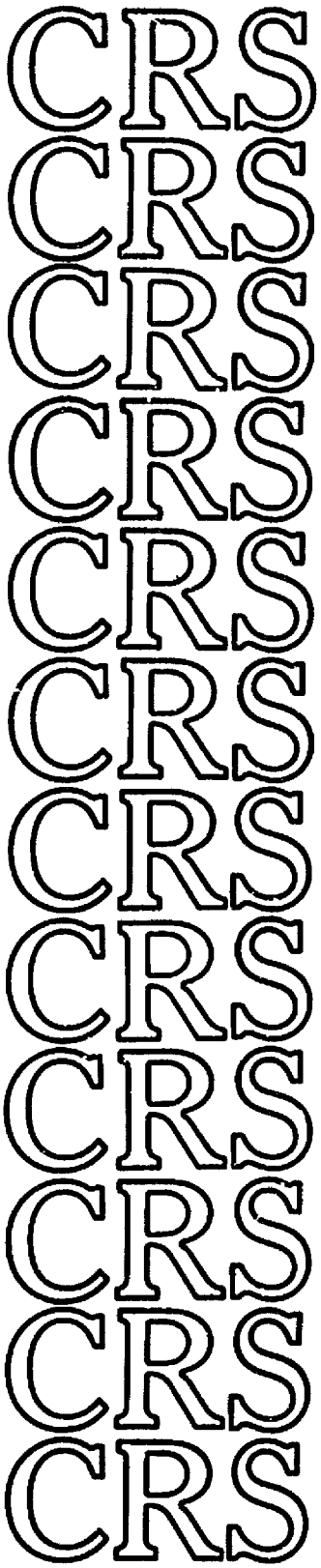

77-25 SP

INTERNATIONAL TECHNOLOGY TRANSFER TO THE DEVELOPING NATIONS AND THE ROLE OF APPROPRIATE TECHNOLOGY: A BACKGROUND PAPER

WENDY H. SCHACHT
Analyst in Science and Technology
Science Policy Research Division

August 22, 1977

CONGRESSIONAL RESEARCH SERVICE
LIBRARY OF CONGRESS



The Congressional Research Service works exclusively for the Congress, conducting research, analyzing legislation, and providing information at the request of Committees, Members and their staffs.

The Service makes such research available, without partisan bias, in many forms including studies, reports, compilations, digests, and background briefings. Upon request, the CRS assists Committees in analyzing legislative proposals and issues, and in assessing the possible effects of these proposals and their alternatives. The Service's senior specialists and subject analysts are also available for personal consultations in their respective fields of expertise.

TABLE OF CONTENTS

	Page
International Technology Transfer Defined	1
Mechanisms of Transfer	2
Methods of Transfer	2
Limits of Transfer to Underdeveloped Nations	5
Appropriate Technology: Concepts and Definition	6
Production	9
Policies of the Developing Nations	10
Innovation	13
Limitations of Appropriate Technology	14
Appropriate Technology and the Rich Developing Nations	16
The Multinational Corporation	17
U.S. Government Programs	19
AID	19
ERDA	20
NSF	21
Concluding Observations	22
Bibliography	24

NOTE: This paper was originally prepared in response to a request by the House International Relations Committee.

INTERNATIONAL TECHNOLOGY TRANSFER TO THE DEVELOPING NATIONS AND THE ROLE OF APPROPRIATE TECHNOLOGY: A BACKGROUND PAPER

The purpose of this background paper on international technology transfer to the developing nations and the role of appropriate technology is to provide general information on a topic which has received increasing attention in recent months. The paper discusses the concepts of, and mechanisms for, technology transfer and the difficulties in applying this process to the less developed countries (LDC's). Appropriate technology (AT) is discussed as an alternative approach to the familiar methods of technology transfer and development assistance in conjunction with the particular problems faced by the LDC's. Both the advantages and limitations of AT are developed. The paper provides a contextual framework for the consideration of alternate actions for bringing the benefits of technology to the developing nations.

