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"SCIENCE AND TECHNOLOGY IN A NEW APPROACH TO DEVELOPMENT"

a paper prepared to stimulate discussion at a meeting on

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Amilcar O. Herrera
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SCIENCE AND TECHNOLOGY IN A NEW APPROACH TO DEVELOPMENT

Introduction

The objective of the seminar to be held in Crete in October 18th-25th, is to help to broadly define the lines of research to be pursued in the future by the International Development Research Centre in connection with its programme in science policy. The main reason for organising the meeting is that the changes taking place in the world in relation with the conception of development, makes it imperative for a revision of the role of science and technology in the developing countries.

This paper is intended only as a starting point to stimulate discussion and in no way pretends to be a guide or a frame of reference to limit its scope. A few words to explain how the paper was conceived will serve to clarify its intention.

One of the few things in science policy we have truly learned in the last years, is that the connection between science and society is deeper and subtler than it was formerly believed. Consequently, the first condition to devise a science policy for the future, is to have some idea about how society will evolve.

Starting from that premise, this paper intends to present a very brief account of how the conception of development has evolved in the last decades, and how it will probably affect the evolution of the developing countries in the future. Such a tentative requires to take decisions as to which facts are considered historically relevant, and this undoubtedly involves a certain degree of subjectivity. This however, is not a grave sin; "objective" history has never been written, and surely will never be. To select a given possible future, is an integral part of the task of shaping it.

The last part of the paper introduces some of the problems that the new approach to development poses to science policy. This should be seen solely as a contribution from one of the participants, to the general discussion to take place at the seminar.

THE TRADITIONAL APPROACH TO DEVELOPMENT

The general principles

The process of development was conceived - and is still being conceived by most international organisations engaged in financial and technical aid or assistance - as a linear process. According to this concept, underdevelopment is an early stage of development and, essentially, not very different from the situation of the present developed countries before, or at the beginning, of the Industrial Revolution.

In this context the problem of development, at least from a conceptual point of view, is relatively easy; it consists of repeating the path followed in the past by the developed countries. In practice, this rich and complex evolution is reduced to a process of industrialisation. In a certain sense, and in different contexts, "development is industrialisation" and Lenin's dictum "communism is electricity" reflects the same nineteenth century mechanistic view of human progress. In this conception of development - which amounts to a whole vision of the world - cultural differences were almost completely neglected. The specific characteristics of the poor societies were mainly valued - despite the lip service paid to their "cultural achievements" - in relation to their relevance to the prevailing conception of progress. To the extent that those cultural specificities posed obstacles to the western-style transformation of those societies, they were considered a sign of backwardness and were destined to be changed. In other words, cultural differences were implicitly assimilated to the stages of economic development.

Following explicitly or implicitly that simple scheme, the underdeveloped countries had to solve their economic and social problems through the introduction of modern (or perhaps, better, western) methods of production. The key factor was the generation of a process of industrialisation based on the well-known mechanisms of import substitution. The general pattern adopted was more or less similar in all countries: a first stage in which only the most elementary and simple consumer goods were produced, followed by the production of increasingly sophisticated durable goods, and finally, in some countries, by the building up of an incipient heavy industry.

The trickle dawn effect

This industrialisation was based on the demand of the privileged minorities who constitute between ten and thirty per cent of the population in most developing countries; they are predominantly urban, have an essentially european education, and follow the cultural habits and pattern of consumption of the middle and upper classes of the advanced countries.

~~This effect of accentuating inequalities was contemplated in the industrialisation scheme, and justified by the "trickle dawn" hypothesis.~~ According to this concept, it is unavoidable, not to say desirable - that the benefits of the first phase of industrialisation should go to the upper classes, as they are the only ones with the economic capacity to acquire the sophisticated consumer and durable goods produced by modern industry. However, a small part of those benefits - the "trickle dawn" effect - should reach the rest of the population through the creation of more jobs, extension of certain services, cultural "modernization" through the demonstration effect, etc. As the upper economic strata of society becomes "saturated" the number of benefits reaching the poor will gradually increase; eventually, the modern sector of the economy will encroach on the whole of society.

As it is now widely known, this scheme of development did not work as expected and, as a result, in most developing countries the majority of the population remains more or less in the same state of poverty and backwardness that has been its lot for many generations.

~~The reasons for the failure of this approach to development have been amply discussed, and there is no need to repeat the main arguments here.~~ However, a few considerations on the basis of the physical simile utilized in the approach could be useful. The "trickle dawn" or "over flow" argument is based on the fact that a physical container being continuously filled with a liquid will lose part of its content through leakage (permeability or holes) or through overflow, when totally filled. Put in this simple way the argument looks convincing but, ⁱⁿ ~~as/most physical similes applied to social problems,~~ a closer examination proves it to be essentially misleading.

In the first place, a dominant social class has a self-correcting capacity with respect to "holes" or "permeability" through which wealth can escape, that no physical container possesses. The upper classes of most underdeveloped countries have shown a remarkable skill in allowing only a minimum amount of leakage or permeability of the products of economic growth to reach the lower

strata of society. In some countries - the southern part of Latin America is a good example - where due to social pressure the amount of wealth being transferred to the lower classes was increasing, the privileged minorities reacted by not only stopping the "excess" leakage, but also by placing back into the container part of the economic benefits already transferred in the previous stage.

