vary extremely quickly, a considerable margin of flexibility is needed to permit the necessary adaptation of the existing institutions. The definition of the aspects that are to be the subject of joint decision must, however, be sufficiently clear. The training of

/workers, for



workers, for example, is an educational programme, but its objective is directly linked to economic development and consequently its scope, content, volume and orientation are outside the competence of Ministries of Education. There is however, a clear relationship between permanent training activities and systematic technical education at the basic or secondary level; therefore, both aspects must be analysed and clearly defined and the purpose and sphere of action of each specified. This task should be assigned to a co-ordinating agency of the kind indicated.

A co-ordinating agency is also essential for deciding how to allocate the limited human and financial resources that the State can spare for scientific and technological research and related activities; these resources have to be distributed among programmes whose objective is the development of science, initiatives whose purpose is to bring about specific technical progress in agriculture, mining, industry or areas of social development, and mixed projects designed to achieve several of these ends at the same time.

Furthermore, these specific problems both of education and of science and technology are so complex that a duly co-ordinated institutional network must be established in each sphere. The educational sector not only includes a series of levels ranging from pre-school activities to higher education but also covers traditional systematic education as well as various forms of non-conventional or non-formal apprenticeship, permanent or continuous education programmes, etc. As to the scientific field, mainly autonomous universities exist side by side with various types of research institutes and public agencies whose responsibilities have to do with policy, study, promotion and control. Finally, as regards technology, although they are closely linked, the questions arising from the transfer of technology from abroad, the problems of creating or adapting technology locally, the work of extension and technical assistance and the requirements of information and dissemination of technology are quite different. Moreover, in each of these areas it is the State's

/responsibility, to

responsibility, to a greater or lesser degree, to engage in policy work, study, direct action, promotion, financing, control and evaluation. Further on, a more specific analysis will be made of the role of the State in the transfer and creation of technology.

The degree of differentiation between the functions involved and consequently, the number and dimension of the co-ordinating institutions and committees that are needed will depend on the particular structure and conditions prevailing in each country. The lower its level of development and the greater its shortage of resources, the more the country will be inclined to concentrate on a limited number of objectives and programmes and, therefore, the simpler the corresponding State organizational set-up will be.

Finally, the most suitable institutional solution will largely depend on the style of development chosen and, more specifically, on the predominant sphere and kind of action of the State in each country. A situation where the action of the State is preferably indirect is obviously very different from a situation where social objectives take the form of compulsory edicts issued by the public authority; in practice, there are numerous intermediate stages between these two alternatives that give rise to institutional structures of an extremely varied nature.

### 3. Policies whose direct objective is the development of science and technology

In the past, the government policies most directly connected with technological change have had mostly to do with foreign investment and the importation of capital goods.

The most frequently adopted attitude towards the importation of equipment has been to offer as many facilities as are compatible with the balance-of-payments situation and reduce its cost by means of low tariffs and preferential credits, so as to stimulate investment and thus raise the level of economic growth.

Latin America's attitude towards importation of capital has traditionally varied between ample concessions and strict bureaucratic control, according to the prevailing view of foreign investment as being essentially beneficial or prejudicial.

It is not the purpose of this document to analyse these aspects. However, since foreign investment and the purchase of equipment are ways of importing technology, the significance of the measures adopted in this respect must be clearly understood if they are not to have undesired repercussions on the process of technological change.

However, a number of major efforts have been made in recent years to orient technological change by means of the formulation of a series of coherent policies. Brazil and the Andean Group are two striking cases in point.

(a) The programme of Brazil

The Brazilian government has published an integrated technological development programme which broadly speaking establishes the following priorities:

- (i) Strengthening of the domestic capacity for absorbing and creating technology by means of the establishment of institutes for conducting research and disseminating its findings to the productive sector;
- (ii) Formulation of a policy on the transfer of technology from abroad containing the following objectives:
  - Preferential development of priority industrial sectors
  - Reduction in the cost of transferring technology
  - Improved knowledge of the world supply of technology
  - Flexible use of the world system of patents
  - Elimination of restrictive clauses from imports of technology;
- (iii) Reduction in the risk and cost of local investment in research;
- (iv) Consolidation of the scientific and technological research infrastructure;

/(v) Consolidation

- (v) Consolidation of the system for supporting scientific and technological development, especially in respect of information and dissemination, regulations governing industrial ownership, inspection and certification of industrial quality, metrology and standardization;
- (vi) Integration of the industrial sector and university research by means of research agreements in priority sectors, and other measures.

(b) The policy of the Andean Group

In the case of the Andean Group, progress in this area has resulted largely from initiatives taken by the Board of the Cartagena Agreement that have led to agreement among its member countries.

For the purposes of the present document, attention should be drawn to certain aspects of the recently adopted Decision 84 of the Commission of the Cartagena Agreement entitled "Bases for a subregional technological policy", and of the well known Decision 24 of the Commission which it complements. Significantly, Decision 24 is entitled "Common regime for the treatment of foreign capital, trademarks, patents, licences and royalties".

Apart from references to royalties and other payments abroad that are not directly relevant to this study, its most important provisions include the following:

Article 2. All foreign investors wishing to invest in one of the member countries shall submit a request to the competent national agency which, after evaluation, shall authorize it if it corresponds to the development priorities of the receiving country.

Article 5. All direct foreign investment shall be registered by the competent national agency, together with the agreement stipulating the terms of the authorization.

/Article 6.

Article 6. Responsibility for ensuring the compliance of the foreign investors with the commitments undertaken shall belong to the agency registering the investment, in co-ordination with the competent State department or service in each case.

Article 22. The national authorities shall undertake the continuous and systematic identification of technology available on the world market for the various branches of industry...

Article 23. The Commission ... shall approve a programme designed to promote and protect the production of subregional technology.

Decision 84, for its part, stipulates the following:

Article 3. The member countries undertake to adopt ... in particular, such measures as may be essential for establishing close and systematic links between the agencies responsible for formulating and executing national development policies, bodies generating scientific and technological know-how and the users of such know-how.

Article 4. The member countries shall carry out specific actions ... at both the national and subregional level with a view to: ... (g) The development of the necessary infrastructure for the objectives indicated (creation and protection of subregional technology, evaluation, selection and control of technology to be imported, copying, assimilation and adaptation of external technology, collection and dissemination of information on available technology, etc.).

(c) Some conclusions

A comparison of the policies and provisions mentioned above reveal both similarities and dissimilarities between the cases described. They would seem to differ in their development strategy in so far as the agreements of the member countries of the Andean Pact place more emphasis on the control of foreign investment, whereas Brazil is pursuing an aggressive policy of absorption of foreign technology in which foreign investment has hitherto played a decisive role.

/Being particularly

Being particularly interested in the control of foreign investment, the Andean Pact places more emphasis on the need for selection and negotiation when importing technology and on the copying and adaptation of foreign technology, whereas Brazil would seem rather to rely on the capacity of its "modern" industrial sector, which is unquestionably more developed than that of the Andean countries. Accordingly, the Brazilian plan stresses the need to increase the domestic capacity for absorbing technology and its dissemination in the productive sector.

Perhaps the most significant aspect of the programmes is that they concur entirely in assigning priority to the development of an indigenous capacity for adapting and creating technology and suggest similar methods of bringing this about. This aspect will also be analysed in the present document.

The passing of the General Law on Industries in Peru is another example of legislation that attempts to deal with this aspect of the process of technological change. Article 14 of this Law creates the Institute for Industrial Technological Research and Technical Standards (Instituto de Investigación Tecnológica Industrial y de Normas Técnicas - ITINTEC) and Article 50 stipulates that all industrial enterprises shall deduct 2 per cent from their net revenue to be used in scientific and technological research for industry.

The examples given reveal definite progress in the technological policies of Latin American countries which were initially restricted to strengthening the scientific and technical infrastructure, subsequently included the control of the process of transfer of technology and now extend to the development of the demand for technical change and of the capacity for innovation.<sup>11/</sup>

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<sup>11/</sup> "LAFTA Plan of Action. Technological development by area and the transfer of technology" (ALALC/SEC/PA/21), June 1973, p.53-69

The advocacy of an integrated policy covering similar areas and emphasizing the undertaking of the State to promote it in every way is, therefore, the most striking aspect of the examples given. It is also interesting to note their agreement in respect of the priorities and machinery that are recommended, especially in connexion with the domestic capacity to supply technology, the need for information and dissemination and the improvement of the terms under which technology is imported. The differences in emphasis between them, in turn, draw attention to the need for the strategy or style of development selected to be compatible with the policy of technical change, which is one of its most vital expressions.

This is precisely the conclusion that this section of the document would like to emphasize. Scientific development and technological change require the formulation of integrated policies in line with the national development strategy, whose design and execution require the participation of the sectors of demand and supply of technology defined in previous paragraphs. According to the capacity of each country and the external links it establishes, such policies may also involve a major element of co-operation at the subregional level. The differences between Brazil and the countries of the Andean Group are particularly striking in this respect, for example, as are the internal disparities between the member countries of the latter subregional association. This fact is recognized in the aforementioned Decision 84, which states in Article 2 (c):

"(The member countries agree) to eliminate progressively the differences that exist between the member countries in this respect by means of the adoption of machinery conducive to the progress of the least developed among them."

Experience nevertheless shows that considerable success can be obtained by means of partial solutions applied to specific sectors, spheres of knowledge or problems. Accordingly, steady progress has been made in the entire region and major advances have been recorded in several fields that have made it possible to raise the general productivity of the economy or of particular sectors of activity - as

/has already

has already been pointed out in the case of technological progress in the agricultural sector, the generalized introduction of modern administration techniques, and computer work. The industrial development already achieved by Argentina, Brazil, Mexico and other countries is also an eloquent testimonial to this fact, as are such striking examples of high-level technological production as the textile industry and cultivation of flowers in Colombia and, in general, Latin America's efforts to export to the world market.

In future, therefore, the application of more coherent or integrated policies should lead to much greater achievements, a prospect to which even the countries that are initially in a less favourable situation can look forward, since the cases referred to can be applied at least in part to them too and since they will undoubtedly benefit particularly from a more consistent effort to make better use of the limited resources available.

4. Policies that affect science and technology without this being their principal objective

A large number of government decisions affect science and technology in one way or another without the State necessarily being aware of its repercussions in this respect or - even less - intending them to occur.

In other words, general government policies have not paid proper attention to their impact on scientific development and, above all, on the process of technological change. This is obviously partly due to the fact that this field has only taken on importance and become the subject of conscientious and deliberate analysis in the course of the last ten years and that many of the existing incompatibilities and contradictions derive from situations that arose previously. It is therefore urgent that Latin American countries should conduct a systematic review of all laws, procedures, mechanisms, institutions and policies that influence technological decisions in one way or another.

/To start



To start with, emphasis has been placed on the fact that the technology created in developed countries is not appropriate for the composition of the productive factors, since their relative capital-intensiveness does not fit in with the greater offer and lower cost of manpower in the countries of the Third World in general and in Latin America in particular. The need must therefore be emphasized of creating more appropriate technology that can contribute to solving the critical problem of employment, which is a major obstacle to the more harmonious development of almost all the countries of the region. The world-wide tendency to cut down on manpower has, however, been in fact reinforced by a series of decisions that entail increasing the cost of manpower and subsidizing the use of capital.

Several studies have drawn attention to the effect that the distortion of the price of factors has had on the technology being used in the developing countries.

Others question its importance, emphasizing rather the more decisive influence of other phenomena, such as the international "demonstration effect" and economies of scale.

The point that is being made here is that, whatever the relative effect of the distortion of prices of productive factors on the choice of technology, it has to be corrected if a more appropriate selection is to be made - although this may be far from sufficient.

Financing social security with contributions calculated as a percentage of wages (which, for example, in Chile increase the effective cost of labour by more than 50 per cent) is the most flagrant example of this kind. According to a study conducted in the latter country, a change in the system of financing could have an impact on employment of no less than 2.25 per cent.<sup>12/</sup> This

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<sup>12/</sup> La eliminación del sistema de cotizaciones previsionales: estimaciones de su impacto sobre el empleo, CEPLAN, 1971.

consideration may have a major influence on the decision to free the labour factor from this cost item and transfer the necessary financing to the general tax system or other alternative mechanisms.

A similar effect is produced by subsidizing capital by means of preferential interest rates and tariffs for the importation of equipment and other measures that are designed to encourage not technological innovation in general but the specific use of capital. Inflation is also a contributing factor, especially when it is chronic, and decisively so when it is so great that the real rate of interest becomes negative. What is needed here is to reconcile the necessary incentive to save and invest, rather than increase consumption, with the equally fundamental priority of increasing employment opportunities. This means that the rate of interest must not only be positive, but also reflect the social cost of capital, and that the reward should go to the kind of investment that is intended to create or expand productive activities that generate more employment. A study could accordingly be made of tax and other incentives calculated in terms of indexes that include the number of workers or the payroll. Maintaining or even increasing the incentive to save is, of course, a different matter.

It should also be borne in mind that, for the entrepreneur, labour usually has a greater subjective cost which in varying degree, may be translated into real cost based on the potential existence of labour disputes which, in turn, are linked to such fundamental social problem as the distribution of the fruits of work. Hence, for labour to be placed on an equal footing with capital for the purposes of taking a decision in the field of technology, the factor that should be subsidized to allow for the "social conflict or negotiation" element should in any case be labour.

Similarly, the introduction of preferential tariffs for imported capital goods as a general incentive to investment should, where possible, be reconciled with the measures that may be needed to provide a special incentive to investment that is conducive to an increase in employment.

/A similar

A similar reasoning applies to the restrictive effect that the tax system of many countries of the region has on the link that the current trend towards specialization and division of labour make it possible to establish between the "modern" manufacturing industry and small-scale industry. A considerable number of branches of industry are resorting more and more to the subcontracting of maintenance and repair services, manufacture of parts and components, and even certain stages of a productive process to smaller specialized enterprises. From the point of view of this study, this is an ideal means of spreading more sophisticated techniques among lower-productivity sectors. This internal transfer of know-how is hindered by the traditional purchase taxes on all successive stages of a transaction, which has its advantages as a fiscal instrument but also has the effect of fostering vertical integration for the sole purpose of reducing taxation. It may therefore be desirable that this tax should be replaced by the value-added tax system, which has been sufficiently tested but requires a more modern and efficient system of tax administration.

It is not intended here to give a complete list of all the policies that are intended for one purpose but have unwanted repercussions on the process of technological change. Although reference has already been made elsewhere to other similar cases, the examples cited here serve not only to formulate proposals for modifying some of the policies analysed but also draw attention to the need to create an inter-ministerial committee of the highest level in each country that can analyse and express its opinion about the probable impact on science and technology of the State's plans, programmes and policies.

Finally, the foregoing reasoning can certainly be extended to policies being applied at, or only affecting, the sectoral level. A possible example of this is the influence that decisions regarding the rate of exchange or external credit have on technology in the agricultural, mining or industrial sector. The scope, orientation,

/interest rates

interest rates and other factors of agricultural credit systems also influence the kind of technological development that takes place in the sector and, specifically, among the groups of farmers and rural workers who benefit from the process.

The impact of the various government measures on the process of technological change must therefore also be studied at the level of each economic and social sector and requires the creation of appropriate co-ordination machinery.

### III. THE PHASES OF THE PROCESS OF TECHNOLOGICAL CHANGE

#### A. THE MOTIVATION OF THE AGENTS OF CHANGE AND GOVERNMENT POLICIES

In accordance with the analysis contained in the previous paragraphs, a distinction can be made between three motivations or sources of technological change.

First, technological change may derive from a decision taken by the public or private producer or user of the technology. This is the case with medium and large-scale economic activity in the modern sector, especially the manufacturing industry.

Secondly, technological change may result from a supply of technological know-how that generates its own demand. This is the case with social development programmes or the large-scale exploitation of natural resources under the responsibility of the State (mining, forest industry, etc.) in which, once technical progress has been achieved, it is immediately incorporated in the corresponding programme or activity by decision of the State itself.

Thirdly, technological change may occur as the result of the dissemination of freely available technology or of extension services designed to teach or persuade the user. This is what usually happens in the agricultural sector and in small-scale industry and mining.

The particular slant of the scientific development policy and technological change will differ according to which of these situations prevail.

When the fundamental factor is the decision or demand of the user, an effort should be made to suit his conduct to the comportment that is considered socially desirable. This means creating generally favourable conditions, using various kinds of incentives and/or control and, above all, establishing communication channels between the user and those who, from the supply side, are in a position to provide him with the data and advisory services he may require. This function belongs to the local scientific and technological infrastructure and to the person selling or offering external technology.

/On the

On the other hand, when the initiative comes from the side of supply, the emphasis must be placed on the identification of the possibilities of technological progress and on the formulation of the corresponding research programmes.

Finally, the development of extension and dissemination activities is a fundamental responsibility of the State, which must establish the necessary institutional machinery, identify priority areas for action and utilize the most suitable instruments and procedures in each case. Here, though, a major role must also be played by the "modern" productive sector, as we shall see later.

The aim of this section is to draw attention to a number of specific policies and measures that can be applied to situations in which technical change is instigated by the demand of the user, bearing in mind and emphasizing certain aspects of the analysis presented in previous sections.

Broadly speaking, these policies and measures can be placed in four different categories, it being understood of course that they may serve more than one of the purposes enumerated below.

- Policies designed to bring the interest of society and private interests closer together, in accordance with national priorities.
- Policies that are aimed at bringing about a more suitable rate and form of technological change in the user.
- Measures whose objective is to improve the conditions of information and communication under which the user operates.
- Steps that are conducive to increasing the effectiveness of the support which the national scientific and technological infrastructure affords the productive sector so as to obtain the kind of technological change that is most suited to the country's interests.

Based on these categories, a number of general criteria, policies and specific measures are accordingly listed below.