International Technology Transfer Defined

Technology transfer is the process whereby a product or process developed in one area is utilized in another area or for another purpose. The transfer from the public to the private sector, from one governmental unit to another, from one government to a foreign country, or from industry to industry enables technologies developed to have benefits beyond their original usage. In a general sense, international technology transfer is accomplished through one of three processes. The technology in its original form can be transferred from one country or one industry to another and utilized for identical purposes. In other situations, the technology may be applied to a different purpose while retaining its original construction or components. And finally, the technology may be adapted for application to new and different problems and environments.

Mechanisms of Transfer

The transfer of technology both domestically and internationally, can be effected through various mechanisms. Among these are:

The sale or purchase of hardware
The sale or purchase of technical information
The sale of licenses
The sale of patents
Technical assistance contracts
Cooperative ventures (government-government, industry-government, industry-industry)
Co-production (foreign and domestic companies produce together)
Turn-key manufacturing plants 1/
Multinational corporations
Training
Education
Scientific and engineering exchanges
Conferences and professional meetings
Trade and professional journals
International organizations
Technical information services
Foreign aid programs
Theft and espionage

Methods of Transfer

The international transfer of technology has various dimensions and can be conceptualized in various ways. These differing orientations serve to delineate the means and methods by which the transfer process operates. The transfer effected may be (1) direct or indirect; (2) formal or informal; (3) personal or impersonal; (4) based on technical acquisition, on data acquisition, or "know-how" acquisition; (5) "embodied" or "disembodied"; (6) horizontal or vertical; and/or (7) the result of technological "push" or "pull", or a combination of these. Rarely does a method of transfer fit exclusively into one descriptive category nor are the categories mutually exclusive.

1/ Turn-key manufacturing plants are those built and operated by a foreign company which also trains employees on the job and then turns ownership and operation over to a domestic source according to a prearranged agreement.

Direct transfer involves the point-to-point transfer of a product, process, or technical specifications. It can involve, but is not necessarily limited to, licensing or purchase of patents, trademarks and/or design specifications; direct investment; the purchase of hardware, capital equipment, or intermediate products; turn-key manufacturing plants; the purchase of software and information systems; management contracts; and cooperative ventures. In contrast, indirect transfer is the transfer of information in a more general sense, that not specifically geared to a product or process. These indirect methods include training, education and personnel exchanges. Industrial shows and conferences serve as vehicles for technology transfer. Publications such as professional and trade journals also provide for indirect transfer as do personal contacts between scientists and technicians.

Formal and informal technology transfers involve similar concepts. Formal transfer concerns the exchange of technology through the negotiation of contracts, technical, industrial or scientific agreements, or the purchase of patent, trademark, or design rights, all of which have legal, governmental or contractual sanction. Informal transfer occurs in instances where information and know-how are transferred through unstructured channels such as published material, personal contacts and professional meetings.

Personal technology transfer requires the exchange of information and/or processes through face-to-face contacts with skilled workers and experts cooperating with the recipient countries or industries. Impersonal transfer involves those transactions where the transfer is effected through the acquisition of tangible property such as design specifications, equipment, turn-key plants and patents.

An additional approach to technology transfer is to view it as technical acquisition, data acquisition, or "know-how" acquisition. The first relates to the purchase or exchange of technical products; machinery and equipment, prototypes and/or turn-key operations. The second, data acquisition concerns the purchase of technical information including licenses and patents. In contrast, "know-how" is acquired through people, transferred through training, experience, and demonstration.

Following much the same reasoning, technology may be conceptualized as being transferred "embodied" in other inputs of production such as in the purchase of equipment, turn-key operations and total systems, or "disembodied" through specific contractual arrangements such as the purchase of patents or industrial and technical cooperation agreements. 2/

Horizontal technology transfer occurs when a technology is transferred between industries or institutions and is adapted to an environment other than that for which it was originally developed. As described by Harvey Brooks, "horizontal transfer occurs through the adaption of a technology from one application to another, possibly wholly unrelated to the first . . ." 3/ Vertical transfer concerns the movement of technical knowledge within an industry or institution and from the general to the specific in regard to application. Vertical transfer includes:

2/ Egea, Alejandro Nadal. Multinational Corporations in the Operation and Ideology of International Transfer of Technology. Studies in Comparative International Development, v. 10, Spring 1975: 11.

