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TECHNOLOGY AND SOCIO-ECONOMIC DEVELOPMENT IN LATIN AMERICA: A GENERAL  
ANALYSIS AND RECOMMENDATIONS FOR TECHNOLOGICAL POLICY

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## Summary of the document

### TECHNOLOGY AND SOCIO-ECONOMIC DEVELOPMENT IN LATIN AMERICA: A GENERAL ANALYSIS AND RECOMMENDATIONS FOR TECHNOLOGICAL POLICY

#### Introduction

Science and technology, or perhaps more specifically the problem of technological advance, has been one of the pillars of what is generally called ECLA thinking since the inception of the institution. In its earliest documents, and in the writings of its intellectual director of the time, Dr. Raúl Prebisch, the problem of technology was identified as one of the central aspects in its concept of the centre-periphery system.

Attention was called to the fact that technical progress had spread only slowly and irregularly from the countries where it originated to the rest of the world. A few great industrial centers grow up while the bulk of the world's population in the heterogeneous peripheral areas shared only to a slight extent in the improvements of productivity.

This now sounds commonplace, but it should be recalled that through the 19th century the dominant liberal belief was that technological advance would more or less automatically spread to other nations and relatively evenly benefit all mankind. The opposing marxist view was in this respect similar, sharing the conviction that industrial capitalism would spread urbi et orbi, replicating in outline the central economies. Even the legal and institutional arrangements built up at the end of the Second World War rested to a major extent on implicit beliefs of this sort.

Many individuals have contributed to the clarification of this situation, but it is no boast to say that ECLA has played a role here.

The contrast between the development and advance of technology in the industrial centres and its slow and irregular spread to the periphery is a basic factor in the final results: concentration on the one hand, marginalization (relative or absolute) on the other.

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The features of industrialized economies are the diversification of their productive machinery, their internal integration, their relative homogeneity, their specialization in manufactures in world trade, and their status as international investors and creditors, - all of which leads to high levels of income and a high capacity to accumulate and create science and technology. The characteristics of the periphery are completely different, and in extreme cases are the opposite.

The purpose of this brief account is to attempt to show that the analysis and discussions on science and technology, at least vis-a-vis the problems and tasks of economic and social development, cannot be separated from the overall context and the functioning and relations of the centre-periphery system. Only in this way is it possible to see the deep roots of the so-called "technological gap" and to understand that the allied problem of the concentration of technical progress in the central economies and the relative marginalization of the periphery can only be solved in so far as it is possible to change the structural basis and contrasts which give rise to this problem, as well as the types of relationships which exist between the two spheres.

This general approach must be reformulated in the light of the important changes resulting from the post-war diversification, particularly in the more developed Latin American economies. First, there is visible evidence of the spread of technical progress in all sectors, but especially in industry. The pattern of the "outward oriented" phase, in which improvements were largely confined to the exporter-importer complex, was transformed, creating a context of "technological heterogeneity".

Secondly, although in the initial stage the change was within the restrictive framework of national markets and without greater participation of foreign capital, these aspects have changed in recent years. The role of foreign investment increased and became of primary importance in the diversification of the productive system, particularly in the more dynamic industrial activities and its

/supporting services.

supporting services. Also, in a number of these economies the foreign sector widened and became more complex.

There is thus the need for a critical reappraisal of the new situation. Concern with the intensity, quality and conditions of the transfer of technical progress, and the clearly unsatisfactory state of affairs with regard to national or regional creation and adaptation of science and technology, is evidence of the fact that the changes recorded fell far short of satisfying Latin American aspirations in this respect.

Of prime concern here is the scope and tendency of this new stage in the spread of technical progress, as well as its social implications. Doubts have increased with respect to the capacity of the process to extend to the entire economy and to thus introduce an integrated and relatively homogeneous system incorporating the mass of the population.

It seems clear that thus far the higher productivity has been limited to some urban areas, some regions, and to the enterprises which form the so-called "modern stratum" of these economies. The fruits of the process have gone largely to those having the closest ties to these productive and territorial centres.