(a) In this as in all other fields of economic activity, the stability, clarity and simplicity of the "rules of the game" which

/the State

the State imposes, through the relevant development strategy, both on the national producer and on the foreign investor are a fundamental requirement for ensuring that an enterprise is run along the desired lines, in so far as they reduce the element of risk and uncertainty that makes it impossible to take decisions or causes them to be postponed and introduces all kinds of distortions into the calculation of costs.

(b) The compatibility of the general policies of the State with the objectives and priorities of technological change is a necessary requirement for the purposes referred to in this study, although it may be far from sufficient; each policy should therefore be evaluated from this standpoint.

(c) Above all, factors that distort the relationship between capital and manpower, by increasing the cost of the latter or subsidizing the former (see previous sections), must be eliminated if the process of technological change is to help as far as possible to increase employment opportunities - which are themselves negatively affected by the general trend of modern technological progress. The following lines of action can be adopted in this respect:

- Progressive elimination of tax on labour as a means of financing social security;
- Modification of provisions that discourage the recruitment of new workers (for example, certain irremovability laws) and their replacement by more functional systems for protecting or guaranteeing employment;
- Incentives to increase employment at least equivalent to the subsidies that are granted to capital in the form of reduced tariffs, preferential interest rates, special credit amortization periods, and so on. Incentives of this kind could be based on such factors as the permanent increase in the number of workers or in the real payroll.

(d) The inclusion of restrictive clauses in licence contracts which, without directly affecting the enterprises, are harmful to the national interest should be prohibited by law, on the understanding

/that such

that such measures should only be applied to factors that can be effectively controlled (e.g., restrictions on exports to other markets, compulsory purchase of certain inputs or supplies, the obligation to maintain production or fix prices at certain levels, etc.). This subject will be dealt with more fully in a later section.

(e) A greater degree of competition should be gradually introduced in the market so as to oblige the producer to increase his efficiency, by eliminating his monopolistic power through the opening up of foreign trade by means of special subregional and regional terms or agreements or of a general reduction in tariffs. Policies of this kind should be applied selectively on a sectoral basis, since it is necessary to consider the problems that arise, for example, when technologies are available in advanced countries whose economies of scale prevent any possibility of competition, and, in general, so that the rate and extent of the tariff reduction can be graded.

Opening up markets through subregional associations or other mechanisms will, in any case, only be able to eliminate or reduce monopolistic situations partially, since economies of scale have already reached such magnitude that they have led to the creation in several sectors of marketing networks and optimum levels of production of world wide dimensions; production on the Latin American scale may therefore be far from representing any real competition. This, for example, is the opinion of the Commission of the Cartagena Agreement which has divided up various branches of the metal manufactures and machinery industry among its member countries, by allocating specific production quotas to each.

(f) At the same time, a clearly defined system of reward and punishment for public enterprises must be introduced, so that their executives can be judged on the performance of the enterprise in terms of priority social objectives. Promotion or dismissal would depend on their efficiency judged in this way. In any case, measures should be taken to make it possible to evaluate the performance of such enterprises and to preventing the kind of situation from arising in which a State subsidy is needed in order to avoid bankruptcy. In the

/field of



field of technology, preliminary technical and economic evaluation of investment projects by ad hoc groups not attached to the enterprise is a useful way of offsetting the tendency of public enterprises to see the expansion of activities and "modernization" as an end in itself.

(g) Foreign investment must also be clearly and precisely regulated and submitted to appropriate controls that are not merely bureaucratic obstacles, within the framework of the corresponding national or subregional policy. Accordingly, the public agencies responsible for registering and evaluating projects for the importation of technology or foreign investment, such as the "competent national agencies" referred to in the aforementioned Decision 24 of the Commission of the Cartagena Agreement, must have access to adequate technical assistance. The matters they are called upon to examine are too varied and complex to be studied in sufficient detail by a group of permanent officials, however excellent their qualifications. The danger is that they will therefore act as a mere bureaucratic obstacle or restrict their work to routine approval and registration. In this respect, national and regional research institutes and consultant firms can play a role of the utmost importance by providing the corresponding public authority with its principal source of technical support. Only with the help of an organization of this kind will the "competent national agencies" be able to take appropriate and well-founded decisions.

(h) Quality control systems, norms and standards must be established for authorizing the export, purchase by the State and even the sale of certain products.

(i) The State must guarantee to purchase the experimental production and/or absorb the cost of experimental plants, as these are stages of technological innovation that involve considerable risk and high cost.

(j) The association of producers must be promoted and encouraged so that they can undertake jointly tasks connected with technological change at either the national or subregional level. The association

/of producers

of producers in an oligopolistic market naturally comes up against difficulties arising from the conflict of interests between them. Information and evaluation of technology and other similar services of common interest therefore provide a promising area for co-operative action; in Norway, for example, 18 "research associations" exist which really provide information and consultant services for the "associates", i.e., the various enterprises of a particular sector.

Taken a step further, such forms of association could, either directly or as agencies for recruiting and co-ordinating specialized consultants, provide the technical support that enterprises require for negotiating the importation of technology and adapting it - a development that would be particularly beneficial to the least developed countries.

(k) The creation of sectoral productivity committees is necessary for the joint analysis of various policy instruments. These committees would also serve as a meeting place for the productive sector, government officials and representatives of the scientific and technological infrastructure; the power of decision would, however, naturally remain with the public authority. Such bodies could thus serve the dual purpose of providing communication and advisory services for the formulation of policies.

(l) The creation of analysis and evaluation machinery and the financing of the so-called "breakdown of the imported technological package", in the manner advocated by the Board of the Cartagena Agreement, are also required so as to enable the user to distinguish the fundamental components of that technology (backbone technology) from those, such as design and various engineering services, that are accessories (peripheral technology) that can more easily be provided at the local or regional level. Systems could accordingly be created, for example, for making a preliminary report on a licence contract or on foreign investment, involving an analysis along these lines, whose cost could be shared by the user and the State.

/(m) Promotion

(m) Promotion of systematic communication is needed between local producers and the external technological market. By encouraging travel to and from other countries, organizing seminars and congresses and attending international fairs, significant results can be obtained. Priority should be given to contact between Latin American countries, especially with enterprises in the relatively more developed countries of the region, and to the establishment of links with medium- and small-scale enterprises in the industrialized countries. The relatively smaller gap between them in terms of scales of production and political and financial power, should provide opportunities for a more beneficial relationship than could be established with the large multinational corporations.

(n) Leading figures or experts connected with the productive sector should be included on the boards of directors of the technological research institutes so as to gear their specific programmes and projects to the study of problems that genuinely interest the user and to provide the latter with more knowledge of technological progress and a greater interest in it.

(o) The State should partially finance studies requested by enterprises from national or subregional (or even regional where feasible) research institutes and consultant firms, whether for the purpose of selection, evaluation, adaptation or creation of technology.

(p) The State should directly subsidize research institutes. These subsidies would be gradually decreased in order to encourage contract work but would in no event be eliminated so as to guarantee that the institutes retain sufficient freedom of initiative.

(q) Credit and tax incentives should be established so as to reduce the cost and risk of technological research activities being conducted or financed by the enterprises.

(r) Preferential credits should be offered for investment involving an element of local, subregional or regional technology.

(s) Future purchases of certain products by the State should be geared to the realization of national and regional research, the employment of national and regional consultants and the exclusion of restrictive clauses from licence contracts.

/(t) The

(t) The granting of credits for investment purposes or of certain tax advantages should likewise be dependent upon the appropriate pursuit, selection and evaluation of technologies by firms in the region or directly by the enterprise concerned.

Several of the above points mention explicitly the possibility of the proposed instruments having a regional or subregional application. It need only be added that it is important to create or encourage the further development of Latin American associations or research institutes and engineering firms and to act on the assumption that all information and communication machinery must be developed at the regional or subregional level as appropriate.

#### B. INFORMATION AND DISSEMINATION OF TECHNOLOGY

Adequate information and dissemination of knowledge, experiences, opportunities, cases, etc., play a vital role in the process of technological development and transfer.

In fact, from the practical standpoint of actual results, these services are probably the most effective link in the chain of stages of technological change: the quality of the technology that is selected, copied, adapted, acquired or created is as important as the speed with which the process takes place.

Consequently, each of the agents of the process of technical change - that is to say, the users, suppliers, governments, research institutes, etc. - must have the most comprehensive and up-to-date range of information possible on all the aspects in which they are interested, for example:

- Where and who is offering what is being looked for?
- Under what terms?
- What alternatives are there?
- What are the basic technological characteristics of the various alternatives?
- What has been the experience of any other users that may have applied or are applying the technology or research in question?

/- What

- What support can be obtained in each case in order to tackle, negotiate, adapt, create or copy the desired technology?
- What real contacts can be established?

The suppliers must also have permanent access to the various kinds of information that they require to take part in any of the forms of sale, contribution, association, exchange or support for local creation and to be able to transfer the technology they possess.

This information includes:

- Markets, locally employed technology, possible competition, etc.
- Potential users of the technology, knowledge of the sector, current technological level, etc.
- Local conditions (legal, financial, etc.).
- Direct contact with, and general knowledge of, areas or countries in which the technology can be used.
- Cost factors, technical and human level.
- Existing research centres.

The possibility of having easy and rapid access to more and better information is of prime importance both for the supplier and for the user, the research centres and, in general, all the agents of technological change, since it is a practical means of discovering, evaluating and eventually selecting and deciding upon the best available alternative, the best way to apply the chosen technology.

The same is true of science and research, since proper information on applications of technology, progress made and studies under way can be useful both to the research institutes and to the universities, dissemination channels and potential suppliers.

It should be noted that the information requirements indicated are equally valid for productive enterprises and for services (communication, transport, etc.) or social activities (health, education, etc.).

Previous paragraphs have drawn attention to the requirements of users and suppliers who have a specific motivation and wish to express their need in a practical way.

/However, probably

However, probably the majority of potential suppliers and users have not realized the prospects and possibilities that can be opened up by adopting, in any of the ways indicated (copying, adaptation, acquisition or creation), new products, services, methods, technology, etc.; in other words, by achieving technological progress in the widest sense of the term.

In fact, many producers have never considered or even heard about all the possibilities that really exist outside their normal sphere of action, when in many cases they are making an appearance or have already been tested at the national or international level.

However hard governments may try to create appropriate conditions, if the users and suppliers are unaware of the existence of various techniques and the definite possibility of applying them or creating new technology as the case may be, there is no hope of obtaining the desired results.

It is therefore important, first, to have the necessary basic information and then to promote its integral dissemination so that it can reach those who can use it and so as to encourage potential users and suppliers. This would lead to the desired activity and permanent interest in the field, supported by a constantly updated supply of information on every aspect of technological progress.

The process of dissemination referred to here is geared more to creating favourable conditions, passing on information, establishing contacts, etc., than to describing existing situations, answering questions and studying individual cases. In other words, what is important is for the system of dissemination to take the form of aggressive promotion within the context of a medium and long-term programme. Everything that can be done in this respect is important, including measures with specific objectives such as programmes for establishing direct contact between potential users and suppliers of technology, since one of the most valuable stages of the process of technological change is direct contact with people, situations, products, services, experiences, markets, etc.

/It is

It is difficult to think of technological change just in terms of objective analyses, study of reports or isolated research; at best, this could serve the purpose of productive units that are already motivated, without being applicable to the majority which, for lack of knowledge, cannot share in the general progress.

At a time of startling technological advances, developments often take place faster than people not kept constantly informed can imagine; it is no exaggeration to say that direct contact with reality produces the best possible motivation for action, as the contrast can be felt and the possibilities of change can be imagined much more accurately and quickly. This kind of contact can have much more impact than all the information, data, experiences and opinions meticulously described in reports, studies and/or research work.

The validity of this argument should be abundantly clear if one considers that technological change is never "one" formula, process, procedure or technique but rather a set of aspects, some of which are fundamental and others less significant but all, from the most complicated to the most simple, important for the improvement of technological know-how. Marketing, administration, training, policies, objectives, etc., are not usually taken into account in applying or analysing technological change, possibly because of the overriding importance that is attached to specialized technical aspects and because it is difficult for someone who has had no practical contact with the real domestic and external situation to imagine and assimilate the possibilities afforded by the whole range of aspects involved. This is why, for dissemination purposes, the utmost importance is attached to permanent contact and visits, the incorporation of foreign experts, etc.

To sum up, the aim of dissemination is to arouse the existing and potential concern of the world of users and suppliers of technology on a systematic rather than sporadic basis so as to bring about the necessary interest, motivation, information and support for any initiative conducive to an improvement in the existing level of technology.

/Because of

Because of their nature, the cost of setting them up, the scale on which certain action has to be undertaken, etc., these centres of information and, above all, dissemination should perhaps be supported by governments or international agencies. However, since they basically serve users and suppliers, they should be able to rely on their efficiency alone. The centres should consequently be created in such a way as to ensure maximum autonomy.

Denmark is an interesting case in point since it possesses a particularly comprehensive system of information for those who have a technology to provide, whereby the characteristics, services, address, line of products, basic process, etc., appear by sector, in highly technical form on no more than one sheet of paper per supplier containing all the information in which a user may be interested. This system is sufficient for Denmark's purposes because the country is located in such major centres of technological development as Europe. The situation is quite different in Latin America and the Caribbean where such negative factors as difficulty of access, high cost and distance have to be overcome by means of systematic efforts to disseminate information about suppliers of technology, technological progress, etc.

Japan is another interesting example of an efficacious integrated system of information, dissemination and promotion of technological change, as it has efficient agencies that specialize in promoting external technological innovations among local users.

As regards the supply of technology in Latin American countries, the information system described above could perhaps be used, duly complemented with information regarding suppliers in developed countries as well as the essential function of dissemination and promotion.

Many institutes and information centres have been created with the valid purpose of serving as a vehicle of dissemination and information in a particular sector but, although they have been in operation for several years, have not managed to provide information

/on aspects



on aspects of interest to users but only on aspects that they themselves consider important. For the most part, they cannot be considered an efficient source of information; in many cases they are not even known about or, worse still, they are only known for other activities that they have endeavour to develop while their work of dissemination, far from being systematic, is more a form of public relations.

On the other hand, there are cases where results and objectives have been adequately identified; this is true of the Centro de Servicios Metalúrgicos (CESME) in Chile (quality control for the metallurgical sector). There have also been cases where enterprises of a particular sector have successfully joined forces in the field of information, technology and dissemination (for themselves and for their suppliers).

Another interesting body is the Industrial Information Service of the United Nations Industrial Development Organization (UNIDO) which queries from the developing countries (in 1966, it dealt with 3,266 questions from all over the world).

In recent years, moreover, a number of initiatives have been taken and several proposals formulated in the region which suggest that rapid progress has been made in appreciating the importance of this field. The proposal to establish a subregional technological information system for Andean countries and the experience of the National Institute of Technology in Brazil are striking examples of this trend.

There has been another somewhat unusual development in the field of information and dissemination in Latin America; namely, the specialized promotion of groups engaged in the identification of suitable opportunities and the promotion and organization at the national or regional level of enterprise that can take advantage of them. This they do either on their own initiative or by identifying and developing in the country opportunities that have been previously identified elsewhere. These groups are on the lookout for investment projects that can bring some kind of technical progress.

This kind of technical, financial and commercial activity should be supported by governments and international agencies, especially

/in the

in the least developed countries, where the motivations of the user are nascent and less strong and where the interest of suppliers is unquestionably more limited, mainly by reason of the relative volume of the present and future market.

Because of the nature of the work to be carried out and because of the aggressiveness, mobility and versatility required, the most suitable bodies for the purpose would be specialized groups or enterprises rather than State agencies of a traditional nature.

Information and dissemination is one of the most important aspects of technological change and one which tends to create a serious "bottleneck". One of its essential elements is promotion and direct communication between the various agents of the process and, above all, the establishment of a permanent and systematic link with what is happening in the rest of the world. No system of documentation, however modern and efficient, can be a substitute for direct contact between people and for the broad view of the situation that can be obtained from travel, meetings and international fairs, seminars and other forms of communication.

Of course, scientific and technological information centres in any case have a major responsibility in the matter. It is important that, if these centres are to perform a practical, rapid and efficient service, they should preferably be responsible for collecting data on the origin and sources of technological and scientific information and not attempt to provide technical answers or solutions. The purpose of information should be to provide guidelines and to enable the person receiving it to establish the contacts that may be necessary for the specific objective pursued. The tremendous volume and variety of information in the world means that the centres must in practice be more concerned with providing "information about information" than with amassing all available information, since otherwise they would end up being absolutely unmanageable.

In other words, the emphasis must be more on their role as "reference services" than on the traditional role of national documentation and information services as comprehensive data banks.

/Finally, a

Finally, a distinction must be drawn between two types of dissemination. On the one hand, there is the appropriate and systematic spreading of information so that it can be made available to, and be assimilated by, interested parties, which is suitable for the "modern" sector of the economy. On the other, there is the kind of information that is closely linked to the promotion of technology and technical assistance, which is applicable to the "traditional" economic sector.

### C. THE TRANSFER OF TECHNOLOGY

#### 1. General observations

The transfer of technology, in the sense of the importation of technology from abroad, is undoubtedly one of the subjects to which governing and student circles have devoted most attention within the wider field of scientific development and technological change. The growing interest in the matter was also reflected in the International Development Strategy, which states in paragraph 64: "Developed and developing countries and competent international organizations will draw up and implement a programme for promoting the transfer of technology to developing countries, which will include inter alia, the review of international conventions on patents, the identification and reduction of obstacles to the transfer of technology to developing countries, facilitating access to patented and non-patented technology for developing countries under fair and reasonable terms and conditions..."

More recently, at its third session in Santiago, Chile, UNCTAD decided to create an intergovernmental group on the transfer of technology, thereby confirming the priority it assigned to the problem while emphasizing, above all, the terms and cost of transfer.

