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WORLD TECHNOLOGICAL CHANGE AND ITS CONSEQUENCES FOR LATIN AMERICA AND THE CARIBBEAN

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Introduction

The long period of prosperity experienced by the world economy during the postwar period has entered a period of slowdown and instability. Following the upsets caused by the sudden oil price rises and the consequent changes in the economic policies of the developed countries, enormous and persistent imbalances have become apparent in the world economy: the two deficits --fiscal and trade-- in the United States, the external imbalances between the industrialized nations, the persistence of high levels of unemployment in these countries, the international situation of indebtedness and the volatility of financial and exchange markets.

These imbalances may be interpreted as being the expressions of a long-term deterioration in the economic behaviour of the industrialized nations. This is only partly accounted for by the policies adopted: at a deeper level it reflects changes in the underlying social and economic circumstances which render the existing institutional arrangements inadequate.

Viewed from this angle, the present phase of slowdown in world growth appears more as the outcome of latent economic conflicts and as a transition towards new patterns of trade, production, technology and organization than as a mere pause in the postwar boom.

Although these imbalances may have been furthered by external upheavals or by changes in the orientation of economic policies, their roots lie in transformations which occurred in the world economic and technological scene during the long period of growth following the war. Only the most striking of these need be mentioned here: the changes in the patterns of growth of the developed countries and in the reciprocal economic weight of the main industrialized economies, the emergence of the recently-industrialized economies, the expansion of international trade and the development of the organizations set up to manage it or to render it more fluid, the expansion and diversification of transnational structures, the pronounced growth and diversification of international financial transactions and of the financial system within which they are carried out, changes in the patterns of international co-operation, changes in life styles, the emergence of new values and social aspirations, the industrial redeployment which is affecting sectors, activities, regions, public enterprises and transnational corporations, and the tremendous scientific and technological progress made in different spheres.

There can be little doubt as to the existence of close and complex reciprocal links between the changes in the economy, in production, in organizations and institutions, in society and in technology. Some of these are plainly apparent, while others lie deeper and are less perceptible. This is not a suitable place to sketch out a theory to account for the long-term transformations in the world economy and their interrelations. Here we shall merely acknowledge that a broad range of interpretations exists regarding the nature of the transformations and the imbalances or upheavals besetting the

world economy, as well as the role played by technological progress therein; this range extends from interpretations which see them as conjunctural episodes, arising out of unforeseen events and erroneous policies, through those which attribute them to the rigidities of systems of production and of institutions which shackle the normal evolution of advanced market economies, to those for whom they represent a transition --whether cyclical or not-- towards a new long-term phase of expansion in the world economy, based on a new technological and economic patterns, or even a crisis in the modes of production, accumulation and regulation of the principal advanced market economies and in their interrelationships.

Nor is there any question of reducing the differences between the time scales of the processes of change in the different spheres to mere technological determinism, however fundamental science and technology may be for human survival and development or however powerful and lasting its repercussions on economic dynamics may be. There is undoubtedly an inextricable link between technological transformations and the set of changes which occur, at different rates and in the face of a variety of hurdles, in other spheres. The technological patterns underlying production are fundamental in determining the economic, social, organizational or institutional structures; however, their emergence (their spread and consolidation) is also deeply determined by the actual historical conditions of these structures and of their transformation.

However, a number of characteristics of the technological changes of recent decades and of their relations with changes in the economic, social and institutional spheres are widely acknowledged:

i) major breakthroughs in fundamental sciences, which have enormously widened the field of human knowledge and are transforming our view of the world;

ii) a marked acceleration in the rate of change, of technological activities and of expenditure on research and development;

iii) the emergence and consolidation of new generic technologies which facilitate innovation and technical change in a broad and ever-growing range of activities;

iv) the convergence between the progress made, both within each technological system and between systems, not only in terms of their coinciding impact on different technological developments but also in terms of the synergy originating from their interaction;

v) the broad range of influences exerted, within this context, by information technologies based on microelectronics, to such an extent that they have developed into a fundamental factor in the transformation of the technological patterns underlying world production;

vi) the gap between, on the one hand, the acceleration of the rate at which technical knowledge advances (discoveries, inventions and innovations) and the widening perception of its applications and

opportunities, and on the other hand, the declining rate of increase of productivity which basically reflects the slower rate at which technical and organizational changes are incorporated into the productive apparatuses of the industrialized countries;

vii) the decisive influence of technical progress in the achievement of lasting levels of international competitiveness and the need for institutional, social, political and even cultural changes —which will be specific to each society— in order for such technical progress to take shape, on the basis of mastery of the technologies at present under development;

viii) the lack of integration which characterizes the whole range of processes of technological development and technical change, associated with the replacement of mature technologies by new ones, the economic and organizational hurdles which firms run into in bringing about technical change, and the emergence of discrepancies between the characteristics of technological development, the mechanisms of capital formation and those of the social and institutional framework;

ix) the resulting differences in the rates and time horizons through which technological progress leads to technical change in the various productive sectors and in the different segments of each national productive apparatus;

x) the decisive influence, from the long-term angle, of the current technological transformations and the corresponding changes in production on the pattern of comparative advantages and the international division of labour.

The repercussions of these changes on the countries of Latin America may lead to historic turning points in their development processes. It would be vain to attempt to draw up a balance of the dangers and opportunities involved; on the other hand, it is both possible and urgent to examine the actual manifestations of the technological changes under way and to endeavour to identify the principal currents of change and progress together with their structural impact and their potential and contrasting consequences on the international division of labour.

This document represents an attempt to contribute to this task in awareness of the need to come to grips with a world undergoing rapid and far-reaching change, to envisage the future from a broader perspective than that imposed by the present crisis and its restrictions, to develop an awareness of the challenges —both old and new— implicit in both the long-term transformations of the world economy and those taking place in its present phase of transition, to identify the opportunities offered by the different rates and time horizons of change for drawing up flexible and phased strategies for international reinsertion, and finally, to grasp the scale and nature of the responses required to take up these challenges and seize these opportunities.

I. THE NEW TECHNOLOGIES AND THEIR PROPAGATION

The technological changes which have been gathering impetus in recent decades, and which are laying down the lines of a new technological pattern in world production, are reflected in the emergence of new generic technologies. Each of these, either individually or in conjunction with others, offers a broad range of opportunities for technical change and organizational restructuring throughout the whole spectrum of productive activities and of intersectoral relations, with the consequent repercussions on social relations and life styles.

The dissemination of the innovations introduced in microelectronics and opto-electronics has brought into being the family of information technologies which covers the spheres of computation, software, sensors, optics, telecommunications, industrial automation and precision mechanics within complex and increasingly interactive systems. The drastic cuts in the cost of microelectronic components, the miniaturization and constant increase --measured by whole orders of magnitude-- in the capacity and processing and transmission speeds of computer systems, together with the gradual convergence of information technologies, are giving rise to a multitude of applications which represent radical changes in the production of goods and services, whose "information content" tends to rise at an astronomical rate.

These breakthroughs have been paralleled by the progress made in the field of molecular biology, genetic engineering and cell and tissue culture, which have led to a quantum leap in the opportunities offered by biotechnology, as they make it possible to identify, manipulate, alter and synthesize genetic material, to design and accelerate the reproduction of cells and micro-organisms, and to utilize their vital capacities in production and to enhance life.

Although materials technology has always been a key factor in technical progress, at the present time there is a trend --which is also associated with the progress and applications of microelectronics-- towards the development of high-quality composite materials or of special-purpose synthetic materials. This feature, together with the need to save energy and natural raw materials in products and processes, has led to a general trend towards materials with a greater knowledge content (either in terms of information or intellectual refinement) per unit of weight. Optical materials, composite ceramics, the new metals and composite superconductors all represent technological frontiers which hold out promise of decisive innovations in the fields of energy, transport, computers and telecommunications.

The momentum gathered by energy technologies following the oil crisis has opened up broad avenues of innovation. On the supply side, there is the economic use of non-traditional sources of energy, most notably the progress made in photovoltaic technology and technologies to produce energy from the biomass; on the use side, there is the development of techniques for saving and conserving energy. Although their evolution is subject to trends in the prices and supply conditions of fossil fuels, these developments have a firm projection towards the future, in ever-closer association with electronics and biotechnology. In the future it will probably be necessary to add to these a technological breakthrough in the generation of nuclear energy, by which its present limitations will be overcome. Moreover, if the promises held out by superconductivity become an economic reality during the coming decade it is even possible that a revolutionary era will begin for the generation and transmission of energy, as well as for its storage, and consequently for the design of energy systems, equipment and production processes.

Profound organizational changes are taking place in transport systems, based on the possibilities opened up by information technologies, to which it may be possible to add, in the near future, technological progress based on new materials and the emerging energy technologies. All of these factors point towards structural changes in transport, and consequently in the spatial and temporal pattern of production and trade.

Finally, although space technologies are as yet essentially restricted to strategic uses, they have already sparked off a revolution in telecommunications --and, thereby, in the whole range of applications of information technologies-- and have opened up enormous potential for measuring and managing the resources of the earth and of the biosphere.

