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CONTENTS

The energy challenge <i>Enrique V. Iglesias</i>	7
Meeting on a new Latin America in a changing world economy Introduction <i>Abraham F. Lowenthal and David H. Pollock</i>	20
The export of manufactures <i>Pedro I. Mendive</i>	21
Exports of non-fuel primary products <i>Jere R. Behrman</i>	32
A new Latin America in a new international capital market <i>Albert Fishlow</i>	49
Latin America and the international monetary system: some comments and suggestions <i>Carlos Massad</i>	59
The Latin American countries and the New International Economic Order <i>Pedro Malan</i>	66
Technological development in Latin America and the Caribbean <i>Jorge A. Sabato</i>	81
The major unresolved issues in the negotiations on the UNCTAD Code of Conduct for the transfer of technology <i>Miguel Wionczek</i>	95
International economic reform and income distribution <i>William R. Cline</i>	103
Interpretative summary <i>Colin I. Bradford, Jr.</i>	113
Monetary and real repercussions of financial opening-up to the exterior. The case of Chile, 1975-1978. <i>Roberto Zahler</i>	127
Towards a theory of change <i>Raúl Prebisch</i>	155
Some CEPAL publications	209

Technological development in Latin America and the Caribbean

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Introduction

The scope and limitations of this document are as follows:

(i) It refers to technology in its broadest sense, that is, as the organized body of *all* knowledge used in the production, distribution (by trade or any other means) and use of goods and services. Accordingly, it encompasses not only the scientific and technical knowledge generated by research and development (R&D), but also that which results from empiricism, tradition, manual skills, intuition, imitation, adaptation and so on.

(ii) Secondly, it recognizes that this broad scope means that technology is an essential component of economic, educational, cultural and political systems, and as a result has an influence throughout society. However, the document *restricts* itself to analysing technology as a component of economic and social development and it therefore presents an analysis of the interface between the structure of production and technology without dealing with the interfaces between science and technology, culture and technology or education and technology, except to the extent necessary for better understanding of the central theme.

(iii) Another important limitation of this document is that the analysis covers most, but not all, of the structure of production. It includes manufacturing, with its subsectors of consumer durables, intermediate goods and capital goods, as well as the basic infrastructure of energy, transport, communications and so on

and the so-called "high-technology" industries (electronics, computers and data processing, nuclear power and the aeronautical industry), but it excludes agriculture, forestry, fisheries, and the finance and insurance sectors, which are outside the author's province. It is possible that much of what is asserted for the other sectors is valid for these sectors, but this will have to be evaluated by competent experts.

In preparing this document the author has endeavoured to bear constantly in mind that:

(a) Latin America and the Caribbean (hereinafter referred to as LAC) is *not* a unit, but a collection of nations which are at very different stages of development and which have governments of different kinds, are carrying out development plans with different aims based on very different economic policies, are implementing subregional and bilateral agreements of various types, possess substantial areas of competition, and so on.

(b) The United States, though it has maintained a sort of special relationship with LAC, has political, economic, cultural, scientific and military interests which extend far beyond the context of LAC and its institutions, while at the same time it is the political, administrative, technical and financial headquarters of most of the transnational corporations operating in LAC.

As a result, the policies, strategies and actions recommended in this document are not those which might be valid for a more homogeneous group, but those most capable of being undertaken in such a heterogeneous framework, through existing or similar bodies.

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I

Technology in LAC: a balance-sheet

It is necessary to draw up a balance-sheet of the situation in order to ascertain what has been done and where matters now stand. To begin with, it is important to mention that, in the two decades following the end of the Second World War, an intensive effort was made in Latin America to establish a scientific and technical infrastructure and create public awareness of the importance of science and the urgent need to develop this subject in our countries: a campaign which was crowned with success in the establishment of faculties of science in many Latin American universities, research institutes and centres, and national councils for scientific and technical research. However, technology was not very important in this effort, because it was assumed that once the capacity to produce science was acquired, it would flow in a continuous manner and become quite smoothly integrated within the structure of production, which was anxiously awaiting it. It is only in the past decade that attention has focussed on problems such as: When, why and how is demand for science created in specific circumstances? What are the relations between science and technology? Is technology merely "applied science"? How do the flows of supply and demand for technology move through the various socioeconomic circuits? Who benefits from the results of scientific and technological research? How and why are the structure of production and the scientific and technical infrastructure not properly interconnected? What relations are there between technology and foreign investment? What is technological dependence? —and so on and so forth. These and other similar questions have been studied with thoroughness and originality, leading to significant progress both in the *academic* field —in other words the field of studies and research on the group of problems involved in science, technology, development and dependence— and in the *political* field, which covers the action taken to use science and technology to attain specific objectives of eco-

nomie and social development, as summarized below:

Recognition of the existence of structural obstacles to scientific and technical progress. Study of these obstacles made it possible to draw a distinction between explicit and implicit scientific policy; to understand the causes of the usual attitudes of the governing élites to science and technology (hostility, lukewarm support or indifference); to explain apparent contradictions, such as the relative advance of certain branches of science (such as biology) and the backwardness of others (such as geology); to discover the impact of the import-substituting model of development on the assimilation of technology; to create awareness of the existence of a new international division of labour, centred on the production and consumption of technology; and so on. The practical result was the explicit formulation of science and technology policies and the establishment of appropriate bodies (ministries and the like) to implement them. Outstanding examples are Decisions 84 and 85 of the Andean Pact, the Science and Technology Plan prepared by CONACYT in Mexico (1976), the organization of the CNP (Conselho Nacional de Pesquisas) in Brazil, etc.

