

CEPAL

Review

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UNITED NATIONS
ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN

SANTIAGO, CHILE, DECEMBER 1988

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LC/G.1537-P

December 1988

Notes and explanation of symbols

The following symbols are used in tables in the *Review*:

Three dots (...) indicate that data are not available or are not separately reported.

A dash (—) indicates that the amount is nil or negligible.

A blank space in a table means that the item in question is not applicable.

A minus sign (-) indicates a deficit or decrease, unless otherwise specified.

A point (.) is used to indicate decimals.

A slash (/) indicates a crop year or fiscal year, e.g., 1970/1971.

Use of a hyphen (-) between years, e.g., 1971-1973, indicates reference to the complete number of calendar years involved, including the beginning and end years.

Reference to "tons" mean metric tons, and to "dollars", United States dollars, unless otherwise stated.

Unless otherwise stated, references to annual rates of growth or variation signify compound annual rates.

Individual figures and percentages in tables do not necessarily add up to corresponding totals, because of rounding.

UNITED NATIONS PUBLICATION

ISSN 0251-2920

CEPAL

Review

Santiago, Chile

Number 36

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Technical change and productive restructuring

*Eugenio Labera**

This article analyses the direct and indirect impact of new technologies on the Latin American economy, and in particular the way in which such technologies can become a factor capable of easing the present situation. Of particular interest is the contribution made by technical change to the increase in international competitiveness and to the necessary restructuring of national economies.

The influence of technical change on developing countries is somewhat ambiguous, since it potentially includes both positive and negative aspects. One independent variable that may help to make the difference between these two kinds of result consists in the policies applied in each country.

In the text we analyse various approaches to the design of these policies, arriving at the conclusion that a prerequisite for their viability is their integration into overall economic options.

*Technical Secretary of *CEPAL Review*. The author wishes to thank Fernando Fajnzylber, Alicia Frohmann, Martine Guerguil, Hugo Nochteff and Anibal Pinto for their comments. This article is based on a lecture given by the author at the seminar on Technology and Prospects of Development in Latin America organized by UNCTAD and PRODEC at JUNAC, Lima, in November 1987.

"But things get darker as we move to ask them"
John Ashberry, *The Grapevine*

Introduction

Even though the first patent offices in the region were created towards the end of the nineteenth century —the patent office in Guatemala City has just celebrated its one-hundredth anniversary— there is in Latin America a marked dissatisfaction with the handling of technological problems. The following discussion, which includes elements that are clearly subjective, is intended to make a modest contribution to the debate on the subject, a thankless task because it requires the consideration of questions highly diverse in scope, some of them of the most fundamental kind, inasmuch as technology is interwoven with a very broad range of social relationships.

The article consists of four sections. In the first section we consider the types of technological change that are represented by the new technologies and the principal characteristics of each. The second section contains an analysis of some of the consequences these innovations produce in the international economy. Next we shall study technical progress as one of the factors offering a way out of the present regional crisis. Lastly, in the fourth section we formulate some lines of policy. The work is supplemented by a basic bibliography on the impact of new technologies.

I

What is the problem?: technical change or Industrial Revolution

1. *The "emerging technological paradigm"*

It has been said that we are now witnessing the exhaustion of a long Kondratiev wave and the development of a new Industrial Revolution, although the question whether it is the second or a later Industrial Revolution is in dispute. It

appears that we are facing not so much a series of technological changes as a new technical and economic paradigm. This paradigm, it is claimed, relates all of these changes to a fundamental transformation: the central role played by data processing and the development of the electronic complex.

This globalizing vision has unquestionable merit, since it enables us to capture in a single concept the dynamism and the direction of technological change. However, it puts too much emphasis on the continuities that characterize the present process, and this fact is translated into the vision of an integrated "package", which may seem accessible as a single entity to the developing countries; furthermore, its comprehensive nature makes it difficult to analyse it for operational and policy purposes.

In reality "technology" is an abstraction which covers a collection of techniques, methods and skills related to the way to attain specific objectives. It includes such diverse elements as data processing, medical practices, analytical techniques based on mathematics, the synthesis of engineering and design, algorithms for the solution of problems, computer programmes and the systems associated with them, and the application of new scientific discoveries to the economical production of goods and services. It is not easy to make accurate generalizations about such a broad collection of items.

