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Science for Development–A View from Latin America

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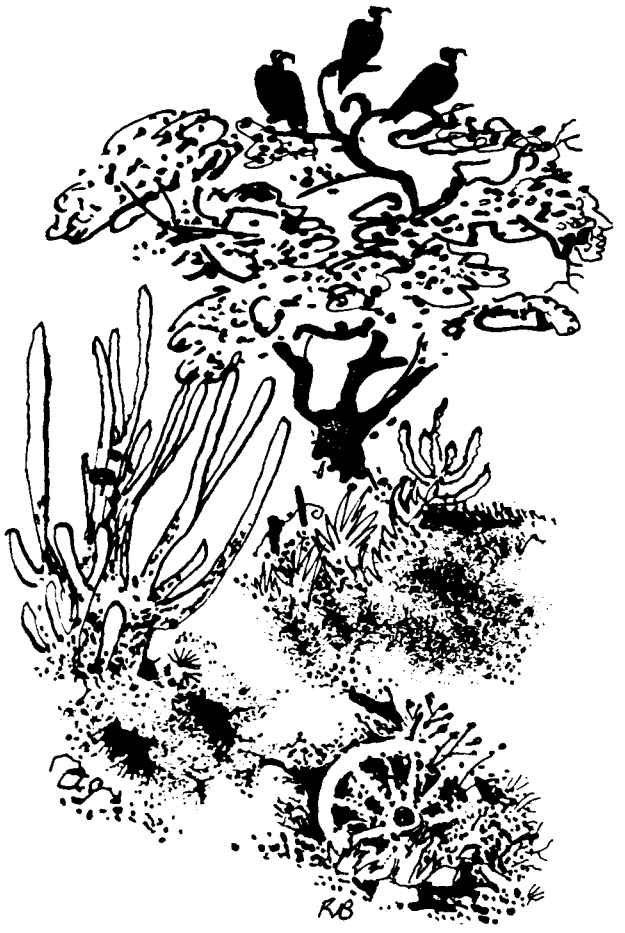

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In the advanced, scientifically developed countries, the idea of the importance of scientific research for economic development has evolved slowly and has itself been a part of the countries' progress.

The interaction among inventions, empirically discovered techniques, and theoretical culture produced, mainly over the last four centuries, a unique body of knowledge which distinguishes modern civilization. The search for and understanding of the laws of nature, the exploration and mastery of natural resources, appear as fundamental processes in the historical development of mankind and the upsurge of contemporary advanced civilization. Twentieth century society owes its material power and its accompanying intellectual vitality to the development of science and technology. This development was ultimately built on the inquiring attitude of man which took a socially meaningful form in the seventeenth century; it brought about the Industrial Revolution and today has a fundamental influence on the economic and political relationships among nations.

It is true that only recently statesmen and business leaders in the advanced countries took full cognizance of the role of science as a basic force, through technology, in the economic expansion of these nations. World

War I and more especially World War II provided the historical processes that definitely proved to the leaders of those countries that technical inventions and scientific discoveries, even in the most abstract fields, are essential for the build-up of a strong economy and a corresponding military power. Indeed, it was during and immediately after World War I that the first organizations for diffusion, coordination, and development of scientific research were created: the National Research Councils in the United States and Canada in 1916 and the Department for Industrial and Scientific Research in the United Kingdom in the same year. In Italy, the Consiglio Nazionale delle Ricerche was created in 1923. And after the 1917 Revolution the Academy of Sciences of the Soviet Union became a government department, endowed with a large number of scientific institutes, in charge of the planning, execution, and encouragement of research.

Science, in this way, began to be institutionalized; it became a social entity, to be taken into account by government and industry, as a force for production and development. In the United Kingdom science obtained Cabinet status in 1959, and today most of the countries of Europe, as well as India and the United Arab Republic, boast a minister for scientific research.