Recognition of the importance of technology as a carrier of values, so that importing technology means importing not only an organized body of knowledge, but also the production relations which gave rise to it, the sociocultural characteristics of the market for which it was originally devised, and so forth. Technology transmits the value system for which it was designed, just as if it bore a "genetic code" within its structure. This means that the scope of technological dependence goes far beyond merely economic considerations.

Comprehensive study of trade in technology on the basis of recognition that technology is a valuable commodity in the system of production, and that most movements of

technology occur through trade and not through free transfers. This study was also accompanied by an examination of the technology market, highlighting its imperfections, criticizing its worst distortions and unfair practices, penetrating into the sanctified area of industrial property and discovering the importance of "unpackaging" in the importation of technology. The result has been the introduction of measures to analyse and control the flow of imported technology (for example, the establishment of registers of technology), to govern relations with foreign investment (Decision 24 of the Andean Pact), to revise legislation on industrial property (as in Brazil and Mexico), etc.

Verification that most imports of technology have occurred through direct foreign investment, with recognition of the growing role of the transnational corporations in producing and marketing technology, the growing importance of movements of technology between the head offices of such corporations and their subsidiaries, and recognition that the concept of industrial property has broadened to include property which is not legally protected and is known as quasi-property (know-how, engineering services, trade names, place in the market and so on), which accounts for an increasing volume of commercial technological operations.

Recognition that the process of industrialization is leading to a growing "technologization" of LAC, measured in terms of the larger number of persons from various levels of society who have acquired scientific abilities or technical skills, giving rise to an important qualitative change in the structure of employment. The local output of technology is small compared with the flow of imported technology, but some encouraging successes have been recorded (PEMEX in Mexico, agricultural machinery in Argentina, machine tools in Brazil, and so on), as well as progress in "unpackaging" technology (Atucha nuclear power station in Argentina; the Brazilian iron and steel plan; petrochemicals in the Andean Pact, and so on) and growing activity in the field of adaptation of imported technology to local conditions, which means that the flow of

internal innovatory activity is by no means non-existent. The first cases of substantial exports of packaged and unpackaged technology are being recorded, and measures are being introduced to support and encourage them (preferential credits, tax relief, favourable exchange rates). Exports of capital and technology within the region, especially from the three largest countries, are beginning to acquire importance. Brazil, for example, exported unpackaged technology worth US\$ 135 million in 1975, against a total of only US\$ 3 million in 1967.

Critical analyses of multilateral and bilateral co-operation and assistance in the field of science and technology, and of the bodies and executing agencies involved. These have led to corresponding stimulation of a new strategy for co-operation and negotiation at the regional level (OAS and SELA), the subregional level (Andean Pact) and the international level (United Nations agencies), and adoption of a new attitude to the United States (declaration by the CACTAL conference, position in UNIDO and UNCTAD and so forth).

Increases in local consultancy and engineering capacity, in some cases to international levels of quality and quantity, thus making it possible to extend such services, in open competition, outside national frontiers and even outside LAC.

Significant increases in scientific and technical exchanges among the countries of the region and with the rest of the world.

So far, we have indicated the most significant advances. In order to complete the balance-sheet it is now necessary to mention the areas where there has been no progress, and possibly even retrogression. Perhaps the most important of all these areas is the limited impact, in the field of technology, of the science and technology development plans implemented in various countries, and the failure to link the structure of production and the scientific and technological infrastructure. In contrast to science which can develop in the isolated environment of a university, academy, institute or laboratory, technology operates in a much larger area of society, that of the units of the structure of production, with a wide range of active participants. In particular, entrepre-

neers and managers in the industrial sector and farmers in the agricultural sector are of fundamental importance in introducing technology in their activities. These activities, however, have been and remain totally isolated from the policies, strategies, plans, agencies and actions related to technological development, which, as a result, have remained as if floating in a socioeconomic void, without real links with reality. In short, technology has so far been handled more as an item of data than as an operational variable to which the tools of economic policy must be applied if it is truly wished to achieve some impact on reality.

The importation of technology, whether by subsidiaries of the transnational corporations, private national enterprises or by State enterprises, is effected first and foremost in the light of the micro-economic interests of such enterprises, regardless of the ecological, socioeconomic and cultural consequences. There is implicit or explicit acceptance that certain assumptions are firm truths: (a) that technology from the central countries is the only, the best, and the most suitable technology; (b) that technology is neutral, in other words, value-free; (c) that any "modern" technology will, by definition, be of the greatest use for development; (d) that this technology is sufficiently well tested, and that its introduction therefore poses no risks. It is forgotten that such technologies are designed in the light of the availability of factors and resources in the country where they were created; that for that very reason they are capital-intensive and energy-intensive; that they are aimed fundamentally at meeting the needs of sectors of the population of those countries which, because of their incomes, stand far above the mass sectors of the importing country, so that a technology which, in a central country, meets the needs of a large number of consumers can, in a peripheral country, be of use only for the élites, etc.