3/ Brooks, Harvey. National Science Policy and Technology Transfer. In Technology Transfer and Innovation. Washington, U.S. Govt. Print. Off., NSF 67-5 [1967] p. 54.

> . . . the process by which new scientific knowledge is incorporated into technology, and by which a 'state of the art' becomes embodied in a system, and by which a confluence of several different, and apparently unrelated technologies, leads to a new technology. 4/

The "push" approach to technology transfer relies on the availability of a technology and its subsequent development into a marketable product. This development occurs in response to an expectation of the creation of a market and a user demand for the new technology. On the other hand, the "pull" approach to technology transfer is based on the notion that a technology should be developed or adapted in response to a specific market demand or to a previously defined user need. In this case, the technology is "pulled" from the unutilized store of research to be developed and/or commercialized because it will address a specific problem.

Limits of Transfer to Underdeveloped Nations

Technology transfer is a vital element in a country's growth and development. This is especially important when applied to the developing nations. It provides the means by which countries can acquire new technologies and generate indigenous ones to meet the needs of the nation without extensive research and development. However, there are various barriers to technology transfer. Small domestic markets in the underdeveloped countries create small returns on investment in technology and production. The technical skills of the local population are often not sufficient to support advanced manufacturing procedures and upkeep. Above all, the needs and resources of the developing nations are usually different from those of the countries providing the technology, thus necessitating

---

4/ Ibid., p. 54.

adaptation and flexibility in its application. In an attempt to deal with technology transfer to the developing countries, the appropriate technology concept seeks to provide options within the limits imposed by the environment in which the transfer is effected.

Appropriate Technology: Concepts and Definition

A major concern of the developing nations is how to conduct an orderly, nondisruptive, successful growth process and bring the benefits of technology to their nations. These countries look largely toward the West and Japan for their industrialization model, as the world becomes increasingly interdependent through science and technology. In many cases they expect the West to provide for modernization and growth via capital, expertise, and technology, and that it is a "right" to receive this assistance. However, the conditions present when the West was industrializing and the environment under which Western economies operate at the current time are vastly different from the situations in the less developed countries (LDC's). Thus the wholesale transfer of complex, capital-intensive technologies from the industrialized nations does not in itself insure the modernization of the developing world. The requirements of the LDC's can be met by adapting technologies to the specific situations within particular countries. Appropriate technology (AT) -- also called "intermediate" technology -- is one approach to modernization and economic growth. It is discussed in this report within the context of international technology transfer and the developing nations.

The West began its industrialization process at a period of time when new technologies were largely mechanical in nature. 5/ Competition for

---

5/ Myrdal, Gunnar. The Transfer of Technology to Underdeveloped Countries. Scientific American, v. 231, September 1974: 174.

innovation and for profit built up a technological infrastructure (an underlying framework of technical knowledge, know-how and understanding which provides support for the science and technology endeavor) within which industrialization progressed. This infrastructure was flexible enough to adapt to the changes brought about by technologies based on the nature of matter and energy. It has been able to support additional innovations and industrialization rooted in physical and chemical laws. The alteration in the nature of the modernization process in the West is built upon the foundation laid during the late 18th and 19th century Industrial Revolution. It largely took place within those countries which possessed an organized governmental structure and a strong sense of nationhood, whether authoritarian or not. Most of the developing nations lack this stability. It is evident that the process of modernization has changed since it began in the West. Thus an attempt by the LDC's to achieve industrialization principally through the transfer of complex technologies will most likely be met by numerous problems if not failure. The placement of advanced technologies within an underdeveloped economy, void of economies of scale, market, communication or transportation networks, without a technically skilled or innovative working population -- without a technological, scientific infrastructure -- is unlikely to result in a secure modernization process leading to a viable, sound economy.