- *SCIENCE AND THE UNDERDEVELOPED NATIONS*

The historical processes which gave rise to the development of science in the advanced countries did not take place—in a systematic and sustained way at least—among today's underdeveloped peoples.

Because the systematic development of techniques and the search for scientific knowledge were not sustained in these societies, they lacked a basic tool for realizing progress in the form which led to modern civilization and indeed for ensuring their very survival. And once the inequality among nations was established, the economic and political forces frequently exerted themselves toward increasing it. Economic forces pushed the development of the societies equipped with the methods of scientific and technological research, employing all ways and means available, including economic, political, and military domination of the underdeveloped peoples.

Thus science and technology became a powerful factor in the prosperity of the presently advanced peoples. And the lack of scientific knowledge and technological means became an equally powerful factor in the backwardness of the underdeveloped peoples. The absence of those conditions which stimulated the search for scientific knowledge—the lack of elementary as well as scientific and technical education—thus constituted an obstacle for the presently underdeveloped peoples to attain the economic and cultural levels of progress which characterize the modern advanced nations. Since scientists, scientific institutes, and universities are stimulated and supported by the economic and social advances of a country, the fruits of their activities revert mainly, as a matter of course, to the further development of such countries. The thesis that science is universal is thus applicable essentially to the reduced universe of the rich and advanced nations themselves.

Underdeveloped nations are unable to apply the developed nations' scientific research for their own benefit —the underdeveloped peoples and the natural resources of their countries remain at the mercy of the advanced ones—and this will be the case until forces and conditions arise among them which will enable them to establish structures adequately adapted to socially meaningful, self-sustained development.

- *AN EXAMPLE OF THE GROWTH OF SCIENCE IN BRAZIL*

Science in Brazil provides one example—among many —of the efforts made by a few scientists, many of them edu ed and trained abroad who are endowed with the essential qualifications for research. But they are not "understood." Scientific development, like other, more fundamental, social and economic reforms in the developing countries, is in conflict with the interests of the traditional ruling classes. Consequently their efforts are not encouraged by either public authorities or private enterprises in their country. It must be mentioned, however, that with the need for medical doctors to fight disease, the first schools of medicine were created in Brazil in the nineteenth century.

As a colony of Portugal, the function of the country and its small population had been essentially to be duly explored and exploited, and to provide resources and goods—cane sugar, gold, cotton, tobacco—for the enrichment of the mother county and her allies. It was not until 1810 that Brazil's ports were opened, and then only to nations at peace wtih Portugal. This was the result of the King of Portugal having established himself in Brazil in 1808, after fleeing Napoleon's invasion of the Iberian Peninsula. It was not until 1854 that the first railway was set up in the country by a British concern. This slow progress may perhaps provide some understanding of why it was only in the late 1800s that schools of higher education were founded in Brazil.

The first research institutes date from the beginning of the twentieth century, when public health calamities forced the organization by the government, of institutes of biology and experimental medicine, independent of the medical schools. Thus the plague in the city of Santos led to the foundation in 1889 of the Instituto Butantan in São Paulo. The upsurge of plague and yellow fever in Rio de Janeiro was responsible for the creation by the federal government in 1900 of the Instituto Oswaldo Cruz, founded by—and later named after—the medical scientist who coordinated the work to eliminate those epidemics. The founding of the Biological Institute of the city of São Paulo was essentially a consequence of a disease which attacked the coffee plantations. But even in these fields, so directly asso-

ciated with the health of the people and the economic resources of the country—capable, therefore, of attracting the interest of the public authorities—the scientific development in Brazil progressed very slowly. Once it had eliminated the public calamities, science did not appear to the country's leaders as a positive force, needed for progress and change in normal times, to improve the health of the people and otherwise implement national development. Although meant to benefit many, scientific activities were conducted by a very few. In 1905, biologist João Baptista de Lacerda, Director of the National Museum of Rio de Janeiro wrote: "In general, in Brazil, the men dedicated to studies and to science constitute a kind of noble proletariat, who exist on small salaries, hardly sufficient for a modest living. Neglecting the frivolous grandeurs of the world and feeling the inexpressible pleasures that scientific research communicates, they comp' vith this situation and accept it without constraint."