As for the "overflow" effect, the main obstacle is that social containers are of variable geometry and its volume is continuously increasing, a condition rarely found in physical containers. We are not referring to the "horizontal" growth of the modern sector or to its relative increase in size with respect to the rest of the society; this would be a beneficial effect and, in fact, its almost complete absence is an indication that this approach does not work. We refer to the "vertical" increase in size, by which the demand of goods and services of the rich sector increases rapidly and continuously, while the relative size of the sector remains approximately constant.

This effect can easily be explained. The demand of the upper and middle classes of the affluent societies tend to grow rapidly, not only in absolute terms, but also mainly in the diversity and sophistication of the goods and services required. As their pattern of consumption is moulded on that prevailing in the developed countries, the upper classes of the backward countries feel compelled to increase their consumption in order to reach the standard of living of their chosen model. The result is an endless and rather hopeless race, due to the immense economic and technological superiority of the industrialised societies.

The effect of this process in the productive system of the developing countries is well known; as industrialisation has been geared mainly to satisfy the needs of the upper economic strata, the market thus generated obliges the entrepreneurs to compete amongst themselves on the same basis as in developed countries; producing more "up-to-date" and increasingly sophisticated goods, marketing the prestige of a particular internationally renowned brand, etc. In this situation, even if they wished otherwise (which is highly doubtful, as they have a vested interest in the system) they can only survive by adapting the latest technologies produced in the advanced countries, so as to rapidly put the new products into the market. In this way, a growing share of the scarce capital of the poor countries goes to the production of goods and services required by a small minority of the population. At the same time, the marginal benefit that goes to the rest of the population relatively diminishes, as the capital intensity of the new units of production increases continually, therefore reducing the job creating capacity of the new investments.

This scheme of development has, of course, many variants - one of them maintains that industrialisation should begin with heavy industry, instead of consumer goods - but all of them have a central element in common: its emphasis on economic growth, treated as a relatively independent variable, and the conviction that the growth of the economy will eventually change the whole social fabric. As a consequence, and despite its many limitations, the increase of the GNP is still regarded as proof of development.

Science and technology in the classical approach to development

What was the role of science and technology in this scheme of development? In the first place, and taking the evolution of the developed countries as a determinant paradigm, it was implicitly assumed that technology evolves in a kind of self-contained process relatively independent of the human will. To use a biological simile, technology evolves as if directed by an internal genetic code little affected by the external environment.

The fact that modern technology originated in a particular group of countries with given cultural and socio-economic conditions and that, consequently, it might not be adequate in a different environment was not taken into account, except for the recognition of the necessity of minor adaptations. This is a logical consequence of considering cultural differences as mere stages in the process of development; the idea was that the "universal" western technology - not the scientific knowledge on which this is based - superimposed on "backward" societies, will finally lead them towards the true road to progress.

As a consequence of this conception, R&D systems were created in the developing countries with the same ^{imitative} criteria that were used to induce industrialisation. They have the same structure and follow the same general principles of those in existence in the advanced countries. It was assumed that once a "modern" scientific system - in the sense of subjects of research, quality of personnel, equipment, etc. - came into existence, it would, in due time, naturally connect with the productive system through the classical chain of basic, applied, and development research.

As it is now well known, those expectations were not fulfilled. Despite the advice and material help of international institutions and scientific centres of the advanced countries, the R&D system of the developing countries proved incapable of generating any significant amount of indigenous technology.

Even in the field of adaptation, in most cases they are only able to introduce minor modifications to adapt a final product or process to local conditions, or to make better use of the particular combination of factors of the country involved. And for the study and solution of the basic problems of the poor sector - mostly rural - of these societies, their contribution has been negligible.

The reasons for the failure of the R&D systems of the underdeveloped countries are very complex, and include socio-economic and political factors which we cannot analyse here. However, even from the point of view of the technological dimension, the causes of the failure are fairly evident. The explicit objectives of the R&D systems of the developing countries were first to interact with the productive system - mainly the industrial sector - to satisfy the demands of the international market, and second, to generate innovations in order to be able to compete in the international market.

As the internal demand, as we have already seen, is shaped by the pattern of consumption of the developed countries, and consequently requires the same technology, it is difficult to see how the weak R&D systems in the poor countries could compete with the scientific and technological structure of the industrialised centres. The failure to contribute to solutions of the problems of the rural areas is determined by the fact that the R&D systems are connected with the modern or rich sectors, and have very weak links with the traditional sectors. In addition, the vast masses of the poor rural areas exert very little demand on the economy, and consequently on the scientific system. They have needs, but not the means to transform them into effective demand.

A NEW APPROACH TO DEVELOPMENT

Some of the elements of this new approach are not new, and in some cases they were advanced several decades ago. What is new is that these old concepts have been enriched with new ideas, and are now in the stage of being organised into a coherent body of doctrine that, for the first time in modern history, offers a real alternative to the traditional approach to development.

In the following pages we will try to describe briefly how those ideas evolved, and what potential they have for the future. Although we will roughly follow a time sequence, we are more interested in the logical, rather than in the chronological coherence.