This dramatic panorama of scientific progress and the emergence of new and increasingly interrelated generic technologies gives grounds for the conviction that the world is on the threshold of a technological revolution of incalculable potential, with untold repercussions for the material bases of civilization and for the modes of social organization and life styles.

The awareness of this potential contrasts with the relative sluggishness with which these discoveries and inventions are disseminated and utilized, with the above-mentioned imbalances in the world economy, with the deceleration of the rate of growth, and with the growing dysfunction between social and institutional structures and the requirements and possibilities of the emerging technological patterns. It would seem that these problem areas are interlinked expressions of the difficulties and rigidities which emerge during a phase of structural change towards a new era for industry, technology and organization. Whatever the case may be, they draw attention to the temporal dimension of scientific and technological development, its crystallization around technological and organizational changes, and its combination with innovations in social and institutional arrangements.

The technological revolution currently under way is organized around information technologies, whose dissemination and increasing convergence are changing systems of production and bringing about a transformation from energy- and material-intensive mass production to more flexible and

differentiated forms of production which make more intensive use of information and communications.

It is around this new model and around the capacity for the dissemination of information technologies that progress based on the other emergent generic technologies is taking shape. However, convergence between the different technological systems is not a uniform process; the degree of maturity and the rate of dissemination of the different forms of technological progress varies. There are undoubtedly grounds for imagining that the promising horizons of these other technologies may witness, in the coming century, a burgeoning of technology equivalent to that of information technology, with a revolutionary impact on the fundamental organization of systems of production. However, the technological transformations which we are now observing integrate the manifold and rapid progress made in the different spheres of technological development in forms of technical change --throughout the whole fabric of society and production-- which are deeply influenced by the basic features of the new pattern of intensive use of information.

II. STRUCTURAL IMPACT OF THE EMERGING TECHNOLOGICAL PATTERN

At the centre of the emerging technological pattern, spectacular changes are being observed in those activities directly linked to the system of information technology. The rapid and sustained technical change in the integration of electronic circuits, with the consequent diminution of costs, is associated with similar changes in the design and performance of computers and is paralleled by comparable progress and cost reductions in telecommunications technologies.

The increased and ever-cheaper possibilities for communicating, processing and storing information, together with the growing interaction between technological systems, endow the emerging technological pattern with certain already-discernible features which may prove to have a decisive impact on the basic structures of economic growth. It is possible to observe extraordinary changes, covering the organization of production, entrepreneurial structures, the layout of productive apparatuses and infrastructure networks, the direction of technological development itself and the rate of technical change, as well as patterns of consumption.

A. Effects on the organization of production

The emerging technological pattern is currently transforming the conceptual notions underlying the definition of the "state of the art" or optimum mode of production in an ever-increasing range of activities. The capacities offered by information technologies tend to endow production with greater flexibility, with the consequent possibility of changing models and designs more rapidly. Flexibility opens up prospects of benefitting from the lower costs of automation in a growing range of processes. At the same time, flexible automation facilitates the automation of small production runs: a trend which is transforming the very concept of the "scale of production".

This new technological potential also facilitates the integration of the different spheres of production such as design, manufacture, co-ordination, supplies, management, sales and technical services, both at the level of the firm and among networks of firms. This is already having an impact not only on the nature of the skills required of labour in all of these spheres of production, but also on entrepreneurial structures.

B. Repercussions on the use of material resources

The new technological pattern is also being felt in the structure of production, through a number of features which converge in a trend towards savings of materials and energy. On the one hand, the manifold possibilities offered by information technologies for "on-line" control of production not only make it possible to considerably improve the quality of products but also allow noteworthy cuts to be made in costs through rationalization of the use of materials and energy. In the case of manufacturing activities, it has become possible to considerably reduce wastage of material, thanks to more precise manufacturing operations and a cut in the number of components and units rejected on quality grounds; this trend combines with the new possibilities for designing use-specific materials, in a trend towards growing integration of materials engineering with production-line engineering, with the resulting rationalization of the use of inputs. In continuous manufacturing processes, the possibilities for recycling energy and recovering raw materials tend to substantially diminish the "leakage" of these inputs, thereby reducing the requirements per unit of production. Furthermore, the trends towards smaller products and fewer electro-mechanical components also lead to savings of materials and energy, both in industry and in other user sectors.

C. Impact on employment and skills

The structural repercussions of the new technological pattern on employment and on the demand for skills are already causing concern in the industrialized countries, on account of their impact on material welfare, on the role of labour in society and on the local economies. Of course, the employment crisis which began to affect most industrialized societies during the present decade cannot be attributed solely to the impact of technical change, but nevertheless, the innovations introduced in production processes in a number of sectors have, in general, tended to replace labour by capital, while the expected new wave of product innovations —which would favour the creation of jobs, on account of the fresh demand generated— has, at the very least, been delayed by the prolonged downturn in growth.

Looking beyond the present phase through which the world economy is passing, the characteristics of the new technological pattern bring to bear a complex set of influences on production systems and on the demand for labour and skills, with the consequent changes in social relations and challenges to the world of work, to which trade union organizations and governments in the industrialized countries are now beginning to rise.

On the one hand, at the microeconomic and sectoral levels it is possible to observe a trend towards the displacement of employment. Industrial automation, together with the possibilities of on-line control and computerized integration of systems of production, both in industrial activities and in services, is bringing about significant transformations in the profiles of skills required, but on balance it tends to act to the detriment of the number of jobs. The production sphere is more deeply affected than the spheres of co-ordination and design, as a result of which there has been a significant improvement in employment on information-processing

activities even in manufacturing. However, it is possible to discern trends towards future labour-saving automation in these spheres also.

Moreover, at the macroeconomic level, opposing developments may be observed in respect of the levels of employment likely to be attained in the industrialized countries within the set of structural changes associated with the emerging technological pattern, even at normal levels of economic activity. Clearly, the trend towards the displacement of jobs in the metal manufactures and machinery, electrical, chemical and mining industries, as well as in a number of service activities, is counterbalanced by the creation of jobs in the information-technology sectors: the electronics industries, communications and producer services. Technological innovation which leads to new products also opens up new areas of activity and generates employment. Nevertheless, the manifold structural repercussions of the new technological pattern, which permeates the whole of the productive structure, crystallize in the form of new relations between employment and growth.

During the long period of prosperity following the war, increases in productivity achieved by means of technical changes in production processes had their counterpart, in the developed countries, in the creation of jobs to meet continually expanding demand, stimulated by the appearance of new products. In the present phase, applications of the key technology —microelectronics— have mainly been in the form of innovations to rationalize production processes, and cost cutting has prevailed over the development of new markets. While it is true that reductions in costs do stimulate demand and employment, this process is taking place within a context of sluggish economic growth. Moreover, the new products tend to replace other products manufactured by more labour-intensive methods. However, there is also the possibility that changes may take place in patterns of consumption, replacing industrial goods by more labour-intensive services.

In the final reckoning, the impact of the new technological pattern upon levels of employment in the industrialized countries will depend, in the long term, on the processes of structural change and the policies adopted to influence them. However, the problem surpasses the sphere of aggregate demand and even that of its structure. The new technological pattern is transforming the profile of skills required of the labour force in two basic ways: on the one hand, through the rapid increase in the demand for high-level technical skills, reflected in the persistent shortage of personnel possessing the skills which are crucial to the application of information technologies; on the other, through the modification of the skills required over the whole range of job qualifications in order to operate the new means and systems of production. This explains the vital importance attached to the education, training and re-training of labour.

D. Repercussions on linkages between the production and infrastructure systems

The possibility of linking together networks of suppliers with assemblers or producers of services using large amounts of material inputs offers real possibilities for cutting stocks and for accelerating and optimizing the response of production to demand, along the whole length of the chain of

interrelated activities. This possibility also affects the traditional notions of optimum scales of production and lays the foundations for new forms of symbiosis between small and medium-sized enterprises and large firms, giving a new meaning and a larger number of dimensions to the articulation between industry, primary activities and services.

In short, the changes taking place in methods of sale and supply, in inventory management and in financial transactions as a result of the progress made in the field of information technologies are bringing about structural transformations in the systems of marketing, transport and financial services which may prove to have decisive repercussions on the organization of the international economy and of the national productive apparatuses.

E. The impact of the new biotechnologies in different spheres

The impact of the new biotechnologies springs from their capacity to create new products and processes, and to improve traditional ones, in a broad range of activities. The scale and diversity of these applications hold out the prospect that present and future innovations in biotechnology may become a powerful factor for structural change and renewal of the material bases of society. Nevertheless, it must be acknowledged that so far few of the innovations made in biotechnology have found a range of applications comparable to those of information technologies, and still less have they shown evidence of a capacity to influence the emerging technological patterns. However, it is possible to anticipate a point in historical development at which the biotechnologies of the future will succeed in providing economic means for overcoming some of the strategic restrictions affecting the world --and in particular the Third World-- in the areas of health, the production and storage of food, nutrition, energy and the environment.