In Brazil, the educational system is open to only a small elite; schools of higher education were founded late, and only recently have been organized in universities, the structure of which has not favored the growth of scientific research in their laboratories. Thus the socially meaningful aspects of the search for new knowledge have remained essentially absent from Brazil. The fauna and flora of the country have been studied to some extent by scientists from abroad, attracted by the unexplored tropical areas, and their teachings have contributed to the training of local investigators who continued their work.

Mathematics, physics, and chemistry, having no practical application in fighting public health calamities, were reduced to courses in the Royal Military Academy, founded in 1810 and later changed into the Polytechnical School of Rio de Janeiro—today the School of Engineering of the Federal University of Rio de Janeiro. In 1875 a School of Mines was organized in the city of Ouro Preto, the region of gold mines and precious stones; and in 1896 the Polytechnical School of São Paulo was founded. Such were—in addition to the schools of law—the centers of higher education available to the elite at that time.

It was only after 1930 that there were created the first schools of chemical engineering and the first schools of philosophy, sciences, and letters, aimed at providing teacher education for secondary schools and training for scientists.

In all societies of a certain cultural level, good scientists and scholars appear from time to time. But the social significance of science and technology depends on a number of critical conditions, among which are generalized elementary and secondary education, good universities and laboratories. These guarantee the continuous output of at least a minimum number of scientists and technical experts in interaction with the economic development of the nation. According to a 1950 census, the percentage of the workers in Brazilian industry with a technical education was 1.15 per cent; the number of engineers, including those who had only administrative functions or did not practice their profession, was about 26,000, corresponding to one engineer per 2,000 inhabitants. By way of comparison, the number of U.S. engineers and scientists working in industry in 1957 was 738,000, including 528,000 engineers, 152,000 scientists, and 58,000 administrators. Of these, 176,000 engineers and 50,000 scientists were employed in development and research work.

• *GOVERNMENT AND SCIENCE*

After World War II, a substantial industrialization effort was made in Brazil. From 1949 to 1959, the industrial power of the country jumped from the index 100 to 279. Created in 1953, against all kinds of internal and external obstacles, the National Petroleum Company attained within ten years the level of furnishing about one-third of the country's crude oil needs. The consumption of steel in the year 1960 was about 2.9 million tons and was expected to attain 5.4 million tons in 1965. In the four years between 1957 and 1961, about 470,000 automobiles were manufactured in Brazil.

It was in 1951 that the Brazilian Congress approved a bill creating the National Research Council, directly subordinate to the President of the Republic. Only after the establishment of this organization was it possible for Brazilian universities and scientific institutes to receive special grants from the federal government for scientific research programs. Scientists, formerly obliged to have at least two underpaid jobs, were able, for the first time, to obtain grants from the Council and devote themselves to scientific work in only one institution. A small program of fellowships to train graduate students at home and abroad was instituted. At the same time, new schools of engineering were created.

After 1960, however, it became evident that the progress attained was not enough to meet the needs and demands of the growing population. "In 1955," writes Pierre George (*Panorama du Monde Actuel*, Paris: Presses Universitaires, 1965, page 219), "Brazil produced less than 300,000 tons of petroleum; it topped the figure of five million tons in 1963. But the amounts, when related to the population or to the area of the country, are not significant. Brazil needs 20 or 30 million tons of cement, 15 to 20 million tons of steel per year to supply its requirement at a reasonable rate. It fulfills less than one-fifth of this requirement." Industrialization, based on a substitution of local production for imports, did not maintain its initial rate of growth. Moreover, industrial enterprises in Brazil, being affiliated with foreign societies and corporations, have their own programs of profit and investment, not always coincident with the national interests of the country. Their influence on the growth of pure and applied science in Brazil is practically nonexistent. Such enterprises have

their own research laboratories, or they finance university research work in their own countries, from which they receive the latest inventions and products. They are, therefore, not interested in stimulating laboratories and universities in the countries where they are operating. They want only a minimum number of needed technicians to run the plants, and a few native lawyers and engineers as administrative associates, chosen from among the politically important groups of the country. It thus becomes perhaps clear why a conjunction of interests between such corporations and the local ruling groups does not seem to favor the development of education and of science and technology in the country.