Faced with this unsatisfactory situation, there are two well known and opposing points of view - with all the classic variations and nuances. On the one hand, there are the arguments of those who maintain that the restricted spread of technical progress and its benefits - and the type or style of development involved - do not help to open a way to establishing a homogeneous system, to wide spread social participation and, particularly, to finding a solution to the problem of the critical poverty of the large section of the population. On the other hand, there are those who think that the solution to the problem depends basically on steady and intense growth. To the extent that such growth can be maintained at sufficiently high rates and for sufficiently long periods those objectives will be attained in the end, as they were in the central economies.

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It is of course not possible to reproduce the chain of arguments here. As with any analysis projected in time decisive answers are difficult because they depend on the validity of forecasts of future trends. Available information does justify the investigation of prospects and reasonable alternatives however, at least for the region as a whole, and this is done in Chapter II of this document. It is clear that it will be at best very difficult for prevailing patterns of development to resolve the problems within any reasonable time span.

Similar conclusions follow from the experience of the past decade with respect to the distribution of income. For the region as a whole there were some changes in the income distribution pattern, but of a restricted sort. The percentage share of the top 10 % of the population declined significantly (although their real per capita income increased by US\$ 292, far more than for any other group). The percentage share lost by the top 10 % was gained by the 20 % just below this top group. Through the rest of the distribution the changes in relative shares were of minor importance. The share of the poorer half of the population in particular showed only a small rise (the share of the poorest 30 % actually fell slightly) and the real per capita income of this half of the population increased only US\$ 30 during the decade. These figures show that the new variety of development has had little effect on income levels and living conditions of a large part of the population.

All of this raises a number of questions regarding the role of technical advance in economic and social development. The complacent view that technology will resolve, or be a key factor in resolving, the world's problems has been increasingly challenged. The most alarming reason for suspicion is its relationship with the destructive arts of war. But there are others, such as repercussions on the environment and the quality of life, the distortions of an economy of waste, and the pessimistic future picture of a cybernetic society. Thus far these views have naturally mainly been prevalent in the industrialized economies, but it is clear that countries such as ours have already been affected as well.

The main point of this critical reappraisal should be to avoid any kind of technological "fetishism". Technical progress per se is neither the philosopher's stone nor the root of all contemporary ills. The fundamental issue is for what, for whom and how the potential for technical progress is employed and mobilized.

The experience in Latin America referred to is a case in point. The progress achieved, as well as the failure to solve various problems in the area, reflects the style of development which has been followed, which has established the pattern and destination of technological progress.

From this standpoint the alternative technological policies would be quite clear. So long as the style of development remains the same, they should be adjusted to it and fulfill the tasks set as efficiently as possible. If, on the other hand, they are intended to operate in another manner and in terms of other objectives, it is a sine qua non that these new objectives should be specified in a new economic and social strategy.

This does not mean that technological progress is regarded as a dependent, or passive variable - there are reciprocal influences between the style of development and the technology. But the matter must be looked at from the standpoint of the circumstances and preoccupations of Latin American economic and social policy. There is an increasing concern with problems that have either not been resolved or have been created by the dominant styles of development. This is apparent from public statements, in action plans and in discussions among influential circles.

From the standpoint of this document, the positive guidelines that derive from this critical re-appraisal are quite clear. The centripetal forces encouraging the concentration of technical progress

and of its benefits must be replaced by a sustained incentive to spread outwards, tending toward the homogenization of the productive system, towards a marked attenuation of disequilibria between regions and between the urban and rural areas, towards internal integration, towards new, less precarious and more fruitful external relationships and, finally and above all, towards a better distribution of income.

This being so - whatever one's views or forecasts regarding the action that would eventually be taken as a result of these preoccupations - it is obvious that technological policy should not wait passively for the complete definition of a new approach to development but should already start establishing the basis of its own reorganization.