The Theory of Dependency

The concept that development is not a linear process, and that underdevelopment is not simply an early stage of development, had already been stated in the nineteenth century, although the word "development" was not yet incorporated into the socio-political language. The analysis of imperialism by Marx and his followers was a crucial step in this direction.

In the last decade, mainly in Latin America, a stream of ideas developed in which the central theme was the structural character of underdevelopment. According to this position, capitalism in underdeveloped countries, although having the same general characteristics as ⁱⁿ the industrialised countries, also has some peculiarities that are largely due to the position of those countries in the international power structure. Underdevelopment is not merely the first stage of development but represents a different structural situation, largely generated and conditioned by the existence and evolution of developed societies. During the process of colonial expansion, and particularly as a result of the industrial revolution, the countries of the Third World were incorporated into the international capitalist system as peripheral, dependant economies, essentially exporters of raw materials and importers of manufactured goods originating from the great industrial centres. The structure was based on the alliance between local beneficiaries (land owners, importers and exporters, financial elite, etc.) and the international centres of world power.

This type of unequal international capitalist evolution is also reflected in the internal structure of the underdeveloped countries, with the development of the so-called dual societies. In these countries there is a "modern", or more appropriately a rich sector, and a "traditional" or poor sector. The former in most countries comprises between five and thirty per cent of the population, is predominantly urban, has an average income per capita several times higher than the traditional sector, and has the cultural habits and patterns of consumption of the middle and upper classes of the advanced countries. The latter comprises the vast majority of the population, lives mostly in a subsistence economy, and its cultural patterns are still mainly based on those prevailing in the past.

The relationship between the modern and the traditional sector is one of dependency that closely resembles that prevailing between developed and underdeveloped countries. The traditional sector produces the raw materials that are exported or required as inputs by the modern sector. Most of the benefits

of international trade are invested in the modern sector - a considerable part goes to consumption of luxuries - which, added to the great wage difference between the two sectors, tends to widen, or at least maintain, the economic gap between the two sectors.

The form of the dependency at the international level has suffered certain changes in the last few decades. A great part of the goods which were formerly imported are now produced in the developing countries, mainly by multinational corporations or by local enterprises associated with them. Another development in the last few years, but still in its very early stage of implementation, is the transfer to the developing countries of those industries that, due to their low profitability or emission of pollutants, are not compatible with the high standard of living of the industrialised countries. All this development tends to create a new international division of labour, in which the fate of the poor countries is again to be the peripheral proletariat of the big powers. The instrument of domination is now, more than military and political power, the scientific and technological superiority of the advanced countries.

The theory of dependency, developed outside the traditional left, but greatly influenced by it, represents a great step forward from the classical approach. By recognising the structural character of underdevelopment it showed that, unless radical changes occur in the international as well as in the national relations of power, there is little hope of a true and sustained development of the poor countries. As for the way to induce those changes, there is a wide range of opinion: from the hope that they can be achieved by promoting gradual changes, even with the support, or at least the acquiescence, of the centres of power ^(the NIEO is a manifestation of this tendency) to the conviction that only through armed struggle can the necessary changes be produced.

There was a point, however, where all these positions coincided until very recently: once overcoming the structural obstacles, the objective was to build societies as "advanced" as the modern industrialised countries. The model could be a modified, more "humane" form of capitalism, or a socialist society, but the central objective remained more or less constant: a society in which every person can have the standard of living, or the level of consumption which is now the privilege of the developed countries.

In this context the role of science and technology remained basically unchanged: "to catch up" with the advanced countries, and to give the developing countries the same benefits as those given to the rich countries. The model of

scientific and technological development of the western societies remained unchallenged; technology was still conceived implicitly as a sort of independent variable, and the backward societies have the duty to adapt themselves in order to be able to incorporate all its benefits.

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In the last few years the conception of the western model as being practically the only model of "progressive" societies has undergone radical changes, and the integrated approach to development we referred to above has started to emerge. The reasons for these changes - as in all social processes - are difficult to trace in detail, but there are some basic elements that can be identified.

The classical approach to development reevaluated at the centre

One of the most important of the elements of change - if not in the building of the new approach, at least in helping to convert it into an intellectually respectable option - is the fact that ~~for the first time since the industrial revolution the western world has started to have serious doubts about the soundness and rationality of its own way of development.~~ As is well known, ~~doubts about the intrinsic values on which present western culture rests have been expressed from inside~~ in the past. However, those critical analyses were always restricted to individuals or small groups - artists, philosophers, dissident political groups - and never reached any kind of consensus in the society as a whole. What is different now is that these doubts extend even to the material basis of the western society, and they have reached wide sectors of the population, including scientists, politicians, intellectuals, and a considerable part of the informed general public.

If one looks at the evolution of ideas in the last few years, it seems apparent that the main cause of the reevaluation of the western approach to its own development was the sudden revelation that humanity was probably exceeding the carrying capacity of its physical environment. A deeper look, however, reveals that the realisation of the environmental risk only triggered off fears and doubts that were more deeply rooted than the simple concern for physical survival. A very brief analysis of a few facts will be enough to clarify this point.