2. Brief summary of the principal technological innovations and their development

In what follows, we present a relatively arbitrary grouping of the main technological developments of the recent past.

Electronics. Technologies based on microelectronics relate fundamentally to the production, processing, transmission and storage of information by electronic means. Microelectronics actually consists of four major groups which are interrelated: the first group includes basic technologies (microelectronics and optoelectronics), whose most immediate scientific roots are found in electronics, optics and electromagnetism; the second includes the field of information science, or the technologies relating to computation; the third group is that of telecom-

munications, which deals with the transmission of images, sounds and data by various means; and the fourth group consists of instrumentation, especially instrumentation for measurement and control. The boundaries between the last three groups are tending to disappear because of the advances made in basic technologies.

New materials. This group consists chiefly of light materials, high-temperature materials and materials for electronic components. They may be metals, treated to make them harder and to attain various configurations and concentrations; ceramic and inorganic materials; polymers; composite materials, prominent among which are those reinforced with fibres; and silicon, a key input for information sciences.

Biotechnology. This consists in the utilization of living micro-organisms (yeasts, fungi and bacteria), as well as animals, plants and cellular components for the conversion, synthesis, decomposition and concentration of specific substances. DNA recombination technology implies the direct manipulation of genetic material by selecting the desired gene and chemically bonding it to the DNA of a recipient, with a view to introducing the resultant hybrid into a cell capable of reproduction and protein synthesis.

New sources of energy. These are solar, wind, ocean, geothermal, bituminous-shale, biomass and thermochemical energy. There are also new developments in nuclear energy.

Other technologies. Some others are the result of applications of the above-mentioned generic technologies to specific spheres, such as changes in the handling of sea-going ships and remote sensing by means of satellites.

3. Principal characteristics of technical innovations

These technologies, generated principally in industrialized countries which have a high degree of social organization, have helped to increase productivity and competitiveness in general: the manner in which they do this depends on the country's scientific resources, the characteristics of its economy—including the natural resources it possesses—and the specific problems confronted by that economy. These technologies, endowed with a growing scientific

base, produce savings in manpower, natural inputs and energy, highlighting their systemic character in contrast with the separate existence of artifacts and machines. Their creation and development have been produced, to a decisive extent, by the support and financing they obtained from the State. This is so because the risk associated with technological innovation, especially its financial cost, has increased dangerously.

There exist specific sectors which are privileged carriers of technical change. They are to be found with absolute preference in the industrial sector (Fajnzylber, 1987). Technologies relating to information, for their part, have tended to take the flow of information as the centre of the production process. They have accelerated the process of direct incorporation of knowledge into capital equipment, which has a strong influence on the participation of human labour in the production process (Nochteff, 1987).

New technologies create more leisure time, that is to say, time not devoted to the mere reproduction of life. This creates the challenge of satisfactorily filling such time and raises the problem of the distribution of the fruits of leisure time, which are adapted in a differentiated manner, as pointed out by Prebisch and Pinto.¹ In the particular case of the genetic manipulation of living organisms, technology raises questions which go beyond the technical and economic field.

Considered from a different point of view, for the first time in history it is becoming technically feasible to ensure the material future of mankind—within the present limits of social life—through the hypothetical extensive application of current technological knowledge. Paradoxically, this also makes it possible to bring about the total destruction of life on our planet.

II

Some consequences for the international economy

1. *Impact on the economies of the industrialized countries*

The versatility and flexibility of microelectronics is breaking down the sectoral barriers to entry, altering the prevailing views about economies of scale and generating a great many possibilities for particular applications to new products and systems, including application by marginal variations oriented towards the differentiation of the product (Lahera and Nochteff, 1983).

"Optimal practice" in production will be modified by the increases in productivity, the savings in material inputs, the reduced share represented by labour costs in total costs, and a certain reduction in the importance of economies of scale. These changes affect policies concerning research and development policies and concerning employment, as does the geographical location of plants, among other factors.

From another point of view, the demand for labour is also undergoing changes. A separation

tends to arise between increases in productivity and increases in employment, and relatively high rates of structural unemployment are being reached, which is causing an unprecedented social problem. Parallel with this, there is a polarization of the skills required.

While the share represented by direct labour costs is decreasing, there is an increase in the share represented by costs associated with research and development. To the increased financial costs is added the need for greater research and development capacity in order to strengthen the relative power of the principal productive organizations, so that we observe a relative "dematerialization" of production in terms of costs.