Local production of technology has not been properly promoted: it has not been given the protection essential to permit competition with imported technology, nor has it been possible to introduce efficient means for its production.

Studies on technology in the fields of food, housing and health fall below those carried out

for the industrial sector in terms of quality and quantity, so that they have received little attention, while the importation of technology for use in the production of goods and services for the privileged sectors has continued to increase.

There is still no sound theory on the role which the State should play as a producer and as an owner of units (industries, banks, business, insurance, and so on) which are major consumers of technology and which frequently behave *vis-à-vis* science and technology as regressively as the private sector, or even more so, thus giving the lie to the belief that nationalizing a unit of production or bringing it into the hands of the State is sufficient to put an end to its technological dependence.

The brain drain has continued, and in a number of countries has increased, basically because of political persecution and ideological discrimination.

Demand for local technology remains weak, since under the prevailing rationale of the structure of production it continues to be more convenient to import technology than to produce it or purchase it locally.

Regional and subregional co-operation, which are essential for achieving the "critical mass" and thus jointly tackling the multitude of problems which need to be solved, are making slow progress, and in particular the ability to fulfil the formal undertakings entered into is very inadequate. No machinery has been established for trade co-operation in the field of technology.

Technological dependence and technological dualism have been denounced vigorously, but not thoroughly studied, and there is still no proper strategy to overcome them.

No country of the area, with the possible exception of Brazil, has yet passed from a *defensive* strategy, consisting of such actions as strengthening the infrastructure, operating registers of technology, and so on, to an *attacking* strategy, with emphasis on the production of technology and on aggressive negotiations with the external suppliers of technology. It is urgently necessary to recognize that the defensive strategy has a structural and operational upper limit, and that this limit can only be passed by going over to an *attacking* strategy.

The scientific and technical infrastructure is not linked either with the structure of production or with its own "owner", the State, thus showing that institutional obstacles of a socio-political and cultural nature can be as important as strictly economic obstacles.

Local efforts at scientific and technological development continue to be weak, and only Brazil has planned a significant change, through its Second Plan for Scientific and Technological Development, which provided for investments of the order of US\$ 2,700 mil-

lion for the three years 1975 to 1977. This situation is all the more serious since economic, material and human resources continue to be used very inefficiently. Skilled personnel still do not receive proper social and political recognition.

In these efforts there is a clear absence of projections and decisions regarding the relation between technology and the quality of life in the broadest sense. If this situation is not rapidly corrected, the consequences will be serious.

II

Objectives and strategies

A possible common objective

The above outline of the present situation defines the frame of reference within which it will be necessary to specify objectives and strategies for the better use of technology in the socioeconomic development of LAC. Three conclusions should be emphasized:

(a) There is now clear awareness that the problems are highly complex: much more so than was naively thought in previous decades. As Máximo Halty clearly put it: "The first step towards solving a problem is to know that the problem exists. This step has been taken. Simplistic solutions have gradually been put aside: the problem is not solved merely by training skilled technical staff and increasing research funds. Neither is the evaluation and control of the importation of technology, with all its strategic importance, a complete solution on its own and in itself. The two are necessary but not sufficient conditions..."

(b) The LAC countries are basically consumers of technology but poor producers. As a result, they are spectators and not actors: passive recipients of what others do in the light of their own needs and interests, and they thus inexorably tend to adopt the general outlook of the suppliers, against which mere rhetorical protest is of no use. This leads to one of two

equally harmful positions: to the worst kind of technolatriy —slavish copying or imitation— or to furious denunciations of technology, which are completely sterile if no viable alternatives are proposed.

(c) International co-operation has taken place particularly in respect of the science/technology interface, and the greatest efforts have been applied to creating and strengthening the scientific and technical infrastructure (training of staff, exchange of scientific and technical personnel, equipping of laboratories and pilot plants, establishment of institutions, technical service centres, etc.), and carrying out academic and field research on the many aspects of the problems of science, technology and development. The programmes applied to the interface between technology and the structure of production have been few in number, and so far very limited in scope and resources.

There is no doubt, in these circumstances, that the next stage should focus on objectives which are directly related to technology as an operational variable *in and for* the system of production, and should proceed on the basis of overall *attacking* strategies which are consistent with the objectives and strategies of socio-economic development. A fundamental preliminary question immediately arises: in view of the large number of nations which make up the continent, each with its own interests and its

own conception of economic and social development, will it be feasible to define objectives and strategies which are useful for all in such a way as to make firmly based and continuing co-operation possible and desirable? We are not referring, of course, to co-operation to strengthen the scientific and technical infrastructure, which can and should continue, since a firm basis exists for it, but to the area of socioeconomic development, because co-operation in the exchange of scholarship-holders and teachers, the organization of courses and seminars, the equipping of libraries and laboratories, and so on, is one matter, while tackling problems so bound up with power and interests as the regulation of imports of technology, reform of industrial property laws, and the evaluation of technology in relation to income distribution, for example, is very different. What is convenient and desirable for country A may not be so for country B: thus, A may pursue socioeconomic development through extreme liberalization *vis-à-vis* foreign investment and technology, while B, in contrast, may pursue the same goal by restricting and controlling such investment; country C may hope to improve its non-traditional exports through the massive assimilation of imported technology, while D may give priority to meeting the basic needs of its rural population (food, health and housing), sharply reducing imports of technology for use in the production of luxury items and applying its greatest efforts to the development of indigenous technology, and so forth.