In the first place, it is interesting to see the evolution of the content of the "environmental problematique". When it began, a few years ago, its

its main influence was on the limitation of the physical resources ultimately available to mankind, and the main responsibility for the ensuing dangers was placed on the rapid growth of the population, particularly in the underdeveloped countries. Typical literature on this subject were The Population Bomb (Ehrlich) and The Limits to Growth (Meadows et al.). Despite its limitations, this approach contained two basic ideas that, although not new in themselves, were new in their global implications. The first was the conception of a single humanity, in the sense of total interdependence of all human societies - "the Spaceship Earth" - and secondly the awareness that the indefinite increase in material consumption is in the long term a physical impossibility, as well as a doubtful social goal.

From those simple ideas, what can be called the "environmental movement" has developed a current of thinking that greatly transcends the original approach. It has incorporated the concept of "human environment" not merely to denote the human material counterpart of the physical environment, but as a proxy to call in question all the basic values and goals of western society. To a certain extent, the environmental movement is substituting for the political parties, who are wholly incorporated into the system, and are unable to express the deep sense of frustration and lack of meaning and purpose that permeates all social strata of the western world.

Another fact that reveals the true nature of the environmental problematique, is that it is difficult to conceive that the revelation of the possibility of physical limits to economic development would have caused so much concern, had it taken place in the nineteenth century, or even before the Second World War. Until that time there was a general belief in the basic values of western society and, above all, a seemingly unshakeable conviction on the capacity of science to overcome all possible obstacles to an endless human material progress. In the last few decades this blind confidence in science - or perhaps more exactly in technology - had, to a great extent, vanished: for the first time since the beginning of the Scientific Revolution, the western man started to question the aims and the role of science in society. Some of the reasons for this attitude can easily be identified and refer to the awareness of the actual or potential dangers of some recent scientific developments: the atomic bomb, the possibility of manipulation of the human mind through psycho drugs, the possible implications of the manipulation of the genetic code, the visible deterioration of the physical environment, etc. There is another motive however, that is deeper and subtler: the growing realisation that to consider technology as a sort of independent variable that increasingly shapes the whole social fabric -

values, motivations, interpersonal and social relations - has led to a degree of alienation that deprives individual and social life of all real meaning and purpose.

The extent and the content of the process of self-criticism that the western world is undergoing is well known, so we do not need to revise it here. There are some consequences of the process, nevertheless, that we will examine briefly, because they are especially relevant to our purpose.

The main consequence of the debate has been to destroy irreversibly the conviction that the way of development of the western world in the last two centuries is the best possible one or, at least, is the one inexorably and unilinearly predetermined by the "natural" growth of scientific and technological knowledge. This reasoning, although started in a necessarily negative attitude, has an important positive counterpart: the way a society develops is based ultimately on the basic values of that society, and these values can change, as they have changed throughout history. The direction in which science - or better technology - develops is, to a great extent, also a function of those values; there is nothing predetermined in the type of technology a society creates. It is true that scientific knowledge evolves through a certain logical sequence due to its very nature, but a given body of scientific knowledge allows the creation of many possible types of technology, and the one adopted depends ultimately on the goals and values of the society involved. In other words, the predicament of western society is not an irreversible process, as some lines of criticism seem to imply; there are options, and history is still an open-ended process with many degrees of freedom.

One of the main results of the debate going on, has been to change the attitude of the western world towards other cultures. Faced with its own limitations, and with the necessity to find new options, the western countries had to begin to reevaluate the content of other cultures. It is not only a question of trying to assess their approach to development in the traditional material sense, but, above all, it is an effort to try to understand their whole conception of life manifested through values, social and interpersonal relationships, philosophy and religion. It is the growing awareness that other cultures can make fundamental contributions to the construction of a better society.

This realization of the presence and importance of other cultures has another root, no less important than the one referred to above, but less obvious. Since the consolidation of the European dominance in the nineteenth century, the predominant vision of the world of the western culture was that of a "civilized" centre, surrounded by a vast hinterland whose only real importance lay in the provision of raw materials and a few luxury goods, and the absorption of western industrial production. The cultural backgrounds of those dimly perceived societies were considered mainly as relics of the past, opposed, or at least irrelevant, to the building up of a really progressive and "modern" society.

During this century the conditions of the world on which that vision was based has greatly changed. The now so-called Third World has left its passive role to become a living, dynamic presence. First, there was the ~~Russian Revolution~~ on the very fringe of the western world, followed by the process of decolonisation; the emergence of China as a big power and a new option of development; the liberation wars: Vietnam, Argelia, Cuba, the portuguese colonies; the creation of OPEC, through which, for the first time in modern history, a group of developing countries can influence the very economic foundations of the developed world. These are only the more visible manifestations of a deeper, widespread phenomenon: the will of the masses of the Third World to put an end to misery and oppression and to reassert their own identity.

For the western world one of the results of this complex process has been the realisation that they are no longer the only protagonists of history; the awareness that humanity is really composed of more than four billion people, and that everyone has the right and the will to contribute, in some way, to shape the future.

In conclusion, the process of "westernization", in which the developing countries acted almost entirely as passive recipients of an external culture is coming to an end, and a more equilibrated relationship is emerging. There is no doubt that western influence in the rest of the world, if liberated from the evils of imperialism, can have many beneficial effects; there is no doubt either, that the Third World can make substantial cultural contributions to the benefit of the western world. This process of mutual fertilization could be a basis for the construction of a true new world order. It will be, however, a long and difficult task, and one of the preconditions of success is for the Third World countries to find their own approach to development.