/These and

These and other agreements show that technological change takes place in the Third World overwhelmingly by means of the incorporation of technology imported from the industrialized countries and, at the same time, reflect the dominant interest that Latin American government policies have shown in the development of the modern sector of the economy, which is the sector that introduces advanced technology.

It is also unquestionable that, however great an effort is made to increase the region's own creativity, the transfer of technology from abroad will continue to be the main form of technological change in Latin America for the next few decades. Furthermore, it has already been seen in previous sections of this document that the importation of technology may provide development with a powerful impulse but that its indiscriminate use may also lead to serious economic and social disequilibria and to a growing degree of dependency. It is therefore necessary to formulate a policy for the transfer of technology within the framework of national plans and priorities which is entirely compatible with the other objectives of an integrated process of scientific development and technological change.

It is not intended here, of course, to offer a comprehensive analysis of a subject that has been so widely discussed in numerous publications but to draw attention to some of its most significant aspects. In the first place, the concept of technological transfer in the sense used here does not refer solely to its importation and use by a local producer but includes, above all, its subsequent absorption by the receiving country through a process of assimilation and internal dissemination. The term "pseudo-transfer" has been used to refer to the formation of "enclaves" of advanced technology which is employed in a particular enterprise but which, because it is not properly understood or has not been heard of, has no effect on the rest of the economy.

Whether a genuine transfer of technology occurs or not depends in each case on the nature and terms of its acquisition and on the capacity of the local user to absorb it. The first point must be

/taken into

taken into consideration in formulating policies and regulations in respect of foreign investment and licence contracts, which will be discussed in greater detail later. As to the capacity to absorb, this is in turn dependent upon the level of education and the scientific and technological infrastructure in the receiving country and upon the proper use of the technology by the user. The differences between Latin American countries in this respect are common knowledge, whether these differences be between countries or between sectors of activity or even between individual enterprises in the same country. One of the first steps in defining specific policies in this field is therefore to determine whether or not a capacity to absorb complex technical know-how exists, what is the nature and degree of the limitations there may be, and how long and what kind of action is needed to overcome them.

Although the transfer of technology tends to be associated above all with the industrial sector and, specifically, with a certain process, piece of equipment or product, it can occur in any sector capable of being affected by such a transfer; this includes a vast range of aspects that may signify technological progress, including - it must be repeated - modern techniques of administration.

A typical example is the health sector, whose equipment can be rightly said, generally speaking, to incorporate the latest technological advances; nevertheless, there are techniques of hospital administration, formulation and execution of health programmes and policies and other aspects which, if assimilated in their latest form, can with little investment, contribute appreciably to the attainment of the sector's objectives, namely, the provision of more and better health services at the lowest possible cost.

Moreover, problems arising from the transfer of technology are generally analysed in terms of its importation from industrialized countries. However, insufficient attention has been given to the possibility of transferring technology between countries of the region and from other parts of the Third World, which would seem a particularly

/suitable alternative

suitable alternative in the case of the smallest or least developed countries. The gap between these and the more advanced Latin American countries is in any case smaller than that which separates the region from the developed countries, which means that this kind of transfer would enable them to acquire technologies more suited to their internal conditions, as far as optimum scale of production, relative use of capital and manpower and other factors analysed above are concerned.

This argument is valid to the extent that the technology originally transferred to or created in one of the more developed countries or enterprises is adapted at least in part to the local conditions of the receiving country and then re-exported in modified form. Adaptation is taken here as meaning the introduction of the kind of non-fundamental modifications that the receiving enterprise usually carries out with its own operating personnel, with or without the technical assistance of the seller of the technology or specialized consultants.

The adaptation of technology is, therefore, the nascent expression of a local creative ability and would receive a considerable stimulus if systematic market opportunities existed for such modified technology.

Naturally, the intra-regional transfer of technology is also affected by considerations of dependency, cost and other problems that arise in the dealings of Latin American countries with the industrialized nations. It is, therefore, particularly important that the corrective or preventive policies adopted in this area should give due consideration to the transfer of technology that can take place between countries of the region.

The following sections analyse in greater detail certain aspects of the transfer of technology that takes place through various channels, has a cost, involves a choice among alternatives, and usually entails negotiation between the supplier and the user.

First however, it must be emphasized that the direct receiver of the technology transferred from abroad is essentially the "modern" sector of the economy. Other economic activities may have subsequent

access to the technology imported or to certain aspects of it by means of a process of internal dissemination of know-how. Such dissemination can take the form of the relationship that exists between different units of production (subcontracting, for example), mobility among enterprises of the people who first learned the new techniques and were able to assimilate them, and the intermediaries who helped to spread technology and provide technical assistance. Technology may be disseminated in its original form or with successive adaptations, according to local requirements and conditions.

A country imports technology by decision of the State or with its agreement for the purpose of increasing productivity or, in more general terms, because it is hoped to derive some social benefit from its application. The direct objective of improving a process, reducing the cost of a known product, increasing national exports or launching a new product on the domestic market may be achieved by means of the adoption of the technology transferred. However, in the case of a national policy seeking a general improvement in the level of productivity and, above all, in that of the "traditional" sector of the economy, the social impact will only be satisfactory to the extent that the imported technique or the lessons that can be learnt from it are placed within the reach of those who need progress most. In other words, if the development strategy is geared to the more rapid improvement of the level of efficiency and income of the least favoured sectors, the process of internal dissemination referred to above is particularly important and becomes a decisive factor in a policy relating to the transfer of technology.

From another angle, the foregoing considerations draw attention to the need to develop the capacity to assimilate different or more advanced technologies as a basic requirement for an effective process of dissemination and general technical progress, and this requires intensive and systematic action in the field of education, including training, and in general in respect of the development of the scientific and technological infrastructure, as already pointed out in other parts of this document.

/Naturally, the

Naturally, the emphasis on the absorption and dissemination of the technology imported does not justify the importation of any technology, since its evaluation will depend on many aspects of the development strategy referred to elsewhere. Nor should it mean overlooking the fact that there are many cases where dissemination is impossible, where the specialized nature of the imported know-how is such that it is of little interest outside its immediate application and where the conditions under which it can be obtained involve deciding between limiting its use directly to the user (the export industry or other major national activity, for example) or foregoing it altogether. The point which it is intended to stress is the importance of achieving the maximum possible assimilation and dissemination of the technology imported.

Under these circumstances, it is in any case obvious that the technology imported through one or other of the channels analysed in the previous section must be evaluated in terms of its probable direct and indirect contribution to the priorities of the national development strategy. Increasing employment and productivity in a "traditional" sector is an objective which is understandably shared by all countries in the region; it should therefore be taken explicitly into account in the policy relating to the transfer of technology, along with factors that normally receive special attention, such as the increase in exports, the direct contribution to the gross national product and the cost of the transfer. In view of the same objectives, it is also necessary to analyse the advantages and disadvantages involved in the use of the various channels for transmitting technology, a matter which will be dealt with in the following section.

Finally, because of the large proportion of the active population still employed in agriculture, the transfer of technology from industrialized nations in this sector, which is of such vital importance for Latin America, can necessarily only have a limited effect and can only be conceived as part of a wider programme involving a considerable amount of national research and a major effort at extension

/and training.



and training. It is precisely in this sector, however, that the best prospects exist for transferring technology between Latin American countries, given the similarities of climate and socio-cultural conditions in several cases and the relatively higher level of development that has been attained by agricultural research in the region.

The preceding comments and observations must be kept constantly in mind in reading the following analysis, which deals with the transfer of technology as the method of transferring technology employed by the modern sector of the Latin American economy.

## 2. The channels for transferring technology

For the purpose of this analysis, a distinction must be made between the following channels for transferring technology:

- The use of free technological know-how
- The copying or imitation of technology
- Technical assistance
- Importation of capital goods
- Licence contracts
- Foreign investment.

The use of one or other of these mechanisms or of a combination of them depends on a large variety of factors, such as the nature of the product or process involved, the preferences of the suppliers and users, the prevailing legal and administrative provisions, and general social, economic and political conditions.

### (a) The process of transfer

The analysis of the ideal process of selection, evaluation, negotiation, decision-making and implementation in respect of imported technology involves the following stages:

- Analysis of the motivations, possibilities and limitations of the user in respect of the application of the new or improved technology
- Information regarding alternative technologies, both under present circumstances and in the light of technological prospects in the near future

/This analysis

This analysis covers the suppliers, sellers of equipment, consultants and experts, so that the existing technological alternatives, procedures, conditions, origin, time horizons, training, etc., can be identified both inside and outside Latin America.

- Analysis of the users' own resources and capacity to absorb technology; the determination and evaluation of economically and technically feasible alternatives will depend on this estimate of human, financial and technical resources
- Evaluation of various technological alternatives in terms of real possibilities and original motivation
- Decision, negotiation and implementation, generally including the adaptation of external technology; negotiation itself involves a whole stage of searching for the most appropriate, least risky and most economical solutions
- Subsequent generation of local technology, as a result of the technological advance achieved by means of the imitation and/or adaptation of the technologies imported.

The foregoing is the ideal pattern which is not always followed, at least in Latin America, since the user sometimes does not have a clear idea of what he wants; there are also other limiting problems, such as his administrative or financial capacity, the general situation of the country, etc.

Secondly, the necessary information and technical support is often not available to carry out a thorough analysis of alternatives.

This is particularly true in the case of small and medium-scale enterprises that do not have sufficient technico-economic know-how and are more interested in the timeliness and speed of the operation than in studies that are excessively expensive and complex.

To sum up, except in enterprises of a certain size, the process of selection, evaluation and decision-making is generally rudimentary, and the process of negotiation even more so. Moreover, since the users and government authorities in Latin America are not accustomed to this kind of work, they are not usually efficient negotiators or analysts.

/Obviously, however,

Obviously, however, nothing can take the place of experience in this respect; as time goes by, the repetition of the process by users, governments and consultant agencies will increase their level of efficiency and eventually generate a genuine capacity for obtaining information, evaluating, negotiating and deciding.

(b) The use of free know-how and imitation

Despite the restrictions that its role as a "merchandise" possessing an economic value has imposed on the free circulation of know-how, an enormous amount of it has been accumulated over the years which, for lack of suitable channels of information and communication and of any local capacity for analysis, evaluation and adaptation, is by no means being used to its best advantage. Latin American producers and agencies concerned with the region's "supply" of technology should therefore make a greater effort to discover the opportunities that may exist.

Similarly, the copying or imitation of products or components of products is a potential agent of technological change that has been successfully used in some countries, Japan being usually cited as a particularly striking example. Leaving aside the problems that may arise with regard to existing norms governing industrial ownership, it should be pointed out that analysing the characteristics of a product and identifying the technology employed in its manufacture is a task that Latin American enterprises, research institutes and university laboratories are in a position to tackle more successfully than the creation of original technology.

It would be as well to analyse more systematically the real prospects for this kind of activity which, if it would be justified from the strictly economic standpoint, could easily be organized on the basis of contracts with carefully defined objectives, financed by the enterprises and the State, and would, in addition, have the merit of stimulating the indigenous creative ability.

/(c) Technical

(c) Technical assistance

Technical assistance is taken here as meaning the recruitment of an expert or of a consultant firm or similar body, financed by the national user, by the government or by an international agency. This is a particularly suitable method for ensuring the genuine transfer of technology, since the expert normally works in a team with professionals from the receiving country, passes on to them the know-how he possesses and trains them to operate the corresponding technology. The individual expert also has obvious advantages in that he is less expensive, can devote himself entirely to his task and enters into a personal and independent commitment. These factors may not be applicable to the same extent to consultant firms, which sometimes have connexions with external suppliers and, above all, with manufactures of equipment. In any case, technical assistance is an adequate channel for transferring a wide range of know-how and can, therefore, play a major role in Latin America, particularly in the services it can render to medium-scale enterprises and the relatively less developed countries.

A number of valuable initiatives have already been taken in this field, such as the International Executive Service, which supplies experts upon request. Similar groups could be set up in the region so as to place the experience of Latin American professionals at the service of the entire region.

(d) The purchase of capital goods

The importation of machinery and equipment is probably the most usual channel for transferring technology. This is an "implicit" transfer of technology which is of course the most common method with small-scale projects but is also widely used in larger-scale industries whose technology is not particularly sophisticated and does not involve the use of patented know-how. It results in a relationship between the supplier and national user which frequently entails technical assistance and may be in the interests of the user and of the receiving country, provided the user has sufficient knowledge of the various

/existing alternatives

existing alternatives and is capable of evaluating them properly. Naturally, the possibility of taking a well-founded decision will depend on the information available, on the technical level of the purchasing enterprise and on the support of the local or subregional scientific and technological infrastructure as the case may be.

The progressive renewal of equipment with a view to "modernizing" a factory or replacing damaged machinery, is one of the most frequent methods of introducing a gradual technological change and depends largely on the "line" or origin of the original equipment. In this process, it is difficult to distinguish between the technical deterioration of the equipment and different forms of obsolescence connected with such factors as genuine competition, the real demand for a new type of product and more subjective considerations of its "demonstration effect".

It is thus important to establish productivity and technological analysis committees by subsector or branch of industry, with the participation of users and experts from the public sector who should inter alia be in a position to evaluate the obsolescence factor. It would be useful to study the possibility of tying in the type and magnitude of incentives offered for the importation of capital goods with such factors as these - a suggestion which can be added to that made in a previous section to the effect that the recruiting of additional manpower should receive at least as much incentive as that given to investment in equipment.

(e) Foreign investment

Foreign investment and licence contracts differ from the channels for transferring technology referred to hitherto in that they involve the participation (or control) or a supplier not only in the process of transfer itself but also in the subsequent process of production. They are the channels that are used for sophisticated techniques and "spear-head" technology in general, which are normally protected by a patent.

/It is

It is not intended here to carry out a thorough analysis of this aspect or to take a stand in respect of the merits or demerits of foreign investment but to examine it from the point of view of its role in the process of technological transfer.

Briefly, it can be said that foreign investment serves three purposes: it contributes capital, it transfers technical know-how and it makes possible the production of a good or service for which real or potential demand exists. It may also bring with it a foreign market that is controlled or influenced by the investor.

The decision whether or not to authorize foreign investment for the production of a particular good or service is a decision which, according to the style and strategy of development pursued by each country, depends on the market, on the public authority or on a combination of both. In any case, production is the social objective for which capital or technical know-how from abroad may be required.

The contribution of capital - which is scarce in developing countries - is usually considered as a compelling reason for stimulating external investment. The importance of this aspect, of course, depends on the balance-of-payments situation of the receiving country and on the magnitude and terms of alternative sources of capital. The contribution of external capital takes the form of an inflow of foreign currency to cover expenditure in the country that is exchanged at the Central Bank where it generates a corresponding issue of local currency, or else takes the form of equipment and material from abroad which have to be paid for out of foreign loans or the country's exports.

This being so, some experts consider that, where there is a steady balance-of-payments surplus - as in the case, for example, of petroleum-exporting countries - no foreign investment is needed in the form of an inflow of physical capital or of currency and that the same applies if any deficit that exists can be met out of long-term external loans which are usually more favourable in terms of interest and amortization payments.

An opposite view, on the other hand, maintains that foreign investment brings with it a series of direct and indirect advantages and benefits for the "modernization" of the economy, dissemination of advanced technology, development of administrative and marketing capability, etc., which fully justify it even in situations such as those described above, which are in any case highly exceptional and temporary in Latin America.

The foregoing paragraphs go to show that foreign investment is a controversial subject on which opposing views are held that find their expression in markedly different national policies. However, whether foreign investment is encouraged or authorized as a source of inflow of capital, so as to gain access to a new export market or for some other reason, it is nearly always accompanied by a transfer of technology.

Furthermore, in numerous cases a country will resort to foreign investment because it needs technologies to which it cannot gain access in any other way, since they are the exclusive property of the investor, who considers that this channel best suits his interests.

It is therefore essential to find channels whereby foreign investment implies a transfer of technology - in the sense of its assimilation by the receiving country - which, as repeatedly pointed out in previous sections, is an essential condition for the existence of a real process of technological change and gradual emergence from a state of dependency. The point has been stressed here because the transfer of technology may represent the principal justification for foreign investment and because this is precisely the channel where the risk is greatest that no real transfer of technology to the receiving country takes place.

With few exceptions, the legislation governing foreign investment in Latin American countries does not contain any machinery or other provision for achieving this objective. According to a study conducted by INTAL, only in Brazil is incoming technology submitted to an assessment by the Central Bank with the collaboration of the National Department of Industrial Property.

The setting up of subsidiaries or branches of foreign enterprises, especially of the large multinational corporations, is the most obvious illustration of the danger of the development of "technological enclaves" isolated from the rest of the economy and, of course, from the scientific and technological infrastructure of the receiving country. Independent foreign enterprises and semi-public enterprises with a majority participation of foreign investors are in a similar, although less acute, situation. Decisions regarding production and innovation and the administration of the enterprise in general naturally remain in foreign hands, the top level expert personnel is usually mostly foreign and the enterprise has easy access to research and development services and to consultant firms in the country of origin or to the services of the parent company, as the case may be.

Moreover, the tendency to modify the situation that has prevailed in the past, has no doubt been accentuated by political pressure exerted by the countries of the Third World through such initiatives as the drawing up of an International Code of Conduct for multinational enterprises, according to which the problem of transfer of technology should receive preferential treatment.

National control and national participation are undoubtedly factors that are conducive to a genuine transfer of technology. Measures intended to bring about a progressive "nationalization" or majority control by national capital (or subregional capital, where appropriate) of the kind approved by the Commission of the Cartagena Agreement - and as a result of which a provision exists in Colombia, Ecuador and Peru, for example, to the effect that new investment agreements must accept State nationalization of 51 per cent of the capital over 15 years - also contribute to this objective. Provisions which grant the power of veto over certain matters to the State of the country in which the investment takes place or to certain shares held by public or private national capital have a similar effect.