It is not by accident that institutions of higher education in the developing nations are almost all created and supported by the government. In general, the national enterprises of these countries do not have the funds needed for investment in those sectors which do not bring them immediate profit. And when such funds are available, the native industrialists lack, in general, the necessary information and knowledge about the long-range results of significant investments in scientific research and education—or else there are no stipulations in the income tax laws, analogous to those existing in the advanced countries, which would induce them to make such grants.

Generally, the national industries of the developing countries utilize scientific knowledge and techniques imported—or rented—from abroad in the form of patents. Scientific and technological research, the ultimate origin of such industries, is thus conducted abroad, and the native industrialists of the developing nations, many of whom finally become minor partners in subsidiaries of foreign corporations, do not feel the need to stimulate the growth of scientific research in their own countries.

It is, therefore, the state which must support the education program, the universities, and the scientific institutes. In general, the few private universities and scientific institutes are supported—most often with substantial governmental grants—by religious organizations, as is the case with the Catholic universities in many countries of Latin America. The number and role of such private universities is, however, negligible compared with the needs of these countries.

Scientific research in the developing nations is also aided by grants and donations from foreign foundations, and through cooperation programs with other governments, or with international organizations. Such aid, however, is usually minor compared with the massive effort which would have to be made in the great majority of the underdeveloped countries for basic education as well as for university and scientific and technological activities to acquire a real social meaning. And very often, some of these cooperation programs are counter-indicated, for they give the erroneous impression that the basic problems are being attacked and thus avoid the formulation and execution of a vigorous plan on the part of the local government and the productive forces themselves.

• *SCIENTISTS AND INDUSTRY*

Even if the government of a developing country is advised by its national scientists to support good universities and scientific research, plus a program of intensive basic education—and the request of this advice is not a common practice—another difficulty remains: the utilization of the scientists by local industries. If these rely on research and technological work carried out abroad, it is clear that the local scientists will not have much opportunity for jobs in hypothetical research laboratories of the industrial enterprises established in underdeveloped countries. This may, perhaps, help in understanding why, in Brazil, with a population of almost 80 million inhabitants, only 553 fellowships were granted in 1963 by the National Research Council in all fields of science and technology; in the same year, only two fellowships in agriculture, seven in chemistry, and one in geology were granted by the Council for study abroad. The Brazilian Research Council sent a total of only 86 fellows to study abroad in 1956; the number of similar fellowships in 1961 was allowed to drop to 30.

This decline is not an isolated fact in the recent evolution of the country. It is clear that reasonable scientific progress in the underdeveloped countries cannot occur without the removal of obstacles—political, social, economic—to development in general. If they are not accompanied by a policy of intensive economic development, the educational programs will ultimately result in the emigration of qualified labor and scientists to the more advanced countries, as a parallel to the exportation of raw materials as the basis of their economy. Integrated programs and policies must be formulated by the national governments of the underdeveloped countries with the aim of achieving an ever-increasing standard of living for their people. If government programs are, on the contrary, devoted to the protection of the interests of a few privileged groups, they will not reflect the aspirations of the people; they will not lead to a self-sustained and healthy development; and science and technology will find no way to flourish.