This is a consequence of the very nature of technology and its full participation in the process of production, which means that everything related to it is necessarily linked to conflicts of interests between classes, groups, countries, and so on. Any decision on technology *benefits* some and *harms* others, just as occurs with other variables of socioeconomic progress, such as wages, rents, interest, etc. In itself, there is nothing bad about this, since it is a natural consequence of the prevailing rules of the society; what is really important is *to be aware* that the situation is thus, and this is often forgotten or ignored, perhaps because technology is often confused with science. In scientific matters conflicts are usually academic, while in the field of technology they are

political. "The capacity of technology to transform the nature and orientation of development is such that whoever controls technology controls development. Thus this is a fundamentally political issue" (Dag Hammarskjöld Foundation).

The argument of this document is that it is possible to define at least one objective which, since it is shared by each of the countries, makes co-operation among all of them possible and desirable; this objective is that each sovereign nation should, by definition, attempt to achieve an *autonomous* capacity to handle technology, so as to be able to direct it and use it in the way most convenient and appropriate to its interests and objectives. However opposed the interests of nations A and B, or C and D, each and every one of them needs to *know how to handle* technology, just as it needs to know how to handle taxes, currency, income distribution and external trade.

Only insofar as a nation acquires this capacity for handling technology will it be able to achieve the desired objective of converting technology into a special tool for its own development, an operational variable in the system of production, subject to its own decisions and not to those of others. In this complicated game there is a crucial dilemma: either one manages technology, or one ends up by being managed by it. Whatever each nation does with the technology once it has learned to manage it will be exclusively a matter for its own policy, and its decisions in this regard will be taken in the light of its own plans and programmes, its specific characteristics and its degree of interdependence with other nations.

Why does the pursuit of this objective make co-operation between nations desirable? In the first place, because such co-operation is an essential element in achieving a local capacity to produce technology, the effort to secure which will, because of its magnitude in terms of human and material resources, necessarily demand all the co-operation which can possibly be obtained. Moreover, such joint action also offers the participating countries greater latitude and makes it possible to achieve reasonable scales of operation. Secondly, because concerted action will help to develop the capacity to identify and formulate specific

technological requests, a capacity which is notably absent at the moment. Finally, because it will make it possible to negotiate with the United States and other nations which provide technology to the region from a position of greater strength.

Considered as a political and social process, knowing how to manage technology also means knowing how to define it in the terms which are most convenient and appropriate to the objectives proposed, knowing how to produce it using one's own resources, knowing how to select it from the existing local or foreign stock, and finally knowing how to use it in the existing socioeconomic circumstances. Two areas must be distinguished in all this:

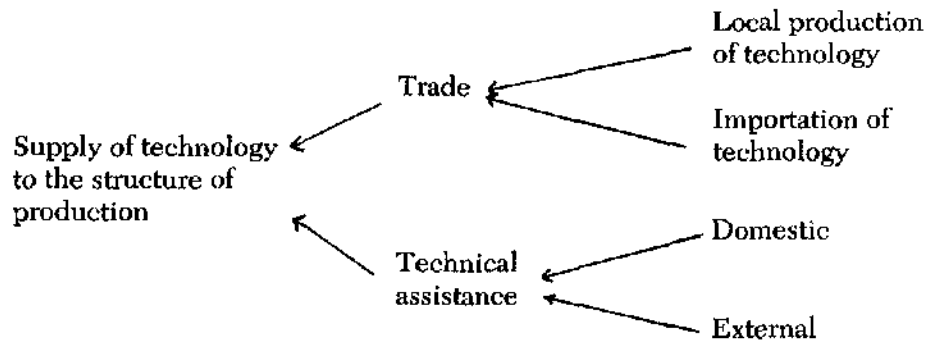
Area I, that of the structure of production of goods and services, where technology behaves as a commodity and the problem consists in the

smooth and reliable *supply*, in quality and quantity, of the technology needed for the area's proper operation, in keeping with the inherent rationale of this structure of production and using the machinery and channels which normally operate within it;