As construed within an international setting, appropriate technologies are those introduced to, or developed within, a country designed to parallel the technical skills, indigenous resources and needs of that nation. They represent an attempt to work within the socio-economic structure of the LDC to ensure that the technologies meet that nation's industrial, financial,

educational and employment capabilities. Appropriate technology requires a concerted effort to combine local requisites with local technical skills and resources to provide products or processes which can be utilized by the population. It usually involves low-cost outputs made from low-cost inputs. The products and processes derived from AT are those designed to match the needs of the population while simultaneously remaining low in maintenance requirements, easy to operate, and easy to replace. The technologies sought are responsive to demand and adaptations can be made as changes are indicated. Meeting these criteria, appropriate technologies create self-reliance and decentralization in the provision of goods and services. To attain these objectives, a combination of advanced technical expertise and a knowledge of practical application and adaptability within the current environment are required.

Recognizing that the advanced technologies of industrial nations are not necessarily the answer to the developmental problems of the LDC's, the appropriate technology concept attempts to deal with alternative orientations to the economic environment within these nations. The idea behind AT is that there is more than one way of accomplishing an objective. Basically, the underdeveloped nations have a large unemployed, underemployed and unskilled labor force, few capital assets (with the exception of the oil-rich states which will be discussed separately), and at best, a limited technological infrastructure. The appropriate technology concept accepts these conditions for development and attempts to work at promoting modernization and the provision of needed goods and services within these constraints.

The concept of choice is fundamental to appropriate technology. A balanced approach to AT requires that all types of technologies be considered.

While developing nations' desires to industrialize cannot be fulfilled strictly through the importation of Western technologies, neither should these advanced technologies be excluded from consideration. The choice of technology should be dependent on the indigenous patterns of consumption, labor and resources. The criteria on which the choice of "appropriateness" is based are not limited solely to technological considerations. Also of consequence are economic, cultural, environmental, energy, value, and social standards.

Appropriate technology attempts to deal with the total benefits of technological development. While production methods and distribution channels may not operate at optimum efficiency, AT requires that the social, economic, environmental and political advantages to be derived from a technology be considered. In other words, there are other individual and group efficiencies (i.e., social, cultural, medical) which must be satisfied for gains to be made. Appropriate technology addresses itself to this idea and provides alternatives; the governments of the developing nations must decide if and how these benefits are to be assured and distributed.

Production

The factors of production -- labor, land, and capital -- are present in the economy of the LDC's in proportions different from those of the industrialized nations. The formers' environments are frequently dominated by a relatively large workforce faced with high unemployment, underemployment, poverty, and limited skills. The economies of the developing nations are also typically characterized by poor income distribution, small domestic markets, and a lack of marketing mechanisms and networks. The capital-intensive technologies of the industrialized nations do not address themselves to these

economic and social conditions. Given the developed countries' concern with efficiencies, the Western technologies tend to be labor-saving and designed to promote economies of scale. However, the economies of scale inherent in Western production often do not apply equally to the LDC's. The established communications, distribution and transportation networks available in the developed nations and fundamental to this concept of scale, are not present in the developing countries. Markets have not been established or aggregated. Thus, as the basis for a program of development, capital-intensive technologies often do not address the problems and possibilities inherent in the particular situation. The idea presented by the AT concept is that labor-intensive technologies should be adaptable to provide overall benefits equal to, if not superior to, highly technical innovation within the economic confines of the developing nations.

Policies of the Developing Nations

The technologies transferred to the LDC's by the Western nations and those developed within the countries themselves reflect governmental policies towards science, technology and industrialization. Among the barriers to the acceptance and utilization of appropriate technologies are the attitudes of the LDC's themselves. In modeling their developmental planning after the West, many developing nations aspire to the advanced, capital-intensive technologies which characterize the economies of the industrialized countries. While these technologies may have definite place within the LDC, the uncritical acceptance of this form of transfer can put strains on the economic and political viability of the country.