The Main Elements of the New Approach to Development

The theory of dependency, the critical analysis of the western concept of development which we have referred to above, and the explicit and implicit content of the liberation movements that have taken and are taking place in the Third World countries, constitute the frame of reference for the new approach to development that is emerging in the developing countries. As it is a complex process still full of contradictions, as all historical changes are, it is difficult to build up a complete, coherent picture, of what is taking shape. Consequently, in what follows we will try to identify its main elements, those that seem to be permanent, whatever changes the overall scheme may undergo.

~~The central element in the search for a new approach, is the realisation that underdeveloped countries cannot repeat the path followed in the past by the now developed countries, because the historical conditions are totally different. During the Industrial Revolution the western countries had no competitors in the world; they were the centre of economic, military, scientific and technological power, and so they could shape international trade, and to a great extent the national economies of the peripheral countries, according to their needs. They could export whatever manufactured goods they produce and, protected when needed by their political and military power, they had easy access to the raw materials of the rest of the world. It is obvious that this situation cannot be recreated today for the benefit of the developing world.~~

But even leaving aside the type of path to be followed to develop, it is obvious that it will be practically impossible for most developing countries to reach the standard of living of the industrialised countries - in terms of the same pattern of consumption - in the foreseeable future. In 1970 the average GNP per capita of the advanced countries was about 2030 \$US (1960 \$US); for the developing countries it was about 170 for Africa; 115 for Asia, and 445 for Latin America. The GNP of the developed countries increased during the period 1960-1970 at a rate of 6% per year, which means an annual growth of around 5% for the GNP per capita. In the developing countries, during the same period, the GNP was growing at 4 to 5%, which means 1.5 to 2.5 for the GNP per capita. Even assuming for the poor countries rates of growth of the economy considerably higher than those observed historically, there is practically no chance for the developing countries to catch up with the industrialised world in terms of overall consumption.

The availability of resources also merits a special consideration. According to the most reliable forecasts, around the beginning of the next century the population of the earth will be approximately 7 billion - with more than 5.5 billion belonging to the developing countries - and this could stabilise at about 10 billion during the first half of the 21st century.

If this huge population is going to have the same type and volume of consumption that the average industrialised countries has today - not referring to the level of consumption they would probably have thirty years from now - the pressure on the natural resources of the earth will be enormous. It is not so much a problem of ultimate physical limits but that of the generation of the capital required to develop such amount of conventional resources, or of the technology needed to create new ones, in the next thirty or forty years.

Another point related to the material constraints is that environmental considerations will make it increasingly difficult to reach the rate of growth in the exploitation of natural resources that would be required to raise the level of living of the whole world, to the standards that are still forseen by the advanced countries. It is very difficult to predict the exact form these environmental restrictions will take, but they will surely impose some limitations on the unrestricted exploitation of natural raw materials.

The above arguments against the possibility of the developing countries repeating the type of development of the industrialised countries are all on the negative side. There are, however, positive reasons to justify the search for a new ideal of development, that stems from the previous discussion on the western model of progress. First, to repeat the western model - despite the many positive aspects it contains - will lead to the same situation of social and international inequality, wasteful use of resources, deterioration of the natural environment, and growing alienation that confronts the western culture today. Secondly, the Third World countries have cultural characteristics that are worth preserving; they are the common heritage of mankind, and using an ecological analogy they constitute the genetic reservoir of future cultural options.

The distinctive element of the new approach to development, as compared with the "traditional" one, is that it is centered in the concrete human beings; in other words, the well being of individuals will not be the by-product of general economic growth - whose version for the underdeveloped countries is the "trickle down" effect - but a specific target whose attainment will condition the whole social and economic organisation of the country.

According with this approach, development will be centered around the concept of "basic needs". There are many definitions of this concept, but it is basically the recognition that each human being simply because of his existence, has the inalienable right to the satisfaction of certain needs which are essential for a complete and active incorporation into his culture. Some of those basic needs - as food, shelter, health and education - are relatively invariant through time and cultures, and easy to identify. Other needs, however, associated with consumption, or of a more spiritual nature, are more difficult to define. Historically they have changed with each society and with time. New needs are generated by the evolution of cultures, by new forms of social organisation, and by technological change. In judging which of those needs are really "basic", and their relative priority, a large dose of subjectivity, or social bias, is inevitable.

The only way out of this dilemma - determining which are the legitimate social needs for the majority of the population, and not only for an economic or intellectual elite - is to establish mechanisms of participation to ensure that all social decisions really represent the will and aspirations of the populace.

This emphasis on popular participation in the new approach to development have other reasons, besides the determination of social needs. The creation of new societies in the developing countries, within its own cultural characteristics, requires the creative effort of the whole community. No real social change can take place unless it has the support of the majority of the population, and this support will be given only if people feel that they can participate in the process.