- /Of course,



Of course, measures of this kind may be negative from the standpoint of the foreign investor, which means that each country or subregion must define its policy in this respect after careful consideration of the various factors at stake and in the light of national requirements and objectives and of the chosen development strategy.

Furthermore, foreign investment authorizations should require the high-level technical and administrative personnel to be mainly national and/or training programmes to be organized so to provide whatever personnel is lacking. It should also be agreed that promising students from the region should be allowed to carry out professional work and ways found for disseminating the technology throughout the national or subregional scientific and technological infrastructure.

(f) Contract licences

Contract licences differ from foreign investment in that they authorize the user in the receiving country to use specific patents and know-how. In this case, foreign control is only exerted in so far as the share of foreign capital in the national enterprise gives it decisive influence or the power of veto, or in so far as the contract contains "restrictive clauses".

Consequently, as far as the transfer of technology is concerned, this method must be judged in the light of the nature of the technology imported, its suitability to the conditions and priorities of the country, the cost of the transfer and the clauses of the relevant contract.

This general statement should, however, be qualified inasmuch as licence contracts also exist that represent no real transfer of technology at all. This is the case of agreements whose principal purpose is to obtain an authorization to use trademarks in which the national user is interested because of the commercial advantage of using a known name that is associated with a product enjoying great prestige abroad. In such cases, the technological content of the contract is frequently minimal. The use of a trademark is therefore

/only justified

only justified when it is necessarily linked to the use of a technology that is not within the reach of the national user or when definite possibilities exist of being able to export the product to other countries; consequently, when neither of these conditions is fulfilled, the use of trademarks should be discouraged.

Contract licences and foreign investment draw particular attention to the problem of the cost of transfer of technology. This is an aspect of justifiable concern to Latin American countries, both because of the absolute magnitude of payments made to other countries under this heading or their proportion in terms of national exports and because of the conclusions that are usually reached from cost-benefit calculations, in which the findings of the private user generally differ from the estimates made on the basis of "social values". This is, once again, a problem that Latin American countries can only solve if they have access to better information regarding existing alternatives and a greater capacity for evaluating and negotiating technology and if they can devise means of inducing the user to behave in a manner more in keeping with national interests, whereby he is committed to reducing the cost of imported technology as far as possible.

The book-keeping devices that are often used by multinational enterprises to distribute the costs and benefits of their operations under different headings and countries (transfer accounting and transfer pricing) and the possibility of justifying payments abroad indiscriminately as royalties, technical assistance, profits, cost of inputs or parts, etc., strongly emphasize the advantage that the external supplier enjoys over the national user or, in any case, over the receiving country, since they enable him to justify the greater cost of transfer by spreading it over a number of different items. Further study must be made of means of ensuring a more precise evaluation of these factors, without falling into the pitfall of unnecessary bureaucracy or running counter to current policies.

### 3. Negotiating the transfer of technology

The transfer of technology is a process which usually involves a link between a national user and a foreign supplier who have to agree on the terms of the operation. An important exception has to be made, of course, when total or majority control of an enterprise is in the hands of a foreign parent company, in which case the supplier is in the hands of a foreign parent company, in which case the supplier is at the same time the user.

The supplier may be a manufacturing enterprise, a supplier of capital goods or a specialized consultant and the process of negotiation culminates in the drawing up of a licence contract, the purchase of equipment or some other form of agreement.

Relations between supplier and user vary according to the extent to which their respective interests coincide or diverge, the relative equality or inequality of their negotiating power and the similarity or difference in their characteristics and prospects.

Mention has already been made in a previous section of the problem of the national user's motivations and of the policies and instruments that can serve to adjust his conduct to the national interest. As far as the importation of technology is concerned, the importance of this factor naturally lies in the fact that, if there is a fair degree of identity between the interests of the local user and those of the receiving country, the coming together of supplier and user is altogether satisfactory. On the other hand, a serious problem may arise if there is a divergence of interests between society and the private user, since there is then a risk that the agreement between the parties concerned will be prejudicial to the receiving country. It must be remembered that, as far as the supplier is concerned, the transfer of technology is a way of turning to an external market in order to take advantage of the fact that he possesses a technology from which the national user also hopes to benefit.

Assuming that this preliminary problem has been satisfactorily solved along the lines discussed above, the following remarks relate essentially to the relative negotiating power.

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There are three aspects which, from the social point of view, are of major importance in negotiating the transfer of technology; namely, the reduction of its cost (which has already been dealt with), the genuine absorption of the imported technology and the exclusion from the contract of any restrictive conditions that may run counter to the interests of the country concerned.

Furthermore, the negotiating power of the user depends on the extent of his knowledge of the world technological market, on the technical and administrative level of the enterprise, on the solidity of his financial and market situation, on the support that he may receive and on the general situation of the national or subregional economy, as the case may be, both in absolute terms and in relation to the size and financial and political power of the supplier.

Reference has already been made to the importance of information and dissemination of technology and, in general, of the user's direct access to world technology. Suffice it to say, once again, that without adequate information there can be no negotiating capacity whatsoever, and that absolute priority must therefore be given to achieving a satisfactory level in this respect. In the short term, there is little chance of the relatively less developed countries reaching this level and it is therefore particularly urgent to create appropriate and efficient co-operation machinery at the subregional level in the form of associations of the private or public users themselves or of a network of consultant firms and/or competent public agencies.

(a) The capacity to absorb technology

The technical level and administrative capability of the user is unquestionably a decisive factor in that it determines his possibility of absorbing the technology that he can obtain from the supplier in the form of capital goods, processes, designs, quality specifications, type of product, etc., that may be covered by the agreement.

/Put briefly,

Put briefly, the user cannot expect in the short term to assimilate fully a technology which differs greatly in its sophistication and complexity from that which he is currently employing and in which the technical personnel he may be able to recruit is experienced.

It must be borne in mind that the technology that is imported usually consists of a number of components of different nature and degree of complexity. The Board of the Cartagena Agreement has analysed the subject in detail and has made a distinction between the "total technological package", the "backbone technology" and the "peripheral technology".<sup>1/</sup> In the opinion of this body, the distinction between backbone and peripheral technology serves a dual purpose. On the one hand it helps to define accurately what is the key element of a particular form of technology which, by leaving its mark on the process or product concerned, makes its production possible; on the other hand, it serves to determine what components of the technology need to be imported in a particular region where they are absent and how their acquisition can be negotiated. The said document goes on to point out that the definition of backbone technology varies according to the specific sector of productive activity concerned. In the processing industry, for example, backbone technology is the basic design of the process for which it is used. In the metal manufactures and machinery industry, it may relate both to the sequence of qualitative and quantitative changes needed to transform the raw material and intermediate products into individual final products and to a certain specific know-how in the use of particular machinery and equipment. In the extractive industry, it refers to key aspects of the process of transformation of the raw material in its various stages. Finally, the document states that, by abstraction, peripheral technology can be defined as technology which, not being an actual characteristic

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<sup>1/</sup> Board of the Cartagena Agreement, Resumen de los Estudios realizados por la Junta del acuerdo de Cartagena sobre política tecnológica (Summary of the Studies conducted by the Board of Cartagena Agreement on Technological Policy), JUNAC, 1973.

of a process, is its necessary complement for use in production. This may take the form of engineering services, experience in the handling of machinery or plant, design of parts and secondary mechanisms, civil, electrical, control and land engineering, etc.

However vague the definition of backbone technology may be in certain cases, the importance of this concept lies in the fact that, as already illustrated in previous examples, a "technological package" is made up of a number of very different components, some of which the user may be able to provide or purchase at lesser cost in his own country or, at least, in the region - which has the further important advantage of encouraging the development of the local technological supply infrastructure.

An important consideration is the fact that this peripheral technology, which is of course more likely to be within the reach of the Latin American user, tends not to be restricted to a single sector or branch of industry but to correspond to particular kinds of work or activity. Once developed, such know-how may be used in other sectors, thanks to the generation of human fixed capital involved.<sup>2/</sup>

Similar views are expressed in the study on the transfer of technical know-how in the machine-tools industry of Brazil already referred to.<sup>3/</sup> A distinction is drawn between internal and external know-how. The former represents all the know-how owned and applied in its activities by the enterprise whereas the latter represents the know-how of third parties which the enterprise acquires in the form of services or component parts. Internal know-how includes the selection, definition and general conception of the product, its study and design, planning and flow of production, internal technical standards, controls, commercial organization, administration of the enterprise, etc. The most important external know-how, on the other hand, is the smelted and wrought parts, motors, components for electrical, hydraulic, pneumatic, lubrication, refrigeration, transmission, power and control circuits, ballbearings, specialized services, and so on.

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<sup>2/</sup> Board of the Cartagena Agreement. Ibid.

<sup>3/</sup> Franco Vidossich, "The transfer of technical know-how in the machine-tools industry in Brazil" (ECLA, 1971), op. cit.

/The study

The study indicates that the capacity of Brazil to assimilate these various components of know-how has gradually progressed but is still far from being satisfactory. Its own capability in respect of the know-how referred to is, therefore, much more limited.

On the whole, the situation of Latin American users is less favourable than that of Brazil's metal manufactures and machinery industry. One can therefore easily appreciate the general preference of enterprises of the region for "turn-key" contracts, under which, once the terms have been agreed upon the user concentrates on developing his capacity to operate the plants after it has been installed and is in working condition.

The "breakdown of the technological package" therefore faces overwhelming obstacles, both from the technical point of view and from the standpoint of the incentives for the user to tackle it. Socially speaking, on the other hand, it presents undeniable advantages: reduction in the cost of transfer, partial selection of various technological alternatives, development of the national capacity for supplying technology. Moreover, project and design engineering is a major factor in the process of transfer since the quantity of information that can be obtained depends on the capacity of the local user in this respect. In other words, local participation in project and design engineering and in the installation of the plant is an important requirement for the effective assimilation of the technology imported.

The establishment of financial machinery for sharing and amortizing the cost of studies whose purpose is to distinguish the components of technology that have to be imported from those that can be obtained in the country or region and the insistence that national or subregional engineering firms should participate in the design and installation of the plant, with part of the corresponding cost being borne by the State, are measures that can contribute to a progressive evolution towards a more favourable state of affairs. Similarly, it may be useful to use public funds to employ technological research institutes or university laboratories to engage in the

systematic study redesigning of parts and assembly of imported machinery, in collaboration, of course, with experts from the enterprises concerned.

From a more general standpoint, training programmes, continuous education and practical experience in more advanced enterprises of the region or of industrialized countries should be arranged for the technical staff of national enterprises; this would require incentives and public financing at least as a complement of the action that the user himself might take in this direction.

It is desirable for licence contracts to include specific provisions or agreements regarding such matters since, although they may not be altogether in the direct interests of the signatories, they are undeniably in the interest of society.

(b) Restrictive clauses in licence contracts

The numerous studies dealing with this subject have given special attention to the problem of "restrictive clauses", i.e., provisions included in licence contracts which impose restrictions or obligations on the licensee. The most frequent kind of restrictive clauses involve the prohibition to export to other countries, compulsory purchase of certain raw materia, accessories or equipment from the supplier himself or from other specifically identified suppliers, the establishment of a minimum guaranteed annual participation for the licensor, the imposition on the licensee of quality controls from abroad and the obligation to negotiate his pricing policies.

In addition, the licensee may be obliged to accept maximum production levels, or to grant the licensor exclusive distribution rights while not usually being granted the right to access to future technological innovations that may be introduced by the supplier.

It is not enough just to say that the acquirer of the technology must refuse any such restrictions. His possibility of doing so will depend on his negotiating power and on whether the terms being imposed on him are prejudicial or not in his own view. Consequently, the user

/will try



will try to avoid the, and will be able to do so, only if he has adequate negotiating power and if his personal interests happen to coincide with those of society.

It is therefore necessary to establish a framework for the negotiation of licence contracts and other kinds of agreement that protects the licensee and prevents the inclusion of certain restrictive clauses. Legislation can be passed, for example, forbidding the inclusion of provisions that restrict the right to export (except to countries where the licensor may have already granted another licence). As regards the compulsory purchase of certain inputs from the supplier, it is possible to impose the condition that the prices charged should be competitive at the world level or to include proviso that suitable substitutes do not become available within the country, subregion or region, as the case may be. Book-keeping, however, is so flexible that it is impossible to fix ceilings for certain kinds of payment since they can simply be transferred to another heading representing a remittance abroad.

However, it is certainly unlikely that the efforts made in this direction by individual countries of the region will be successful, save in the possible case of some larger nations, since the attempt to avoid this kind of restriction will probably encourage the licensor to negotiate with a user in some other country. Even a common policy at the level of such an important subregion as the Andean Group would seem insufficient. What is needed, in other words, is close collaboration at the regional level if genuine progress is to be made in this area.

4. The role of the State and of the national scientific and technological infrastructure in the transfer of technology

The foregoing analysis shows how necessary it is for the user to receive genuine support from the State in order to reduce the number of undesirable restrictions and obligations in licence contracts. State action is even more necessary if such agreements are to include some of the socially desirable clauses referred to in a previous

/section. Moreover

section. Moreover, the presence and action of the State is essential when foreign investment is involved since in such cases, where the supplier and user are the same, the State must necessarily stand in for the latter in the negotiations.

Nevertheless, the participation of the State in the negotiation of licence contracts and other forms of imported technology, in view of the above, should not result in its taking the place of the user in the process. Its role is to see that the interests of society are respected and strengthen the negotiating capacity of the national enterprise.

This point is made because government intervention usually takes the form of a series of tiresome and random formalities and controls that do not serve their main purpose and tend to discourage both suppliers and users. Moreover, in these circumstances, the local enterprise feels inclined to transfer responsibility and initiative to the State, thereby failing in its essential function of negotiating efficiently so as to obtain the greatest possible advantages.

It has therefore been thought useful to complement the analysis presented in previous sections in connexion with the role of the State in the field of science and technology with a few remarks regarding its function in the particular area of the transfer of technology from abroad.

As already pointed out, it is possible to distinguish between government policies whose aim is to orient the importation of technology in a particular direction and those which have other objectives but nonetheless influence the process.

The latter include, for example, policies relating to balance-of-payments problems and the promotion of investment. Mention has already been made of the effect that investment incentives and industrial development policies have on the importation of capital goods, and, therefore, on certain types of technology, since they tend to accentuate the already considerable prejudice in favour of the use of capital rather than manpower.

/More specifically,

More specifically, the choice between available technological alternatives in the world market is restricted by problems connected with the non-convertibility of balances held in certain currencies and by the existence of tied credits. It is necessary that such matters should be urgently analysed with explicit reference to the technology variable if the various State policies are to be more consistent among themselves. This is equally applicable to international credit organizations, as has also been pointed out before. Such bodies must encourage a more open and systematic process of evaluation, selection and adoption of technology in accordance with the priorities of the developing countries.

Furthermore, the analysis of current regulations in Latin America directly connected with the transfer of technology from abroad, according to information compiled by the Institute for the Integration of Latin America (INTAL), shows first of all the heterogeneity of existing provisions, which undoubtedly makes it difficult for any concerted action to be taken in this respect in the region.

As far as foreign investment is concerned, for example, the eleven countries covered by the INTAL study can be divided into three categories. In some countries the foreign investor has ample freedom of action; in others, the emphasis is on various forms of control and on the gradual nationalization of foreign capital; finally, the smallest nations have virtually no regulations regarding the matter. These differences are reflected again in the range of taxes on remittances abroad under various headings and in such matters as access to domestic credit, endorsement of external loans, treatment of non-residential shareholders, domestic control over enterprises and recruitment of foreign personnel. This latter aspect is particularly important in the context of this document; it would seem appropriate to suggest that countries that have fixed no limits to such participation should study the possibility of its gradual reduction, of giving relatively preferential treatment to Latin American experts and of establishing programmes for the intensive training of national personnel.

/By and

By and large, there is a lack of criteria and regulations in respect of technology, although in some cases - according to INTAL studies - legislation has been passed to prohibit the inclusion of the restrictive clauses referred to above in licence contracts while imposing a limit on the period of validity of patents.

The Law on the National Office for the Transfer of Technology and Use and Exploitation of Patents and Trademarks, which was adopted in Mexico in 1972, and Argentina's Decree Number 19231 of 1972, which created the National Office for Licence Contracts and Transfer of Technology, laid down regulations for their registration and indicated the clauses whose inclusion in contracts was not accepted, are leading examples of legislation in this respect. The reasons given for refusal of licence contracts under Argentine law (D.L. 19231, Article 3) are listed below:

- When the contract refers to the utilization for a national product of a foreign trademark or of a national trademark whose owner is a person residing abroad or a foreign entity, without its involving any innovation or technological contribution
- When the contract involves the importation of technology of a level that can be shown to be available in the country
- When the price or counterpart undertaking is out of proportion with the licence contracted or technology transferred
- When rights are granted that permit the direct or indirect regulation or modification of production, distribution, marketing, investment, research or national technological development
- When the contract includes a commitment to acquire equipment or raw materials of a particular origin outside the country
- When the export of the national products or their sale with a view to exportation is prohibited, when the right of sale is subject to authorization from abroad, or when exportation is limited or regulated in any way.

/Put briefly,

Put briefly, in accordance with what has been said in previous paragraphs, the action of the State in the transfer of technology from abroad should be geared to the attainment of the following objectives:

(a) Protection of the acquirer of a licence contract or other kind of contract. For this purpose, it can draw up a series of regulations preventing the acceptance of clauses that run counter to the national interests. The drawing up of model contracts and of certain guidelines to assist the user in his negotiations would also contribute to this objective.

(b) Drawing up of a set of regulations governing foreign investment, in accordance with the development strategy and general policy of each country, with explicit reference to technological aspects. It is important not only to evaluate the technological contribution involved in the investment but also to find ways of ensuring that the technology thus imported is genuinely absorbed and spread throughout the national or subregional economy, as the case may be.