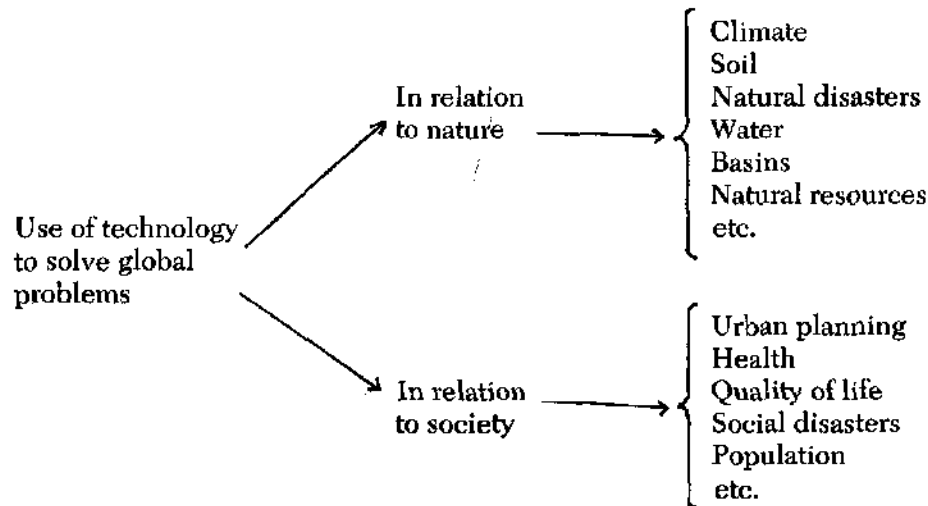
Area II, that of the "global problems", where managing technology means knowing how to use it effectively to solve problems which, by their very nature, extend beyond the framework of the structure of production, such as weather control, the development of hydrographical basins, forest or desert management, the occurrence and control of natural disasters, urban planning, control of the environment, health protection, and so on.

In both areas the management of technology comprises various stages, as summarized in the following diagram:

AREA I



AREA II



It is clear that the rules are different in the two areas, as are the principal participants. In area I the economic system rules, and the principal protagonists are the entrepreneurs (private and public, national and foreign, industrial, commercial and agricultural), because they are directly responsible for producing the goods and services and therefore for taking the final decisions regarding the technology to be used. The State participates in its dual function as regulator and controller of the structure of production, and as owner of productive enterprises. In area II, on the other hand, it is fundamentally the system of penalties and rewards that governs the behaviour of the State as the entity responsible for managing the territory of the country and its resources, the health and protection of its inhabitants, the provision of urban infrastructure, defence against natural and social disasters, and so on.

In both areas I and II *local production of technology* is an essential element for achieving the desired autonomous capacity, not least because it will permit better management of the importation of technology and of technical assistance, for a sound local productive capacity substantially strengthens a country's bargaining position.

While for thousands of years man produced technology in a spontaneous, unsystematic and almost amateurish way (i.e., in the manner of the craftsmen of those days), in recent decades this mode of production has sharply changed, and has been converted into a specific, organized, differentiated and continuous activity with its own identity, its own legitimacy and its own economic characteristics. Just as everyday goods are produced in establishments broadly referred to as factories, the same occurs with technology, with the difference that the technology factories or firms are given such names as "research and development laboratories", "R&D departments", and so on. In area I in the developed countries the technology factories and firms are the largest and most efficient units producing technology, and represent one of the fundamental components of the power of the transnational corporations.

The situation is different in area I of the LAC countries, however, where the production

of technology fundamentally remains at the craftsman level; while such production is important and therefore should be suitably encouraged, it is far from enough to enable these countries to become efficient producers of technology.

The technology used to tackle the global problems of area II usually —although not always— originates from specialized applied research institutes along the lines of those dealing with lake studies, integrated basin studies, seismology and soil dynamics, urban planning, infant nutrition, and so on. The vast majority are State, para-State or university institutions, and the results of their work are distributed much more by means of technical assistance than by means of trade. These institutes provide services which are very important for the community and undoubtedly provide a basis for the knowledge and control of natural resources, the natural and human environment, natural and social disasters, and so on. In all the LAC countries there are institutions of this type, and in many cases they have achieved significant successes: indeed, some of them have acquired international prestige.

Only in the last few years have the principal aspects of the importation of technology into LAC begun to be understood, thanks to the establishment of National Registers of Technology.

Since this procedure has been introduced not only in various countries in LAC, but in many others in the Third World, the importation of technology is becoming more open, and this will in due course make it possible to bring into effect appropriate regulating legislation, like that which exists for the importation of other commodities. It will then be possible to control imports of technology in terms of *cost*, *use* (reducing or eliminating provisions restricting its use) and *content*. Among the most important consequences of this process are the negotiations at present under way within UNCTAD to formulate a Code of Conduct for the Transfer of Technology.

In order to ensure that the supply of technology in area I is properly managed, the LAC countries should concern themselves first and foremost with *promoting the local produc-*

tion of technology and *controlling its importation*. These two processes should be carried out simultaneously, since one is supported by the other, because imports cannot be replaced if there is no local replacement, and it is not possible to produce locally without a certain degree of protectionism against external production.