The three elements we have identified - not to repeat the path of the developed countries; to make the satisfaction of the needs of the people the specific objective of development, and to ensure as much popular participation as possible - are not enough to give a complete picture of the content and meaning of the new approach to development. History shows, however, that this is not an exception. All social changes in the past have started with a nucleus of very simple and basic objectives- the extent to which those objectives are attained, and the operative forms they take, are determined essentially by the characteristics of the process of change itself. In other words, and this is not new, the ends are largely a function of the means.

In the case of the new approach to development, the mechanism of change is centered around the concept of "self-reliance". A brief analysis of its origin and content, will give some indications as to whether or not it is the appropriate means to achieve the simple objectives we were referring to.

The emergence of the concept of self-reliance was received in many circles of the developed countries with strong feelings of distrust: it was considered at best naive and unrealistic, and at worst a tentative of disruption of the international system. Leaving aside the cases where the motivation of the distrust was rooted on the defense of vested interests, this attitude was based generally on a misunderstanding of the true meaning of self-reliance.

In a very simple definition, self-reliance

"... is to be understood at the national level of each developing country as the will to build up the capacity for autonomous decision-making and implementation in all aspects of the development process including science and technology. This approach to self-reliance is reflected internationally as opposition to all forms of dependency. It calls for changing the mode of incorporation of the developing countries in the international, political, economic and cultural systems."
(The Role of Self-Reliance in Alternative Strategies for Development, Pugwash Symposium, Dar es Salaam, 2nd-6th June, 1977)

Before entering into the consideration of the meaning of the above definition, it is interesting to analyse why the concept of self-reliance emerged, as it is often argued that ~~it is not necessary to achieve the objectives of development~~. This position is largely based on the old premise that the reservoir of scientific and technological capability, managerial skill, and capital of the developed countries, could be used through ~~transference and foreign aid~~, to create modern societies in the poor countries.

The long and bitter experience of the post war period has shown, as it is widely known, that this conception is at best, the truly naive and unrealistic one. The foreign aid has been, besides the economic and political condition often attached to it, only marginal to the needs of the countries involved; as for the transference of knowledge and skill, it had been too often a transference of problems rather than of solutions. The developing countries are finally learning what they should have learnt much earlier: ~~that what they do not do for themselves nobody will do for them~~. Foreign aid and transference of knowledge could be very useful, but only in the context of a really autonomous development policy.

~~Consequently, self-reliance is basically the recognition that the main responsibility to solve the problems of underdevelopment lies in the developing countries themselves~~. If it is accepted, furthermore, that the developing countries, for the reasons already given, cannot copy the type of society of the industrialised countries, it is clear that they will have to rely mainly on their own resources, human as well as material. To follow a path to development different from the one followed in the past by the now advanced countries, means that they will have to initiate a process on which there is no previous historical experience. They will have to confront new problems because socio-political conditions have changed, and also because the relationship between knowledge, technology, resources and population had very little resemblance with those prevailing in the past. In these conditions, it is obvious that the developing countries will have to look for solutions in the effort, imagination and creative capacity of their own societies.

Finally, development, progress or evolution - whatever we may choose to call it - it is not simply a techno-economic phenomenon: it is also, and mainly, a process through which a society continuously creates and reasserts its own identity. The cultural heritage of a society is an obstacle to development only when this is seen as the passive and indiscriminate acceptance of an exogenous conception of the world. However, when development is conceived basically as an endogenous transformation in which external experience is not imposed but voluntarily and selectively incorporated, the specific cultural characteristics of developing countries could be, instead of obstacles, the dynamic nucleus of the process of change.

Collective self-reliance is only the natural extension of the concept of self-reliance. In the first place it is the awareness that, sharing basically the same problems, regional cooperation could be the best way to enlarge the basis of human and natural resources required for development. Secondly, but not less important, cooperation for a conception of development that it is not centered in economic growth, but on human being considered in all their dimensions - material, cultural, spiritual - could be the first step in the creation of a more equitable world order.

A criticism that has been frequently raised against self-reliance, and specially against collective self-reliance, is that it represents a tendency towards autarchy or self-sufficiency that will disrupt the present world order, and will be an obstacle to the objective of an unified humanity.

The truth is that self-reliance not only is not against solidarity at world level, but it is a contribution to that ideal. In the present world order relationships between countries are of competition and dominance, and the whole structure tends to benefit the rich industrialised centres. It is a system with strong interconnections, but with an almost complete lack of solidarity.

The aim of self-reliance is to substitute a system of real solidary cooperation among partners with equal rights and obligation, for the present structure of institutionalised injustice. During the transitional period it is highly probable that the developing countries will have to

detach themselves partially from the international system - above all in connection with trade - to reorient their productive systems in the new direction. The concentration on the satisfaction of basic needs with the resulting changes in the patterns of consumption; the reliance on local natural resources, and the regional cooperation between developing countries, will undoubtedly call for a drastic change in the present pattern of international trade. This partial detachment - or de-linking - will be, however, only transitory, and it will be followed by a recoupling on a new more equitable basis.

In conclusion, self-reliance is not an unrealistic, romantic conception, destined to fade away when confronted with the "hard facts". It is the natural, unavoidable strategy of development stemming precisely from the acceptance, at last, of the hard facts.