There is an accelerated increase in productivity and capital-intensiveness within the service sector, which has recently undergone a

¹Concerning Prebisch's views, see Gurrieri (1981); concerning those of Anibal Pinto, see Pinto (1965).

technological transformation equivalent to what the first Industrial Revolution meant for manufacturing activities.

The consequences outlined above are operating as a process in time, without completely changing a factor or branch of activity simultaneously in the same direction. We are dealing with changes which follow the logic of flow, not the logic of a change in stockpiles (Nochteff, 1987).

2. Effects on the international economy

a) Trade

Under some circumstances technological advances may create trade, while under others they may destroy it. The substantial increase in the information sent beyond national frontiers will, at least in part, compensate for the flow of goods. As Latin American countries gradually approach the conditions of supply and demand in the industrialized countries, they will also come closer to the innovations they generate, and therefore we must suppose that trade resulting from technological differences will decrease. On the other hand, in an environment characterized by low growth rates, the orientation of technology will be based more on shortening the cycle and differentiating the product, and less on expanding the demand. Lastly, the increased flow of information will make it easier for non-traditional exporters to participate in international trade. Transactions in services will continue to grow in importance (Vernon, 1983).

b) Direct foreign investment

The process of internationalization of the production process is affected, among other variables, by technical innovations. There are alterations in comparative advantages and in the optimal organization of production. Both factors

may accentuate the orientation of direct foreign investment towards industrialized countries. At the same time, the persistence or expansion of the technological gap acts as a stimulus for such investment, both for investment from industrialized countries and for investment originating in the developing world. The successive sectoral restructurings —whether total or partial— will redefine the differences between the resources possessed by different enterprises, the point of departure for the dynamics of direct investment in foreign countries. The modalities of internationalization will also be affected, with a probable increase in vertical integration.

c) Financing

"Electronic money" and national and international transactions carried out by means of computers are accentuating the volatility of financial flows, causing a decrease in the scope of currency-exchange policies and financial policies. According to some sources, currency and securities operations across national frontiers exceed US\$2 trillion daily.

d) Culture

The omnipresence of telecommunications and the similarity of the content originating in the principal industrialized countries tend to overcome local preferences and traditions. This homogenization is a response to and also a prerequisite for the dissemination of certain goods, and services, which satisfy needs or preferences, even though there may often be reason to question the social desirability of the way in which these things are being done. What seems difficult is to have the best of both worlds. The demonstration effect of consumption becomes magnified, and exclusion from access to the new goods and services is regarded as a deterioration in the quality of life.

III

Technical progress as one of the factors offering a way out of the present regional crisis

1. *Technology and crisis*

Earlier generations of Latin American leaders often hastened to embrace the "Protestant ethic" and, as a result, became privileged and precocious students of "consumer hedonism", in the words of Daniel Bell (1977). For several decades this was facilitated by selective access to political decisions and by the fact that the masses of the rest of the people resigned themselves to the existing order of things; the permanence of these factors has ceased to be viable in a system in which information is available to everyone and which tends to break down personalized links to moral and economic authorities. A model which does not grow fast enough and nevertheless guarantees high profits to a small number of people is politically not viable as a democracy: it must use force to maintain itself.

Growth that is devoid of creativity and is limited to basic exports can function only if it is hooked to a locomotive of the international economy which is moving forward rapidly and which has a dynamic demand for basic commodities. When this circle is cut, then perhaps a door can be opened for creativity.

The crisis in the foreign-financing sector did not create the present crisis in the incorporation of technology into the regional economy; it only weakened this process even further. In fact, a relative looseness in the balance of payments has recently made possible the massive import of computer elements, which was translated in many cases into the extensive utilization of computers as high-priced typewriters or overgrown calculators for payroll accounts. Technology provides a way out, but rigorous prerequisites, both economic and non-economic, must be satisfied for its proper utilization. There must be time and capital formation, but there must also be policies which define precise objectives and there must be the design of effective instruments for attaining those objectives. Technological policy should form part of an overall strategy of positive adjustment.

In the same way as this has occurred and is occurring in other parts of the world, technical change and the consequent increase in productivity and international competitiveness offer a way out of Latin America's present crisis. The magnitude of what is possible is now approaching the magnitude of what is necessary, although, as always, this relationship depends on the social framework in which it is situated. The crisis represents an opportunity for improvement but also a chance of falling further behind.