(c) Technical and financial support for the user in the search for technology, its selection and the negotiation of its transfer. Emphasis has been placed on the particular importance of technological information in this respect. Special priority must also be given to the participation of the national scientific and technological infrastructure both in the search for technology and its evaluation and in the process of project and design engineering, installation of the plant and other allied services and, finally, adaptation of the external technology.

This requires the existence of agencies to serve as liaison between the user and the "technological supply", which are authorized to contract consultant firms and other bodies and to finance such activities on their own or in conjunction with the user himself.

(d) Study and establishment of norms and machinery to encourage transfer of technology within Latin America, together with all necessary guarantees.

/(e) Direct

(e) Direct participation in the negotiation when the projects involved have particular national significance. The decision in this respect would be the responsibility of an interministerial committee of the kind suggested in earlier sections of this document. Care must be taken to ensure that the State is represented by qualified people, who would probably have to be recruited in each case for a specific objective or project.

"The establishment of specialized institutions, departments or other official agencies, or of public or semipublic autonomous institutions, in the developing countries is manifestly necessary without delay if the whole range of complex questions connected with the transfer of technology is to be satisfactorily dealt with in the interests of each country concerned. At present such insitutional machinery is either non-existent, or the main functions that may be performed by it are spread over so many different ministries and departments that it would be surprising if co-ordinated and sound decisions were to emerge."<sup>4/</sup> So says a recent UNCTAD document, which is extremely relevant in the light of the analysis contained in the foregoing paragraph.

It is, however, necessary to be on one's guard against the tendency to believe that any problem can be solved by passing a law or creating an institution; the matter should therefore be looked at more closely. Decision 24 of the Commission of the Cartagena Agreement, for example, entrusts a number of functions to what it calls "appropriate national agencies" without specifying whether there is to be a single institution in each country or a co-ordinated set of different agencies, thus indicating - logically enough - that each member country is entitled to take its own decision regarding its internal organization.

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<sup>4/</sup> United Nations Conference on Trade and Development, Third Session, Santiago de Chile, 1972 (United Nations Publication: Sales No:E.73.II.D.6), page 118, paragraph 56.

From the discussion of the subject in this document, it can be gathered that the principal agencies connected with the transfer of technology have to do with registration and control, information, study, policy formulation, financing, technological marketing and decision-making. The different nature of these various functions is such that it would be advisable to maintain a similar distinction in the corresponding public institutional network. An office for the registration of investment, patents, licence contracts, payments abroad and other matters is a typical administrative department of the central State administration. By definition, on the other hand, information services should be eminently flexible and autonomous and need not even necessarily be governmental. In any case, the participation or close communication of the public and private user with such services is essential if it is to operate efficiently, just as it is vital that they should be free from all the more strict controls of State bureaucracy.

Study groups should not have to assume administrative responsibilities, which should normally be undertaken by the institutes, laboratories and firms making up the scientific and technological infrastructure. Finally, the formulation of policies requires the participation of all the agents of the process of technological transfer and, in view of the highly specific nature of many of the problems with which they deal, their proceedings should be at the level of a particular branch of industry or sector of economic activity.

The financing activities of the type indicated above could be placed in the hands of the agencies or committees responsible for the policies, for which purpose they could set up divisions that were operationally decentralized or attached to them as appropriate. If these divisions were established as separate entities, they should at least maintain close contact with the agencies or committees. The same applies to agencies responsible for authorizing foreign investment, licence contracts or other similar agreements, which need to be in close communication with the study institutes and receive their general mandate from the policy-making bodies.

/Finally, it

Finally, it should be repeated that an interministerial committee is also naturally required to deal with all the problems of national importance or which affect more than one sector or branch of activity.

As already stated, the efficiency of such institutions as these will depend essentially on the suitability of their staff; it must therefore be stressed that they should be made up of a minimum nucleus of permanent officials responsible for seeking collaboration and ad hoc advisory services from experts on the specific problems that they are called upon to tackle.

#### D. THE CREATION OF TECHNOLOGY

##### 1. Research deriving from demand

As pointed out in previous sections, technological change in the manufacturing industry of the "modern" sector is usually generated by "demand". In such cases, it is the user who carries out research and development activities in order to adopt or create technology in the corresponding departments of his enterprise or, in their absence, recruits a competent agency, such as a technological research institute, engineering firm or other similar body. In this case, the decision regarding the problem to be investigated is generally taken by the user. Reference has already been made to the information and communication machinery that is needed to provide the enterprise with the technical support from the "supply" side of technology.

It is the general view that research programmes or projects which are divorced from the specific requirements and problems of the production sector and which tend to convert research institutes into academic agencies, which may be of a very high level but fail in their principal mission of contributing to technological change, have very little impact.

It must not be assumed from this, however, that the people conducting the research have no participation or influence in the definition of such programmes and projects. On the contrary, the

/logical solution



logical solution is that they should be formulated jointly by users, scientists and technological experts so as to ensure the indispensable link between research and the enterprise which has been so often mentioned. At the same time, it may serve as an effective means of ensuring that technological research reconciles the interests of the private sector with social priorities.

The increase of employment, the production of "cheap" goods for mass consumption by the low-income group, the more satisfactory conservation of natural resources and other objectives of national development plans are not of immediate concern to the private manufacturing industry. An effective and realistic research programme that gives priority to social objectives must, therefore, contain projects designed both from the standpoint of the enterprise and in terms of the global or sectoral development targets.

As already pointed out on several occasions, it is the responsibility of the State to create the conditions and provide the incentives that are necessary to help generate an effective demand on the part of the user, and several specific suggestions have been made in this connexion.

It is important, however, that such incentives should as far as possible give preference to a limited number of priority sectors. It can be gathered from the analysis contained in this document that the great majority of Latin American nations cannot hope to achieve and maintain a competitive technological standard at the world level but only in respect of a small number of products. This point is valid whether the technological progress is achieved by a process of national creation or adaptation or by a transfer of technology from abroad, and it is therefore equally applicable to the preceding and following sections.

Finally, attention has already been drawn to the importance of administrative techniques; a dynamic process of innovation generated by the transfer, adaptation or creation of technology also raises a problem of administration or management of technology that requires the systematic training of the executive personnel.

## 2. Technological change generated by supply

Reference has already been made to the fact that in certain sectors the supply of new technology creates its own demand, as in the case of social programmes in which the State incorporates the technical progress achieved into its activities. A typical example is the preparation of low-cost, high-protein food which is a fundamental instrument of public nutrition programmes.

The organization of research for technological change requires that priorities should be established in such a way as to allocate the limited resources available as efficiently as possible from the social standpoint. It is essential to look for areas of common interest permitting the realization of co-operative efforts in the region, based on the association of appropriate bodies from the countries concerned in a joint programme. This is especially true in the case of the less favoured nations of the area which, because they do not have the minimum scientific and technological infrastructure described above, can only hope to make any substantial advance over the long term, once they have managed to reach the required scientific level.

The actual choice of the priority areas for research is, of course, a matter over which the countries have sole power of decision. The following paragraphs are not intended in any way to disregard this obvious fact; except in cases where priority is unanimously agreed upon or which arise from assumptions on which the previous sections of the document generally coincide, the criteria advanced and specific problems and sectors referred to are only given by way of example.

### (a) Research designed to create more employment opportunities

Housing construction, public works and the forest industry have been repeatedly cited in this context. The identification of industrial sectors in which, thanks to the advance of world technology, there are reasonable prospects of formulating efficient technologies involving a smaller optimum scale of production and a more intensive use of manpower should unquestionably receive the highest priority. This is an extremely difficult task which involves the selection of specific aspects; it can only be tackled successfully by means of

/regional or

regional or subregional association and the collaboration of experts and research institutes from the industrialized countries.

Reconciling an increase in productivity with the maximum utilization of manpower is also one of the basic objectives of agricultural research which, because of its particular importance, will be dealt with separately.

Technological policies designed to increase employment opportunities and thus improve the distribution of income in the industrial sector have received a considerable impulse from recent studies carried out under the OAS/ILPES programme already referred to. Research conducted in Ecuador, Peru and Venezuela, for example, has shown that, in the first place, there are certain products of regular consumption whose production involves the use of highly capital-intensive technology (tobacco and beverages); secondly, the production of processed food and textiles normally involves the use of intermediate techniques as regards their intensity in manpower; finally, in the industrial sector only footwear, clothing and furniture stand out as employing more labour intensive techniques.<sup>5/</sup>

In addition to identifying the sectors that use labour-intensive techniques, the studies contain a model designed to illustrate the impact on employment of a hypothetical policy which, in sectors demonstrating a certain technological flexibility where enterprises employing labour-intensive techniques are in the majority, concentrates the future increase in demand in productive units showing the highest employment ratios. Data taken from Ecuador show that the introduction of a technological policy of this kind would generate an increase of about 17 per cent in the level of industrial employment over a period of ten years compared with that which would be obtained if technology remained at its present level.<sup>6/</sup>

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<sup>5/</sup> Víctor Tokman, Distribución del Ingreso, tecnología y empleo. Un análisis del sector industrial del Ecuador, Perú y Venezuela (Distribution of income, technology and employment. An analysis of the industrial sector of Ecuador, Peru and Venezuela), op. cit., p. 5.

<sup>6/</sup> Víctor E. Tokman, Ingresos, tecnología y empleo en la industria del Ecuador (Incomes, technology and employment in the industry of Ecuador), op. cit.

Similarly, in the footwear, clothing and furniture sectors of Ecuador industrial sector, 98, 95 and 100 per cent of employment and 95, 74 and 100 per cent of production respectively are concentrated in artisan-type and small-scale industry 7/ - an important point to consider in looking for sectors where economies of scale do not necessarily mean that the optimum volume of production has to be excessive.

Reference has been made to these studies in order to show that research by specific branches of economic activity can produce alternative techniques and material for the formulation of technological policies (even policies that are applicable to the least developed countries of the region) which are geared mainly to solving such fundamental problems as employment and the existence of economies of scale that are incompatible with the small markets available to Latin American countries.

(b) The agricultural sector

Generally speaking, it is a characteristic of the agricultural sector that, except for a small number of modern commercial farms, technological change can only take place by means of the cycle of research-dissemination-extension-application.

Traditional agriculture, in the form of small family properties or farms created as a result of agrarian reform, share some of the features of small-scale industry: inadequate level of education, lack of entrepreneurial capability, shortage of financial resources and limited access to markets. In addition, there is the cultural dichotomy, the scattering of the units of production over a wide area and possible structural limitation arising from the nature of the soil, climate and size, which are normally less favourable than those with which the commercial type of agricultural enterprise has to contend - not to mention the dramatic situation of the minifundia.

Moreover, because of the relationship that exists between these very conditions and the most appropriate type and method of cultivation, agricultural research and the dissemination of its findings is

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7/ Ibid.

particularly important. What is quite clear is that, except in certain commercial enterprises, the initiative for technological change comes from the side of the "supply" of technology and that the principal agents of such change are the research institutes and extension services.

The well-known income-inelasticity of demand for food limits the possibilities of the sector and, in countries where the rural population is still responsible for a considerable percentage of production, the real challenge is how to increase productivity while retaining as much manpower as possible in rural areas, in view of the impossibility of industrial activities or other urban occupations absorbing any large surplus.

The need, therefore, is to encourage the farming of high-yield crops requiring a relatively intensive use of manpower - a good example of this is the "green revolution" or "fertilizers-and-seeds revolution" - as well as the promotion of the production of raw materials for industry and the cultivation of "noble" products for export (flowers in Colombia, for example).

Experience shows, however, that the green revolution tends to favour farmers with more fertile or irrigated land who have easy access to credit and to the purchase of inputs and it may therefore have a negative effect on the distribution of income. Hence the need to study how to avoid such undesirable side effects, so that this vital technical instrument can serve to raise the real standard of living of the poorest segments of the rural population.

Countries with a large food deficit, such as Chile, for example, have a wider margin for increasing productivity without restrictions arising on the side of demand, and have the additional advantage of being able to expand such activities as the rearing of "confined animals" (poultry, pigs) which are in fact taking on the proportions of rural industries.

For the reasons given, a major effort to increase productivity is required here, especially as it is a sector whose income represents almost all the value added - in this it resembles artisan-type activities - so that the standard of living in the sector can only improve if there is an increase in output.

(c) Other priorities for the creation of technology

(i) Sectors or problem areas in which no significant research is taking place in the advanced countries or where the technology being used at the world level is inadequate, when the economic activities concerned are important for the region and when there is reason to believe that definite possibilities exist of making significant progress. Mention might once again be made of prospecting for mineral deposits, which the OECD has started studying. The view has also been expressed that this kind of situation is particularly prevalent in the mining sector.

(ii) Research into new uses for natural resources which have been replaced by synthetic products or which are competing with resources of which the industrialized countries have an abundant supply; this is another high priority sector (which gives rise to "counter-research" to prevent or reduce future substitution).

(iii) Research into natural resources and their exploitation is another area in which the motivation for technological change usually comes from the supply side and which requires a great deal of further study. These are frequently areas in which the developed countries are not interested because they do not possess the necessary resources; even when their exploitation in the developing countries is in the hands of foreign enterprises, the latter sometimes refrain from any major research and content themselves with extracting and selling the raw material with high profit margins. Moreover, the growing risk of expropriation further discourages any investment with a view to reducing production costs.

This heading also includes research into natural resources with a high potential economic value, their exploitation and possible new uses. This is the case, for example, of sea resources in countries with

a long coast-line and of the forest industry and forest products in countries with substantial reserves or favourable conditions for planting trees.

(iv) Undeniable priority should be given to certain social sectors whose evolution depends essentially on government programmes; in such cases, the incentive for technological change derives from the programmes themselves, and the supply of technology from institutes and laboratories connected with - but in no event dependent on - the corresponding sector generates the appropriate demand. This is, moreover, an area which is particularly suitable for regional and international co-operation since it is a generally accepted priority in which there is no great conflict of interests and greater facilities exist for the international dissemination of know-how.

Housing construction and health programmes (nutrition, vaccination, improvement of sanitary conditions, etc.) are striking examples. Special mention should be made of educational research, as an essential means of developing pedagogic techniques for application to mass education with limited resources, utilizing mass communication media and improving education at every level so as to promote the creativity and critical ability which are essential to a process of innovation.

In this respect, a comparison should be made between the creative tradition that has been developed in certain countries of the region in the field of biology and medicine and the tendency of engineers to be mainly "operators". This evolution is no doubt partly attributable to motivation, to free access to biological and medical know-how (which contrasts with the restrictions that exist in respect of the transfer of technologies), and to the dominant influence of a research professor, on the one hand, and of a practical professional, on the other. In any case, these problems must be studied much more thoroughly if the desire for change is to dominate the attitude of professionals working in the field of technology.

The development of a network of educational research institutes in Latin America and their association with similar centres in the advanced countries should therefore receive undeniable priority, especially as there can be absolutely no conflict of interests.

(v) The problem of environmental pollution have been receiving more and more attention in the industrialized countries and have spread to the Third World with considerable differences in approach and emphasis. On the other hand, research into problems of the quality of life are particularly important in areas where poverty and economic, social and cultural marginality still exist. It is, for example, not enough to build a certain number of square metres of housing. What is needed, at a time of dramatic shortage of resources, is an integrated approach to the wider problem of the "habitat" so as to prevent the emergence of all kinds of ghettos. The term "social technology" has been coined to identify this kind of study which is still at an early stage in Latin America and merits a more generous allocation of resources in the future.

(d) Co-operative research in Latin America

The need for co-operative action has been emphasized in several sections of this document. In view of the importance of the objectives proposed - the attainment of a considerable degree of autonomous decision making-capacity in the field of technology - and because of the magnitude of the challenge compared with the scant progress that Latin America has made so far in the field of indigenous innovation and of genuine, selective absorption of external techniques, technological research is perhaps the field where such collaboration is particularly indispensable.

Previous sections have drawn attention to the different ways in which technical progress can take place, as regards both the origin and promotion of the initiative and the agents and channels involved. These different ways are inevitably reflected in the field of co-operative research, which may require the services of different institutions, take place at the national, subregional or regional level and be conducive to the attainment of a wide variety of objectives.

/The experience



The experience of the Economic Commission for Europe (ECE) and of the OECD is particularly interesting. In a study prepared for an international seminar recently held in Warsaw, the Commission makes a distinction between the following kinds of co-operative research:<sup>8/</sup>

- A. Co-operation in industrial research at the national level
  - (i) Co-operation between research and development departments of enterprises with similar interests
  - (ii) Co-operative industrial research organizations with no financial support from the government
  - (iii) Research associations with the joint participation of government and industry
  - (iv) Recruitment of, or entrepreneurial support for, research services being conducted in university or government laboratories or in the organization referred to under (ii) and (iii).
- B. Co-operative applied research at the international level
  - (i) Multinational enterprises
  - (ii) Co-operative research between enterprises
  - (iii) Bilateral research agreements between governments
  - (iv) Multilateral research agreements among governments
  - (v) Multilateral research agreements promoted and organized by intergovernmental organizations (for example, OECD).

From the point of view of Latin America, one of the more interesting points is the proliferation of national co-operative research associations, with or without government support, in several European countries. This method could be advocated in Latin America in subregional agreements, with financial contributions from the respective governments, international development and credit institutions and the corresponding productive sectors.

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<sup>8/</sup> "Organization, Financing and Management of Co-operative Research within and among OECD countries", Economic Commission for Europe, June, 1974.

In 1962, there were 380 research laboratories of this kind in 12 member countries of the OECD, with a joint annual income of over a hundred million dollars. Most of them operated independently but maintained a link with the State through some ministry and received a varying proportion of their financing from the State and the productive sector. Of particular interest is a French law which stipulates that if a majority of enterprises in a given branch of industry pronounces itself in favour of the creation of an association of this kind, participation in it and a consequent financial contribution may be made compulsory for all enterprises in that branch of activity.