The last question is whether or not self-reliance is the adequate means to achieve the very basic objectives we have identified in the new approach to development. The answer, in general terms, is relatively easy. The following of a development pattern different from the one followed in the past by the industrialised countries, and the concentration on the satisfaction of the basic needs, is an integral and necessary part of the strategy: it is a part of its very definition. On the other hand, as the success of the strategy depend almost exclusively on the capacity to mobilise local support and creativity, a high degree of popular participation is an indispensable operational requirement. Finally, this popular participation is the most adequate means of introducing in the new scheme of development the basic cultural elements of the society involved.

The Role of Science in the New Approach to Development

A Few Suggestions

The above description - or better, interpretation - admittedly too schematic, only intends to show the extent and possible direction of the process of change that affects the present world. Our main concern now is: what is the role that science and technology will, or should play, in that process of transformation?

For an institution as IDRC, trying to help the developing countries to make good use of science and technology for their progress, an adequate answer to this question is essential. Unless it has some clear ideas about the type of problems that science and technology will have to confront in the context of a changing world, it runs the risk of becoming irrelevant, at best, or another obstacle to the process of transformation at worst.

The purpose of this paper is not to give an answer to those questions - this is the specific task of the seminar - but to serve as a stimulus, and as a starting point for the discussion. However, and without any attempt at being exhaustive, we will try to broadly define some of the problem areas that we consider relevant for the discussion.

As we have already seen, the most important problem the developing countries has to face, is how to implement self-reliance. Although in terms of its sociopolitical and cultural content self-reliance is still the subject of much controversy, from the point of view of its implications in science policy the problem is conceptually very clear: how to connect effectively the R and D systems of the developing countries with their own societies, and how to make them able to produce the knowledge and technologies needed for an autonomous and self-induced development.

That a problem is conceptually clear, does not mean necessarily that its practical solution is easy. To connect the R and D systems with society seemed relatively simple thirty years ago; now the facts have shown that it is extremely difficult. We are aware now that we have only one historical example of "natural" evolution of that process - the countries that entered the Industrial Revolution in the nineteenth century - and the economic, social and political conditions of that phenomenon were entirely different from the ones prevailing today. Afterwards, only three countries - Japan, the Soviet Union and China - have succeeded in using science affectively for an autonomous development project, and in all three cases this has been one of the results of deep political, social and economic changes. From all those antecedents the Third World countries can extract some useful teachings, but on the whole they will have to devise their own solutions.

Probably the most relevant teaching on the past experiences is that science becomes really linked with society, when society exerts an effective demand for technological solutions on the R and D systems. In the western countries this demand was provided by the Industrial Revolution and the emergence of parliamentary democracies; in Japan, the Soviet Union and China, by autonomous national projects devised and implemented by political and economic elites, or by revolutionary parties.

In the Third World countries, it is difficult to predict through what type of mechanism they will generate adequate societal demand on their R and D system. We know, however, that participation - one of the central elements of the emerging new approach to development - will play a determining role. Consequently, one of the main areas of problems to explore is social participation in the generation of technologies appropriate for an autonomous development project.

Some of the problems associated with participation are:

Which are the possible mechanisms of social participation? In the western societies those mechanisms, although in general very indirect, have been reasonably effective in the past. However, with the growing

influence of science in every day life, even in the advanced countries there is a general feeling that much more direct participation is needed in the generation of the technologies that so deeply affect all aspects of people's life. In the developing world those mechanisms have really never existed for the majority of the population, and should be created.

In the few instances where mechanisms or popular participation in the creation of technologies are being implemented or studied, they refer almost exclusively to the rural areas or traditional sector. However, if the objective of development is to create finally integrated societies, participation should extend also to the urban or modern sector. How can participation be induced in the whole society? What are the specific forms of participation applicable to the rural sector, and the the urban sector? How to interrelate them in order to generate a coherent overall scheme of development?

Another problem related with participation, refers to the structure of the R and D systems. They have the same type of organisation and methodology of work that prevails in the developed countries, although the links with their societies are entirely different. What kind of organisational modifications should be introduced in the R and D system of the developing countries to adapt them to people's participation? What methodology of technological research should be adopted to make the R and D systems able to cope with a new approach as to the role of science, and the scientist, in society?

In the solution of all those problems there is always the danger of forgetting that scientific activity has certain intrinsic requirements that cannot be changed without endangering the whole process of creation. This poses an additional question: how to modify the R and D system in order to adapt those to participation, without affecting those elements and internal relationships which are essential to maintain scientific creativity?

As there is very little experience on how to confront those problems, more reliable information is needed. This information can only be obtained through projects that can give empirical evidence about the possible results of different approaches. So, one of the points that deserves careful consideration, is what type of projects are needed to contribute empirical evidence to the building up of a new strategy of scientific and technological research.

One of the central characteristics of the new approach to development is its concentration on the satisfactions of the basic needs of the population. This is a field of special interest for the application of a new strategy of research for the following reasons: (a) due to the great volume of resources required - natural as well as human - basic needs should be satisfied mainly on the basis of local inputs; (b) in the definition of what are basic needs and in the determination as to their level of satisfaction, is where popular participation is most needed and feasible; (c) most of the traditional technologies are related to the satisfaction of basic needs, so it is an ideal field to couple empirical local knowledge with modern science; (d) although basic needs are relatively invariant for all societies, their specific forms of satisfaction are strongly determined by local conditions - i.e. climate, type of family, territorial space and natural resources for housing; climate, altitude, soils, cultural characteristics for food; (e) basic needs are strongly interdependent, and therefore they require an overall strategy of research. The characteristics of this strategy, and the type of project required for its empirical definition, are subjects that require detailed analysis.