For this, it is essential to make a critical analysis of certain fashionable attitudes in Latin America. The following chapter attempts to do this. It is also essential to give a broad outline of alternatives for the future according to the style of development adopted by the region. This is dealt with in Chapter II. Finally, a rough outline is needed of a technological policy that reflects the awaited new directions and responsibilities. An attempt at such an outline will be found in Chapter III.



## Chapter I

Since World War II there has been a substantial increase in the importation of new techniques, mainly "embodied" in foreign equipment, product designs, technical assistance, contracts with foreign firms, and in direct private foreign investment. This was initially viewed as one of the key benefits from industrialization; and it was expected there would be a progressive movement from this phase, where copying foreign technologies is the rule, to a second, characterized by an enhanced capability for creatively modifying the imported technology, and finally to a third where the country becomes a technological innovator on an internationally competitive level.

This optimistic perspective has now given way to concern that, despite substantial industrialization, there is little sign of the region moving out of the first stage of technological dependency. This concern has been sharpened by criticism of other socio-economic trends: the distribution of income, employment, effects on the balance of payments, dependence on foreign industrial investment, and the brain drain.

There is, however, no general agreement about what is wrong with Latin America's technological performance and how to improve it. Three broad views can be identified which will be referred to as the technological gap approach, the relative price distortion approach, and the lack of indigenous creativity view. Adherents of each of these views usually accept that there are elements of validity in the other two, but believe their own perception of what's wrong and what can be done about it is the most comprehensive and relevant. The present diagnosis recognizes the partial validity of the technological gap and relative price distortion views, but contends that at heart the problem is not simply a lack of knowledge and experience but also the socio-economic forces that filter new technological knowledge into the economy in such ways as to unduly retard the development of indigenous technological creativity. An effective long-run technology strategy for Latin American countries will therefore have

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to focus strongly on means for overcoming these retarding forces, rather than merely on means for disseminating technological information.

The best way to support this view is by an analysis of the shortcomings of the other two main views noted. In the technological gap approach technological dependence is viewed as appropriate for Latin American countries under existing circumstances. The approach recognizes that the unfavorable socio-economic trends mentioned above represent very serious problems, but it believes that the main technological source of these problems is the inadequate rate of transfer of best-practice foreign technologies to the region. In its reading of the situation modern activities in Latin America are still quite young and inexperienced. Their main needs are for much greater exposure to imported technology and organization, and more production and marketing experience. Its reading of the economic history of earlier successful late-industrializers is that a long gestation period during which reliance was chiefly on foreign technology, was an essential pre-requisite for establishing the conditions for passing on the phase of indigenous technological creativity. However, since the demographic explosion, rural-urban migration rates, and aspirations for individual material improvements in Latin America today are more intense than in the earlier experiences elsewhere, national technology policies are needed, their main thrust being to accelerate the importation and diffusion of modern technology and organizational methods.

Specific policy proposals emphasize, therefore, the creation of documentation centres, technical assistance institutes, the expansion of science and engineering curricula in universities, etc. Concurrently, firms should be encouraged to expand their technological assistance and licensing contracts with foreign firms, and a favourable climate should be created to attract foreign investment in high technology activities. These measures to increase the inflow and dissemination of technological information should be accompanied

/by measures

by measures to help finance the adoption of new equipment, particularly by small- and medium-size firms. In addition, since the international market for technology has strong monopoly elements, the state should oversee the specifications of the foreign contracts so as to improve the "technological terms of trade". These various measures would not only facilitate the modernization of the entire society as regards values, aspirations and material rewards, but would also help create the broad knowledge base necessary for entry in the phase of indigenous technological creativity.

Though not without merit, the approach has three main diagnostic weaknesses, which cast doubt on the adequacy of its policy prescriptions.