A realistic political project with strong citizen support could use what exists today as a basis for advancing into the future. As has been pointed out, public administrations have no better social objective than economic growth. Hence, even though technology has need of politics, politics also has need of technology.

Technology, growth and democracy are, therefore, related terms. Democratization without productive transformation is not viable since its economic limits are very quickly reached. At that point there arises the risk that the economic policies of democracy will be no different from those used by authoritarianism. There is no conclusive foundation for asserting that there must be a "selective affinity" between authoritarian political organization and competitive participation in the international economy, as there is between democratic political organization and equitable development. Authoritarian organization does not guarantee development, a fact shown by many experiences; when it does promote development, it tends to shape an inequitable kind of growth. Democratic political organization is a necessary but not sufficient condition for equitable economic development, which in turn, reinforces democratization. The attainment of this vision requires overcoming an unfocused collective imagination and politicians who frequently have no imagination at all.

The concept of technological problems as a self-contained subject often prompts people to make partial diagnoses and predictions. Technological innovation, incorporation and adaptation

form part of a country's economic and social dynamism, which defines its potential and its limits.

Technology is not something that is added to other things on one side or another. It is a relationship which implies minimum conditions of acceptability. Quite often it is not even an artifact, nor can it be purchased separately.

2. Ambiguity of the technological impact on the region

While there are some who believe that technological innovations will tend to keep widening the gap between the industrialized and the developing countries, others postulate that this gap actually constitutes an opportunity. For example, Gerschenkron (1962) pointed out that the technology acquired by the less developed countries affords them an opportunity to grow more rapidly and avoid some of the mistakes made by the societies that had to travel the whole distance on their own. This presupposes a sudden awakening to the world of technology.

From another point of view, the question arises: is it possible to institute whatever policy one wishes, in any society and at any time? Obviously it is not. The relevant question, then, is: can we make our lives more modern when there are archaic hangovers which are still powerful? In reality this question is not new in Latin America, one of whose fundamental features is structural heterogeneity.

Technology should enable people to deal successfully with the challenges posed both by international trade and by the domestic markets of the region, including the task of meeting people's basic needs. The two questions are related, but they are not the same. Any analysis—especially a political one—must take account of the natural differences between the two markets, as well as between the types of technological solutions required. However, there is no contradiction in making an effort to advance on both of these fronts at the same time.

The probable effects of the incorporation of technical change are, with few exceptions, chiefly ambiguous, with high positive and negative potential at the same time, in view of the difficulty of identifying the technological, economic and social factors that bring it about.

Prominent among the latter are the policies which the countries of the region themselves adopt, even though these do not constitute an independent variable of unlimited power.

There is no way to "normalize" a regional, sectoral or regional/sectoral average. Consequently the comments given below are in fact merely well-intentioned generalities. There are circumstances which modify the impact of the new technologies with regard to the availability of resources, public policies, institutional rigidity and the roles played by the various factors.

a) Entry into the international economy

The disparity between the developed countries and the countries of Latin America with regard to the rate at which they introduce innovations and to the capacity to adapt them to national economies may increase the differences in productivity which separate them at present. If a sudden technological and production gap between the two groups were to appear, the developing countries would have to make desperate efforts merely to keep from falling further behind (Lahera and Nochteff, 1983). It is also possible that differentiation within the region will be intensified.

Technology may have a considerable effect on comparative advantages, reducing the importance of those which are based on low labour costs and accentuating those deriving from greater scientific and technological development. At the same time, a careful selection of products and technologies may contribute to the creation of dynamic comparative advantages. Here it seems important to consider the high elasticity towards protectionism of goods successfully exported to the industrialized countries. Account should also be taken of the world-wide tendency towards the proliferation of niches in the most diverse markets.

The cost of the new productive systems and the reduction of the coefficient of imports will increase the contribution of capital goods to imports, which will also be pressured by the spreading demand for certain products or inputs. At the same time, exports of basic commodities will make themselves felt, inasmuch as the growth of manufactured products will probably be slower, differentiated and concentrated.

Various metals and materials may undergo significant shifts in the coming years. Estimates of the consumption of metals in the coming decades indicate relatively moderate, although positive, rates for iron, copper, tin and lead. The rates for aluminium, chromium, nickel and the metals used in the manufacture of special steels will be somewhat higher. Lastly, other metals and materials, closely related to state-of-the-art technologies —columbium, titanium and gallium— will be imported at accelerated rates. The fact that some producers among the developing countries lack some of these new materials will put them at a disadvantage.

