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TECHNOLOGY IN EMERGING COUNTRIES

by

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Technology in Focus--The Emerging Nations

TECHNOLOGY IN EMERGING COUNTRIES*

Arthur Goldschmidt**

For more than a decade we have been engaged in the most comprehensive effort in history to transfer technology. It has been largely a voluntary and peaceful effort to improve economic and social conditions in less-developed lands through the application of science and the introduction of modern techniques. It has been undertaken by governments, international organizations, private philanthropic and business groups for a variety of motives. It has involved nationals of almost all of the nations of the world and most of the sciences, professions and occupations. It has operated at all levels of government and society and has utilized a variety of methods. It has been characterized generally by open discussion, debate, negotiation, appraisal and review. Although far from a planned and coordinated program, its major components of international and bilateral aid have been predicated upon a greater degree of planning and coordination than any comparable international undertaking in history, with the possible exception of some military campaigns. This deliberate effort to improve the economic and social conditions in the less-developed countries of the world evidences a significant step in the history of human relations.

There have been enormous successes. Few countries or areas have not benefited in some measure by some aspect of this peculiar phenomenon of our century. But these programs have not been large in terms of the need for them.

*The views expressed in this paper are personal and not necessarily those of the United Nations.

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They have been widespread and varied rather than sustained or comprehensive. The impression of their size results rather from the amount of discussion and debate involved in their financing and administration, from the mass of popular and scientific literature that has been produced on the general subject and, perhaps, from the number of ancillary workers engaged in some of the programs in locations where their presence is startlingly obvious and discomfoting. But if the programs have not been as large as the gaps in living levels and technology might warrant, they have been an adequate and ubiquitous sample that would provide ample means for studying the potentialities and difficulties in transferring technology. It is not surprising, therefore, that a considerable body of case studies, analyses and theory on the subject has developed. What has been missing is a comprehensive synthesis of this experience and adequate research on, and evaluation of, the techniques of transferring technology.

Toward a Science of Transferring Technology

Concurrently with this broad experience, the social scientists, particularly economists, have been laying some of the scientific groundwork in the field by analysing the processes of development and formulating techniques for their measurement and appraisal. The economists, unlike the other social scientists, have been involved in the aid program both as practitioners and administrators. They have thus begun to establish the reciprocal relationships between those concerned with theory and those engaged in practice essential to both the scientists and the practitioners. But even the economists have too often had a transient advisory role, rather than a concern with operational work of a continuing nature.

The behavioral sciences, in general, have been further removed from the programs. For the most part, their work has not been closely linked to

operations. Some social scientists have, of course, been engaged in these programs. Specialized social science institutions and faculties have followed the work of practitioners. Symposia and conferences have brought scientists, administrators and field workers together. But the programs have largely employed experts chosen primarily for their competence in such professional fields as agronomy, finance, engineering, health or housing. Methods have been pragmatic. In their separate world, the behavioral scientists have been studying cultural patterns, motivation, semantics, incentives and similar aspects of their carefully classified disciplines related to the problem of inducing change.

While those who framed the aid programs recognized some of the difficulties of applying technology in less-developed countries, the ease with which most technological innovations have moved through developed countries has, perhaps, taken some of the edge off concern with the problems of the process of transferring technology. In any case, the symbiotic relationship between science and technology that has effected advances in other fields has yet to be firmly established between the behavioral sciences and those engaged in inducing development and introducing technology. This symbiosis, increasingly characterized in other fields by programs of research and development, has been missing because the aid programs have not been adequately buttressed by such built-in and purposeful research. In part, this has been due to the fact that funds available have generally been too inadequate for obvious program needs. Perhaps, too, the social sciences have been slow in developing techniques and technologies. The language of the behavioral sciences presents a semantic problem to the practitioner relying upon "common sense". The evidence presented by the social sciences on the difficulties of change has generally been too gloomy for the administrator of programs based upon the optimistic assumptions

that illiteracy, disease, hunger and insecurity can be mitigated in a variety of economic and social situations. In any case, the social sciences have never been brought systematically into the major aid programs studying the process of transferring technology.

The relationship of the social sciences to the aid programs may be entering a new phase. The Foreign Assistance Act of 1961 introduced the concept of research and development for the first time in the aid program of the United States through Title V, calling for Development Research. This modest beginning is intended to bring the "formidable talents of the American research community," as a Senate Committee characterized it, to bear on the problems of the under-developed countries and on the techniques of helping them.

This same trend has been evident for some time in the focussing of the research work of the secretariats of the United Nations' agencies on the problems of the developing countries. The current increased emphasis on planning and programing in the United Nations' technical cooperation activities and in the Alliance for Progress indicate a further concern for research. This planning is something more than the usual demand, generally predicated upon a scarcity of resources or a reluctance to provide them, for coordination and priority determination. Behind this planning approach is the recognition that research in the field of development is needed. Inherent in its execution is the possibility of a more systematic development of the theory and the techniques of technological transfer. Research is one of the primary purposes, for instance, of the Latin American Institute for Economic and Social Planning, being established under the aegis of the Economic Commission for Latin America in cooperation with the Inter-American Development Bank and the Organization of American States and largely financed by the United Nations Special Fund.