Scientists, for the most part, have been attracted by the critical problems of war and peace, and by the search for new formulas for international coexistence within the universe of the advanced nations. They have largely ignored questions of the survival of the developing nations; of the relationship between the powerful economies of the advanced countries and the national aspirations of the underdeveloped nations; of, in short, the human ideal of a decent living for the peoples of the latter countries. Recent political developments in many countries of the Third World, however, are be-

coming more and more the object of study by economists, sociologists, and political scientists. In a recent paper on the hegemony of the United States and the future of Latin America, the economist Celos Furtado ("The Hegemony of the United States and the Future of Latin America," Paris, *Le Monde*, January 5, 1966) wrote:

> From the moment United States "security" is defined as including the maintenance of the social status quo in the Latin American region, it becomes perfectly clear that the autonomy of the countries in that region (if we grant that the Latin American nations and states are something more than temporary power structures) in supervising their own development, is reduced to very little. This doctrine implies that fundamental decisions must be taken at a higher level, probably in the political center of the sphe f influence, or in some "supranational" organ hose effective power would have simply been delegated by that political center. In this case, we must enquire what type of "development" the United States envisages for Latin America. . . . Although no unanimous conclusion has been reached on all aspects of this complex problem, there is already a perfectly accepted doctrine in the United States, at least on one point. This is the point that a basic role is being played in Latin American development by private American corporations and that the United States "aid" policy should be carried out principally through these corporations.

Operating in Latin America and other areas of the Third World, under privileged conditions which they secure from the local governments, outside of the control of U.S. antitrust laws, but under the political and military protection of that nation, the big American enterprises will necessarily become superpowers in any Latin American country. One immediately concludes that such an "aid and development" policy is contrary to the growth of scientific research in Latin America. If the development of the countries of the Third World is to be carried out through the operation of big private enterprises from the advanced nations, then at least in one area—science and technology—the development will probably fail. For it is clear that these corporations will not duplicate their own research facilities by establishing new ones in the developing countries which would eventually restrict the amplitude of the ones at home. Without job opportunities, the scientists of underdeveloped states will finally emigrate to the advanced countries. The rate of output of engineers and scientists in the developing nations will decline and tend to a saturated low level. And it is indeed debatable whether, without the flourishing of science and technology, and without generalized basic education and good universities, a country can attain a level of genuine development.

• *WHAT MUST BE DONE*

In the light of the above analysis, the following points are basic:

1. The recognition of the important role of science and technology for economic development is quite recent.

2. An intensive program of universal basic education for the people and an intensive program of support to universities and to scientific and technological research must be integrated with plans for economic expansion.

3. The underdeveloped countries must utilize the results of science and technology for the more rapid modernization of their economies.

4. The genuine development of such nations cannot, however, rest upon the passive importation of scientific and technical knowledge from abroad. Science and technology must be stimulated to flourish, and their scientists—as well as scientists from other nations—must be fully utilized not only by universities and scientific institutes, but also by national research laboratories associated with the main industrial enterprises operating in these countries.

5. It is a fundamental role of government in the developing nations to support fully and to stimulate not only basic education but also the university establishments and institutes for scientific and technological research.

6. A way must be found for the principal industrial enterprises operating in the developing nations to maintain research laboratories or to order and support research work in the universities and scientific and technological institutes of these countries.

7. The big foreign private industrial enterprises refuse to support science and technology in the developing countries on a significant scale. This is further evidence against the possibility of such development for these countries based on the operation of these private corporations.

How can such problems be brought to the attention of the governments of the developing nations? For it is clear that political leaders and men in government everywhere, not being scientifically oriented, are not adequately informed on this complex problem. The solution to the problem is, however, not difficult: the fundamental responsibility for analyzing these issues, and for giving the necessary information to the leaders and to the public, falls upon the scientists of the developing nations. There is no way out of this responsibility. And if some prefer to avoid the discussion by proclaiming obedience to the higher ideal of working for mankind, without regard for nationalities and geographical boundaries, let them know that this ideal would be seriously damaged by their refusal to contribute to the removal of the obstacles which impede the access of the greater part of mankind to the fruits and conquests of modern civilization.