For Latin America the most problematical result that could come from technical change in the regular transport of goods by sea-going ships is their possible marginalization, or —which is the same thing— the relative increase in the cost of maritime transport, with its consequent effect on foreign trade, competitiveness and current accounts (ECLAC, 1987).

As a result of the recent wave of high oil prices, a series of technological advances relating to new sources of energy came into play. If necessary, these could become competitive with oil if the price of oil increases further. This would have a significant effect on the balance of foreign currencies, in both the oil-exporting and the oil-importing countries.

The possible negative effects of biotechnology on the region's agriculture are beyond question. They include such factors as the widening gap in competitiveness with industrialized countries and the intensified competition faced by natural products, such as sugar, when confronted with products that include a component of technological manipulation.

The increase in agricultural yields in the industrialized countries will generate larger surpluses, which will have to be sold at low prices. It is probable that subsidies will continue to constitute a structural feature of agricultural policies. Unlike what happened in the Green Revolution, the technology of the biotechnological revolution is private property, and this fact immediately poses problems of adaptation, patenting and transfer costs.

b) *Internal aspects*

New technologies may help to eliminate crucial bottlenecks, especially in the modernization of processes, and help to raise the productivity of the rural sector, of medium-sized and small enterprises and of labour in general. As has been pointed out, technological backwardness presupposes the existence of reserves of productivity; yields can be raised considerably through the introduction of relatively simple innovations.

Technological options —whose validity will depend on the market that is being catered to— will be expanded, especially in scenarios with a low growth rate. The shortening of the production cycle as a result of the rapidity of innovations accelerates the obsolescence of capital goods. There may also be interesting possibilities of changes in scale advantages.

Information technologies provide solutions for a number of problems that arise at the various levels of public administration, especially with regard to the large-scale processing of information relating to its various functions and to the planning process. National and regional integration may be facilitated by the use of such technologies; decentralization may be helped to move from the level of talk to the level of reality.

The satisfying of various basic needs —food, energy, health, housing, transport, personal safety and a clean environment— may be significantly supported through the utilization of these new technologies. Their dissemination and application in the context of public health will have a positive impact on people's life expectancy.

An especially interesting area is that of construction materials. The appearance of plastic filler opens the possibility for more intensive utilization; the same thing is happening in the case of fibre-reinforced composites.

Biotechnology also offers promising possibilities to Latin American agriculture. Nitrogen-fixing in crops such as rice or maize would reduce the amount of money spent on fertilizers. The development of varieties that make more efficient use of water would permit the farming of new land or the better utilization of currently used land. Fast-growing forest species may make

a significant contribution and prevent the processes of desertification. With regard to livestock, genetic engineering is opening unforeseen possibilities, although it is not yet close to bearing fruit. The creation of hormones, vaccines and reproduction technology may promote the breeding of animals with various predetermined characteristics.

New technologies unquestionably have an effect that is likely to cause unemployment in those cases in which the objective is not to increase production but to make it more efficient. However, there are also sectors in which the introduction of such technologies can increase both productivity and employment at the same time. This is true, for example, of small and medium-sized enterprises, which can

increase their demand for labour if they have a better supply of relatively inexpensive producer goods which are simple and easy to maintain and repair, as has already happened with the introduction of electronic machines. The same can be said of much of the informal sector, especially if appropriate applications are developed, for example in the improvement of hand-held machine tools. A consideration of some importance for the evaluation of this problem is represented by the level and modality of economic growth that can be attained with the new technologies. This is so because under certain conditions of adaptation of the fruits of technical progress, accelerated growth of an economy can raise the entire population's standard of living (Lahera and Nochteff, 1983).

IV Policies

1. Academic and policy approaches concerning technology and development

The relationship between technological policies and regional development has been approached from various points of view. There are divergences between the different approaches, but there are also shared features, depending on the point of departure, the main emphasis, the policies proposed and the development schemes they aim at, among other variables (see the annexed summary table).

The central problem, according to the neo-classical theory, is technical adaptation—which is interpreted chiefly as the acquisition of existing technology—of the developing economies in accordance with the international productive specialization of each of these countries. A preferred vehicle for the transfer of technology is represented by transnational corporations, a fact which emphasizes the importance of the climate for investment. A second channel is international competitiveness, which is attained by reducing protectionism. This view is explicitly associated with a capitalist approach to development.