The repercussions on agriculture may prove to be enormous: the development of new seed varieties by means of genetic engineering opens up broad potential not only for increased yields, but also for products which are better adapted to harvesting, storage, transport and processing operations. The possibility of growing tissues on an industrial scale, for its part, may enable crops to be made independent of their ecological conditions of origin.

Some idea of the potential impact on industrial structures is provided by the fact that, in some industrialized countries, approximately 40% of manufacturing production is of natural or biological origin. If the present trends are consolidated, an increasing number of processes in the food, chemical and pharmaceutical industries will eventually be based on the new biotechnologies. In particular, the emerging intracellular chemistry could come to constitute one of the main sources of renewal and dynamism for the chemical industry.

F. Influence on life styles and consumption patterns

Scientific and technological development is one of the primary forces of social change. It is, furthermore, a social process which closely mirrors the tendencies towards change which are developing in the society. These aspects

are reinforced even more in a period such as the present, when scientific and technological change are becoming particularly deep-rooted and important.

The large extent to which information technologies have penetrated and their potential to affect the most diverse human activities have served to foster the belief in the advanced countries that the world is moving towards an "information society". Quite apart from the various long-term scenarios in which such an image can be conjured up, the notion contains the idea that the technological changes underway, coupled with radical changes in the economic, social and organizational structures, will serve to mould societies very different from the present ones, influencing their structural features. While not overlooking the fact that the processes of change in the different spheres are interdependent, attention is centered here on the way in which the deployment and dissemination of the new technologies are likely to affect first the advanced societies, and then the world at large.

Today's world is made up of increasingly interrelated strategic, trade, financial and technological spheres, with increasingly similar values and life styles. The dissemination of scientific knowledge, the growing transnationalization of economic activities and the revolutionary transformations in telecommunications have played a key role in this process. One consequence of this is that changes in the advanced societies have a more rapid influence on even distant areas of the periphery, whether through structural accommodation, defensive reaction, deliberate policy or empathy phenomena.

It follows, then, that the social consequences of the economic and technological transformations in the developed countries will reach the horizon of the peripheral societies with direct force, over and above their effect through these countries' insertion in the world economy or the effects of their own technological systems or regulatory régimes.

In view of this, the countries of the region should pay close attention to the repercussions that the present technological transformations are having on the advanced societies. In this paper, mention will only be made of the main areas of influence. The trends towards change in employment and skills that have already been mentioned will undoubtedly affect social relations, educational models, and the nature of social stratification, as well as the labour union movement. Changes in the organization of work and in entrepreneurial structures will also lead to changes in labour relations and even in the work concept itself. In societies where information and telecommunications applications are growing apace, life styles also tend to change in other fundamental dimensions such as activities linked with information, know-how, the use of time, leisure and work, travel, the layout of the habitat, etc. The progress made in the new biotechnologies can, for its part, bring about radical changes in the biological dimensions of life and the way it is perceived, as well as in health systems and eating habits. This brief outline only seeks to highlight the vast number of influences which some of the new technologies can exercise on demand patterns. If these are combined with the tendencies of structural change in the organization of production described above, they may eventually revolutionize the consumer goods sector and everyday relations in the more advanced countries. Together with the simultaneous social and institutional transformations, they can help to shape

consumption patterns whose material content and importance in terms of well-being will be radically different from those we know today.

G. The orientation given to technological development

A characteristic feature of today's technological transformations is the internationalization of technological progress in accumulative feedback processes, both within the system of information technologies and between the different technological systems. Examples of this phenomenon are the facts that automation has opened up new frontiers in the production of microelectronic components and that computation and the development of suitable software are facilitating both the design of new "custom-made" materials for specific applications (which, in some cases, such as superconductors, constitute feedback to the process of innovation in information technology) and the analysis and design of genetic and molecular configurations. There are also the opportunities opened up by the use of microelectronics in the development of energy technologies.

Viewed from another angle, since products and processes now become obsolete so quickly this has intensified technological competition, with a consequent feedback effect on the rate of change in all technological systems.

As already noted, the new technologies have, for the most part, taken the form of innovations in the productive processes, and their goal has been to streamline production, reduce costs and enhance international competitiveness. While the number of product improvements and new products is spectacular, they are still far from taking full advantage of the opportunities provided by the new technological systems. This present orientation of the innovation effort is closely linked with the current phase of deceleration, imbalances and restructuring through which the industrial economies are passing, and, as already noted, there has been a change in the traditional relation between growth and employment. It is to be hoped that if and when the world economy enters a new expansion phase, there will be a greater relative reorientation of the innovation effort towards the development of new products and the creation of new markets, and this effort will be more closely integrated with the innovations in processes and products on the basis of the opportunities afforded by the information technologies.

H. The impact on productivity and the pace of technological change

The above comments regarding the main trends discernible in the emerging technological pattern have no clearly marked limits: they merely attempt to indicate the likely direction of the changes and their consequences for the productive and organizational structures in the advanced countries. This is not only because of the fragility of the methodology used in the technological forecasting exercises but also, and primarily, because scientific and technological development is not a spontaneous process determined by forces exogenous to the economic and social changes. On the contrary, the scale and actual form of the repercussions which the new technologies may have on the economic and social structures of the advanced countries will depend on the changes within them that facilitate the

consolidation and dissemination of the new technological pattern, the stubbornness of the resistance to change, or, in the final analysis, the mutual accommodation processes of technical progress, economic and institutional development and social progress which take place in each particular society.

The experience of industrialized countries has so far tended to confirm that the economic applications of the new technologies are usually slower and less widespread than their potential might lead one to expect. Both the costs of developing the new products and processes and those of the attendant restructuring of production tend to be high (in the case of the latter, in both economic and social terms) and their benefits are usually rather uncertain. The increases in productivity that can be obtained through the use of new technologies may be considerable but are not by any means automatic; they require investment, personnel training and organizational changes, in some cases on a radical scale.

There can be little doubt that the emerging technological pattern, which is centered around information technologies, will ultimately affect all productive activities, whether traditional or new, in the sense of increasing their productivity, operational flexibility and product quality. While the emergence of new technologies generates new activities and products, there is still broad scope for innovation and improvement of productivity and of product quality even in the oldest industrial activities. Furthermore, the opportunities offered by information technologies increase the importance of the role of organizational innovation to a level comparable to that of the technological innovations themselves in promoting increases in productivity.

In this sense, it becomes less and less appropriate to think in terms of the isolated impact of new technologies on different productive activities and it is more and more necessary to analyse technical progress and the raising of productivity in the different activities in terms of the emergence and dissemination of new technological patterns which bring with them innovations and the incorporation of goods that promote technological progress and occupational and organizational changes in both new and traditional activities. This viewpoint not only recognizes that there is a vast potential in the new technological patterns being developed, but also that there is an array of obstacles and an unavoidable slowness in converting technological development into concrete technological change and increased productivity and competitiveness in the different activities.

Even though at present the problem of technical progress falls within a historical and structural context undergoing radical transformations, its conceptual basis remains essentially the same. The complex set of relations between technical progress and economic growth can undergo changes, but these act in both directions: growth can only be sustained in the long term if it is backed by high rates of technological innovation and the attendant organizational changes, while technological progress calls for investment in basic science, technological research and development, new types of equipment and personnel training, and the development of markets, all of which can only take place within processes of sustained growth. The expression "over the long term", however, acquires the nature of a warning at a time when the world is faced with far-reaching changes, the productive apparatus is being

radically changed, financial systems are under extraordinary strain, and the institutional mechanisms have to bear the heavy pressure of the social costs and disruptive processes created by the transformations which are taking place.

III. EFFECTS ON COMPARATIVE ADVANTAGES AND THE INTERNATIONAL DIVISION OF LABOUR

Quite apart from the protectionism that has emerged during the present stage of transition in the industrialized countries, the technological trends involved are transforming the bases of the underlying pattern of comparative advantages of national economies and hence the basic conditions for the international division of labour.

A. Weakening of the comparative advantages deriving from natural resources

As the processes of technological change have intensified, the historical tendencies towards the weakening of comparative advantages deriving from natural resources have become more accentuated. Commodity prices are now comparable to those in effect during the crisis of the 1930s. The ratio of oil prices to those of manufactured goods, which had fallen considerably before the oil crisis in 1973, is now hovering around real levels close to those of that period. The raw materials input per unit of industrial output has been declining steadily and today is only 40% of what it was at the beginning of the century. The progress made in materials technologies has, in the past few years, accelerated this tendency and threatened to make it even more acute, as new synthetic or compound materials have been developed which are technical substitutes for natural products in specific uses. Furthermore, from the time of the first oil price shock, there has been a growing trend in the industrialized countries towards energy saving and conservation, and consumption per unit of product has fallen significantly.

These trends towards the weakening of demand for natural resources are reinforced by the materials and energy saving characteristics implicit in the application of information technologies, as referred to earlier.