The first is that many Latin American industries are not comparative infants to the region. Therefore their technological sluggishness cannot be attributed primarily to inexperience. For example, the first and second largest factory textile industries of Latin America, those of Brazil and Mexico, were first established, with imported equipment and technical assistance, over a hundred-and-twenty years ago, predating Japan's first textile factories by two to three decades. Yet today these Latin American industries remain dependent on foreign sources for most basic equipment, new processes and products, and technical assistance. Whatever the reasons for this failure to generate the equipment backward linkages, technical creativity and organization dynamism that the "mother" industry of the industrial revolution was able to set off in successful late-industrializers like the United States, Japan and France, inexperience can hardly be an important part of the explanation.

Secondly, the diagnosis misreads the economic history of successful late-industrializers. Their initial phase of technological dependency was neither very deep nor very prolonged. Indigenous technological creativity emerged quite early in their industrialization. Some of the 19th century Latin American textile mills were erected with equipment and technical assistance imported from the United

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States, which had already captured part of the market from the pioneering British. Japan has reached first rank among world industrial powers, while assiduously excluding private foreign investment throughout its industrial upsurge.

Finally, the diagnosis disregards powerful "systems-maintaining" forces in the contemporary relationship between the high-income centre and the countries of the periphery. Neither modern technology nor the range of modern consumer goods are static in the centre countries. Excessive rates of inflow of new consumption styles via the "demonstration effect", combined with technological borrowing to satisfy the demand for new consumables, can result in the peripheric economy largely exhausting its physical and human investment capital in meeting the changing demands of a thin and only slowly expanding modern strata through continual technological imitation. The resulting gulf separating that strata from the low-income mass of the society may not be bridgeable by "trickling down" within a politically feasible time span.

These points are supported by an analysis of the industrialization of other successful "latecomers" in different historical periods. It is noted how the problems faced and solutions required have changed with the passing of time. Three periods are distinguished: the early period up to 1860, from 1860 to the First World War, and from the First World War to the present. The process of technological advance has changed in important respects from one period to another and so the late industrializer has been faced with changing, and in some ways more difficult problems in the effort to achieve a level of technological innovation similar to that of other centre countries. Experience in late industrialization during the first two periods is drawn from the United States and continental Europe, and for the last period from Japan. For each of the different periods it is shown how conditions in the late industrializing countries differed from those in Latin America today.

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It is also shown that there is not a single set of closely similar sequences of socio-economic experiences on the way to full modernity - the sequences vary in important respects from one country and period to another. Latin America, in the different set of present day circumstances will require its own particular set of sequences.

The other main view - the relative price distortions approach - contends that the main source of the inappropriate technology problem is that Latin American countries have pursued economic and social development strategies which have unduly cheapened the cost of capital in relation to labour costs. Over-valued exchange rates, tax and credit subsidies, and overly protective tariffs against competitive imports have "artificially" lowered the cost of capital to investors, while trade unionism and various conquistas sociales have raised the cost of hiring labour, at least to the larger enterprises. Capital-intensive activities have thus been encouraged, labour-using ones discouraged, and within individual activities, the unduly depressed ratio of capital to labour costs has encouraged firms to import more capital-intensive technological equipment than they would have had "socially correct" relative factor prices determined technological choice.

To be effective, technology policies must therefore be closely linked to economic policies to bring relative prices in the factor markets closer to "true" scarcity price ratios. That is, the technology policies proper are similar to those advocated by the technological gap approach: the creation of entities for the faster entry and diffusion of technological information, plus measures to strengthen bargaining over the "technological terms of trade". But if these are to facilitate the selection of more socially appropriate techniques they should be complemented with trade liberalization measures and a reduction of foreign exchange, credit, and tax biases favouring investment in modern equipment rather than labour, and a curbing of conquistas sociales and of wage pressures from the

/unionized sectors

unionized sectors of the labour force. The main thrust is less dirigiste than is the technological gap approach, the emphasis being less on new forms of financial subsidies linked to industry rationalization, and more on increasing market competition. Apart from correcting the price "distortions", such competition would also pressure enterprises toward greater efficiency; it would force them to be more cost-conscious, aggressive and technologically alert.

This view has also some valid points, notably its recognition that effective technology policy cannot merely focus on increasing information flows, but must also be linked with economic policies that remove decision biases which distort technological choice. The basic weakness of the relative price approach is that it grossly oversimplifies the technological choice matrix.