The activities of these associations include both research projects and the provision of various kinds of services connected with information, dissemination, training, development of specifications and norms, the search for raw materials, etc. Research as such naturally concentrates on points of common interest while subjects liable to provoke a conflict of interest are avoided.

Another study carried out by the Secretariat of the Economic Commission for Europe 9/ makes a distinction between basic forms of co-operative research and higher levels of co-operation. Among the former, it includes the preparation, programming or joint execution of research projects. Among higher levels of co-operation, it includes co-operation between governments and/or enterprises for the integrated implementation of the successive stages indicated. It points out that, in view of the inherent difficulties and obstacles to collaboration in this field, no integrated efforts should be made so long as a series of basic or elementary co-operation projects has not been successfully undertaken.

The most important phase of co-operation is, no doubt, the joint execution of projects, whether by means of a division of tasks among separate research groups or by means of the establishment of a single team consisting of experts from several different institutions. The study referred to points out that the latter system

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9/ "A study on forms of co-operative research: the experience of West European countries", Economic Commission for Europe, August, 1974.

has the advantage of facilitating a multidisciplinary approach and promoting greater contact between enterprises and the scientific and technological infrastructure. It is also interesting to note that the forms of co-operation referred to have reached a relatively higher level of development in the small industrial nations of Western Europe.

The priority which the study assigns to simple co-operation projects is based on the discovery that multilateral action involving several countries and enterprises leads to such complicated problems of programming, reconciliation of objectives and conflicting interests, responsibility and participation in the execution of the project and access to the findings of the research, that the decision-making process becomes excessively slow and complex. (In the European Economic Community, an average of three years is mentioned for the planning and conclusion of an agreement.)

It is apparent from the foregoing that great care and a realistic approach is needed in selecting methods and subjects that are suitable for sustained and gradually increasing co-operative research activities if they are to have the best possible chance of success.

The foregoing references to experiences in Europe are not intended in any way to suggest that they should be reproduced in Latin America. They are mentioned in order to illustrate the difficulties and complications involved in co-operative research so that, in Latin America, a duly realistic approach can be adopted to the problem.

In fact, the European nations have some advantages over Latin America in this respect. Despite a formal adhesion to the concept of co-operation, the prevailing Latin American attitude tends to be more individualistic and joint activities in the region are complicated by distance and other geographical barriers. The European countries have certainly managed to clarify their objectives and to understand more exactly what they can contribute and receive through co-operation. More specifically, co-operative research requires the free movement of professionals between countries. This means that it is urgently necessary to solve such problems as the reciprocal recognition of

/diplomas and

diplomas and degrees and the adaptation of social security legislation and regulations governing remuneration and licences to situations where part of a person's regular work takes place outside his own country.

E. THE DEVELOPMENT OF THE TRADITIONAL SECTOR:  
THE IMPORTANCE OF TECHNICAL ASSISTANCE  
AND OF EXTENSION SERVICES

The point has already been made that most of the literature on technological change and the debates that have taken place in various international fora refer, more or less explicitly, to the medium and large-scale manufacturing industry and in fact concentrate on defining the most suitable development strategy for the "modern" sector of the economy.

It has also been stated that, even assuming that this sector can maintain a high annual growth rate of no less than 8 per cent, by the end of the century it will only absorb about 45 per cent of the active population in Latin America as a whole, which means that, allowing 10 per cent for public employees, another 45 per cent will continue working in the low-productivity traditional sector. In other words, in the course of the next two generations, the dynamic growth of the "spearhead" sector of the region will not be capable of resolving satisfactorily such priority problems of development as the distribution of income and employment. Naturally, if individual cases are taken, the situation varies widely, since in a few countries the prospects are rather more satisfactory - which, in turn, means that at the other extreme there are situations that are considerably more unfavourable than the averages used here for purposes of illustration.

Put briefly, the modern sector is important and may even be decisive. The acceleration of its development and its adaptation to the requirements of Latin American nations is necessary but far from sufficient, especially if one considers that a better distribution of income and an increase in employment opportunities are fundamental objectives of development.

/It is

It is therefore necessary to analyse the other sectors of economic activity and devise policies and machinery for raising their productivity and standard of living; this process also involves a constant technological evolution and undoubtedly requires a greater volume of human and financial resources than those being used to promote progress in the modern sector.

In agriculture, small-scale manufacturing, artisan-type activities, small-scale mining and other similar activities, the problem, of course, is not one of access to world technology or the negotiation of licence contracts. The fundamental task is to disseminate technologies that already exist and are often utilized in the country itself throughout the sector and to decide which production lines can, with appropriate adjustments, compete with products from the expanding modern sector, who has to be retrained within the branch of activity in which he is currently working so as to take advantage of technical capacity and installed equipment, and, finally, who has to change his activity.

Complementary education, administrative and financial training, understanding and handling of market machinery, and special credit channels and conditions are certainly basic problems of the traditional sector of the economy that have to be tackled before technological change can take place. Here again, standards and quality control are particularly important. The fact that this is the sector that has the least entrepreneurial capability clearly shows that it is the responsibility of the State to establish the basis for greater subsequent progress by means of programmes designed to solve such problems as those indicated above; it must therefore also provide a volume of resources for the task which will undoubtedly have to be far greater than that hitherto allocated to any programme of this kind in Latin America.

The State cannot be expected to do everything, however. The small-scale industrial sector manufacturing intermediate goods tends to tie itself to enterprises of the modern sector by accepting subcontracts for the manufacture of parts and components. Under these

/circumstances, the

circumstances, the more advanced enterprises exert pressure on the small firms and, in addition to guaranteeing them a market and providing them with financial support, brings about changes in organization, quality and technical processes. It is extremely important to stimulate this kind of relationship which is in keeping with the current trend towards a division of labour in industry, as in the case of Japan to which reference has already been made. The introduction of a value added tax applied equally to all transactions, instead of purchase tax, is an example of a policy that is conducive to this end.

Maintenance and repair services are in a similar situation since, to a large extent, they work for the manufacturing industry and tend to provide a fairly high proportion of artisan-type employment (31.8 per cent in Ecuador).<sup>10/</sup>

Another measure that deserves priority attention is the formation of "industrial parks" with access to joint laboratory services, quality tests, specific operations, use of special machines and experiments with prototypes. Technical assistance services can be created to make a preliminary diagnosis of a problem affecting an enterprise for its subsequent reference to a workshop, laboratory, engineering firm or research institute if necessary. These series of activities and the association of small-scale producers for supplying and marketing their products are enormously facilitated by the spatial concentration of enterprises in such "parks" or industrial conglomerations.

If programmes of this kind are to be developed on an adequate scale and in the right way, it is essential to create specialized extension, training and technical assistance services and to bear in mind the particular circumstances of the sector when formulating economic and social policies and national development plans.

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<sup>10/</sup> Víctor Tokman, Ingresos, tecnología y empleo en la industria del Ecuador, op. cit.

As already pointed out, this argument is also applicable to the agricultural sector. The factors responsible for its slow progress are so complicated and varied that no policy intended to improve the situation will be successful unless the problems of cultural integration, education, training, technical assistance and extension, technological research and dissemination of findings and training of the professionals and experts that such a huge undertaking requires, are tackled jointly and simultaneously. Such programmes must be located in restricted geographical areas and should cover the various rural areas progressively in accordance with the country's availability of resources.

#### F. THE EVALUATION OF TECHNOLOGY

Public discussions, the initiatives of governments and the studies of science and technology that have been made in the Third World coincide in their concern with finding ways of utilizing more appropriately the tremendous stock of scientific and technological expertise that has already been accumulated so as to improve the living conditions of people as fast as possible and eliminate the poverty that still exists in many parts of the world.

The approach and purpose of this document is much the same. However, an analysis such as this would be incomplete if it did not recognize that, just as there is a general awareness of the dominant role that science and technology have played in promoting the greater material welfare of man, so have more and more voices been raised in criticism and warning.

It is alarming that such opinions should be acquiring increasing force in the industrialized countries at a time when the developing countries are making desperate efforts to increase their capacity to absorb and create technology and are trying to speed up the introduction of new techniques which, basically speaking, are very similar in nature to those which have been employed for many decades now in the advanced countries and are now the subject of various expressions of doubt and criticism.

/It would

It would be wrong to think, however, that the tendency to question the merits of technological progress is restricted solely to developed countries. Of course, the return to the "simple life" which was advocated in India by Mahatma Gandhi was the expression both of an ethical and social criticism and, no doubt, of the disenchantment that he felt when he realized that such a magnificent weapon in the hands of contemporary man would not be able to improve the standard of living of his people to any extent, save in the very long term.

The negative effects of technological progress on contemporary society that are most frequently mentioned include the following aspects, whose real significance and psychological impact it is impossible to overlook:<sup>11/</sup>

- (a) The accumulation of more and more deadly armaments and, above all, the threat of nuclear destruction;
- (b) The breakdown of the ecological and environmental balance as a result of pollution and the accumulation of waste;
- (c) The gradual exhaustion of non-renewable natural resources;
- (d) The gap between technological advance and the social progress of man, in that, while man's control over nature has made spectacular advances, there is no apparent real progress in his capacity to live in peace and justice;
- (e) The utilization of science and technology as instruments of power, of which there are numerous manifestations and which has lent such fire to the debate on multinational enterprises.

There is, on the other hand, a tendency to recognize that the overall impact of technological change is definitely favourable, considering such vital factors as nutrition indexes, education, housing, life expectancy, etc.

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<sup>11/</sup> Francois Hetman, "Society and the Assessment of Technology", OECD, 1973.



Briefly, the controversy would seem to have led to a conviction that it is necessary to evaluate the effect of technology on the social environment in its widest sense and to exercise some kind of control over future technological change.

Naturally, the concept of technological evaluation can be defined in different ways according to the scope one wishes to give it. Some, for example, see it as an extension of the cost-benefit analysis so as to take into account certain indirect effects of technology, while a more ambitious approach is that there should be a "global analysis of its social impact" or a study of the "technico-social systems". It is in the latter sense that the comments contained in this section are intended.

Whatever definition is adopted, it is necessary to specify the period of time in the future that is to be considered and the extent of the secondary effects or repercussions that are to be deemed relevant to the analysis.

Considerable attention has also been devoted to the development of methodologies applicable to one concept or other of technological evaluation. Experiments have been made with the Delphi method of consulting experts, maps have been devised of social consequences classified in order of importance on the basis of certain previously established criteria, matrixes have been made of useful factors for the evaluation of the effect of a particular technology and its many interrelationships and, finally, an attempt has been made to compare real or foreseeable effects with some desirable ideal model.

More practically, experimental studies have been made on the subject by the National Engineering Academy of the United States and research has been undertaken by that country's Office of Science and Technology; in both cases, an effort has been made to define a set of successive steps or stages that make it possible to state the problem, identify areas where a significant impact is being felt, devise criteria for evaluating such effects and detect alternative possibilities of decision and action. Finally, the Ministry of International Trade and Industry (MITI) of Japan has formulated a methodology for

/evaluating technology

evaluating technology within the framework of the industrial development plan for the 1970's, which is to be applied by the said Ministry.

These initiatives represent efforts to systematize the calculation of the cost-benefit ratio in social terms for specific projects, rather than a global evaluation of the impact of modern technology on the quality of life, the physical environment, natural resources reserves and the cultural evolution of man.

Looking at the problem from this angle, what should Latin American countries do? In the first place, it is natural that they should try to avoid the negative effects of technology that have come to light at the world level and, consequently, to take advantage of the experience of the developed countries. However, this in turn means deciding in advance what effects of technology should be considered as undesirable from the point of view of the developing nations, a complex subject which will certainly need further analysis before a consensus can be reached or, at least, before a set of criteria can be found that is applicable to the various cases that arise in the Third World.

The evaluation of technology has to be carried out in the light of specific cases or, at any rate, in the light of the need to formulate definite policies in this areas. Consequently, the general criteria that may be defined in accordance with the above will have to be integrated with the analysis of the direct, and mainly economic, effects on which the currently fashionable cost-benefit calculations are based, so as to form a single process of evaluation.

Finally, the fact that at the moment no satisfactory solution should have been found to the complex problem of evaluation of technology cannot be used as an excuse to postpone decisions that have to be taken constantly in respect of the social and economic development of each country. At every moment, all the available criteria and instruments on which there is sufficient agreement must be used in the process of evaluation.

/Furthermore, close

Furthermore, close attention must be given to studies and opinions on the subject in the rest of the world, and Latin American social scientists must be induced to engage in similar studies from the standpoint of the culture and social and economic problems of Latin America. A leading role can be played in this field by international agencies in the region engaged in scientific and technological activities. Studies and examples of progress in the industrialized countries must be collected and summarized, areas which require priority attention from the Latin American viewpoint must be identified, and the corresponding studies must be undertaken. Finally, it will be necessary to convene international meetings so that a systematic debate on this delicate subject can be started in the region on the basis of the kind of preliminary work suggested here.

#### IV. THE ACTION OF INTERNATIONAL AGENCIES

##### A. SUMMARY OF STEPS TAKEN

Technological change and the factors affecting it have been widely discussed by international agencies in documents, seminars, meetings of experts and conferences, which have given rise to a current of thought that has been constantly evolving ever since the subject was first broached. Some of the steps taken by certain international agencies in this connexion are described below.

##### 1. The United Nations system

The first step was taken in this connexion by the United Nations General Assembly in 1959, when it adopted resolution 1429 (XIV) regarding the possibility of an extension of international contacts and of an increase in the international exchange of knowledge and experience in respect of applied science and technology. Subsequently, in resolution 1713 (XVI) of December 1961, the General Assembly requested the Secretary General to prepare a report containing:

- A study of the effects of patents on the economy of underdeveloped countries;
- A survey of patent legislation in selected developed and underdeveloped countries, with primary emphasis on the treatment given to foreign patents;
- An analysis of the characteristics of the patent legislation of underdeveloped countries in the light of economic development objectives, taking into account the need for the rapid absorption of new products and technology, and the rise in the productivity level of their economies;
- A recommendation on the advisability of holding an international conference in order to examine the problems regarding the granting, protection and use of patents,

/taking into

taking into consideration the provisions of existing international conventions and the special needs of developing countries, and utilizing the existing machinery of the International Union for the Protection of Industrial Property.

(This was one of the first General Assembly resolutions to deal specifically with the problem of the transfer of technology.)

Concern with the problem of technology was also expressed inter alia in resolution 1935 (XVIII) on "The role of patents in the transfer of technology to developing countries" of 11 December 1963, and resolution 2091 (XX) on "Transfer of technology to developing countries" of 20 December 1965. Furthermore, in resolution 2626 (XXV) on the "International Development Strategy for the Second United Nations Development Decade" adopted on 24 October 1970, the General Assembly declared that "the international community must rise to the challenge of the present age of unprecedented opportunities offered by science and technology in order that the scientific and technological advances may be equitably shared by developed and developing countries, thus contributing to accelerate economic development throughout the world". Finally, on 16 December 1971, it adopted resolution 2821 (XXVI) on "Transfer of technology, including know-how and patents".

On the occasion of the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, in Geneva 1963, the Economic and Social Council established the Advisory Committee on the Application of Science and Technology to Development (ACAST). The work of this Committee took the form of a World Plan of Action for the application of science and technology to development, which it prepared during the period 1965-1970 and which was incorporated at the beginning of 1971 in the International Development Strategy for the Second United Nations Development Decade. The purpose of the Plan is to provide a framework so that the developed and developing countries and the United Nations system can combine their efforts to deal with the

problem of technology. Part of this document refers specifically to a Regional Plan of Action for the Application of Science and Technology to Development in Latin America. However, the biggest contribution to the study and solution of the problem of technological development facing the developed countries has been made by the United Nations, through such specialized agencies as UNESCO and UNIDO.

(a) UNESCO, through its Science Policy Division has provided member countries with technical assistance in formulating policies conducive to the introduction of innovations in development. Its activities have been geared first and foremost to the creation and orientation of the machinery governing the scientific system. It has been one of the instigators of national scientific and technological research councils, which have devoted their efforts to the planning and promotion of scientific and technical knowledge and which, in some countries, also provide advisory services in the formulation of scientific and technological policy. In Latin America, their activities have been complemented by the creation of a Regional Office in Montevideo.

In 1965, a Conference on the Application of Science and Technology to the Development of Latin America (CASTALA) was held in Santiago, Chile, with the co-operation of ECLA, and reached a number of conclusions that were extremely useful for studying and increasing knowledge of the problem of technology in the region. Since then, UNESCO has sponsored numerous Conferences and seminars attended by persons responsible for scientific and technological policy. In December 1974, the Fourth Meeting of the Standing Conference of Directors of National Science Policy and Research Councils of Latin American Member States is to be held to discuss:

- The recent evolution of national scientific policy, with special reference to incentives and machinery for the development of science and technology in Latin American countries;

- Identification at the regional level of common obstacles to the harmonious development of science and technology in Latin American countries and of the means of correcting the situation;
- Aspects and instruments of international co-operation in respect of scientific policy and research in Latin America.

Through a series of documents on scientific policy in Latin America, UNESCO has provided those responsible for research and scientific development in the region with information on the scientific policies being implemented by each country. This description of policies takes the form of country studies that take into account inter alia the originality of the methods employed in planning and executing the national scientific policy, practical experience in the field and the country's level of social and economic development. Through UNISIST - a feasibility study on the establishment of a world science information system - attention has been given to the need for an adequate scientific information system, which has been defined as the information necessary for the progress of basic and applied science and technology. It has not, however, taken part in the study of technical change at the sectoral level, since its main concern has been to strengthen the scientific infrastructure of Latin America so as to provide the trained personnel and policy instruments that are needed for the region's integrated technological development.