B. Weakening of the comparative advantages deriving from cheap labour

The spread of the use of information technologies in the production of goods and services, as we have already seen, has tended to displace jobs and to change the type of skills required of workers.

Highly labour-intensive sectors (textiles, clothing, electronics assembly) are rapidly increasing their capital intensity. Fast-growing activities with a high technological content —such as semi-conductors and

high technology chemistry-- require even less labour than robotized motor vehicle plants. Generally speaking, the automation processes in the various productive sectors tend to reduce labour costs as a component of direct production costs because they save labour, replace skilled workers with less-skilled staff, and reap benefits from the rationalization of production. The compensatory increase in the demand for qualified staff to handle the information technologies derives only in part from the spheres of production; much of it tends to originate from the increasingly integrated structures of management, marketing and producer services.

The effects of these trends on the comparative advantages that have been won by the different developing countries during their recent industrialization are complex and multi-faceted. There is clearly a gradual erosion of the comparative advantages deriving from cheap labour. On the other hand, the availability of unskilled non-unionized labour is an incentive to establish activities which are becoming increasingly semi-automated (such as electronics assembly). However, subsequent advances in the automation of such activities, plus the increased possibilities of flexible adaptation to changes in demand (which increase the advantages of closeness to user markets) operate in the opposite direction. Moreover, the advantages that some developing countries may obtain by training workers in fairly high skills (such as those used in the metalworking industries, for example), can be considerably undermined by automation. Skills that can be used in the multiple applications of data processing, on the other hand, could become the source of new competitive advantages.

C. The challenge and promise of biotechnologies

In the coming decades, the repercussions of the innovations in biotechnology on various sectors such as health, agriculture, food, the chemical industry, environmental management and energy will doubtless be considerable. The industrialized countries have the technical and industrial skills to use these opportunities to the maximum. The developing countries are rich in biological resources but poor in meeting new needs. This contradiction can create either vicious or virtuous circles, depending on the processes that are set in train.

The new biotechnologies offer valuable strategic alternatives, but they also threaten to supplant crops and activities which today enjoy well-established advantages. Since the research effort is concentrated in the industrialized countries, such research is conditioned by the needs and opportunity costs of those countries: in the food and agriculture sector, for example, the tendency is to develop new commercial varieties, to propagate commercial plants --especially trees-- on a massive scale, and to reduce the energy, fertilizer and animal feed inputs in agricultural production. It is also foreseeable that many of the substances from which foods are derived will be replaced by others, as for example in the case of isoglucose obtained from starch, which is tending to replace sugar, or the unicellular protein obtained from fossil fuels, which could become an alternative to vegetable proteins for animal fodder or even for human consumption. Furthermore, the time may well come when basic petrochemical products will be replaced by organic compounds derived from carbon dioxide, seaweed or vegetable biomass.

The traditional comparative advantages built up in the production of foodstuffs are being gradually undermined by biotechnological innovation. On the other hand, the progress made in biotechnology can be used to help the countries attain food security and conserve their ecosystems. The fact that a worldwide challenge exists cannot be overlooked, however: to the extent that the advanced countries direct their biotechnological development to economizing their own land use and substituting for imports of agricultural products, the effect of technological change will operate to the detriment of the traditional comparative advantages enjoyed by the countries with agricultural potential. These countries, however, may perhaps have some opportunities for exploiting specific genetic potential in conjunction with their agricultural resources by concentrating their biotechnological training and innovation efforts on taking advantage of these possibilities.

The exploitation of native biomass for energy, on the other hand, represents another promising opportunity for the petroleum-importing developing countries.

Ironically, it is the very shortages suffered by whole populations sunk in poverty that provide a whole new frontier of advantageous opportunities for applying new biomedical technologies in the developing countries. The quality of life and the level of productivity can be significantly improved through progress made in the treatment of communicable diseases, mother and child health care, environmental health and the correction of protein or mineral deficiencies. Since the areas of greatest market potential for the pharmaceutical industry of the industrialized countries do not correspond to the satisfaction of these needs, if priority is given to this objective in the biomedical research pursued by the developing countries, this could both open up new markets and at the same time speed up progress towards the achievement of higher levels of well-being.

D. The dynamics of change in the pattern of comparative advantages

The current technological revolution has lent considerable dynamism to the pattern of comparative advantages in two ways: on the one hand, in the conventional sense of the speed at which these changes are occurring --even though they are hampered by protectionist barriers-- and the possibility that this speed may increase in the future; on the other hand, and above all, because comparative advantages depend less and less on the natural resource endowment or traditional capacities of each particular country and more and more on the development of human resources and the progressive acquisition of technological and industrial capability.

Furthermore, since design, supply, manufacture, marketing and transport, as well as technical and administrative services, can now be integrated into teleinformation networks, the optimum locations for activities and the requisites for competitiveness.

International information networks allow for greater integration between industry and services and permit greater mobility of the latter, which represent a fast-growing sector of trade. As long as the relative cost of moving goods physically continues to increase faster than the cost of

transmitting information, there is an area where information and technology flows can be substituted for traditional trade, depending on the capacity of the recipients to obtain and use information or on the extent to which the transfer of technology among subsidiaries serves the global interests of the transnational corporations. Indeed, the practice of "global trading" through teleinformation networks has an additional adverse effect on primary exporters, depriving them of a chance to control prices or add value to their products.

Although there is no doubt that the traditional comparative advantages of the developing countries are being threatened (quite apart from the protectionism practised by the industrialized countries) by the technological trends now at work, the present pattern of comparative advantages is characterized by its volatility. No country, however advanced, can be sure that it will always enjoy a particular comparative advantage. The developing countries have the opportunity to develop human resources and technological capabilities which can lead to the acquisition of advantages in broad areas of technological application, and they also have the possibility of making big leaps forward in specific lines of technological specialization, once they have acquired the requisite critical mass of technological resources in that field. However, in this era of emerging technology, the fact that the acquisition of new comparative advantages calls for considerable and sustained efforts in education, training and the use of technology which requires large amounts of research resources as well as fixed capital represents a great future challenge for these countries.

IV. THE TECHNOLOGICAL CHALLENGES FACING LATIN AMERICA AND THE CARIBBEAN

A. Technological progress and its dissemination in the postwar development of Latin America

The centrality of technological progress to the development process is not new. Moreover, although this is less often acknowledged, the fact that the specific characteristics of technological progress and its modalities of dissemination within the productive structure form part of the basic structural features of the style of development of the countries on the periphery is not a new feature either. In the case of Latin America, the patterns of incorporation and dissemination of technological progress are integrated into the common development style of the countries of the region and contribute to the structural imbalances that characterize that style.

During the long postwar period of prosperity, the countries of Latin America and the Caribbean grew and industrialized at different, though in all cases significant, rates. Nevertheless, the average increases in productivity, both in industry and in agriculture, have been smaller than those recorded by the industrialized countries during the same period. From this aggregate perspective, technological progress during the same period has contributed less to the development of the countries of the region than to that of the central countries in the world economy. This has undoubtedly led to a widening of the gaps in productivity which separate us from the industrialized countries.

Of even greater significance, however, are the patterns which have characterized the assimilation and spread of technology in the productive systems of Latin America.

The international specialization of the countries of Latin America and the Caribbean in commodity exports and their limited participation in world trade in manufactures have relegated them to the fringes of international competition in products whose manufacture requires higher levels of technology. Nevertheless, the highly imitative consumption patterns that prevail in the region represent a related demand for capital, foreign exchange and technology per unit of production, which is much greater than the rate at which these resources are generated in the countries of the region.

The processes of industrialization which are aimed primarily at supplying domestic markets oriented towards the satisfaction of such imitative consumption patterns have resulted in limited production scales and high

costs, together with rather disjointed systems of industrial production which utilize technologies that are selected with domestic markets in mind and sheltered by unnecessarily high and sustained protectionist barriers. On the other hand, the fact that the limited resources of capital, infrastructure, entrepreneurial skills, technology and foreign exchange have been allocated to the production of goods that are in demand by the higher-income social strata and from which high domestic profits are made has given special relevance to the structural heterogeneity of the productive systems, which has been reflected in ongoing and considerable disparities in productivity, productive organization, technological capacities and incomes. All of this, in turn, has made the production system even more uncoordinated and hindered the spread of technological progress, giving rise to vicious circles of productive compartmentalization, social disaggregation and technological backwardness.

One of the consequences of this structural profile is the lack of international competitiveness of a large part of manufacturing output. Another is the social exclusion that characterizes this style of development, both through occupational insertion into structurally heterogeneous productive systems, and through the impossibility of making the products that are favoured by prevailing consumption patterns available to the entire population.

At the technological level, this style of development has produced various interrelated phenomena: fragility of the scientific and technological base, insufficient development of local technological capacities, inadequate dissemination of technological progress, and finally, the inappropriateness of technical choices to the satisfaction of needs and the exploitation of local resources. In essence, this style of modernization leads to an imbalance between on the one hand the rapid transplantation (both to the markets and to the industrial systems) of those goods that constitute the material elements of modernity, and on the other the rate of assimilation of knowledge and the pace of development of the institutions that are needed to elaborate, produce, and adapt such knowledge to local conditions.