The promotion of production requires action both in the field of demand and in the field of supply. The promotion of demand for local technology can only be successful if the prevailing rationale of the structure of production is adapted to this end, which means using fiscal, economic and financial incentives to increase the consumption of local technology and introducing penalties of the same types for the unnecessary use of imported technology. A certain degree of *technological protectionism* will necessarily have to be established, not by means of "ad valorem" tariffs, but through preferences of a qualitative type, since in general technology is purchased on the basis of its "quality" and the trust inspired but its supplier, rather than its price. One possible mechanism for qualitative technological protectionism would be the giving of preference to local consulting and engineering firms in feasibility studies and design work on investment projects in the public sector, as in the Argentine legislation on "national contracts": the purchase of locally produced capital goods, the engagement of skilled personnel of local origin, and so on.

In order to improve supply, it will be necessary to strengthen the scientific and technological infrastructure and encourage the establishment and operation of enterprises producing technology, consultant services, engineering and design services, and auxiliary technical services. This encouragement should also make use of the machinery and procedures which are accepted and used in the structure of production: bank credit, reduction of taxes, other fiscal benefits, etc. The quasi-artisanal production which takes place within enterprises in the structure of production should also be suitably encouraged, for example by permitting tax deductions in respect of expenditure on the production of technology, with "soft" credits for the development of proto-

types and the establishment and operation of pilot plants, and so forth.

The encouragement of production should be complemented with vigorous *promotion of exports of technology*, which have already been successfully started in various LAC countries and which are likely to experience explosive growth in the next few decades, especially towards the Third World, where countries which are still at an earlier stage of development find that technologies from LAC are more suitable than those from the central countries. In particular, the export of technological services is of the greatest importance, since it prepares the ground for the subsequent export of technological items, capital goods, etc.

As regards the *control of imports of technology*, the principal aim here is not to reduce the volume but to improve the quality and importance of what is imported, to bring it into line with local needs and resources, and to improve the terms on which the imports occur. In fact imports of technology are not only not going to decline, but are very likely to increase, insofar as the development of LAC becomes more thoroughgoing and extensive; what is needed is to avoid superfluous imports, replacing them by imports which are really essential and are negotiated on the basis of fair and non-restrictive conditions.

It is clear from the above that policies to promote the production of technology and control its importation must be mutually consistent, so as to ensure a smooth flow of technology which is suited to the structure of production.

Choice of technology

In recent years there has been increasing awareness of the need that all technology, before being supplied and used, must be selected from among various alternatives so as to ensure that the most appropriate technology has been chosen. This process of elimination should be applied not only to imported technologies, but also to those produced locally, since these are in many cases copies and adaptations of foreign technologies and as a

result transmit the value system carried by their "genetic code", also sometimes called their "ideological content".

Of course, each country will make this selection on the basis of its own criteria and for its own purposes, but co-operation among various countries will be very useful in defining more precisely the questions of: (a) Why to select; (b) What to select; and (c) How to select.

Some limitations

At this point in the document it is necessary to realize that technology, even when selected with the greatest care and supplied to areas I and II with maximum efficiency, is *not* a "magic wand" which solves everything, a "cure" for all the evils of underdevelopment, a "key" to open all the doors to happiness. It is a *necessary*, but not sufficient, condition to enable the LAC countries to pass beyond their present stage of development and succeed in reducing poverty, backwardness, malnutrition, disease and so on; to that end technology should be used in accordance with appropriate overall policies and with plans and programmes for socioeconomic development which are designed to solve these problems. Technology is sometimes expected to eliminate or reduce unemployment, protect ecosystems, uphold cultural independence, and the like, at the same time as it is being used in a context which ignores such objectives or —worse still— implicitly defends what it rhetorically purports to be combating. These are complex demands which cannot be satisfied merely by using appropriate technologies, although it is true that this can help, sometimes to a significant extent. There is a danger of proposing solutions which are unattainable, or which are not solutions at all but merely desires expressed with attractive rhetoric but little profundity. Thus, for example, the demand is often heard in LAC that modern capital-intensive and energy-intensive technologies should no be introduced into rural areas, but that the traditional technologies, appropriately improved and adapted, should be maintained. This position, which has a certain validity and enjoys a degree of recognition in mainland China, India, Indone-

sia, and so on, would seem to be difficult to apply in our continent. In the first place LAC is no longer rural, although it has rural sectors which have very rapidly been "opened up to the world", with the help of geographical mobility (in contrast to Asia, there are no *large* isolated plateaux). Moreover, it has a single language which unifies and promotes integration, widespread urban life patterns, growing penetration by industrial goods, a touching 19th century faith in Progress, and great admiration and respect for Technology with its magic products (radio, the cinema, TV, the telephone, antibiotics, electricity, agricultural machinery, and so on).

Finally, this position is difficult to uphold because the greater productivity of modern technologies makes their introduction almost inevitable. This does not mean that these technologies are the only possible ones, or that they must necessarily be capital-intensive and energy-intensive, for other solutions, better suited to the availability of local resources and factors, might be imagined and possibly developed, but this will only be possible by means of an intensive research and development effort and not simply through a sort of romantic "return to Nature". If modern technology is not appropriate and convenient, the only acceptable response is to produce even more up-to-the-minute technology, which is appropriate and convenient.