This Institute for training officials and providing governments with teams of planning experts is also required to undertake research into the process of economic and social planning itself. The General Assembly of the United Nations has called for the establishment of similar institutes in other regions, particularly in Africa. These research centers should provide an important meeting ground for scientific and practical workers in the field of development, both from within the regions they serve and from outside.

Again, the need for developing the science of transferring technology is recognized in the Resolution of the General Assembly calling for a United Nations Conference on the Application of Science and Technology for the Benefit of the Less-Developed Areas to be convened in the Spring of 1963. This Conference will not only explore wide areas of existing technology capable of transfer and fields of research "directed toward producing new scientific and technological advances of special utility to less-developed areas" but will also "explore the problems of transfer and adaptation."

While these initiatives are intended primarily to accelerate the use of science and technology in solving the problems of the emerging nations, they recognize that the problems of transferring technology also require research and development. They set the stage for moving beyond the study of the less-developed areas and of the phenomenon of development to the study of the processes of inducing development. Science will be brought to bear on the emerging "technology" of transferring technology to the emerging nations. Some observations may be helpful for putting into perspective some of the elements of the complex problems to be found in this new work in research and development.

Emerging Countries Differ

No comprehensive review of the experience of these past dozen years of economic and technical assistance nor any broad synthesis of that experience has yet been attempted. But the accumulation of studies, evaluations, reports and reviews reveal wide variations in the accomplishments of these programs and in the time and effort invested in their achievement. Some places are generally easier to work in than others. Some fields of technology are more easily transferable. Some practices show greater results. But such generalizations must be replaced by specific studies of the various tasks to be performed and the environments in which they must take place.

Such terms as "emerging", "under-developed", "have-not", "low-income", "poor" and similar attempts at classification lose their convenience when dealing with specific problems respecting these areas, such as those relating to the transfer of technology. These generalized terms for the less-developed countries have little utility as a basis for thinking or acting about them as a group. Indeed, for each problem to be considered, the specific countries included in these general categories may differ. India, Guatemala, Mali, Thailand and the Sudan have little in common except the fact that their levels of living are all below those of the more industrialized nations and the circumstance that they all straddle the fifteenth parallel. But they differ in climate, agricultural practices, levels of education, population-land ratios and in their requirements for technical assistance and the likely pattern of their economic growth. These and other less-developed countries, numbering about one hundred in all and containing well over half the world's population, differ in culture, history and degree of development. They present jointly a

spectrum rather than a single classification. They would not always fall in the same order along scales of economic, social or technological achievement and not always separated out from the "developed" countries. The continuum from "poorest" to "richest" is not a growth curve; the use of the term "stages" in relation to economic growth has tended to confuse the layman into thinking that Guatemala or Brazil are simply less-developed versions of France or the United States into which time and effort will transform them. The differences between the emerging countries affect the techniques for transferring technology to them.

Internal Differences

There are also vast internal differences within the emerging nations that affect the transfer of technology. These internal gaps are generally greater than the gaps between countries. The most immediately noticeable is the difference between the capital or major industrial cities and the countryside they command. The larger urban centers of the under-developed countries are more nearly like similar cities elsewhere in the world, including the developed ones. There is less difference between the apparent state of technology in the centers of Mexico City, Lima, Manila and Bangkok than between any of these and the villages within fifty miles of them. Indeed, the technological gap can be more precisely located between the urban and rural areas in the less-developed world than between the have and have-not nations. The corona of slums that generally separates the cities of the less-developed areas from their surrounding countryside is a measure of the pressure to close that gap.

In those countries where agriculture is largely characterized by subsistence farming and a barter economy, this location of the technological gap takes on even greater validity. No similar gap between urban and agricultural worker exists in the more-developed world, where the recent revolution in agricultural technology has increased the productivity of farmers. Although this has created serious problems that have not always been fully resolved, there is far less difference between the technological state of industry and agriculture and in the resultant levels of living in the developed world than between these in the emerging nations. An index of development might be calibrated by measuring the technological gap between countryside and city in the countries of the world.

The internal differences in technology in the less-developed countries are not confined to the gap between city and countryside. The technological developments in some agricultural fields may show considerable progress, generally in large-scale, one-crop developments often associated with corporate or other types of central management (rubber, bananas) or with development schemes (the Gezira in the Sudan). The dual economies of the less-developed countries are not the only evidence of their dual technologies. The problems of the emerging industrialist are usually exacerbated by the differences in the technological levels within industry in the developing countries. "There are two Argentinas, one developed and one not developed," said an engineer concerned with applied research in that country. He was referring not to the urban-rural differences but to the technological gap between the larger foreign corporations and the smaller indigenous industrialists, with no laboratories or standards control techniques.