While research and development activities have intensified considerably during the postwar decade in most of the countries of Latin America and the Caribbean, they continue to be inadequate. The volume of resources allocated to science and technology represents proportions of the national product far below those current in the advanced countries; in absolute terms, the total amount of resources which the countries of the region, taken together, allocate to such activities is comparable to the amount allocated to research and development by a single major transnational corporation in the automobile industry. Even more serious is the fact that only low proportions of such resources are directed to the productive sectors and, in particular, to the industrial sector. Furthermore, the lag in the production of capital goods and the leadership enjoyed by the transnational corporations in technology-intensive sectors constrict the development of local technological capacity and undermine the growth of indigenous technology, with consequent harmful effects on entrepreneurial and labour creativity in assimilating technological advances and adapting or elaborating technologies that are suited to local conditions. Added to this is the weakness of the small and medium-sized industrial sector, whose lower levels of productivity, weak capitalization and marginal position in markets and in employment inhibit its

potential as a channel for the generation and assimilation of technological progress into the productive system. Lastly, the economic environment in which companies operate, characterized by high, indiscriminate and sustained barriers of protection for domestic markets, together with high interest rates, acts as a disincentive to investment and to technological innovations.

The crisis facing the majority of the countries of the region in this decade has made a difficult situation even worse. Research and development spending, which to a large extent is financed from the public treasury, has declined steadily at least in the six relatively larger countries of the region. Moreover, the impact of the crisis on the industrial sectors of Latin America has resulted in numerous cases of dismantling of the engineering capacities that had been developed and consolidated in industrial enterprises during the previous period, as well as in a general reduction of the already limited sums which companies allocated to research and development.

Nevertheless, even against the background of this structural profile --common, although to varying degrees and with different characteristics, to the various countries of the region--, there are cases of enterprises or even of entire activities in which innovation, the intelligent adaptation of technology to local conditions and the gradual development of technological and industrial capabilities have consolidated competitive advantages, thus demonstrating the creative potential that can be fostered under favourable conditions, if development is reoriented by removing the obstacles to the dissemination of technological progress and social harmony.

B. The role of technological progress in the reorientation of development in Latin America and the Caribbean

The international economy is radically altering the framework within which the countries of the region have developed with their current style. It is likely that the reduction in the rate of growth in the industrialized countries will persist during the transition towards new international economic relations, with severe imbalances among the major economies and a high absorption of capital. This will be combined with the profound changes referred to above in the technological patterns on which world production is based.

The traditional comparative advantages of the majority of countries of the region, based on the primary exploitation of abundant natural and energy resources, are challenged by the decline in commodity exports. Even the possibilities of exporting manufactures that have a high input of cheap, semi-skilled labour are diminishing on account of the loss of competitivity caused by some of the technological changes that are underway.

On the other hand, as already mentioned, the international pattern of comparative advantages is tending to become more dynamic, in so far as such advantages are becoming less and less dependent on existing endowments of resources and capacities, and increasingly more dependent on the development of new technological and industrial capacities, even in existing activities.

These trends, within the framework of which the industrial and technological restructuring of the industrialized countries is already taking

place, will continue to be consolidated and will extend to horizons in the next century, but they already reveal some of the grave consequences for the traditional insertion of the countries of Latin America and the Caribbean in the international economy, as well as for the possible opportunities for their positive reinsertion into the emerging international economic order. Meanwhile, the countries of the region are dealing with a world characterized by profoundly unstable processes of transition, with reactive perturbations caused by protectionist pressures and the steady progression of the industrial restructuring with which the industrialized countries counter their own structural disequilibria.

Even when integrating more immediate time horizons with longer-term ones, the positive and dynamic participation of the countries of Latin America and the Caribbean in international trade requires the gradual redirection of their exports towards products of the agroindustrial, mining/industrial and manufacturing sectors with increasingly high technological content.

On the other hand, the challenges of a world that is undergoing rapid change highlight even more sharply, in the diverse national situations that exist in Latin America and the Caribbean, the structural imbalances which characterize the common style of development of the countries of the region and constitute the backdrop against which the crisis of the 1980s is unfolding. The progressive and simultaneous overcoming of the structural obstacles that gave rise to external vulnerability, social exclusion, unco-ordinated productive systems and technological backwardness requires processes of modernization and industrialization based on the increasing assimilation and dissemination of technological progress, together with the steady development of local technological capacities and training of the labour force.

The transformation and modernization of the productive structures on the basis of sustained technological progress is thus required with a renewed urgency by the countries of the region. It constitutes a common prerequisite both for the achievement of a dynamic reinsertion into the world economy and for reorienting development and overcoming the more costly features of an unbalanced and exclusionary style of development, which, in historical terms, is becoming increasingly outmoded. Since each of these processes represent necessary conditions for making possible sustained growth, changes in the productive system supported by technological progress and its dissemination are, once again, central to the problems of development and constitute a key element of strategies for sustained growth.

C. The impact of technological changes and the opportunities provided by them

The gradual spread of new technologies and their convergence in the creation of new technological standards, which will progressively transform the bases of world production and of the international division of labour, constitute --together with the industrial restructuring of the advanced countries, the strategic reorientation of transnational corporations and changes in international economic relations-- one of the aspects of the long-term process of transformation of the world economy. Identifying the main effects of that

process on the national economies of Latin America and the Caribbean and the more promising opportunities which may be created for reorienting the region's development, as well as situating such effects in the correct time frames, are tasks which have recently emerged and which should constitute some of the ongoing concerns of the various actors in society. It is possible here to identify only a few of these elements whose differentiation may be useful for this study.

Firstly, attention should be drawn to the different types of effects, opportunities and options which the new technologies create for the countries of the periphery. Secondly, the time frames for the spread of the various trends towards technological change must be examined. And thirdly, the challenges posed by the new technologies in the areas of international competitiveness and economic and social linkages.

1. Dissemination of new technologies, technological mastery and consolidation of the new technological pattern

The dissemination of information technologies to the most diverse sectors and activities is a process which is progressively extending and which affects all the countries of the region —although in different ways and from different perspectives— irrespective of their size or relative stage of development. The application of information technologies to each specific activity naturally requires investments in equipment and in personnel training. However, what is perhaps more important and more difficult, is that organizational changes are also required which are consistent with the informatization of each activity. Furthermore, the use of information technologies to acquire potential competitive advantages or to enhance the performance of the productive system, requires an appropriate communications infrastructure.

On the other hand, effective access to technological capability in given areas of new technologies commits entire segments of the national productive and technological base: it requires co-ordinated efforts to bring about change, investments and training of human resources in the various sectors, as well as trade and technology transfer policies that contribute to the attainment of technological capacity, in a context of international strategic competition.

Finally, the challenges and opportunities created by the gradual consolidation of a new technological standard in world production, are related to the basic characteristics of the emerging technological pattern, which have been previously mentioned: the increasing importance of information in the production of goods and services, the flexibility of production and design, and the systemic organization of the different spheres of activity (engineering, production, administration, supply and marketing) of the enterprises or of the networks of production linkages. These characteristics pose complex challenges to the countries on the periphery, which are forced to operate amid the tensions caused by opposing trends. The retraining of the human resources made necessary by the trend towards an increasingly high information content of technology, is rendered difficult by the investments and time required to acquire knowledge and information management capacity. At

the same time, the possibilities created by flexibility in operating with smaller scales and adapting better to demands, are restricted by the trends towards concentration, which are facilitated by this same flexibility and strengthened by the organization of the system. The latter facilitates the co-ordination of smaller units, but in larger and more complex networks of activities, which may be managed at the transnational level.

Integrated automatization and the system-wide use of information technologies constitute a great potential of capital savings, a factor which has been traditionally limited in developing countries. But the emerging technological patterns may, in the long run, enter into this "system-wide" phase by the end of the present century or early in the next century, according to various estimates. Meanwhile, the developing countries may take advantage of the dissemination of more commercial technologies, which are less experimental. In general, they can use this opportunity to define their path of technological development in a manner different from that which the currently advanced countries have traced historically, and more consistent with their available resources, by focusing on organizational changes rather than changes in equipment as the basis for increased productivity, using the potential offered by the information technologies.

2. Different horizons for the spread of technological changes

The above considerations underline the importance, to the countries of the region, of taking into account the different time horizons over which the trends towards technological change and their accompanying effects will gradually spread.

The spread of new technologies, as these become commercially viable, poses urgent questions of competitiveness, technological adaptation, development of local skills and organizational changes in production. However, in the industrialized countries themselves, the progression from technological advances to technological changes requires, as already indicated, considerable periods of time as well as progress in the processes of industrial restructuring and even in the modification of prevailing institutional arrangements.

To compete for technological dominance in the areas of information technologies, biotechnologies or the technologies of new materials, which are potentially accessible to some of the countries of the region, requires substantial investments and the strategic planning of productive complexes, at a level of competition with the transnational corporations and in time horizons of decades, within which to implement such strategies.