There are two general aspects of the choice of technique not given sufficient weight in the relative price approach. First, it is assumed that there is a wide range of different techniques readily available so that if relative prices are altered there will be a general shift toward the use of less capital intensive methods. In practice however there are likely to be only a few fully developed techniques in most modern activities. There is usually a wider range of partially developed alternatives, but these require further creative development efforts before they can be put to use - the centre countries will have fully developed only those most suitable for their own use.

It is necessary to take into account the dynamics of technological change in the centre countries. In so far as it is concerned with alternative ways to produce an item, the objective will be to reduce costs. The central factor here in a wide range of activities has been the economies which can be achieved by increasing the scale of production. Increasing size has commonly reduced both capital and labour costs per unit of production. Improvements in technique have also often resulted in important savings in material inputs. Thus in many cases there is only a

single most efficient technique, often requiring a large scale of production. A change in relative prices will not affect the choice of technique in these cases as the efficient technique uses less of all inputs. A limited domestic market may force the use of a smaller scale plant, but this will only mean that costs are higher than in international markets, again regardless of relative factor prices.

The second general flaw in the relative price approach is that it does not give sufficient attention to the type of consumer demand which dominates modern economies. In the centre countries the major part of research expenditures goes to the development of new products or the improvement of existing ones. Product differentiation is further a central feature of the market. These characteristics - differentiated products and rapid change in the model or type of product used - are spread to the countries of the periphery via the demonstration effect.

In these circumstances, and in conditions of technological dependence, a domestic producer is not likely to be influenced by a change in relative factor prices. He will be primarily interested in a production process for a "known" product, and links to the centre firm so that as models, processes and fashions change he will have access to the information required to make the change and so avoid being left behind as the market demand moves on to new things.

All of this discourages any search for alternative production methods which might be less capital and more labour intensive. It discourages even more the research activities required if production patterns are to be developed which are more suitable to the prevailing conditions in Latin America. This is a major aspect of the difficulties faced in proceeding with an imitative style of development.

## Chapter II

This chapter describes the use of a simple simulation model to project different styles of development to the year 2000. Varying

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assumptions are made and the results are compared and checked with the analysis in the preceeding chapter. The assumptions and results are fully described in the document, but only the briefest conclusions are noted in this summary.

The first exercise is an "optimistic" set of assumptions applied to Latin America as a whole and projecting the continuation of the existing development pattern. The central assumption is that the gross product will expand at the rate of 7 % per annum during the 1970-2000 period. This compares with a 5.4 % rate achieved in the 1960-1970 period.

Even after 30 years of relatively rapid growth the contrasts would remain large. Slightly over one-quarter of the labour force would remain in subsistence type activities at the end of the century (compared with 35 % in 1970). Over half the labour force would be in the intermediate sector, with productivity levels not much more than one-quarter those of the modern sector - although far above those in the subsistence area. Productivity in the modern sector would increase in line with that of Western Europe, but although the proportion of the labour force absorbed by the sector rises it would still account for only 20 % of the total at the end of the century.

In the "pessimistic" projection the major change in the assumptions is that the gross product would increase at a rate of 5 % per annum to the end of the century. The results are of course less favourable on all counts.

Even though a 7 % growth rate would not suffice to bring about an integrated economy by the end of the century, this is still a very high rate to sustain over a 30 year period and it needs to be asked whether such an achievement is likely. A complete answer would involve an analysis of all the aspects of economic growth and is well beyond the scope of this document. Attention is however called to an external obstacle which is of particular importance.

With what seem now to be reasonable assumptions there would have to be an enormous expansion of industrial exports to finance a

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rapid growth of this sort - industrial exports would have to increase at about 17.5 % per annum. An increase of this magnitude in the production of exportable industrial goods would in itself be a substantial achievement. But when this is compared with total export markets the situation is much more serious. The demand for industrial imports in the centre countries will increase much more slowly, so this would imply that Latin America's share in the total market would rise from about 1 % to about 26 % during the 30 year period. This would mean a sharp drop in the centre countries' share of industrial exports, and probably also a preferential position for Latin America vis-a-vis other countries of the periphery. Thus success would require not only a successful production effort on the part of Latin America, but also a willingness by the rest of the world to accept major changes in international trade patterns.