Just as the tourist finds the airport management, the hotel or office building and other superficial aspects of cities of the less-developed world showing little difference from those of the developed world, there are many industrial enterprises that operate at obviously the same technological levels

as their counterparts in developed countries. Countries at the lower end of any scale of income, literacy or any other index of development have power plants, bottling works, breweries and textile mills that can hardly be distinguished from those in Europe or North America.

Most of these modern plants are in fields of capital-intensive production. Many have replaced, or are replacing, earlier forms of manufacture in which labor played a greater role. These plants inevitably take over the available market. Nostalgia for the hand loom or desire to maintain jobs by intermediate technologies does not reverse or diminish the trend to mechanize, by the most modern methods, those textile plants producing for mass consumption in the local market economy. In Iran, for instance, cheap cotton textiles made in modern mills have, in a few years, pre-empted the market formerly shared with hand looms and imports. In addition to operations involving the construction of new plants, technological change is affecting existing industries through greater use of presses and other machine tools in the manufacture of furniture, building materials, clothing and other consumer goods. Such modernization generally replaces labor-intensive operations. Many of these operations, however, still compete for the market with labor-intensive competitors on the one hand or mass produced imports on the other.

In the field of large-scale public works --- roads, water and power systems, airports and housing --- the state of technology often appears familiar to the visitor from developed countries because some of the methods used are much the same. As these projects are usually in the public sector, the question of choosing the level of technology presents its most difficult problem to the planners and policy makers of the emerging countries. Unemployed and underemployed workers and shortages of foreign exchange are measured against the pressure for early completion of the needed facility. The technological

gap is often spectacularly revealed when the choice between labor-intensive and capital-intensive methods is resolved by compromises that bring both methods together. Even in countries whose unemployment is not a measure of the pressure of population on resources, there is a tendency to intensify labor on public-works projects. Conversely, countries with a serious excess of available manpower often utilize capital-intensive technologies, in the interest of speed and economy.

Another evidence of the internal gap in the emerging countries, differing in degree among these countries, is found between the state of science in universities and other institutions and the application of technology. Scientific activity, both in the physical and social sciences, tends to maintain the divorce from technology that characterized earlier periods of Western science. Scientists in less-developed countries often have closer connections with their counterparts in the rest of the world than with their own developing technologies. Academic social scientists, particularly the economists, generally maintain a close relationship with government and business in the developed countries. Such arrangements are rare in the emerging countries, and the gap between science and its application is even greater in the physical sciences. The reciprocal relationship between science and technology that has proved so useful to scientific development elsewhere does not exist in the less developed world.

Finally, there is generally an internal cultural gap in the emerging countries: On the one hand, there is a small educated class, at home equally elsewhere in the world, from which innovations are expected even if not always forthcoming. On the other hand, there is the mass of uneducated often illiterate populations. Educational policy in the emerging countries has

tended to maintain this gap with higher educational opportunities for the elite and general literacy for the masses. The technologically important middle is too often neglected. The cultural gap is especially difficult to close in the agricultural sector, where the problem of productivity is most immediate, particularly where agriculture is largely on a subsistence basis with consequent lack of incentives to change. The conditions of rural life that make for ignorance, prejudice and resistance to change are also repugnant to those whose presence is needed to break down that resistance. The cultural gap is a formidable barrier to intensive technological change because precisely those elements needed to effect the process of change are missing.

Technical assistance personnel find the transfer of existing technology easier in the advanced sectors of the dual economies of the under-developed world, since there is generally no cultural barrier to be breached, no question of resistance and receptivity, no problem of absorptive capacity. The internal gaps within the under-developed countries inhibit the spread of technological advances.

The differences within the developing countries tend to bring into better focus the differences among them. The most immediately observed characteristics of less-developed countries are the gaps we have mentioned, the disparities among geographical areas and between economic sectors, the wide differences in income and education. Progress in transferring technology is affected by the differences between the countries in the less-developed world and within the countries as well.

Resistance to Technological Change

The development of the emerging countries will not follow the pattern

of the older industrial societies. The international resources of capital and technical assistance provide a new element in the process; more important is the availability of new technologies for accelerating growth. New methods permit these countries to leapfrog certain periods and programs that were necessary but costly in time and resources in the development of the industrial countries.

Unfortunately, there are considerable pressures to follow the historical patterns of development step by step rather than to embrace these new technologies. Not all of these pressures are internal. Where new technologies require heavy capital investment, there is often a tendency to recommend that the under-developed countries seek older solutions requiring less foreign exchange. But economic considerations have not been the only block to the fuller uses of modern technology by the emerging countries. The built-in conservatism of the professions often tends to tell the less-developed countries that "you must crawl before you can walk." Failure to accept the full consequences of the technological revolution is evidenced even in the domestic policies of the developed world: The revolutionary results of modern technology in agriculture that have multiplied production per man-hour and per acre have not yet been fully reflected in United States agricultural policy, which continues to assume that these results stem from largely fortuitous aberrations of a natural production cycle that must be normalized.