(b) UNIDO was created with a view to the promotion and acceleration of industrialization in the developing countries and the co-ordination of United Nations activities in the field of industrial development. It carries out these activities through technical assistance, research, meetings of groups of experts, seminars, personnel training courses, etc. It has made important sectoral studies that have contributed to the promotion of world-wide knowledge and, by means of a series of documents analysing various factors connected with the transfer of technology, has devised methodologies to enable the underdeveloped countries to take part more actively in negotiations regarding the acquisition of technological inputs.

/At its

At its headquarters in Vienna, UNIDO has created an Industrial Information Service which provides practical assistance to developing countries by answering their queries concerning problems of industry free of charge. The Service can be used by officials and technical staff from public or private bodies concerned with industrial development. The Industrial Information Service also keeps a record of specialized consultants in matters of industrialized development whose services can be requested by the developing countries.

Through its Industrial Promotion Service, UNIDO also takes advantage of industrial and trade fairs to increase contact between businessmen in the developing countries and in the industrialized nations. Centres are set up at such fairs where businessmen can go to discuss their special interest in a project, their requirements and the kind of counterpart services that they would like to establish contact with.

## 2. Regional agencies

Regional international agencies have also made a significant contribution to the study of the problem of technological development. The following paragraphs describe some of the experience of such agencies.

(a) Organization of American States (OAS) is one of the institutions that has made the biggest contribution to the study and solution of the problem of technology in Latin America. In 1972, it held a Specialized Conference on the Application of Science and Technology to Latin American Development (CACTAL) in Brasilia. This meeting provided an opportunity for the discussion of the initial findings of, for example, diagnostic studies of the region's scientific and technological potential, the problem of demand for technology and the process of transfer. CACTAL dealt with the vast range of factors affecting technical progress, with special emphasis on the application of knowledge to development (particularly in respect of demand, innovation and transfer). It analysed the repercussions of restrictive

/clauses and



clauses and studied the possibility of setting up a regional patent bank. In 1973, OAS introduced a pilot project for the transfer of technology, which covers such aspects as the centralization of demand for technology from the various sectors of production, the organization of a system of information on technological alternatives, the evaluation of technology to be acquired, the strengthening of negotiating power, etc.

OAS has taken part in the organization of seminars on methodologies for the planning of science and technology, the most recent of which was held in Caracas in May 1974.<sup>1/</sup> This seminar reached the following conclusions:

- Scientific and technological research should seek its own path and make proper use of the local technological knowledge of those engaged in productive activities;
- The problem of technology must be dealt with not only from the economic point of view but also from the scientific, social, political and cultural standpoint;
- Central scientific and technological policy bodies have been set up within a limited framework and their internal structure, institutional location, composition and functions have not been up to the role that they should play in scientific and technological development; they should therefore be reorganized and relocated within a system that is more suited to their functions;
- Research must be intensified so as to devise a methodology for determining priority areas in the field of science and technology.

In addition, OAS has published a wide range of material which covers most of the factors affecting scientific and technological development and provides an idea of the situation in Latin America.

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<sup>1/</sup> OAS, Third Methodological Seminar on the Planning of Science and Technology, Final report, May 1974.

(b) The Latin American Free Trade Association (LAFTA) has only recently devoted explicit attention to the technology variable. In the past, although its contribution to industrial development and knowledge in the form of studies on specific sectors has been considerable, it has not attached special importance to technology as an instrument.

The organization's future work in the field of technology is partly described in the document on area technological development and the transfer of technology which is part of LAFTA's Plan of Action for the period 1970-1980. The document emphasizes that LAFTA will allocate its resources to fields in which it has comparative advantages vis-à-vis the other agencies working in this field so as not to duplicate efforts. Its technological policy is based essentially on sectoral studies on the marketing of technology, in view of the considerable contact it has with enterprises in countries of the region and with the regional associations of productive sectors. The Plan of Action operates at three levels:

- (i) Minimum level, mainly intended to provide the basic information and technical assistance for marketing technology that is lacking;
  - (ii) Intermediate level, geared to the creation of the means, procedures and machinery for co-ordinating and co-operating in the technological development of the region. This undertaking involves the carrying out of diagnostic studies of sectors and the promotion of provisions and machinery for encouraging production, transfer, demand and application of technology, as far as possible in an atmosphere of co-ordination and co-operation among the countries of the region;
  - (iii) Maximum level, based on the promotion of technological integration by means of the constitution of a regional market for technology, for which the necessary institutional and legal framework and regulations will be established
- technological integration is understood here as meaning

/the integration

the integration of objectives, financial agencies and resources and entails the treatment of technology as a saleable product or merchandise.

(c) The Board of the Cartagena Agreement has made one of the main contributions to the solution of the problem of technology, namely, the adoption of the Common Regime for the Treatment of Foreign Capital, Trademarks, Patents, Licences and Royalties, in December 1970 (Decision 24). This Decision contains a number of Articles (18 to 26) dealing with technological inputs explicitly and has been frequently referred to in this document.

Since the adoption of Decision 24, the Board has continued to study the subject. One of its latest achievements has been the adoption of Decision 85 which deals with various aspects of the formulation of industrial property standards (patents, industrial drawings and models, trademarks) and Decision 86, which is a project for the technological development of copper metallurgy and deals with the treatment of oxidized copper ores by lixiviation with sulphuric acid and cementation with scrap iron. Peru and Bolivia are particularly interested in the project.

At present, the Board is engaged in the formulation of a programme for promoting the region's scientific and technological integration. In this way, it hopes to spread the benefits of technical change to all the countries of the region, not only as a requirement for achieving the objectives of economic and social development but also as a means of promoting subregional integration in both the socio-economic and technological sectors. Finally, at the Thirteenth Session of the Commission in Lima, the foundations were laid for a subregional technological development policy which covers such aspects as the importation, assimilation, creation and adaptation of know-how and the organization of a system of technical information and analyses the need to determine priority areas for technological development.

/The foregoing

The foregoing examples are far from complete and do not in any way reflect the relative contribution of the various international agencies in terms of human and financial resources for scientific and technological development. No reference, for example, has been made to the United Nations Development Programme (UNDP), which has made a valuable contribution to this field, to the Inter-American Bank, which recently committed itself to a number of new projects of considerable scope, to the Andean Development Corporation or to other finance institutions. No mention has been made either of the work of sectoral agencies such as the World Health Organization (WHO), the United Nations Food and Agriculture Organization (FAO) or of such institutions as INTAL, which have carried out a number of excellent studies in the field.

Although the analysis of action taken reflects a large variety of initiatives and a certain amount of duplication of effort, certain preferential "vocations" can also be clearly detected. UNESCO and OAS, for example, whose activities have been particularly varied and intensive, have made their most notable contribution to the field of diagnosis and the establishment of bases for the formulation of scientific and technological policy. From the operational point of view, their major concern has been to strengthen the scientific and technological infrastructure. By contrast, most of the efforts of the Board of the Cartagena Agreement, UNIDO, UNCTAD and the recent Inter-American venture promoted by the region's foreign ministers have been in the field of the transfer of technology, an area in which OAS is also taking more and more interest - especially since CACTAL. Under the circumstances, there is no doubt that, at the level of regional agencies, it is above all the responsibility of ECLA and ILPES to promote the fuller incorporation of science and technology in economic and social development policies and planning. Although this is a field that naturally concerns other institutions too, it should be one of the main responsibilities of these two organizations.

In any case, without wishing to establish any kind of rigid division of functions on the basis of the foregoing, it is certainly possible to start thinking about certain guidelines for future co-ordination and division of work among the international agencies which, in one way or another, have to do with the development of science and technology.

It would also be desirable to make an inventory of the studies and programmes carried out by international institutions in the field of science and technology, so as to obtain a clearer picture of the real situation in this respect, seen from the standpoint of the functions and responsibilities of these bodies.

#### B. SOME SPECIFIC PROJECTS CURRENTLY UNDER WAY

In the following paragraphs, brief reference is made to certain specific projects currently under way, whose nature and orientation is of particular interest.

##### 1. Regional Programme for Scientific and Technological Development of the OAS

This programme, which was established by resolution CIC-14/68 at the Fifth Meeting of the Inter-American Cultural Council held in Maracay, is the most significant attempt made so far to use international resources to contribute to developing the scientific infrastructure of Latin America. By means of basic studies, support for local scientific centres and, above all, the financing of special high-level regional research institutes, it has been very successful. The region's growing concern with problems of technological change, which were analysed in detail by CACTAL, led to the Mar del Plata Agreement in which it was decided to modify the regional programme by the addition of a new kind of technical assistance in the form of "special projects" geared more directly to the application of science to development.

2. IRDC/OAS "instruments" project

This project, which was suggested in 1971 at the meeting of Latin American research councils held in Lima and launched under the auspices of OAS and the International Research and Development Corporation (IRDC) of Canada, is especially interesting in that it is based on a series of national studies being carried out in 11 countries of the Third World. It represents an effort to carry out an empirical comparative analysis of scientific and technological development policies and of the instruments used in their implementation, so as to reach a number of conclusions and recommendations on the subject. Consequently, this project has the special merit of being in very close contact with specific national contexts and of comparing situations that differ substantially from one another.

3. OAS pilot project for the transfer of technology

An ambitious venture, this project sets out to test mechanisms serving for the transfer of technology so as to reach specific conclusions, on the basis of experience acquired, as to the best way of formulating a permanent programme for the transfer of technology.

The operational basis of the project is the establishment of "focal points" for information and contact in each participating country and the identification of technological requirements.

Although hundreds of cases have been dealt with, the success of the project has been limited owing to poor communication between the agencies established at the focal points of each country and the corresponding users and, in general, to all the obstacles to which attention has been drawn in this document.

4. Working group on inter-American co-operation in science and the transfer of technology

The recent inter-American meeting of Foreign Ministers led to the creation of this working group which, at a meeting held in Brasilia, agreed that inter-American action in the field of science and technology should be aimed at the attainment of the following

/principal objectives

principal objectives: improvement of Latin America's research and development capability, the channelling of the scientific and technological potential of the countries participating in the meeting of Foreign Ministers towards the solution of the specific problems of Latin American countries, and the improvement of the conditions under which the process of transfer of technology is currently taking place.

Following this meeting, four sub-groups were created to draw up programmes and decide on appropriate action in the fields indicated and to establish appropriate institutional machinery.

By and large, the participants in the Brasilia meeting suggested similar priorities to those to which studies carried out by various international agencies would seem to point and which also coincide with the main points raised in this document.

#### 5. UNDP/UNESCO Programme in Colombia

This is an ambitious programme which adopts an integrated approach to the problems of education, science and technology. It involves the provision of technical assistance to the educational sector and to the Colombian Fund for Scientific Research (Fondo Colombiano de Investigación Científica - Colciencias).

#### C. FUTURE ACTION

This summary description of action being taken by certain international agencies in the field of science and technology points to the increasing desire of both the agencies of the United Nations system and of regional bodies to study and implement policies designed to enable Latin America to overcome its relative technological underdevelopment and establish the kind of scientific and technological infrastructure that it needs to place science and know-how at the service of the region's integrated development.

/Moreover, because

Moreover, because of the large number of factors affecting scientific and technological development that are being studied by the various agencies, a greater exchange of information is essential so that each project or study being undertaken in the region in the field of technology can come to the notice of the other agencies as quickly as possible. In this way, any national or international institution, in preparing its own projects, will have access to the findings and studies of other agencies in Latin America.

There is no doubt that international agencies have made an extremely valuable contribution to the field of science and technology in Latin America. Numerous studies, international meetings such as CASTALA, CACTAL, the Permanent Conference of National Research Councils, various technical assistance projects, and so on, have played a decisive role in creating an awareness and affording a better understanding of scientific and technological phenomena.

It is undeniable, however, that the efforts that have been made are not sufficient and that there remains a huge area still awaiting further study and initiatives of various kinds. The point to which the analytical process has already been carried in Latin America, however, suggests that the emphasis in future must be placed on the kind of action that is needed to achieve the proposed objectives within the stated time horizons, to obtain the necessary resources and to establish the specific forms of regional and international co-operation that are required.

An important part in the development of the region's own creative capability and, consequently, in a process of technological change involving a greater degree of imitation, adaptation and innovation, can be played by such international credit agencies as the Inter-American Bank, the International Bank for Reconstruction and Development and the Andean Development Corporation. Reference has already been made in an earlier section to the possibility of their allocating resources for technological research in Latin America



and of their encouraging the participation of Latin American groups both in these activities and in feasibility, pre-investments and design studies, engineering projects, etc.

Mention must be made of the plan of action for technical innovation in Latin America and, above all, of the technical innovation projects formulated by the Permanent Executive Committee of the Inter-American Council for Education, Science and Culture (CEPCIECC).

The study referred to describes the technical innovation projects as studies designed to permit the selection and definition of the most suitable technology for new investments or to improve a product or process being used in a particular unit of production. The projects may involve anything from the simple evaluation and/or adaptation of a technology in use to the complete development of original technologies. The common denominator of all the innovation projects is that their ultimate target is the application of know-how in units of production. Technical innovation is taken as meaning the process of change in the productive activity which takes the form of the creation of a new good or service, the improvement of the quality of a product or the reduction of its cost.<sup>2/</sup>

This proposal suggests criteria for the selection projects dealing with such aspects as reduction of unemployment, solution of social problems, development of agroindustries, better use of raw materials, increase in exports and creation of capital goods industries. It also refers to such requirements as the existence of a national sponsor to help finance the project, the need for the project to be of interest to more than one country of the region, its high technical content and the existence of a capability to implement it. Finally, it emphasizes that the participation of

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<sup>2/</sup> Proposiciones en torno a un plan de acción para la innovación técnica en América Latina (Suggestions regarding a plan of action for technical innovation in Latin America), by Patricio Rojas S., President of CEPCIECC (OAS).

the less developed countries of the region in the project and its usefulness as a means of adapting the technological infrastructure to the requirements of the productive system were important factors that should be taken into account.

The implementation of a programme of this kind would seem to correspond to the kind of work carried out by development promotion credit agencies. The parallel or combined action of bodies such as those indicated, by means of the establishment of a special fund and appropriate operational mechanisms, could therefore represent a valuable contribution to the progress of technology in Latin America.

At the same time, international agencies whose sphere of action includes science and technology are looking for new priorities for future action. Though it is true that a wide range of programmes is currently being undertaken and will naturally continue to absorb a large proportion of available resources, more and more initiatives are being taken in the countries themselves which also require considerable support. New problems and new approaches to existing problems are another important field of action. In the light of the analysis contained in previous sections, the following subjects, inter alia, require study, technical assistance or other forms of co-operation that may include participation in certain operational mechanisms. The following chapter deals with the application of the ACAST Regional Plan and the role of ECLA and ILPES.

(a) Educational research, with a view to the detection of important areas for the development of science and of a capacity to promote or generate technological change;

(b) Revision and adaptation of study plans and programmes to the requirements of technological change, in respect of the teaching of science, secondary and higher-level technical education - including training and non-formal education in general - and the training of scientists;

/(c) Mechanisms

(c) Mechanisms and procedures for the co-operative establishment of continuous education programmes;

(d) Specific ways of developing a minimum scientific capability, by identifying priority areas and intraregional collaboration machinery;

(e) Definition of priority criteria for applied scientific research and technological research; support for specific programmes in this field, particularly those of a supranational character; support of and participation in specific projects involving technological research or prospecting for natural resources;

(f) Detailed study of various State policies and their suitability in terms of the requirements of technological change, at both the national and sectoral level and in the light of their implications for the region as a whole;

(g) Permanent analysis of the evolution of world technological progress, by sector and branch of economic activity, with particular emphasis on such problems as economies of scale; empirical study of the significance of the "demonstration effect" on the structure of demand of the Latin American consumer, etc.;

(h) Development of and, where feasible, participation in rapid and efficient systems of information, dissemination and communication of the agents of technological change among themselves, inside the region and with the rest of the world; support for pilot projects, especially in the relatively less developed countries;

(i) Reconciliation of different styles and strategies of development with technological progress policies at the national level; likewise, establishment of mechanisms and legislation for bringing subregional and regional technological policies more in line with each other;

(j) Requirements for the development of the infrastructure of a supply of technology at the national and subregional level, as appropriate; collaboration in specific sectoral projects, particularly those involving co-operation between two or more countries and including the participation of relatively less developed countries;

/(k) Increase

(k) Increase in productivity and income in small and artisan-type industries, small-scale mining and other similar activities; the relevance of technological change to this objective; preferential promotion and support of action programmes in this field;

(l) Integrated development of the agricultural sector; requirements for increasing productivity, particularly among the large masses of the rural population, by ensuring maximum contribution to employment; encouragement of specific study programmes and action at the national level or for specific rural sectors;

(m) Identification of sectors of economic activity in which there is a greater degree of compatibility between employment and technical progress, such as construction, public works, etc.; support for specific research in this field and for the introduction of appropriate technologies in specific sectors;

(n) Analysis of the role of foreign investment in various development strategies, in the process of technological change, and in the improvement of corresponding legislation and regulations;

(o) Technical advisory services in the institutional aspects of the organization of the State for an integrated scientific development and technological change policy, with due attention to the functions of policy, study and evaluation, information, research, registration and control;

(p) Study and support of programmes for the development of the administrative capability of the various sectors of the economy, with emphasis on supranational projects and, above all, projects involving less developed countries;

(q) Establishment of and, where appropriate, participation in machinery for negotiating the transfer of technology and for communicating with the productive sector of developed countries, with emphasis on medium and small-scale enterprises that do not at present have regular contact with Latin America; support of and participation in similar initiatives inside the region;

/(r) Extension

(r) Extension and expansion of the study and possible establishment of machinery for the evaluation of technology in Latin America by area, as indicated in the corresponding section of this document.