The orientation that derives from the theory of dependency centres on the condemnation of a set of problems created by the technology generated in industrialized countries: poor adaptation to the factors found in the country and difficulties relating to the transfer of technology (prices, conditions, time-limits, restrictions and others). Its recommendations for policy are weak ones: opening of the technological package and control of the transfer process. It is implicitly associated with a view of development that assigns a crucial role to the public sector.

A policy answer to the theory of dependency is the approach of adapted technology. This holds that the developing countries should adopt a technology appropriate to the resources they possess—oriented towards capital economies and labour-intensive—which is non-contaminating and which will promote "another kind of development" that is more humane. It reveals a strong ethical inspiration, as well as a special value placed upon participatory development. However, its aims and aspirations are usually unrealistic, and it fails to explore in detail those specific aspects in which its postulates would be valid. Its view of technical progress in terms of an isoquantum resorted to as one

Summary table

ACADEMIC AND POLITICAL APPROACHES CONCERNING TECHNOLOGY AND DEVELOPMENT

Approaches	Point of departure	Main emphasis	Policies proposed	Model of development	Principal authors
Neoclassical	Economic. Existing technology, key to productivity and competitiveness.	Absorption of the necessary technology in accordance with international specialization.	Promotion of direct foreign investment; liberalization of foreign trade.	Capitalist.	Moore (1983)
Dependency	Political economy; asymmetries in the relationship between industrialized countries and developing countries.	Condemnation of developed technology.	Opening of the technological package; State control of the transfer of technology.	Close to socialism, with preponderance of the State sector.	Vaitsos (1974)
Adapted technology	Ethical and social. Lack of humanity of the current approaches to development, technocratism.	The need for "another kind of development".	Promotion of technologies that economize on capital and are labour-intensive. Non-contaminating.	Ecology-oriented, based on the satisfying of basic needs. "Alternative".	Schumacher (1973)
Endogenous nucleus	Economic and technological. "Grotesque" imitation of development. "Show-window" modernization. Limitations of the economic approach to technology.	Creation of a self-sustained and dynamic industrial centre. Opening of the "black box of technical progress". There are sectors which are the preferred carriers of technical change.	Modification of social attitudes in the face of technical progress. Promotion of liquidity, austerity, growth, competitiveness.	Mixed economy.	Fajnzylber (1983)
Selective endogenization	Technological. Potentialities of modern technology.	Technological options exist. Public policies constitute the key variable.	Selectivity in the absorption of technologies. Increase in the capacity for technological analysis.	Mixed, with State preponderance in technological policies.	Nochteff (1987) Lahera y Nochteff (1987) Pérez (1985)
Microeconomic	Consideration of cases. Recognition of the existing technological capacity in developing countries.	Idiosyncratic character of the function of production in developing countries.	Promotion of the local technological cycle. Differentiation of sectors.	Universe of reference: private firms, national and foreign.	Katz (1890)

pleases is an unrealistic one. Its approach to development is an ecology-oriented and alternative one.

The idiosyncrasy of the functions of production in the developing countries, in view of their various characteristics, is the point of departure of the microeconomic approximation. This approach emphasizes the productive and technological capacity existing in the larger countries of Latin America. Its universe consists of private enterprises, chiefly national ones.

The problems of the endogenous nucleus of productivity confer great importance on a country's own technological and industrial capacity, which can enable it to grow beyond a "grotesque imitation" of capitalist development. For attaining that goal, it prescribes the creation of a set of interrelated activities —including the capital-goods sector— which will promote a basic level of self-sustaining development and make it possible to absorb the new technological advances. It is implicitly associated with a mixed-economy scheme.

Close to the preceding approach is the approach of selective endogenization, which gives preference to the incorporation of technological knowledge into the national economy, on the basis of a model of industrial development whose characteristics must be defined in democratic form. It is implicitly associated with a mixed-economy scheme and includes substantial State participation.

The last two approaches are based on two fairly common assumptions: first, that selectivity in the transplanting of technology is possible; and second, that there exists a capacity to evaluate the technology being supplied. Although it is a fact that lack of selectivity causes problems, the question how to operate selectively remains unanswered. Both of these technical assumptions imply that there exists, or there can be formulated, socially shared criteria for the selection of technology and productive and social readaptation.