The complexity and lack of continuity of technological changes enable developing countries to achieve technological "leaps", through adaptation, incremental innovations or copying, which permit them to occupy certain niches in specific areas of the new technologies. Such leaps, however, should be buttressed by the systematic and sustained development of technological capacities, which go beyond the exploitation of a given niche, in view of the speed with which technological progress modifies the competitive advantages that have been attained.

The spread of the emerging technological patterns and the consolidation of its basic features, on the other hand, constitute a process which will probably extend over the next few decades and which is, in turn, subject to gaps and formed by phases in which effects on the countries of the periphery, as already mentioned, may be different. It is especially important to identify the potential of the different information technologies and combinations of such technologies, and the potential for system-wide change that is attributed to them in a later phase, projected to be early in the new century.

3. New technologies, competitiveness and economic and social linkages

The effect of information technologies is being felt in the countries of the region with increasing rapidity and extensiveness, both on account of the incorporation of informatic and telematic media in a wide range of activities, and on account of the demonstration effects of their use in the industrialized countries and the alteration of the conditions of international competitiveness which information technologies represent in a wide spectrum of productive activities.

This helps to further dramatize the dilemma confronting the processes of modernization and development in the region, since the impact of information technologies can either lead to a worsening of the structural imbalances, technological gaps, lack of international competitiveness, and to even fewer productive and social linkages, or it may facilitate the redressing of these imbalances, improve competitiveness and promote co-ordination.

The need to join the mainstream of technological trends in a positive and committed manner is becoming increasingly vital for the countries of the region. In order to place on new bases —which make greater use information technology— the advantages derived from their natural resources and to acquire new competitive advantages in lines of industrial and service specialization, there is need for, inter alia, the widespread application and the effective management of information technologies. However, in order for the international competitiveness acquired at the microeconomic level or through activity to be solid and sustained, to achieve external economies of technological development and to attain critical masses of technological resources, it is necessary to achieve a considerable level of system-wide modernization in important sectors of the productive and institutional network. In order to achieve this objective there is need, in turn, for a considerable degree of co-ordination of the productive system and linkages between the latter and the institutional and infrastructural subsystems. For the reasons outlined above, information technologies offer a favourable medium for system-wide co-ordination and the dissemination of technological progress. However, if this potential is not exploited, the isolated modernization of a few activities can aggravate the process of segmentation and disharmony within the productive system and jeopardize, in the long run, the long-term competitiveness of the very activities that have been modernized.

A description has been given above of the effects which the new technologies and the techno-economic pattern that is gradually being organized around them, have on the distribution structures of advanced societies. In the circumstances of Latin America and the Caribbean and in the context of the

prevailing style of development, the risks are greater and the opportunities more complex. The isolated effects deriving from the incorporation of new technologies or from the deterioration of traditional comparative advantages may easily be negative. Whether the processes of modernization come to constitute processes which accumulate positive effects in terms of employment, standards of qualifications and remunerations, will depend on the reorientation of development, the extent to which technological progress is disseminated and internalized, the efforts made in the fields of education and training, and on the creativity displayed in adapting the applications of the new technologies and the organizational changes which this very potential would impose, as well as better utilization of local resources.

Finally, the processes of modernization based on new technologies may either contribute to a further increase in social disaggregation and in the exclusionary features exhibited by the prevailing style of development in the region, or may constitute the vehicle for new modalities of satisfying social needs, and promoting social harmony and participation. The first may be the result of the purely imitative transfer of consumption patterns, technological solutions and organizational styles that prevail in the advanced countries. In the face of this risk, information technologies and the new biotechnologies offer an opportunity to establish systems and to develop products that satisfy long deferred social needs in a creative manner and at reduced costs, which extend access to modernity and its fruits to the most diverse strata of the population, and which provide ample opportunities for proper education and training. These, in turn, represent a key factor in harmonizing the need to develop local technological capacities, the labour skills required by the modernization process, the possibility of achieving more equitable distributive structures and the effective access of the entire population to modernity.

V. ELEMENTS FOR A STRATEGIC AGENDA

A. Overview of the productive system

The ubiquitous nature of the effects of the new technologies on the most diverse sectors and activities and the eventual emergence of new technological patterns (which require changes in the mechanisms used to achieve optimum productivity and in scales of production, patterns of organization of enterprises, and in the configuration of the networks of activities), lends particular urgency to the old imperative of elaborating technological development strategies and the corresponding public policies on the basis of an overview of the productive system and of its interrelationship with the various subsystems of the public sector and with social activities.

This vision makes it possible, on the one hand, to integrate the panorama composed of the disruptive effects of technological trends with that of opportunities to increase productivity, achieve adequate levels of international competitiveness, promote better productive and social linkages and facilitate the spread of technological progress throughout the productive system.

On the other hand, the very features of the emerging technological pattern require a system-wide approach. The information technologies ascribe new importance to the interactions between primary, industrial and service activities. The opportunities to improve productivity and to create competitive advantages tend to depend increasingly on the interactions between the activities carried out in productive complexes which transcend artificial sectoral boundaries, on the interrelationship between domestic and external markets, and on the availability of adequate telematic infrastructures, factors which determine the effectiveness of technological progress at the level of enterprises or sectors and the spread of such progress throughout the productive system.

Finally, the overview is essential in making a correct decision on a strategy of concentration of technological resources, in view of the tension that exists between, on the one hand, the urgent need to constitute critical masses of such resources in order to attain significant and sustained progress and, on the other hand, their scarcity and the slow pace at which they are developed.

B. Technological progress and new technologies

It is clear that the efforts of the countries of Latin America and the Caribbean to achieve technological development cannot be limited to the area of the new technologies. The opportunities to achieve technological leaps in some of these areas through copying, adaptive innovations or specific original developments, should not lead to the positing of a false dichotomy between new technologies and older or traditional technologies. As the new technologies give rise to a new technological pattern, which is tending to permeate the entire productive structure —both through the application of information technologies in the various activities and through the interactions which they generate—, the technological and organizational change in any activity is placed in a new technological context by which it is nurtured.

It is in this context that the countries of the region can explore the various opportunities for technological progress and the possibilities of acquiring or strengthening the relevant technological capacities. The information technologies offer a broad and complex range of impacts and opportunities, which cover both the productive potential of the information media and the multiple applications of these media to productive activities, to the public service systems and to the functions of the State apparatus. Moreover, the countries of Latin America and the Caribbean possess relatively developed technological capacities in different areas of primary or industrial production, the consolidation of which depends on the capacity to incorporate the new technologies. At the same time, in order to overcome some of the more evident areas of technological backwardness in the industrial structures of the region —as in the case of capital goods, the chemical industry or the food industry— there is need to exploit the opportunities offered by the new technologies to expand the potential for increasing productivity and competitivity, together with the strengthening of the older or more conventional technological capacities. Generally speaking, the constructive integration of new technologies into traditional ones (technological blending) constitutes a promising method of expanding the frontier of technological progress in the countries of the region.

All of these possible paths of technological progress, that are open to different degrees and with various perspectives to the various countries of Latin America and the Caribbean, require the creation and development of technological capacities, both for managing the new technologies and for mastering the conventional ones on scales which represent the critical masses required for bringing about the necessary structural changes and linked to subsystems which promote endogenous technological growth.

C. Utilization of information technologies for competitiveness and linkages

The mere fact that the information technologies constitute the vehicle of a worldwide technological revolution and that they affect, to the extent described above, future comparative advantages, places on the countries of Latin America and the Caribbean the responsibility for attaching special priority to them. However, the exclusive concern with international competitiveness represents a limited view of the ramifications of this new

technological base. As pointed out above, the latter has long-term implications for economic organization, the functioning of the societies and the satisfaction of their needs.

It is necessary to elaborate a strategic concept that stresses the links between the new vector of activities based on the information technologies, social service activities (in which the greatest needs exist), and activities related to natural resources, which hold most of the potential for the countries of the region.

In these circumstances, it is not as important to increase the volume of resources assigned to the assimilation of computer-technology media and to the development of information technologies, as to concentrate on their relevance and on the modalities of their application and, if possible, to co-ordinate around the various applications, employment and the development of resources with local capacities.

In the area of production, attention should be focused on the contribution of information technologies to the following processes:

i) the rationalization of the existing productive structure and the introduction of more dynamic linkages;

ii) greater efficiency of exporting activities, particularly in the marketing stage and in the link between services and the production of goods;

iii) the substitution of imports of information-related elements (equipment, components, computer programmes and technical services), with emphasis on the vital importance of acquiring skills in the areas of systems and product design.

In the spheres of economic, social and regional linkages the following may be considered as priority areas or the application of information technologies:

i) the social services sectors, in which there are major areas of underdevelopment: education, health, social security, food systems;

ii) improved efficiency in public management, through the creative application of technological possibilities to processes such as decentralization, debureaucratization, administrative transparence, and the administration of justice, inter alia;

iii) support for the modernization of small- and medium-sized firms and interlinking them with the most dynamic sectors.