The bias for using less-modern methods is frequently found among experts engaged in technical assistance work. It is occasionally a reaction to uneconomic "showy" undertakings often requested by the developing countries. The generally higher age level of the experts made available to the programs through early retirement policies may also be a factor. In any case, this

bias has often been manifested in economic and technical assistance programs by an emphasis on agriculture, on handicrafts and small industry and on outmoded technologies. This tendency to disregard the use of modern technology has encouraged the belief in the less-developed countries that their development is being thwarted because the industrialized countries still want to use them as sources of raw materials and as markets for industrial products.

At the other extreme in technical recommendations has been the widespread sharing of atomic research facilities and materials which has engaged important resources of scientific and technical manpower and a considerable amount of limited funds in less-developed countries with little possibility for making important contributions to their immediate economic development.

The industrialist who undertakes the transfer of technology as a business matter tends less to go slow on the use of the most recent advanced technology. Where a large manufacturer branches out into the under-developed world, these undertakings will differ little from those at home. Considerations of the market will affect his operations more than questions of employment policy. In general, the major difference in his operations abroad will be the manner in which he meets the problem of supplies and maintenance. Without the support of the rounded technology of a developed economy, he must build into his own operations many of the things for which he would depend on the market at home; for example, maintenance and repair facilities.

The internal pressures against leapfrogging over intermediate stages in development are, perhaps, more difficult to resolve. Lack of capital and foreign exchange are naturally basic problems in the application of modern methods. But much of the opposition to change is embedded in the

social and economic structure of the society. A class or group resists changes that will affect their relative position in that society. The witch doctor's objection to penicillin, the landowner's rejection of agricultural machinery, the merchant importer's opposition to indigenous industry have their counterparts in developed economies. But in the emerging countries these elements have greater relative significance.

A curious example of the attractions of outmoded technologies, even in economic sectors not characterized by private interests, is the persistent emphasis on railroads. While some railroads need to be built in specific instances, no developing country need invest its manpower and resources in railroad building on the scale that was required in Europe or North America. Railroads require heavy investment in steel and although shortage of steel is a major concern of developing countries railroad building and extension has been emphasized in many development plans. Railroads seem to represent glamour or political power not only to the developing countries but also to advisers from developed countries. This may be a reflection of the historical importance of railroad building in the economic development of the industrial countries. But in opening up new areas today, the potentialities of substitution of newer and more flexible forms of transport will provide one of the great potentials for saving capital in the development process.

Large power developments and related transmission facilities similarly could leapfrog the need for costly local power plants. While such large-scale plants are being built throughout the less-developed world, a fully planned and integrated power supply is rarely available. The power supply position of most of the cities in the emerging countries is a primary limiting factor in the development of industry. The requirements of foreign

capital inhibit large-scale power installations; but, more often than not, the individual industrialists' investments in diesel plants imported from abroad are an equal or greater drain on the countries' exchange requirements, without providing the same incentives for development.

Technologies to Telescope the Process of Development

Despite the resistance --- economic, psychological or sociological --- to technological change, there are important examples of the ways that technology has telescoped the development process in the emerging countries. The most startling example is in the field of public health where the effects of technological improvements are measurable. Modern technology in the field of health has even been so effective that it has tended to exacerbate the solution of other development problems, such as employment and food supply, and to raise the question, appropriate to some of the less developed countries, of population control.

In the industrial field, the widespread use of aluminum, plastics, glass and other new materials is evidence that newer technology can replace many of the methods followed in the development of the industrial countries. Perhaps the textile field has shown the most widespread disregard of the pressures against modernization. The hand loom has virtually disappeared as an important economic factor in the period since World War II, even where labor surplus or cultural pressures were brought to bear in its favor. Moreover, efforts at introducing intermediate technologies, such as improvements in the hand loom and small mechanized looms, have not halted the leapfrogging process. Textile mills based on the latest technology are characteristic landmarks in most under-developed countries today.

Modern agricultural techniques, including the use of hybrid seeds and fertilizers and the introduction of newer water-finding and irrigation methods, are also leapfrogging the period between these techniques and the use of the sharpened stick and the sickle. Although technical assistance experts have occasionally had local successes that have bemused readers of their reports by the introduction of the scythe, the iron-faced plow, a hand pump, or animal-actuated threshing devices, these charming examples of step-by-step development do not show the same impact on developing countries as the transfer of such modern technology as hybrid-corn programs or the erection of modern milk and packing plants or the development of the use of fertilizers.