2. Some elements of possible policy

Undoubtedly there are important common factors among the different areas of technological interest outlined above. But beyond the unifying factor of the emerging paradigm (if such a thing exists), the discrepancies are equally significant.

The technological problems related to competitiveness involve the possibilities faced by exporters (actual or potential) with regard to improving supply in comparison with other competitors throughout the world, or of creating a niche for their products.

With regard to the internal market, it would be necessary to follow a policy oriented towards very specific problems: health, housing and education, among others. The main problem in this case is not so much competitiveness as efficiency. In the case of small-scale production, it is necessary to find appropriate technology, in addition to ensuring financial viability and State support for small producers, including the elimination of the institutional barriers that prevent their entry into markets. Organization, participation and self-management are also important.

With regard to the factors promoting the process of incorporation of technical change, it is beyond question that the private sector plays a fundamental role with regard to entry into international competition. Furthermore, small enterprises are, by definition, private firms.

It is also true that the State has an irreplaceable role to play in the progressive satisfying of basic needs. However, the State's role goes considerably further, for various reasons:

- There are areas in which the principal demand for the incorporated technology comes from the public sector.
- Research capacity and careers for researchers are usually found in universities, whose financing comes largely from the public sector.
- Centres for research and applied technology in various fields, especially in agriculture, belong mostly to the public sector.
- The State has greater bargaining power, especially if it knows what it wants and decides to go after it, which, in any case, is not usual.
- A high percentage of operations with technological content are concentrated in the State and in transnational corporations, including atypical markets.
- The mere taking of coherent action by the State would bring a substantial increase in the efficiency with which the scanty funds allocated to technological innovation are utilized.

It is important to avoid an Atlas complex: the State cannot and should not do everything, for technical, political, economic and social reasons. The private sector has a decisive role to play in the design and application of technological strategy, as well as in the distribution of currently available resources. The promotion of the entrepreneurial spirit is essential, beyond the forms assumed by the ownership of firms. At the same time, the age-old contradictions between planning and the market may be overcome in relation to technology as well. It should be mentioned that there have been no successful cases of productive transformation in which there was not some link between the public and private sectors.

Industrial policy should distinguish between the various integrated industrial complexes: the motivating industry in each case, as well as the common technical base, where appropriate. The sectoral emphasis will vary from one country to another, but attention must be given to considerations relating to the preferred carriers of technical change. This implies a clear industrial policy, particularly with respect to capital goods.

It is important to design not merely technological plans but industrial plans with a technological content, as was perceptively put by Carlos Aguirre, head of the Technological Policy Department of the Board of the Cartagena Agreement (JUNAC). Policies of this kind cannot be defined by National Councils for Science and Technology—at least their names would have to be changed. The preferred mechanism for the incorporation of innovations is investment, and the rate of investment has fallen sharply in Latin America, partly because of the troubled situation of the foreign financing sector. Bringing about a reduction in existing interest rates or a decrease in the principal of the debt will be a prerequisite for any technological policy.

With regard to meeting basic needs, we must take a normative approach, whereby society will set goals for the population as a whole or for particular sectors. These "privileged areas of demand" can be met with a significant contribution by technology.

Regional, national and international telecommunications form the indispensable basis for the application of new technologies. The

relevant policies must be based from the outset on a rationalization of these systems, as has been pointed out by Carlota Pérez (1985).

It is essential to maximize the internal capacity for creating and adapting technology, within limits which are consistent with the opportunity cost for the country. Among the factors required for such an effect the most prominent are the country's engineering capacity and the existence of specialized personnel. This presupposes increasing the supply of skilled human resources; preventing the brain drain; having an adequate knowledge of the country's national resources and of the technological options for their exploitation; and meeting important financial requirements (Katz, 1980). The advance of technology is not homogeneous; it actually involves a front of positions along which there is discontinuous and unequal advance, even though it is influenced by the evolution of the general situation. From another point of view, an understanding of the direction and significance of the advance requires a knowledge of the front in its entirety.

A country's capacity to copy and adapt will, in general, impose increasingly severe requirements, although there are exceptions, such as biotechnology. The international competition that exists in the various sectors related to the new technologies is extensive and intense in some cases and almost non-existent in others (Nochteff, 1987).