While export markets would be a major obstacle for the region as a whole, this would be less so for an individual country. One or two countries might in effect become export centers for the region. Success for these countries along the above lines would then be more possible - the increase in exports would not be so large a proportion of the world total. This would of course mean that the rest of the region would be unable to advance in this way, and another form of inequality would be aggravated.

A similar experiment is also made for a different style of development, one oriented not toward rapid advance in the modern sector but toward raising productivity levels in the rest of the economy. If a high rate of growth could be achieved with a development style of this sort much more progress could be made in integrating the economy and reducing the extremes. Even with a lower rate of growth important progress of this sort would be possible.

The external sector would no longer be the main obstacle to accelerated growth as import requirements and other external payments would be less with this style of development. The major obstacles to a high growth rate would be of an internal nature. The region would be largely charting a novel course, away from the economic dynamics that have dominated its growth since the mid-19th century.

### Chapter III

Policy measures in the past decade have concentrated mainly on three aspects of the region's complex technology problems: improving the "technological terms of trade", expanding the channels for disseminating technological information to local producers, and enlarging the cadres of scientists and high-level technical personnel. The basic rationale guiding these policies has been the technological gap approach in combination with the view that the semi-monopolistic international market for technology requires countervailing power by the state to strengthen the weak bargaining position of local producers as purchasers of foreign technology. As yet the direct promotion of indigenous creativity as a partial substitute for technological importing has played a subordinate role in most countries.

The basic implication of the analysis of this document is, however, that a substantial capacity to adapt and create technology is crucial for development strategies that aim for broad-based socio-economic growth. Hence its corollary is that Latin American technology policy must alter its order of priorities and begin focusing on methods to stimulate that capacity.

It should of course be apparent that quick payoffs from such efforts are unlikely, but rather that the rewards will cumulate over time. Initially, the payoffs will be restrained by inexperience as well as by the long gestation and high failure rates that characterize innovative efforts even in societies with long experience at creating technology. But even more basically, the pace of the Latin American effort will be constrained by the socio-economic obstacles analyzed in earlier sections. Nevertheless, the effort need not wait for mass attitudinal conversion and wholesale institutional changes to set the stage. There are openings even within the existing socio-economic setting to start redirecting and amplifying technological strategy, and in so doing, to alter favourably the setting itself.

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In identifying such openings, it is useful to distinguish the productive areas where lack of adequate technological information is a key obstacle to improving social productivity, from those in which decision biases of the enterprises are the chief obstacle. In the first areas, institutions that provide direct technical assistance, data banks, and other means of enriching the flow of information could be quite effective. In the second areas, the attempt to supply such information will be largely met with indifference by the potential recipients, since they already have informational networks suitable for their purposes.

In the private sector large firms producing for the local market are typically engaged in oligopolistic market strategies; and they are the main private channels for importing foreign technology, since their continued participation in product differentiation competition critically depends on replenishing product lines from abroad. Well-established informational channels link them to foreign sources of new technology; to the multi-national headquarters in the case of foreign subsidiaries, and to foreign licensors in the case of domestically-owned firms.

Obtaining technology through these channels has two overwhelming advantages for the firm. One is that it receives as a package a well-tested process or product accompanied by expert assistance in production layout, trouble-shooting, quality control and marketing, at a more or less predictable unit cost. The second is that the licenses often include exclusive distribution rights in the local market. These advantages greatly lower investment uncertainty for the firm in staying abreast of local oligopolistic competition. If these market characteristics continue to prevail it is unlikely that technological institutes can, by simply offering technological services, establish more than marginal relationships with the large private firm. More general changes in economic as well as technological policy are likely to be required to induce the large private firm to become an active participant in the search for more appropriate techniques.