Furthermore, some criticisms of modern technologies, both for the agricultural and for the manufacturing sector, unfairly forget that the only way of breaking away from the old international division of labour has involved the use of technologies which, because of the increased productivity they brought to the economy, have enabled some underdeveloped countries to begin to produce industrial goods on acceptable terms. Without the help of those technologies, these countries would probably have continued to be mere producers of raw materials.

In short, this complex subject requires much more research before the present stage can be passed.

Some important obstacles

In order to attain the desired objective it will be

necessary to overcome a group of obstacles of varying importance, including:

(a) The groups of interests which benefit from technological dependence and will not remain indifferent to a vigorous programme aiming at technological independence.

(b) The weakness of the State, which must play a leading role, and its meagre capacity to implement and ensure the implementation of decisions of a technological nature.

(c) The intellectual alienation of those groups in the ruling class which hold that nothing can change because "we are not capable", and others which hold that nothing can change because "they won't let us".

(d) The existing rationale, according to which it is better business to import technology than to produce it locally.

(e) Cultural dependence, holding that

"any foreign technology is better... because it is foreign".

(f) The prevailing system of values, which gives action to provide for superfluous consumption by the élites priority over providing for essential consumption by the majority of the population.

(g) The slavish imitation practised by the periphery, whereby even the worst products and processes from the centre are copied.

(h) Local financial machinery, which fails to provide risk capital for the production of technology, will provide backing for any "prestigious" imports of technology.

(j) The poor links between the principal participants in the process: State officials, entrepreneurs and managers, scientists and technologists.

III

Possible strategies

Two fundamental strategies are proposed: a strategy of *co-operation*, to help to make technological autonomy in LAC *viable*, and a strategy of *negotiation*, to help to make equitable interdependence between LAC and the United States on a basis of solidarity *possible*.

The *strategy of co-operation* should aim at the same general ends in both areas I and II: to *support* the national plans and programmes for technological development, to *carry out* a coherent set of actions to strengthen national efforts and expand their scope of operation, and to *co-operate* with the programmes of other subregional, regional and international bodies. However, the development of such a strategy cannot be the same in areas I and II: it will take place in each of them in conformity with their particular characteristics. Equally, it will not take place with the same intensity throughout the whole wide range of possibilities, but must select some *priority directions* where efforts will be particularly concentrated so as to use the scarce resources available with maximum efficiency.

Bearing in mind the particular characteristics of area I, it is proposed that the co-operation should focus on the two following lines:

(a) *Promotion of production of technology*, through action aimed at greatly strengthening the capacity to produce technology and promoting the creation of bilateral, multilateral and subregional capabilities which, at an appropriate time, could come to be articulated in a genuine regional technological capability.

The promotion of production should include both industrial and quasi-artisanal production, as well as the protection of them from foreign technology. The extension of production and protectionism to the whole region might be achieved through such appropriate instruments as the operation of Latin American technology enterprises, agreements for technological complementarity, regional preferences, etc.

(b) *Promotion of trade in technology* among the LAC countries, so as to increase the present meagre flow significantly, control the importation of foreign technology by seeking a

reduction in the redundant imports which occur when various countries import the same technology, and develop adequate economic room to permit autonomous technological development.

Trade promotion should encompass both technology embodied in goods and in human knowledge and technology which is not embodied in technological goods and services, and as a result should cover capital goods, the emigration and immigration of skilled personnel, consulting services, design and engineering services, and so on. The instruments used should naturally be compatible with those used in trade within Latin America in general.

Just as in area I the strategy of co-operation proposed highlights the production of and trade in technology, for area II it is proposed that the co-operation should develop on the basis of "joint projects for production and technical assistance". It has already been noted that, because of the very nature of the global problems of area II, technical assistance is more important than trade; thus, for example, if country A has developed a given technology for flood control, while country B needs it for application on its own territory, it is very unusual for the technology to pass from A to B by means of trade: it is most likely to be transferred under an *agreement* between A and B, which might possibly include some payment, but not in terms of an actual *price* for the technology.

An important aspect of the global problems is that, by their nature, although one of them may be specific to one country or a sub-group of countries (for example, the protein deficit), there will certainly be another which is specific to another sub-group (for example, the ecosystem of desert zones) and so on and so forth, so that the set of problems as a whole will in fact be of equal interest to all the countries and, as a result, co-operation will prove to be of genuine mutual interest. There are also problems of regional—and even worldwide—scope, such as general weather control, earthquake prediction and control, exploitation of the seabed, mass hunger and poverty, the exhaustion of natural resources, waste management (industrial, mineral, nuclear and so on), urban marginality, world population growth, and so on,

which will be impossible to study and solve without co-operation by all, which is therefore an ineluctable *imperative*.

The principal characteristics of the "joint projects" would be as follows:

(a) They would be defined and organized around problems to be solved, and not around disciplines. For example, there might be a joint project for the development and use of tropical forests, but not a silviculture project; for the replacement of animal protein in mass diets, but not a protein chemistry project; for the ecological control of marginal problems, but not an ecology project; for the use of non-bauxitic ores for aluminium productions, but not a mineralogy project, and so on.