The system of patents should be revised in accordance with criteria that will combine the necessary protection of intellectual property and its fruits with the possibility of efficient dissemination of technological knowledge (Katz, 1980).

Various experiences prove that a technological policy is conceivable only if it is closely correlated with a scientific policy. Failure to manage the scientific rationale of technological innovation brings the penalty of becoming a mere acceptor of prices, dependent on the decisions taken by others concerning production and the orientation of markets. Technological intelligence constitutes a particularly suitable route when the technology is commercially available and when there is a possibility of taking advantage of it on the basis of development of the nation's engineering capacity. The transfer of technology is a training and information channel

of great importance, provided that there is an actual transfer, that is to say, provided that the technology is eventually mastered in its substantial and operational aspects by the country acquiring it.

With respect to the technology incorporated into equipment, special care must be taken, since this often initiates chains of technological determination whose cost keeps increasing. In this case too, the relationship will be continuous, although it will be increasingly burdensome for the recipient country (Lahera and Nochteff, 1983).

New technologies constitute a particularly favourable field for international co-operation between countries and institutions of the third world in general and of Latin America in particular. The similarity of the problems faced by the various groups of countries, as well as the necessity of achieving essential critical scales and critical masses, should stimulate such co-operation both in development and in the incorporation of this technology.

Transnational enterprises must adapt themselves to national development policies, objectives and priorities, contributing to the creation and strengthening of the recipient countries' scientific and technological capacity. For that purpose, it is indispensable that the recipient countries should define their objectives and priorities and should specify the particular contribution to be made by the transnational enterprises. Once the role of these enterprises has been determined, co-operation may be actively sought both from those already established in the country and from others of various sizes and origins. Policies governing foreign investment must be selective and active.

Negotiation with transnational enterprises is usually complex and not necessarily easy: however, there are points of agreement between the optimization of the firm's profits and the achievement of national objectives. The establishment of clear priorities and clear rules of the game for each case will facilitate the search for an understanding.

3. *Two unsuccessful experiments*

The main results achieved with the system of control over the transfer of technology relate to the balance of payments, not to technological

problems. The application of the various régimes seems to have resulted in a decrease in the annual rate of payments for technology, as well as a decrease in the significance of these payments as a share of the recipient country's total exports. At the same time, State intervention has improved the recipient enterprises' capacity to recognize and resist the imposition of unfavourable contract terms; the time-limits of the contracts have also been shortened (Correa, 1983).

There is one point which is causing concern to the organizations responsible for science and technology in Latin America. In many countries there have been notable advances in the formulation of *ad hoc* national plans, which have *inter alia* the merit of making public opinion aware of the situation, making analysis more homogeneous and providing common foundations for action by various participants. On the other hand, there is a limited—and perhaps already nearly exhausted—area in which measures for the co-ordination or the non-traumatic reallocation of resources can serve to promote effective advances. The organizations are ready, the relationships between the objectives are complete and well-grounded; the lines on the organizational charts are not dotted lines but are straight and clear. And yet problems continue to exist.

In general, national systems lack the essential resources. National plans for science and technology frequently appear as an unintegrated annex to development plans. The link to the production apparatus is weak or non-existent. There is a lack of political will; meanwhile, regulations and institutions proliferate until they reach the proportions of the map in the short story by Borges, which was drawn on a scale equal to that of the real world. The administrators of such organizations are very well aware of these problems. They wonder whether laws are enough. Technology cannot be separated from the productive apparatus, nor from the satisfaction of basic needs, nor from basic research. The scientific and technological system may be able to co-ordinate, to produce incentives, to provide subsidies and the like, but it cannot replace scientific and technological activities.

As has been pointed out: "After a hegemony that has lasted a whole decade in Latin American thinking about scientific and technological policy, the systems approach has completed its cycle

of development. Its principal contributions have been extensively disseminated and incorporated into the theory and practice of scientific and technological policy, and it may be said that they have laid the foundations for new approaches to be used in the future... It does not seem appropriate to go on developing abstract conceptual models and global schemes of the scientific and technological system. There is little that can be added to what already exists in this field... Some applications of the systems approach at the sec-

toral level continue to produce interesting results, but they will probably reach the limit of their usefulness in the near future" (Sagasti, 1983).

It therefore seems inevitable that we must go further and place the debate on technology within the framework required by new circumstances—in other words, a framework of productive restructuring of the Latin American economy.

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