The need for an overall strategy to cope with a whole area of social and economic problems, poses again the much discussed subject of multidisciplinary or transdisciplinary research. Despite the wide recognition that the solution of most modern technological problems requires an integrated approach multidisciplinary, or better, transdisciplinary research, is still little more than an aspiration. What is now called multidisciplinary research in most cases is only the juxtaposition of several disciplines, to collaborate in the implementation of a project already defined. To make real transdisciplinary research the interaction between different disciplines should start at the stage of basic research, at the stage in which problems are identified. One of the reasons of the difficulty in making transdisciplinary research stems from the historical development of the R and D system, centered on disciplines and not on areas of problems. It is not a question of eliminating discipline oriented research, which is also necessary and unavoidable, but of creating a level of activity at which transdisciplinary research becomes a normal part of the action of the R and D system. What are the methodologies to be applied to make possible transdisciplinary research? What kind of modifications are required in the organisation of the R and D systems, and in the training of scientists?

One special point associated with the above mentioned problem, is the collaboration of social scientists with natural scientists and technologists. In an approach to development that is based on the specific needs and aspirations of the human beings, and not on more or less indiscriminate economic growth, the integrated effort of social and natural scientists is one of the conditions of success. However, up to now it has proved to be a most difficult type of collaboration, full of misunderstandings and mutual distrust. What should be done to change this situation? What type of projects should be set up to explore the ways to reach an active and fruitful interaction?

Self-reliance, or endogenous development, calls also for a careful revision of the strategies of transference of technologies from the developed countries. Until now, technologies have been transferred on the general assumption that conditions in the recipient country were more or less the same than in the countries where the technology was generated. With few exceptions the main conditions taken into account to transfer technologies were the existence of a market and, sometimes, the more or less immediate effect on the external balance of payment. The overall effect on pattern of consumption, distribution of income, accessibility to different sectors of the population, cultural adequacy, coherence with long term objectives of development, etc., were seldom given serious consideration.

In self-reliance the type of technology required for autonomous development will be determined by the developing country itself, taking into account its overall effect on the type of society envisaged. In this context, transference should be seen as a part of the process of local generation of technologies; a complementary action when the required technology already exists, or cannot be produced locally. Technologies will be imported when there is a need identified by a careful analysis of the set of coherent technologies required to fulfil a given social function. In other words, the developing countries will not be the passive recipients of the by-products of the increasing consumption of the developed countries, but will play an active role selecting what is needed for an autonomous model, of society.

This strategy of transference will require studies of the available sources of technologies, and of their relative importance. It is generally believed that most technologies are originated and transferred by the multinational corporations, but is that really true, and if so, to what extent? What proportion of the technologies being transferred come from medium and small size enterprises? What is the actual or potential role in transference of the so called "factories of technologies", or enterprise devoted to the creation of technologies but without entering the production stage? What are the possibilities of transferring technologies from the state owned enterprises of the socialist countries, or of the countries with mixed economies? It is obvious that the strategy for transference will vary greatly depending on the source of technology selected, and those alternatives should be carefully studied.

Another point relevant to the problem of transference of technologies is the international system of patents. Should the developing countries accept a system that benefits almost exclusively the industrialised countries? If not, which are the alternatives?

Collective self-reliance implies cooperation between the developing countries, and this is of special significance in the field of science and technology. The international experience on cooperation in technological matters refers mainly to specific projects, and most of them have been carried out in the developed countries. There is practically no experience in cooperation of the R and D systems at a global level, to face wide areas of social and economic problems. What are the possible mechanisms to induce such a type of cooperation? What can be learnt from the limited efforts carried out in the past? What projects could be set up to generate empirical information on this field?

In the last years there have been some interesting efforts of scientific collaboration at world level referred mainly to basic research (i.e. the International Geophysical Year). Why not launch an International Development Year to explore the basic problems of underdevelopment? One of the results of the common undertaking could be the emergence of new methodologies for the R and D systems to cooperate in the general problems of development. Besides, if the international scientific community devotes a part of its attention to the problems of underdevelopment at grass-roots level, it can contribute to give academic prestige to subjects of research that, although intellectually as challenging as the subjects in fashion, are still regarded as second class themes of research by many scientists of the Third World.

Finally, the few areas of problems mentioned above clearly indicates that new instruments of science policy should be devised to guide the scientific and technological effort in the new approach to development. The characteristics that such instruments should have will be a function of the mechanisms and methodologies applied to induce and organise participation, transdisciplinarian research, new forms of transference of technologies, cooperation between the R and D system of the developing countries, etc. However, some useful information for the building up of such instruments can be also extracted from past experiences. In the last two decades most developing countries have established institutions for planning and directing their scientific and technological activities, and some of them have worked for a fairly long time. It is a good time now to make a careful analysis of those experiences and to try to determine the causes of their successes and failures.

Amilcar O. Herrera