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There is however one important exception: industrial exporting. Here even the large Latin American firm would be a marginal supplier and its main concern would not be with product exclusivity and market shares, but with the large financial costs and risks of exporting to highly competitive markets. Technological collaboration should therefore be welcomed. Even in the export area however the foreign subsidiary is likely to remain indifferent.

Another potentially fertile area of industry for technological collaboration is small and medium enterprise. Such firms are usually too small to worry about market shares and technological exclusivity, and are also too small to interest foreign licensors. Effective technological collaboration would require parallel organizational innovations, for example producer co-operatives and special financial institutions to assist the rationalization of production. Models for this can be found in similar efforts of many post-war European countries, notably in France. The technological adaptations need not, indeed should not, be directed toward high technology. Indeed, the intermediate sector could well be the place to begin experimenting with product simplification and the descaling of processes. The base for the technological effort could often be older product designs and processes that the centre countries have since replaced with more complex ones. Knowledge about such products and processes is now largely in the public domain, although considerable data collecting would be needed to establish an adequate information base from which to select suitable products and processes for modification to local needs.

Further down the technological ladder, a potentially fruitful area is the "subsistence sector". The sector includes marginal urban activities, but its main base is still rural, in agricultural minifundia and village artisan industries. The two combine to form the most backward and impoverished part of Latin American society. The "subsistence sector" lacks virtually all the requisite inputs for elevating its productivity and material well-being: lack of access to superior technical information, to skills and finance for exploiting such knowledge, and to group organization for generating the requisite inputs.

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As in the other areas, technical help would have to come in a package that includes the other inputs. The basic objective should be to reproduce the dynamic interaction between agriculture and rural industry that was the dominant feature of earlier 19th century industrialization. In that era, however, the dynamics were sparked by the wealthier and more technologically alert segments of agriculture and industry. By contrast, the Latin American rural "subsistence sector" represents the most impoverished and technologically stagnant part of agriculture and industry. The dynamics have, therefore, to be mainly sparked from without.

Technological progress in this sector does not require sophisticated new techniques, but rather modest but successive improvements of existing techniques in both the minifundia and the artisan industries. In the initial period, the guiding objective should be improvements that the "subsistence sector" could largely reproduce with locally available materials and skills. In this way the initial social cost of minifundia and artisan capital accumulation would be kept low since the major inputs would be labour time from underemployed labour to produce the materials and equipment; while local ingenuity and enterprise would be stimulated rather than overwhelmed. The technological task requires, therefore, very detailed knowledge of local socio-economic conditions. Organizationally this calls for close collaboration between anthropologists, agricultural economists, engineers and agronomists.

Finally, since the "intermediate" and "subsistence" sectors of various Latin American countries have many features in common, there is a strong basis for regional collaboration between national technological efforts, for frequent exchanges of experiences and solutions. This could accelerate the payoffs from these efforts in each of the countries. In these aspects of the strategy, many smaller countries of the region could play a major role in the institutional and technological innovating.

The decision biases of public sector enterprises and agencies which militate against indigenous technological creativity are of a different order than in the private sector. In the public sector they derive from an excessive propensity of high-level Latin American technicians and  
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scientists to take their cues concerning the choice of technology and of scientific research projects from their counterparts in the centre countries. As a result, the potential of these cadres for assisting social and economic development remains seriously underutilized. The general solution lies in greater awareness of the nature and consequences of the decision biases along with policy measures to constrain the exercise of these biases.

Large public sector areas, such as public works, transportation, and telecommunications ministries, have had a considerable amount of autonomy in choosing designs and equipment for their projects and in obtaining external finance. Since they are usually headed by engineers and can envelop their decisions in terms of technological expertise that tend to overwhelm supervisory financial agencies like the Treasury and Central Bank, and economic supervisory agencies like national planning boards, they have considerable scope for exercising their professional biases toward modern techniques and equipment.