In a number of countries in the region, while the physical infrastructure (transport, communications, energy) is relatively developed, backwardness persists in the distribution networks supplying sectors, regions and social groups which are totally or partially excluded by the prevalent mode of development. Proper implementation of information technologies as a means of overcoming such circumstances may improve social and economic

integration and enable countries to meet the external challenge more effectively.

Within the sphere of information technologies, it is world trends that determine the possibilities of local or regional production of information-science media.

As far as standard integrated circuits are concerned, in view of its present potential, it is unlikely that the region will be capable of overcoming the hurdles which new manufacturers have to overcome in order to gain access to this activity. On the other hand, precisely because of the sharp reduction in the prices of the circuits, it is both possible and necessary for the region to participate in the design of systems, the production of computer programmes and even in the manufacture of custom-made or semi-custom-made integrated circuits. The fundamental technical requirement for these activities is the existence of a reserve of academic knowledge; the initial investment requirements are compatible with national, subregional or at the most regional capacity and sufficiently large local markets exist for a variety of applications.

D. Consolidation of the existing technological capacity

There are areas in which some countries in the region have managed to achieve scientific and technological capacity of a sufficiently critical mass, a relative integration of the respective groups with productive activities and a certain degree of international competitiveness, whose consolidation and impact in the future will depend upon its reinforcement and capacity to incorporate the new technologies. This is the case of certain agricultural specialties, of a number of disciplines linked to the energy sector and of certain areas of civil, and to a lesser extent mechanical engineering.

In these areas, it would first of all be necessary to reinforce the existing nuclei, by encouraging an increase in the degree of utilization of the technological base by the productive apparatus, but with different institutional forms in each case.

In the case of the agricultural sector, linking research and the productive sector seems to require a determined effort at articulation, in which a key role could be played by regional and national development banks, as part of the essential process of interlinking industry and agriculture.

In the case of the energy sector, whose market is principally made up of public enterprises, it would be appropriate to examine the possibility of setting up centres or specialized subsidiaries, or of participating in multinational engineering enterprises in order to disseminate the valuable technological heritage which has been built up towards the productive sectors of the region as a whole. In particular, it is clearly necessary to create or consolidate mechanisms for co-operation among the user enterprises and local and regional suppliers of equipment in order to expand technological capacity in respect of the local manufacture of capital goods.

E. Combination of new technologies and traditional methods

To a considerable extent, modernization in Latin American and Caribbean agriculture has been based on the passive assimilation of progress made in advanced agricultural economies. On account of the very characteristics of the technological elements as a whole, only a small number of enterprises in certain agricultural areas of the region have been able to adopt them. Consequently, over-mechanization and even excessive use of agricultural chemicals in some regions, units or on some crops coexists with scant application of industrial inputs or of mechanical means of traction in vast areas and on a large number of production units.

The main challenge in this area —in particular facing countries where there is still a large number of peasant farmers— is to develop technological alternatives for this type of unit, by properly integrating scientific and technological progress —in particular that made in biotechnology and in agricultural chemicals— with the features which characterize the management of the peasant units. In addition, an attempt should be made to utilize the possibilities offered by information technologies to provide technical training for this type of producer and to extend the coverage provided by the scant highly-skilled human technical resources.

If it proves possible to achieve efficient technological mixes in these and in other activities, rather than the replacement of traditional techniques by new technologies, there is reason to hope that constructive integration of both types of technology may preserve a considerable proportion of the resource base associated with traditional techniques of production and facilitate increases of productivity and of income by improving and transforming the techniques adopted in traditional activities.

If this potential were realized, it could bring about more equitable sharing of the fruits of technical progress and a diminution of social and cultural cleavages, as well as facilitating local apprenticeship and experimentation. The use of electronic controls over water use, the application of microcomputers to agricultural planning and administration, the use of radio and television by satellite to provide rural education, the use of photocells in rural electrification, the application of genetic engineering to improve traditional crops or of tissue culture to increase their dissemination are some examples of technological combination, whose requirements and potential have but recently begun to be assessed.

F. Sectors of industry with significant technological lags

There are areas within the industrial sectors of the countries of the region in which there is a wide gap between the physical production capacity and the technological support infrastructure. Throughout the region, this gap may be observed in the chemical, food and capital-goods industries, which represent activities of strategic importance for long-term development.

In each of these sectors, in which the accumulated technological backwardness comes on top of the impact of new technologies, it is vital to implement programmes to develop the scientific and technological

infrastructure and which give due consideration to the already existing nascent infrastructures, the already developed technological capacities of a number of local enterprises, the group of national entrepreneurs committed to technical progress in each of the sectors and the potential support they may provide for the public enterprises involved, either as suppliers or as users, in these sectors.

G. Critical masses of technological resources and endogenous dynamism

In addition to bringing to bear adequate investment resources, one of the requisites for achieving successful structural changes and acquiring comparative advantages is the accumulation of specific technological and organization capacity in sufficient quantity and with adequate synergy to bring about the changes sought, which are generally unattainable through marginal or isolated increases in highly-skilled human resources.

This requirement is even more crucial when constituting areas or nuclei of endogenous dynamism, in which productive, research and educational activities as well as social intercourse mesh together within dynamic processes of generation and dissemination of technological development.

The need to focus technological resources on the smallest sets capable of constituting adequate critical masses is also clearly apparent in the case of attempts to set up specific support infrastructures for the development of particular nuclei or areas of specialization, made up of a combination of equipment, information systems, scientific capability and key technical skills, education and training, organization and marketing.

To a certain extent, labour skills and technological capacity are linked to specific technologies and their development depends on the pattern of specialization chosen. However, skills can be used in a variety of ways, particularly in highly active fields of technology marked by rapid change and widespread dissemination, as is the case of the new technologies. Moreover, the training of human resources and the development of capability in allied fields —within an overall creative environment— has the potential for generating accumulative mechanisms for stimulating technological development.

H. Management of the development of technological capacity and training of human resources

The acquisition of technological capacity constitutes a fundamental requirement for successful long-term industrialization and development processes. However, this process has to deal with extremely defective international technology markets and also involves so many externalities and dynamic economies that the price system is of little utility in allocating resources among different alternatives. Moreover, a country neither needs nor is always capable of counting on sufficient capacity to supply each and every one of the elements of the technology in question.

Consequently, management of the development of technological capacity on selective bases is an essential component of the strategy. This implies that

strategic decisions are taken in respect of technological areas of priority, in accordance with a pattern of specialization which is both in accordance with existing comparative advantages and with the most promising opportunities for acquiring new comparative advantages. It also assumes that selective criteria are applied in respect of technology imports and in respect of the modes of transfer (direct investment, licensing agreements, technical assistance, joint ventures, turnkey plants or the importation of equipment), and on the other hand that informal transfer (copying and apprenticeship) is resorted to. In addition, selectiveness in promoting the substitution of these imports in most cases generally involves relying on imports of some technological components, as well as making use of the information acquired as a result of experience of exports. In dynamic terms, the pattern of technology imports should gradually change as new activities are developed or as local capacity replaces foreign.

In addition, this type of strategy assumes that the capacity to export technology shall be acquired and should take into consideration the many opportunities for complementing regional or subregional technological capability on the basis of relative national specialization in particular areas or elements of the technology. In addition, a detailed examination should be made of the possibilities of undertaking co-operative multinational technological development projects, particularly in areas of new technology.

The development of technological capacity and, in particular, the establishment and reinforcement of export capacity requires a broad base of skilled human resources which are also able to constantly update their knowledge. Consequently, priority must be attributed to the educational process at every level and in the widest possible variety of forms. The possibility of absorbing the internationally available technical progress and disseminating it locally hinges on this.

I. Reallocation of resources and incentives for the development of local technological capacity

Strategies which place technical progress at the heart of the development processes in order to achieve reinsertion in a rapidly changing world and which consider social and productive articulation as the essential requisites, require far-reaching structural changes, a significant reallocation of resources and a coherent and sustained system of incentives.

Even within the overall curtailment of resources which is affecting the countries of the region, such a strategy requires significant changes in the structure of domestic expenditure and in its underlying mechanisms. What is in fact required is a transfer of resources over the whole spectrum of possible uses, ranging from private consumption of refined goods, which are expensive in terms of foreign currency and imported technology, through public expenditure in support of socially exclusive patterns of demand and through speculative or relatively inefficient investment, to --at the other end of the spectrum of strategic efficacity-- investment in lasting technological capacity, the relevant support infrastructure, high-level education in strategic subjects and training in key skills.

J. Organizational changes and capital intensity

Inadequate dynamism, which represents one of the fundamental features of the predominant mode of development in the region, is reflected in the relatively low level of efficiency of investment. Even during the periods of abundant capital inflow, the high rates of investment attained by the majority of the countries of the region represented levels of capital productivity below those required for sustained growth. A complex set of factors, forming a different pattern in each country, underlies this macroeconomic observation. However, outstanding among these is the incorporation of capital-intensive techniques, without any corresponding creation of local technological capacity and with no organizational innovations other than those required for the implantation of a new technique. To a considerable extent, the pattern of incorporation of technical progress in the countries of the region has tended to focus on acquiring the physical components of the technology —the equipment in which it is embodied— with a frequent tendency to neglect both the acquisition of the technical capability by which it is possible to adapt, disseminate and subsequently develop the technology, as well as the organizational requirements for its efficient use.