(b) Thus defined, the projects will necessarily be multidisciplinary, and although some will be linked more to the "hard" sciences such as physics and chemistry and others to the "soft" sciences such as sociology and anthropology, the solution of the problems will require knowledge from various sources and disciplines. Moreover, although applied research will be one of their fundamental tools, the projects will not make use of "applied science", but of "technology", because their final objective is not to *inquire into* the problems, but to propose *solutions*, and for that purpose they will be able to use knowledge of any origin and nature, provided that it is *useful* for that purpose.

(c) The projects will aim to develop technological solutions which are feasible, viable, appropriate and convenient, on the basis of definitions and criteria explicitly set out in the programmes themselves.

(d) The joint projects will encompass all the stages, ranging from prefeasibility and feasibility studies to the production of technology—which will contain an appropriate mix of local and foreign technology—and its application and full use by society. The countries participating in each project will endeavour to participate fully in *all* these stages, so as to transform the static transfer from the owner to the recipient into a dynamic transfer in which all the participants give and receive.

(e) The *joint action* will mean that the countries which wish to embark on a specific project aimed at solving a problem of common

interest will define the nature and structure of the project, the terms of their participation and the adaptation and use of the technological solution achieved and other technologies which it may have been possible to generate in the process.

(f) The projects will be implemented by suitable institutions such as research institutes, technology enterprises, university laboratories, research centres and so on, which will co-ordinate the organization, administration, control and implementation of each project.

(g) It will be essential, for each project, to ensure that it is related as closely as possible to the circumstances which it is supposed to improve; otherwise there will be a risk of producing solutions which might be satisfactory to their authors but impossible to apply. For this reason, the various interest groups linked with the problem which is to be solved should be properly represented in the management of the project. Thus, for example, in an endeavour to solve the problem of improving the everyday diet of the mass of the people through the addition of proteins to bread, the body responsible for managing the joint project should contain representatives not only of the scientists and technologists participating in the project, but also of the bakers who may possibly produce and market the new type of bread, the manufacturers of bread-making equipment, the producers of the raw materials used in producing bread, and so on.

(h) The final form of applying the solution reached will depend on the specific circumstances of each project. Although in general this will be done by means of technical assistance, there will undoubtedly be cases where it is most desirable to do so by means of trade. Thus, for example, in the case of flood control, the technological solution found will no doubt be transferred in the form of technical assistance; but in the case of the new type of bread, it is likely that marketing of the solution through the specific channels of the sector (for example, the manufacturers of bread-making equipment) will be not only the most rapid and efficient way of achieving the goal sought (to improve the diet of the masses), but perhaps the *only* feasibly way, despite the difficulties inherent in it.

(i) In the global projects which are regional or worldwide in scope, where because of their magnitude and complexity scientific, technical and economic leadership will in fact be in the hands of the developed countries, LAC will nevertheless demand genuine co-operation and, as a result, full participation in decision-taking and in the benefits.

The strategy of *negotiation* in the field of technology between LAC and the United States must naturally be part of the strategy of *general* negotiation between the two sides which is carried out in various forums. In the specific case of technological negotiations, the central concern should be to ensure that the United States *recognizes* that it is in its own political interest that the LAC countries should pass beyond their present stage of technological dependence, and that it should *undertake* to *co-operate* actively to ensure that this occurs in the shortest possible time and at the lowest possible cost.

The technological negotiations should encompass at least the following subjects:

(a) Regulation of trade in technology between LAC and the United States, under a "Code of Conduct for the Transfer of Technology", identical or similar to that currently being drawn up within the United Nations;

(b) Regulation of the behaviour of the United States-based transnational corporations, as far as technology is concerned, by means of provisions identical or similar to those which will appear in the United Nations "Code of Conduct for Transnational Corporations" which is being prepared;

(c) Regulation of the behaviour of the United States consulting and engineering firms which sell services in LAC in order to prevent restrictive practices or trade abuses arising from their power;

(d) Sustained support for the development of a local capacity to produce technology, and particularly for the establishment and operation of technology enterprises;

(e) Support for the LAC countries in their negotiations with the World Bank, IDB and other international financial institutions with a view to eliminating the conditions which "tie" their credits to the supply of foreign technology, stimulating full use of local technological

goods and services (especially in consulting and engineering) and allocating "risk capital" for the establishment and operation of local technology enterprises;

(f) Active co-operation in "joint projects" among LAC countries and support to ensure that they achieve full participation in "joint projects" at the global level;

(g) Development of technological transactions with medium-sized and small industry in the United States, and increased use of the programmes of the Small Business Administration.

The *negotiation strategy* aims to ensure not only that a harmful confrontation with the United States is transformed into active co-operation, but also that the LAC countries engage in an active learning process on some

central problems connected with the interface between the structure of production and technology and become aware of their principal shortcomings in this field. The United States knows how to manage technology as an operational variable and has an "implementation system" for decisions in this field, which functions in response to explicit orders from the political authorities. This is precisely an area where LAC falls seriously short, all the more so because there is not even full awareness of its necessity and importance. The negotiations will bring this out very clearly, while at the same time clarifying relationships and mechanisms which are still hidden behind an ideological tangle of absolute pseudo-truths. For this reason the negotiations must constitute a continuous and ongoing process.