Yet civil engineering is one important activity where the potential range of alternative techniques is quite wide. Until the 20th century civil engineering required the directing of large bodies of men, working with hand tools and a modest amount of specialized heavy equipment. Labour intensive techniques in earth moving, grading, reforestation, track-laying and other phases of public projects, could play a much greater role in absorbing labour and in minimizing foreign exchange pressures than they have in Latin America in recent years.

Devising workable solutions for the difficult logistics and management problems would not be easy. It may be that even with ingenuity and experience, such techniques would still increase budgetary costs and delay project completion. But to the customer, the Latin American government, the social benefits of higher employment and reduced foreign exchange outlays should compensate for at least a fair elevation of project costs. What is needed is awareness of the possibilities, decisions to experiment along such lines, and tighter controls over the selection of techniques by the supervisory agencies. One of the tasks that national

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science-technology councils could usefully assume would be to serve as advisors to the national planning boards and financial agencies, reviewing the technical aspects of proposed projects for dispensible modernization biases.

In the more extreme case where drastic changes in socio-economic policy are undertaken, to implement a new development style, it is necessary to consider policies affecting the modern private sector as well as the "easier" sectors discussed above. A few general guidelines can be suggested regarding technological choice for the Latin American modern sector during the initial phases of an "anti-dualistic" style of development.

In the modern sector, the effort to create technology should initially concentrate on final consumer goods and house building materials, notably on product simplification and increased use of local materials. As these are not direct inputs to other productive activities, the risks and costs of technological experimentation with products and processes would be isolated, rather than magnified by an adverse impact on the cost and quality of other products. Successful results, on the other hand, would create new demands for equipment and materials supplied mainly by the modern sector, with some stimulus also to raw materials production in the "rest of the economy".

On the other hand, the production of intermediate materials widely used by the modern sector should continue to rely on best-practice imported technology in the initial phases. The expanding economies of scale and technological subtleties of continuous process technologies, such as in steel, basic chemicals and petro-chemicals, and steam electric power production, are difficult enough for Latin America to keep up with. While adapting processes to differences in the composition of indigenous coal, mineral ores, and chemical feedstocks have often accompanied the establishment of plants in these activities, the redesigning has typically been done by foreign design teams. Progressively enlarging the participation of Latin American professionals in design adaptation would probably be the least risky way of developing cadres of local design /talent. In

talent. In this way a local talent base could be built up to design processes that extend the range of local raw materials the country is able to exploit economically, while minimizing the effect of the build up on the costs and export competitiveness of the modern sector.

Creating channels for supplying design and trouble shooting assistance from the modern sector to the "rest of the economy" should be another important objective. This is one of the major components of the Chinese "walking on two legs" development strategy that has impressed many observers. The Chinese example is not directly imitable as the basic conditions are different in Latin America, but it does illustrate the feasibility of the objective, even under more difficult initial circumstances. How to work out effective links between the modern sector and the rest of the economy would be one of the major tasks facing an antidualistic development strategy in Latin America.

It needs only to be stressed in closing that the foregoing analysis is in no way a case for technological autarchy, but rather for accelerating Latin America's movement out of the phase of technological dependency as a necessary condition for more equitable socio-economic development. The region, under the most realistically optimistic projection about the growth of its indigenous creativity, will continue for some time to be mainly dependent on foreign sources for new technology. Nor does achieving in time a broad capability for technological creativity mean anything other than that Latin America would then be able to participate more effectively in the exchange of technology which has so powerfully facilitated the economic progress of centre countries.

The implications for technological policy have been drawn only in general terms. Obviously, for specific applications each country will need to analyze in much greater detail its existing obstacles and the potentialities for applying institutional and technological innovations, for which analysis, however, the document hopefully provides a useful

/general framework.



general framework. Since the countries of the region differ in their levels of skills, natural resources and ideologies, implementation of these broad policy suggestions will vary in pace and content. However, the present endowment of skills and technical talent of even the small Latin American countries should suffice to enable them to begin work along at least some of the general policy lines of the strategy.