The field of communications, so important for the development process, provides one of the most pervasive examples of the leapfrogging process. The advances in telecommunications not only provide a basis for avoiding waste of scarce resources but also open up possibilities of mass communication and resultant education. In this they provide the greatest impetus to hope for meeting the needs in education, one of the most persistent internal gaps in the emerging countries. The process of modern government itself is dependent upon this technology. Telecommunications are essential to the very viability of divided Pakistan or scattered Indonesia.

To speed up the development process in most of the underdeveloped world, there is an immediate need for data upon which development programs can be based. The lacunae in information about their resources must be filled if investments, domestic or foreign, are to be wisely made. These countries need maps, topographic surveys, river gauging, meteorological data, groundwater studies, geologic and soils information, forest evaluation and other counts and appraisals of their resources. They need census data on their population, its

distribution and activities. Fortunately, technology has taken some of its greatest strides precisely in the fields necessary to provide this pre-investment information. Modern techniques can supply in months data that has taken years to accumulate in the developed countries.

Aerial mapping has replaced, with greater accuracy, older ground methods. Interpretation of aerial photographs for geologic, soils and forest surveys can effectively replace many of the time-consuming ground methods of the past. Geophysical techniques, such as the airborne magnetometer and the scintillometer, provide means for pinpointing areas of potential development, thereby conserving the time and effort of scarce technical personnel. Statistical sampling techniques make possible census information for under-developed countries with speed and accuracy undreamed of in the early periods of our own American quests for census data.

New Research and Development

These and other examples of technological developments that have telescoped the time required to meet the needs of the economic development process have been demonstrated by the technical assistance programs. The demonstrations of the successful transfer of such existing technologies are so compelling that there is ground for the view that, given the financial resources and capacity to apply them, existing technologies in the physical sciences would be adequate to the task of raising the levels of living throughout most of the world. Only the current plight of the larger less-developed countries with populations too large for their resources and their foreshadowing of current population trends elsewhere makes it necessary to modify the optimistic view of the present state of technology.

Further research and development in the physical sciences is attacking

three critical areas of current shortages: energy, water and protein supply. Additionally, work on the means of population control is being developed for the long-run population-resource balance on a world scale. Basic research and technological advances in these fields can be expected to yield early results. Similar work must also be continued in other resource and industrial fields in order to adapt existing technology to the conditions of the less-developed countries.

Work of this nature is being done in a number of countries, especially in health and agriculture. Some regional and national institutes to provide technological research for industry have also been established. But, in general, the centers for adapting technology have been inadequate to the task. This is partly a reflection of the fact that the technical assistance personnel assumed that most technology can be transferred with the minimum of adaptation. They were expected to share known ways of doing things with those who did not know them yet. Their purpose was to extend, geographically, the utilization of technical knowledge in fields related to economic and social development rather than to extend the boundaries of that knowledge. In general, they avoided research programs except in rare instances, and these exceptions called for applied research of a limited nature.

The concept of research and development, moreover, must be extended to include the fields of the social scientists. Much of the work of adaptation of technology is less in its modification than in adjusting the people and their institutions to its introduction. The primary problem in aiding the development of the emerging countries is that of providing the means and improving the methods of transferring technology. Although the technologies for speeding up development have already amply demonstrated their capabilities,

their application is yet far from general. The gap must be bridged by the social sciences. An evolving technology for introducing technical change must be concerned in countering the pressures tending to limit the introduction of new technologies and in developing the institutions required for their introduction and adaptation.

The Institutional Base

The transfer of technology requires experts of a high order who are not only competent in their field but also are capable of teaching others. The adaptation of technology often requires technicians of even greater versatility. At the very least, it requires greater competence than merely practicing a known technique. At most, it requires the scientific skills and facilities to do research and development work in circumstances where the expert must also be an administrator. The use of hybrid corn in a new area is not accomplished by a sympathetic technician with a packet, or even a carload, of seed. The effectiveness of photogeology requires more than good air photography and an itinerant geologist. Statistical sampling techniques are not transferred by a statistician from abroad, even if he carries a computer in his baggage. These and most important technologies necessary to the developing countries require laboratories, experiment stations, organizations, institutions. And these must be equipped with people with the requisite training, experience and interest.

The major point on which success or failure in technical assistance has hinged has been the existence or strength of the necessary institutions in the country being assisted, or the ability of the program to create them. Neither skill in the selection of experts nor funds to implement their recommendations can overcome the lack of local institutions for carrying out an assistance program.

Less-developed areas provide the necessary institutional base for transferring technology in varying degrees, both from country to country and from field to field.

The aid programs have recognized the need to build and strengthen local institutions. Many experts in health, agriculture, education or other subject fields have spent most of their efforts in making more effective the ministries and offices to which they were assigned or to building up new services, such as agricultural research stations, public health departments and geological survey organizations. These institution-building activities have escaped the criticism generally heard of those experts whose reports and advice, however valid, dropped into an institutional void.