The technological and productive patterns which are taking shape on the basis of the new technologies not only make it possible to adjust this bias, but also to adopt different paths towards technological development from those taken in the past, involving greater participation by that technological capacity represented by human resources and organizational innovations, which may lead to greater productivity of physical capital.

K. Technology policy within government policies

The supreme importance of the technological challenges facing the countries of Latin America and the Caribbean and the enormous efforts required to redirect their development and to achieve a satisfactory insertion in the world economy, endow the integration of scientific and technological policy within the broadest spheres of government policy with particular urgency. To do so, it is necessary both to overcome exclusivist sectoral concepts and artificial frontiers of jurisdiction and to harmonize action designed for different time horizons.

Consequently, industrial and technological policies should be designed in unison, as their targets of structural change, international competitiveness and employment are closely interdependent; in addition, decisions on investment, rationalization and the incorporation of technical progress in firms are complementary or even combined and are, moreover, influenced by public incentives and action as a whole.

Thus, the set of sectoral measures of a financial, tax or trade nature and programmes in support of technological research and development, the development and modernization of small- and medium-sized firms, training and rationalization in sectors deserving priority, directed towards common goals of competitiveness, the development of technological capacity and of employment, would acquire a degree of coherence comparable with that already

attained by certain developed countries in the design of their industrial and technology policy.

Even so, under the prevailing circumstances in Latin America and the Caribbean a unified technological and industrial policy, designed as a set of sectoral measures must fit into the broader sphere of macroeconomic policies and long-term policies drawn up for other areas. It represents one component of a development strategy in which a key role is played by intersectoral links, consolidation of the national entrepreneurial, the educational system, physical infrastructures, closer links between domestic and external markets and the harmonization of income distribution, the pattern of consumption and the rate of investment.

At one and the same time the overall macroeconomic setting determines and contributes towards the targeted objectives of structural change. Management of aggregate demand, particularly within stabilization and adjustment programmes, places limitations both on the setting of suitable levels of basic prices and on the amounts of resources available for programmes designed to redirect production and technological development. However, it is not sufficient to focus attention on management of macroeconomic equilibria, counting on market sources to spontaneously or satisfactorily direct the required structural changes. Consequently, present relative prices may and generally do differ from those which will form in the course of far-reaching transformations inspired by more complex objectives and criteria than those characterized by the present functioning of markets. In addition, there is broad scope for reexamining the priorities adopted by public investment and for establishing suitable credit mechanisms for the development of production and technology.

Moreover, from the angle of an efficient and satisfactory external adjustment, it is necessary for structural changes to take place which make it possible to increase the response elasticities of exports, of demand for imports and of the supply of import substitutes. However, these changes assume that exports diversify towards items incorporating greater technological content and added value and with adequate and regular levels of international competitiveness. Nevertheless, in order for them to do so it is necessary to increase levels of investment, as well as their microeconomic productivity and macroeconomic efficacity, which in turn requires the incorporation of technical progress together with constant expansion of local technological capacity.

In view of this, industrial and technological policy must become a dimension of economic policy, particularly in respect of policies relating to the supply and management of the system of incentives, but also incorporating the reallocation of resources deriving from the management of aggregate demand and based on the signals given off by the system of basic prices.

The need to link scientific and technological policy and programmes to develop the transport, energy and communications infrastructures is self-evident. Confirmation of this imperative is provided, first of all, by the above-mentioned repercussions which technological development tends to have on the layout of these infrastructures and on the technical choices made; secondly, by the decisive role played --in particular by the

telecommunications network— in reaping the benefits of the opportunities offered by information technologies for achieving economic and social articulation together with adequate levels of international competitiveness, and thirdly, by the already mentioned potential for making use of the existing technological reserve in service and infrastructure firms to increase local technological capacity for the production of goods.

The efficiency of scientific and technological policy is also often largely determined by the content, scope and organization of the educational system. Interrelations between both spheres of government action and among the relevant infrastructures are manifold and complex, and must, of course, pursue common goals. It is sufficient to mention here the overall need to modify educational systems so as to adapt them to the technological and organizational challenges posed, in terms of subjects, teaching methods, the functionality of the different levels of education and the relations with work training and research.

In addition, both the educational process and the mass media play a key role in heightening social perception of the value of research, of innovation and of technical progress, and in particular of the efforts and achievements of local technological innovation, while simultaneously increasing and disseminating information on worldwide scientific and technological progress.

In the strictly scientific and technological spheres, the experience acquired in the countries of the region over the past decade is fertile both in successes and setbacks, particularly in respect of linkage within the institutional infrastructure. The lessons of this experience, as well as the diverse results obtained by the advanced countries in drawing up their scientific and technological policies provide a rich store of ideas, provided adequate attention is paid to the contexts in which they came into being and to the challenges posed by present circumstances in the region.

It is upon these foundations —a substantial effort at institutional, political and social innovation, and effective insertion within the broader framework of government policies— that it is possible to draw up scientific and technological policies which provide an effective response to the strategies for the transformation of technology and production.

It is possible to identify the following instrumental areas as deserving priority:

i) Strengthening the scientific (fundamental and postgraduate research), technological (standardization, metrology, quality control, technological research) and training infrastructures.

ii) The closest possible linkage between the scientific and technological infrastructure and productive activities.

iii) Diminution of the entrepreneurial risks inherent in technological activities.

iv) Cuts in the costs involved in these activities, at both the research and marketing stages.

v) Closer linkage and co-ordination among agencies providing technical assistance, information, tax or credit incentives for research and development projects or projects which contain a significant technological component.

vi) Encouragement for co-operation in technological research among firms.

vii) Support in respect of information and technical assistance for small- and medium-sized firms.

L. Subregional and regional co-operation

One of the spheres in which the challenges facing technological development are most daunting but which also offers enormous opportunities, is in that of subregional and regional co-operation.

In many fields of new technologies, huge investment is necessary in research and development together with an adequate concentration of highly specialized, and at present scarce, scientific and technical human resources in order to acquire technological expertise and the capacity to innovate.

This heightens the hurdles which have to be overcome in order to penetrate many areas of information technologies, as well as a number of biotechnologies and a considerable proportion of the new materials technologies.

This has already spurred the countries of the European Economic Community into setting up regional co-operation programmes for technological development and a number of transnational corporations into undertaking co-operative projects in spheres of new technologies.

In Latin America and the Caribbean, there is an even greater need for co-operative strategies. The shortage of capital and entrepreneurial resources, of scientific and technological infrastructure and of highly specialized human resources mean that the scale of any national effort which might be mustered would be inferior to that required to surmount the hurdles to entry into the majority of the spheres of new technologies. Even those countries with the most developed scientific and technological resources and potential markets are only capable of contesting technological leadership in a small number of these areas. It follows that the spectrum of potential areas and the likelihood of success would be considerably increased through regional or subregional co-operation.

The manifold applications of information technologies also open up a vast field for regional co-operation, beyond the mere possibility of attaining the critical masses of resources necessary for their development. As far as the above dilemma --that of exacerbating or improving the competitiveness and economic and social linkage-- posed by a considerable proportion of these applications is concerned, it is possible to considerably increase the achievements through regional co-operation programmes facilitating the development of original solutions adapted to local potential and shortcomings, or taking advantage, at the regional level, of the results of successful

national experience. The fact that the impact of information science is felt in all countries of the region, regardless of their size or level of development, considerably lengthens the cast of possible actors and the variety of experience which may contribute to such regional co-operation programmes.

The wealth and variety of the region's biotic resources and the similarity of the food and sanitary requirements which have to be met also constitute sound foundations for undertaking co-operative development projects in areas of biotechnology, to develop new products —in particular products best suited to local resources, ecological conditions and requirements-- to ensure the geographical dissemination of crops and to reap the benefits of national experience.

In all areas of technology, be they new or more conventional, regional or subregional co-operation may overcome the restriction imposed by the shortage of technical resources at the national level, by creating centres of excellence and regional training or information networks, as well as through agreements among firms relating to technology transfer or the supply of technical services, which exist in a number of countries, to the other countries in the region.

Moreover, the present external restriction may encourage the various agents facing technological hurdles, accentuated by the shortage of foreign currency, to resort to solutions which are available in the region, at lower cost and on better terms in respect of technology transfer.

These considerations raise the possibility of pushing back the restrictions which the countries of the region have to face in meeting the technological challenges of the present, through regional or subregional co-operation. However, this possibility should not be perceived as being merely a bonus, on top of national efforts. If its full implications are realized, it represents a key factor in any national scientific and technological development strategy, capable of bringing about significant changes in the elements and orientation of the strategy, particularly --but not exclusively-- in the case of the less-developed countries in the region.