Naturally, such a long list of items raises the problem of a division of labour among international agencies. Moreover, the considerable progress that has been made at the conceptual level and the growing insistence on the obtainment of positive results at the national level explain the interest of Latin American countries in the contents of future international co-operation programmes and their concern about the possibility of a duplication of effort.

In order to forestall an insufficient future allocation of resources, some form of joint or co-ordinated programming of activities in this field should be sought so as to ensure an effective division of labour among the various international agencies involved. What is needed is the kind of co-ordination which gives practical form to the undeniable identity of objectives that exists and which aims, not at the rigid allocation or classification of functions and spheres of activity, but rather at the complementarity that comes from looking at the same problem from different angles.

A certain amount of progress has been made in this field; in particular, LAFTA has recognized that it would not be desirable for it to commit itself to providing technical assistance to countries in the formulation of their national scientific and technological policies, since both UNESCO and OAS are already doing excellent work in this field, and that it should not undertake national studies on the conditions of importation of technology, which is being investigated by OAS and the Board of the Cartagena Agreement.<sup>3/</sup>

Furthermore, a suggestion can be made for future action in the field of science and technology that would seem to be valid for several kinds of international co-operation: namely, that greater

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<sup>3/</sup> See LAFTA, El desarrollo tecnológico zonal y la transferencia de tecnología: plan de acción de ALALC para los años 1970-1980 (Technological Development by area and the transfer of technology: plan of action of LAFTA for the period 1970-1980) (ALALC/SEC/PA/21), June 1973.

/emphasis should

emphasis should be placed on the carrying out of national studies specifically linking theory to an actual situation, in which a major part is played by appropriate local or regional bodies, so that comparative studies can be made from which both recommendations at the national level and proposals of more general validity can be inferred. This latter kind of study is gradually assuming more and more importance in the activities of international agencies.

As a working method, it has certain major advantages. It encourages the participation of agencies that are more directly in contact with those who, in the last analysis, have to "do what has to be done". It makes it possible to base the analysis on problems arising from real national situations. Finally, it is an effective means of mobilizing the intellectual capability of Latin American nations jointly and simultaneously in pursuit of common objectives. The latter, moreover, is not simply a means of ensuring a more efficient use of resources; it represents the basis of human solidarity and common purpose which is the fundamental requirement of any genuine process of co-operation and integration.

## V. THE APPLICATION OF THE ACAST REGIONAL PLAN

### A. GENERAL OBSERVATIONS

As indicated in the introduction to this document, the Regional Plan of Action for the Application of Science and Technology to Development in Latin America is one of the most important steps taken so far to provide "a basis for policy and action by the countries in the region, through United Nations and other mechanisms, in order to strengthen the science and technology components of their development programmes".<sup>1/</sup>

The Regional Plan of Action "is essentially a series of guidelines on research needed and the application of existing knowledge, together with requirements in the formulation of science policy and the strengthening or establishment of institutions. As such, it is not strictly a "plan" but a compilation of recommendations and proposals, in the light of the broader framework of the World Plan of Action submitted by the Advisory Committee to the Economic and Social Council in accordance with the Second Development Decade Strategy".<sup>2/</sup>

Accordingly, the ACAST Plan contains a series of observations and suggestions based on a dual analysis which deals both with general problems (policies, institutions, education and a scientific and technological infrastructure) and with sectors of economic and social development, especially natural resources, agriculture and food, industry, transport and communication, housing,

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<sup>1/</sup> See Advisory Committee on the Application of Science and Technology to Development (ACAST), A Latin American Plan of Action for the application of science and technology to development (E/CN.12/966), preface, paragraph 6.

<sup>2/</sup> Ibid. Chapter X, paragraph 1.

health and population. The recommendations concerned refer both to action that should be taken at the national level and to activities that require a major development of regional co-operation.

It is clear from the foregoing that the ACAST Plan and this document have a common inspiration and deal with similar subjects.

This can be appreciated from the fact that the Regional Plan considers that "a better application of science and technology, including the adoption of science and technology policies and the creation of the necessary institutions, the transfer of appropriate technology, the development and strengthening of indigeneous research, and the improvement of science and technical education, will be necessary in Latin America";<sup>3/</sup> these priority aspects are dealt with in detail in this document. In addition, the ACAST Plan covers certain aspects which the present study analyses more fully and about which it contains certain specific recommendations, since it states: "a first important point is the need for the policy on science and technology of the various countries to be integrated with their economic policy, trade policy, etc. A second point is that scientific and technological policies will necessarily have to be concerned with all scientific and technical activities, ranging from basic research to the practical application of know-how and to innovation... Third point: technological policy is of special importance in Latin America. Hence, the countries of the region should pay particular attention to the evaluation and selection of technologies, since these activities facilitate the structuring of sectoral and regional programmers, as well as have deep effects on employment and income distribution".<sup>4/</sup>

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<sup>3/</sup> Ibid., Introduction, paragraph 11.

<sup>4/</sup> Ibid., Chapter I, paragraph 11.



Finally, the similarity of approach is apparent from the importance that ACAST attaches inter alia to the following objectives:

" - the need to strengthen the capability of decision of the Latin American countries towards the creation and adaptation of science and technology as required by the development of such countries;

" - the need to orient the efforts in science and technology towards the integration of the Latin American countries;

" - the need to establish close links between the Government, the productive sector and the scientific and technological system".<sup>5/</sup>

Consequently, in view of "the reality of economic and social conditions in Latin America", it is "essential that national, subregional and regional policies on science and technology be designed".<sup>6/</sup>

It is apparent, therefore, that there is a dual similarity between the ACAST Plan of Action and this document. On the one hand, they are complementary in so far as this study adopts an integrated approach to the nature of the process of technological change, the behaviour of the agents involved in it, the nature and characteristics of the various recognizable phases of the process, the interrelationships of the various factors referred to and the specific policies, institutions and measures that are needed to ensure the harmonious development of science and technology. Furthermore, an effort has been made to put forward a set of principles, criteria and suggestions for establishing priorities and contributing to the subsequent realization of the numerous sectoral activities indicated in the Regional Plan of Action.

In other words, the ACAST Plan concentrates on the know-how that is available in the world but is not being taken advantage of in Latin America, a fact which is illustrated by the dramatic example

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<sup>5/</sup> Ibid., Chapter I, paragraph 20.

<sup>6/</sup> Ibid., Chapter I, paragraph 2.

of the habitual wastage of a considerable percentage of crops because of a failure to use widely-known techniques of conservation and storage of food. ACAST is also alarmed by the existence of a vast range of subjects and problems which require further research and which have not been tackled quickly or thoroughly enough.

The present ILPES document is based on the assumption that the social effectiveness of any systematic action in this respect requires the adoption of an integrated approach to the problems of science and technology, the detection of special mechanisms, instruments and measures at the national, subregional and regional level for ensuring harmonious development, and the establishment of definite priorities with clear targets and realistic time horizons.

#### B. CRITERIA AND PRIORITIES FOR THE APPLICATION OF THE ACAST PLAN

From the above, it will be understood that, generally speaking, the proposals contained in this document are prerequisites for the application of the ACAST Plan, form part of the Plan or are complementary to it.

From another point of view, the application of the ACAST Plan entails action at the national level, whose definition and execution is the responsibility of the respective countries, and the formulation of regional and subregional co-operation programmes to deal with priority problems and critical areas that cannot very easily be tackled efficiently and quickly enough by isolated action of individual countries.

Although, as already pointed out in other sections of this study, it is impossible to make an a priori distinction between national action and subregional co-operation, since the same problem may be tackled in one way or another according to the planned time horizon for its solution and to the individual capacity of each country to cope with it, a number of specific criteria and priorities for international co-operation in respect of the application of the

ACAST Regional Plan of Action are indicated below. Special attention will be paid to the responsibilities of ECLA and ILPES themselves, so as to suggest certain methods of operation in accordance with the decisions that are taken.

The identification of priority areas for regional co-operation makes it necessary to define mechanisms suited to the various requirements and capabilities of the countries, according to their respective development strategies and policies and their individual scientific and technological potential, so as to see where there is a convergence of objectives that would be conducive to joint activities.

This must be done in two stages.

First, an analysis must be made of priority areas and sectors, without attempting to take decisions on the subject but simply to draw up a list of first and second priority projects. This kind of analysis is the responsibility of governmental representatives.

Secondly, on the basis of these lists and possible further inquiries, a limited number of aspects would be selected. The purpose of this selection would be to permit the formulation of an integrated programme for each aspect which would include action at the national and regional level both in the field of education and development of the scientific and technological infrastructure and in that of the creation, adaptation, transfer and dissemination of technology.

The designing of action programmes for each aspect will have to be carried out by ad hoc groups of experts designated both by the countries involved and by the international institutions whose co-operation is to be requested.

The action programmes formulated will presumably contain proposals for action that will require both bilateral and multilateral technical assistance. They will therefore serve as useful criteria for drawing up the programmes of UNDP, which is responsible for co-ordinating and financing technical assistance.

Both ECLA and ILPES, whose programme of activities assign priority to science and technology, are capable of providing secretarial services, carrying out co-ordination activities and formulating proposals for the expert groups referred to above.

The criteria for selecting priority projects for the application of the ACAST Plan of Action must be based on the merits of the project itself and in the likelihood of its successful outcome leading to new initiatives. As far as the intrinsic priority of the chosen aspect is concerned, the points raised in other sections of this document are entirely applicable.

Since the identification of such aspects is the sole right and concern of the countries themselves, the topics listed below are intended merely as tentative suggestions and as a contribution to the analysis of the aspects selected, which, in the light of the ACAST Plan of Action and of the present document, should presumably receive the highest priority.

(a) Priority aspects

(i) Identification of productive activities in which labour-intensive technologies can be efficiently utilized, and development of specifically applicable techniques;

(ii) Possibilities and terms for the transfer and adaptation of technologies employed by medium and small-scale enterprises in the industrialized countries, and identification of appropriate production items;

(iii) Establishment of training programmes in respect of financial and commercial administration and management of small-scale Latin American enterprises, and determination of their contents;

(iv) Identification of conditions for the establishment and efficient operation of agricultural extension and training services and determination of their contents in respect of educational material, technical assistance for production, administration, marketing and financial support;

(v) Characteristics and conditions for the establishment of technological information centres designed as reference services;

/(vi) Strengthening

(vi) Strengthening of the regional negotiating power in respect of the transfer of technology;

(vii) Creation or improvement of quality control services and norms and standards.

(b) Sectoral priorities

(i) Increased production of food, especially edible proteins, fish products and high-yield varieties in staple food crops, with emphasis on co-operative research;7/

(ii) Use of known techniques for the storage and preservation of agricultural products, with emphasis on the transfer and adaptation of available technologies;8/

(iii) Development of food industries;9/

(iv) Development of metal manufactures and machinery industries, with emphasis on co-operative research and the selection and adaptation of imported technologies;

(v) Development of forest-based industries, by means of the selection of a limited number of species and including both co-operative research and the transfer and adaptation of technology;10/

(vi) Development of economical methods for the mass construction of housing;11/

The regional agencies are responsible for contributing to and supporting the development of programmes such as those enumerated above; in view of the mandate that they have received in the field of economic and social development, this is particularly applicable to ECLA and ILPES.

Considering the problem of scientific and technological development and the application of the ACAST Plan from the standpoint of international agencies, it should be mentioned that their future

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7/ ACAST, op.cit., Chapter IV, paragraphs 12 to 30.

8/ Ibid., Chapter IV, paragraphs 63 to 66.

9/ Ibid., Chapter V, paragraphs 24 to 27.

10/ Ibid., Chapter V, paragraphs 20 to 21.

11/ Ibid., Chapter VII, paragraphs 1 to 18.

action must combine the carrying out of methodological and theoretical studies capable of shedding further light on the problems of technical progress with operational action programmes capable of furthering the search for specific solutions to problems of priority importance from the point of view of the Latin American countries - the category to which the projects suggested in the foregoing paragraphs belong.

## VI. CONCLUSION

Technological change is a complex process that is affected by all kinds of economic, educational, scientific, social, cultural and political factors. In all these fields, technical progress requires fulfilment of several necessary conditions, none of which is sufficient on its own, in order to make any significant advance.

The chosen style and strategy of development unquestionably have a decisive influence on the kind of technological change that can be promoted, since the role and participation of the State, of foreign investment and of the public or private enterprise will differ in each case, as will the incentive and control policies and the priority accorded to the various sectors of economic activity and to social development. Consequently, the policy for technological change must be fully and explicitly integrated in the national development policy and corresponding planning system. In other words, it must be part of the chosen style of development.

However, the foregoing analysis also shows that certain objectives and priorities have a general validity. The overcoming of educational shortcomings, the development of an adequate scientific capability and the promotion of creativity with the consequent establishment of a "technological supply" sector that is capable of evaluating, assimilating and innovating, are fundamental to any attempt at sustained and integrated development.

Similarly, since the importance of the distribution of income and employment is unanimously recognized, the various development strategies will contain explicit measures for gradually solving the problems involved. As far as technological progress is concerned, the priority given to such action should take the form of a special effort to promote a more rapid advance of the agricultural, small industry and artisan-type sectors, small-scale mining and other similar activities.

/Research and,

Research and, of course, technological policy must therefore give top priority to studies and activities connected with the identification and promotion of labour-intensive activities and the solution of the increasingly acute problem of the growing economies of scale that are incorporated in technology coming from the industrialized countries. A progressive and permanent improvement in the distribution of income should also be wrought by means of a massive programme of training, dissemination and technical assistance, while at the same time attempting to obtain a more satisfactory structure of production and consumption from this point of view. In all these fields, this document has drawn attention to the importance of developing administrative capacity by means of a wider and more rapid dissemination of modern techniques of administration, financing and marketing.

More generally, emphasis must again be placed on the need for a policy of scientific development and technological progress to be based throughout on a social evaluation of its probable effect and results. It must also be borne in mind that the transfer of technology from abroad will also inevitably continue for a long time to be the main source of technological progress in the modern sector of Latin American economies. This means that priority must be given to the adequate absorption and dissemination of this technology in the countries and underlines the urgent need for policies aimed at generating a real capacity for adapting and creating technology so as eventually to be able to reverse the present trend towards increasing disequilibrium.

In other words, one of the fundamental objectives of scientific and technological development policy is to reach a high level of autonomous capacity for decision-making. This will involve, on the one hand, a creative potential geared above all to the promotion of national or subregional technological specialization, as appropriate, and, on the other, a limited number of production lines that are fully capable of competing on the international market.



One of the principal forms that this objective will take will also be the development of a considerable ability to absorb, adapt, evaluate and disseminate technology within the country. As a result, there will be a dual strategy in which creation and the transfer of technology are instruments in the service of the simultaneous progress of the modern and traditional sectors of the economy.

Naturally, for the application of a strategy of this kind, a clear formulation of national priorities within the framework of the chosen development style is needed; on this will depend largely the greater or lesser emphasis that is placed on one or other aspect of the aforementioned scientific and technological development strategy. This applies equally to national priorities which, taken together, will serve to establish the guidelines for the application of the ACAST Plan of Action, as described in a previous section.

In each field it will be necessary to ensure that the policies adopted are consistent and that the lead times for the various targets are realistic, in view of existing limitations which, as has been pointed out, vary widely from country to country. Subregional, regional and international co-operation programmes should give special attention to these factors, since supranational collaboration is intended precisely to supplement the capacity of each country.

Furthermore, any integrated formulation of policies such as those described in this document requires an estimation of the resources needed to carry them out within the period of time indicated. No attempt has been made here to include a tentative quantification of resource requirements for Latin America as a whole or for specific countries of the region, since conditions vary so widely that the solution applied must inevitably be very different in each case.

It would seem to be insufficient to attempt once again to make suggestions on the basis of percentages of the gross national product, since abundant publications and statistical data are available on the subject. In the first place, the limitations and disparities are expressed not only in financial terms but also, almost more often, in terms of the availability of human resources

of a suitable level and quality. Moreover, such uniform percentages are not necessarily sufficient to correct the disequilibria between the countries of the region or meet their different requirements.

Attention must once again be drawn to the fact that the emphasis placed on the formulation of integrated policies does not mean forgetting the possibility, and even the necessity, of making partial progress rapidly in specific areas. At least in the short term, the adoption of specific measures of undeniable priority will continue to be a major source of progress. The important thing is that they should be properly co-ordinated with other measures that may be necessary to consolidate and further the progress already made.

Intra-regional co-operation should give preferential attention to the problems of the least developed nations of Latin America, both because their requirements and limitations are greater and because the accentuation of internal imbalances may lead to serious disequilibria in the future. The validity of this reasoning at the world level should also determine the international community's attitude towards Latin America in this field. It is necessary not only to provide the corresponding international agencies with appropriate guidelines and a larger volume of resources but also to find out how to mobilize part of the tremendous scientific and technological potential of the most advanced countries on behalf of the less developed nations.

Finally, it is essential never to lose sight of the nature of the process of technological change and the motivations of the various agents of the process. The participation and initiative of the public or private user of technology and of the scientific and technological infrastructure are necessary for the attainment of the targets set by each national community, within the framework of the chosen development strategy and the corresponding norms and policies that the State must formulate.

/An effective

An effective policy requires a proper understanding and consequent strengthening of the link that exists between science and technological change, but one must also recognize the dichotomy that arises from the fact that science is essentially a cultural manifestation while technical progress is intimately related to economic activity.

The structure and orientation of the State agencies that are responsible for policies, studies, incentives, financing and control, and the machinery for co-ordination among themselves and with other national institutions must reflect the complex network of objectives and interrelationships described in this document.

Through the foregoing analysis, which lays no claim to originality, ILPES has endeavoured to draw attention both to the importance of the subject and to the need for multiple integrated action in a strategic field which is of vital importance for the more rapid and harmonious development of Latin America, for the greater benefit of the vast majority of the Latin American people.