Recognizing that the reports of ad hoc survey or planning missions have generally been of greater use to students abroad than to the country for which they were undertaken, administrators have made it their business to change the terms of reference of such missions so that they will build planning institutions rather than simply presenting a plan. Experience has turned programs away from simply supplying data or works. Too much costly air photography has been wasted where no local institutions for its maintenance and use existed or was created. Costly geological studies repeated each other because of a failure to maintain systematic files of hard-won data. Costly new strains of seed and stock were squandered because their introduction was unaccompanied by the necessary institutional instrumentalities for adapting and maintaining them. OPEX, the United Nations program for providing operational and executive personnel to the developing countries, is a practical response to the need for strengthening the institutions of these governments.

The under-developed world is littered with demonstrations that have not

demonstrated. The effects of many large-scale assistance efforts have been dissipated because there was no means of fixing their innovations in the local economy. Experience is multiplied only if there is an institution to effect the multiplication. Roads, irrigation systems and other works have been built for the less-developed countries, but their usefulness has been limited by the failure to arrange for the institutions necessary to their maintenance.

These requirements for an institutional framework for the introduction of technology are even of greater importance where the adaptation of the technology to the conditions of the local scene is required. Here, in the long run, the symbiosis of science and technology will be required to provide the "take-off" of an indigenous technological order and the self-sustaining growth of technology.

Institutional Development

Although it has long been recognized that the introduction of technology in the emerging countries must be accompanied by the introduction of the institutions required for its adaptation and use, little systematic work has been done on the problem of how to create institutions or to stimulate their growth. The research and development concept needs to be applied to this key problem in the aid programs. The advance of resource and industrial technology and particularly its adaptation to new environments will require a joint effort of the physical and social sciences. The need for more knowledge of the techniques of transferring technology will involve the social sciences in many ways. Among the problems for which the social scientists' contribution is required, none is more crucial than the need to discover ways to develop institutions for introducing change.

The programs of the past provide some experience in this field. The United States Aid Program began at an early stage to transfer the principle of the land-grant college as the key to agricultural extension services, an institutional complex that had effectively served American agricultural development. Much of this work was contracted to universities on the assumption that the land-grant colleges were the most likely instrumentalities for creating counterparts in their own image in the less-developed world. Similar contracts for creating other training and research organizations in other fields, such as faculties of public administration, teacher-training schools, have been a major feature of the United States program. Many of these projects have been successful, in spite of administrative difficulties, and the invalidity of two basic assumptions: that such institutions can be transplanted with little modification into the emerging countries; and that the personnel required by existing institutions at home would have the competence to build a similar institution abroad under difficult circumstances.

Efforts in the institution-building field by the United States program go back to the "servicios" that characterized the work of the Institute of Interamerican Affairs, the pioneer assistance program in Latin America that preceded Point Four. The "servicio" was a joint enterprise of the United States and the country to be assisted for the purpose of improving agriculture, health or education. It was financed by contributions from both, with a specific and agreed program of work and staffed with experts from the United States and professionally trained local counterparts. The important early successes of the "servicio" in introducing new techniques and developing new services have tended to blind partisans of this approach to some of the defects: Primarily the "servicios" were kept outside of the normal government services --- to avoid

the uncertainties of politics --- and were considered extra-budgetary requirements guaranteed by intergovernmental agreements to assure continuity and stability. These factors, and better pay and perquisites, tended to draw many of the better professionals away from other governmental offices with a consequent weakening of important government agencies. Moreover, as an extra-budgetary item, the "servicio" tended to command a greater share of the financial resources of the government than subsequent policy makers might find desirable. The "servicio", which was intended to be a step in the development of an indigenous institution, locally financed and operated, often remained an alien thing not fully integrated into the government's family of services.

One would expect that the propensity for organization in the United States would have created a technology for institution building. The recent publication of an Encyclopedia of Associations, claiming to be a "reference guide to America's 11,000 national associations," is evidence of a knack for institutionalization. But the adaptation of this aptitude or technology for the purposes of the developing countries has not been uniformly successful. Perhaps there has been too much emphasis on transfer of United States institutions and not enough on adaptation.

Other countries have also lagged in devising techniques of institution-building. Even the former colonial areas are generally deficient in local institutions essential to their development. An exception may be the creation by the United Kingdom of the Indian Civil Service, which provided the basis for important institutional developments in the Government of India. Elsewhere, the British emphasized training people rather than developing institutions. The effort to build the services of government necessary to their development has been a major preoccupation of Burma, Ceylon and other former colonies.

Where geological and other resource services important to the process of development were created, they were often based upon the professional resources and the interests of the metropolitan powers rather than upon the needs of the local economy. In the newer emerging countries, efforts to develop indigenous services have generally come too late. But, if institutions are inadequate in the former colonies, the problem is even greater in those countries that had no institutional tutelage. From the standpoint of services necessary to economic development, such countries as Iran and Ethiopia have been an institutional wasteland.

The emerging countries of Africa South of the Sahara are generally inadequately endowed with institutions necessary for their development. This is one of the primary difficulties in making an impact with technical assistance on that continent. Governmental organizations, formerly staffed from abroad, have not been africanized fast enough to take up the reins of expatriates who are leaving. Education policies have not produced the required African professionals to take up the job. Higher education of the young has not only been meager, but it has also been unrelated to development needs; it has traditionally emphasized the fields of law or medicine with, perhaps in the past few years, some economics. The people required for development programs --- agronomists, hydrologists, geologists, engineers, statisticians and chemists --- are rare in these emerging countries. Moreover, where these are available, there are none of the middle-echelon technologists --- the laboratory workers, surveyors, cartographers and other aides of the professions --- who come from the high schools and trade schools in developed countries. Thus, while most of these new nations may be able to get a quorum of legislators with some training in that field, few can staff the technical services required for their national

development programs. Experience in the Congo highlighted the crucial importance of the availability of "human capital", as Harbison calls it, not only for effective utilization of physical capital in the development process but also for the maintenance of a viable government. The current emphasis on training to provide the infrastructure of skills essential to increasing productivity must be matched, however, by an effort to develop the institutions necessary to utilize trained manpower. The unemployed intellectual is a growing problem in emerging countries. He is often a product of the wrong training. He may be unemployed because the government or the economy of his country has not the resources or the institutions required for his effective employment.

While the French established a number of local services in Africa and trained a considerable number of middle-level technologists, this effectiveness has been seriously impaired by the small size of the independent units into which these territories have split. The divisions of Africa, stemming from long-standing tribal and cultural patterns or from the recent colonial administration, have made it more difficult to develop indigenous institutions. A checkerboard of cultures, languages and administrations with little opportunity for joint consideration of common interests or problems has not made easy the creation of regional associations that reinforce local institutions. The Consultative Committee on Technical Assistance in Africa South of the Sahara sought to bring African leaders in science and technology together on their development problems. Regional projects of the United Nations family of Specialized Agencies worked to the same end. But these efforts have as yet resulted in few organized regional activities of a continuing nature of the kind found in other regions of the world, such as Latin America. Fortunately there is a growing interest among African leaders in the development of regional institutions.

The recipient governments themselves are not always aware of their need for institution building. Moreover, when governments have asked for help in creating local institutions, they too have failed to reckon with the problem of adaptation. The impulse behind the request from the Turkish Government for assistance in establishing the Middle East Technical University was the desire of a group of government officials and businessmen who had been trained in engineering colleges in the United States to transplant these institutions to Ankara. They wanted it to provide the same kind of education they had received abroad, including the use of the English language in all courses. The opposition from the leaders of higher education in the country to this revolutionary move was considerably less important than the inability of Turkish secondary education to provide the ecological framework for such an institution. The process of adaptation has been long and difficult.

The lure of physical plant as a substitute, symbol or starting point for institution building has often appealed to both recipients and donors of technical assistance. Laboratories have an especial appeal but it is easier to equip a laboratory than to recruit people who can make it useful. Community centers, clinics, schools, orphanages, agricultural stations have also been built without providing a basis for their use, maintenance and development. In the industrial field arrangements for training local operators and developing local management are generally included in the construction or equipment contracts. The arrangement for the Russian-financed steel plant in India, for instance, involved its operation by Russian experts in each job until an Indian counterpart could be trained to take over. But neither the Russian nor other bilateral assistance has always followed such a fortunate arrangement in other fields.

Research and Development in the Social Sciences

Research and development in the social sciences for improving the

techniques of inducing technological change cannot be confined to the institution-building field. Economists must still improve and adapt techniques of planning and of financing economic development. Building up local savings mechanisms, liberalizing external financing and improving the terms of trade of these raw-material supplying countries are still the crucial problems in inducing development. Delays in solving them are the principal cause of delays in development.

Educational practices require adaptation. The development of short cuts to training is basic to accelerating the development process throughout the under-developed world. Inter-disciplinary approaches between social scientists and communications technology should be brought to bear upon this crucial problem.

Problems of recruitment and conditioning of experts for the technical assistance programs have never been given enough attention. Leaders and entrepreneurs in the developing societies must be identified.

Most of these areas for research and development call for the attention of the behavioral sciences. These sciences and their less-developed technologies must begin to accompany the economists who have begun work in the field of inducing development. Experience has demonstrated Wiesner's charge that the behavioral sciences have been "timid" in asking support for their scientific activities. But more important, the behavioral sciences have not been brought to bear sufficiently on the specific problems of the transfer of technology. Problems involved in the recruitment and conditioning of people engaged in overseas assignments, problems of motivation and incentives in different societies, problems of semantics and attitudes and related sociological and psychological issues have engaged the scholars as well as the practitioners. But, for the most part, the social scientist has not had the close relationship to the technician

in this field that would provide a feedback of experience data for the further development of the science.

One of the principal areas of social scientists' concern must necessarily be in the field of institution building. We must know more about the birth, growth, health and decay of institutions. We must know more about their inter-relationships, their effect on one another and how they may be affected from outside. As institutions are the primary instrument for transferring technology by accepting and adapting it, and by applying and perpetuating it, institution building and strengthening are key skills or aptitudes to be sought. The identification of personnel with these skills becomes an important area of study itself. The methods of developing these aptitudes, must also be studied.

These studies are unlikely to yield simple answers that are universally applicable. Not only are we engaged in different cultural and economic circumstances, but there is great variety in the institutions required for the purposes of development and the transfer of technology. We are not merely seeking to identify the charismatic leaders of movements; the institution to be built or strengthened may not call for such political aptitudes but rather for administrative ability and for a measure of organization orientation. Nor is the quest for the possible institution builder simply for the person who makes the decisions for a village, an industry or a ministry. These leaders may well be the nay-sayers concerned with the maintenance of a particular institutional status quo.

Incipient innovators are required in many "private" and "public" areas of activity. TaTa in India or Di Tella in Argentina, Ford, Jane Addams or Mark Hopkins in the United States, have developed private institutions in both the immediate organizations they founded and in the larger sense of founding

a process. Innovators in government are equally varied: John Wesley Powell's role in the United States Geological Survey; Macedo-Suares' leadership in the Brazilian steel works; Lilienthal in his TVA period; Navarre of the Institut Francais de Petrole; Gallatin; Monet. These "bureaucratic" empire builders of governmental institutions and programs must also provide historical models for the innovators and entrepreneurs needed in the emerging nations.

The study of institutions will be more than the study of the attitudes, aptitudes and incentives of the people who give them leadership. Economic considerations and patterns of custom and culture will be of major importance in measuring the viability, indeed the possibility, of institutional development. The aid programs are not the sole source of material for reviewing these questions. Experts, merchants, immigrants and other foreigners have had diverse roles for many years in relation to indigenous institutions. Such outsiders as the Pharsees, Jews, Lebanese and overseas Chinese have had important impacts on the development of local institutions, especially in the private sector of developing countries. But the aid programs provide the possibility of combining research and practice on a broad basis that would be difficult to duplicate elsewhere.

Institution building, moreover, may require the destruction or weakening of other institutions. Such ground-clearing operations are also a fruitful area for study. Why do the bulldozing tactics of Kemal Ataturk or MacArthur appear to have been more effective in preparing the ground for institutional changes than the similar methods of Reza Shah? What is the relationship of Mexico's current phenomenal development to the twenty-five years of institution wrecking that followed the fall of Porfirio Diaz?

The variety of the institutions required is itself formidable. Both

governmental and non-governmental institutions are necessary to the economic and social development of the less-developed countries. The specific institutional requirements may vary from country to country and circumstance to circumstance, but the resultant complex will be much the same. Education, credit, transport and communications, health and welfare, production and trade, as well as law enforcement and taxation, call for organized offices, bureaus, firms and associations. The planning of institutions becomes especially important where there is a scarcity of personnel to man them. Any effort to accelerate the process of development calls for the establishment of priorities and other planning techniques to assure the most effective use of resources. But the creation of planning agencies assumes the availability of institutions for providing data, on the one hand, and the institutions for carrying out the plans, on the other.

The place of institutional forms in the rapid and unique industrial development of Japan or in the maintenance of Denmark's relatively high levels of living on her relatively low-resource base deserve attention of those concerned with technological changes. Such broad questions have been under review by social scientists. But of more immediate concern to the aid programs for the under-developed countries is the possible role of the outsider in institutional development. For these programs are an institutional embodiment of the outsider.

The aid programs provide, in this field as elsewhere in the study of institutional development, the most recent basis for sharpening up the questions as well as the constant flow of fresh data in which the answers may be sought. To be sure, the aid programs cannot stand still for these examinations. Nor would a static inspection be likely to reveal ready answers. The social scientists must formulate methods of studying the programs while they are in motion. To this end, they must seek the cooperation of the successful practitioners,

even though they may not always be their most helpful allies. Not only are the practitioners busy and preoccupied, but they themselves may not know the reasons for their success or even be aware of the methods they have used to bring it about. The social scientists must recognize that most of their offerings of guiding information and interpretation are still too tentative and lacking in immediacy to be of great help to the practitioner. On the other hand, a close relationship between the scientists and the practitioners is essential to progress in this field.

The study of the institution-building process requires an interdisciplinary approach. The required reciprocity between the scientist and the practitioner, although difficult to achieve, is essential to the task of creating a science and technology in the field of transferring technology. The research and development concept, itself an institutional approach, has shown such success in other fields of human endeavour that its introduction into the field of development of the emerging nations is a welcome initiative at the beginning of this Decade of Development.