In general, the past and present policies and priorities of the developing countries have served to promote the transfer of capital-intensive technologies. Various policies have made capital inexpensive relative to the price of labor,

thus promoting technologies which favor the former. Many LDC's have artificially underpriced capital by distorting exchange rates. Favorable rates of exchange are established on foreign currencies which serve to encourage the development of technologies which utilize a high proportion of imported goods and resources and ignore the higher priced domestic resources. Technologies from the West thus become a better "buy" and the replacement supplies for these capital-intensive production methods are purchased from foreign sources.

Other policies of the LDC's promote artificially low prices for capital. Low-interest loans for the purchase of foreign capital goods and production methods are subsidized by the government. Preferential tariffs on capital goods are combined with preferential foreign exchange rates to favor the transfer of capital-intensive technologies. Accelerated depreciation allowances on the tools of production, which are themselves capital-intensive, also serve to make it more economical to promote advanced technologies. Many LDC's do not have well planned protectionist policies and thus tend to create non-competitive, high-cost, high-profit industries catering to luxury items and capital goods.

While the economic programs of the developing nations have lowered the price of capital and thus capital-intensive production methods, labor is rendered expensive through the implementation of minimum wage laws, lay-off restrictions, and mandated fringe benefits. Wages are distorted by exogenous factors which have contributed to massive urban unemployment in the LDC's. Among the amenities often required to be provided in addition to wages are housing, sanitation, water supply, and medical and educational facilities. When these are made obligatory they add substantially to the cost of production in labor-intensive manufacturing. Thus, there is a sizable economic disincentive to the implementation of labor-intensive technologies.

The predisposition of the various persons involved in the transfer process also builds a barrier to the acceptance of AT. Oriented towards advanced technologies and production methods, efficiency concepts, and labor-saving manufacturing, those persons involved in technology transfer and industrialization bring a particular outlook to the problems posed within the LDC's. The elements of appropriate technology are unfamiliar and require an orientation and ability to adapt innovation which is not inherent in the trained abilities of most involved in production.

Additional constraints to the adoption of appropriate technology within the developing nations revolve around the entrenched self-interest of various specialized segments of the population. Institutional structures as well as political alliances often work to promote the capital-intensive technologies and methods of production which tend to benefit the wealthier elements of the societies. Economic policies favorable to business and capital-intensive industrialization have created established economic structures. In conjunction with business, these groups control the economic development of many LDC's and can work to suppress innovation in the area of appropriate technology.

Given the economic environment of the developing countries, various suggestions have been made concerning policies which these nations can implement to promote appropriate technologies within the context of their developmental requirements. Foremost is the prerequisite that the LDC's curtail their policies of cheap exchange rates and credit which substantially alter resource prices. In conjunction with this, unrealistic minimum wage structures and benefits need to be discontinued so as to provide an incentive

to promote labor-intensive technologies. A program of more effective tax policies, removal of interest rate ceilings and subsidies to capital would also make AT (and its labor-intensive aspects) more desirable. Additional opportunities available to the developing nations include promotion of a technological infrastructure, advancement of the skills of the population, improvement of technically related services and marketing networks, encouragement of competition within the population, and the developing of export markets for the products of AT.

Innovation

Most developing nations with their limited technological infrastructures have not developed innovative capabilities among their populations. Without indigenous innovation a country cannot maintain long-term development, which requires adaptation and evolution of processes and products as needs, demands, and resources change over time. Local entrepreneurs and innovators are necessary to sustain the adoption of technologies suited to the local environment as well as the development of familiar domestic resources. The flexibility necessary to promote this process is often not present in the environment of the LDC's. This is partially a result of limited technological expertise in the population and of government policies which work to dissuade innovative projects.

Technical education and training are necessities for indigenous innovation. However, in developing nations there is a limited supply of skilled persons to draw on for innovation. Attempts to improve this situation by sending students abroad to study often results in "brain drain" when these students remain abroad to take advantage of other environments where their talents can be better utilized.

The economic policies of the governments within the LDC's usually are not constructed to foster indigenous innovation and often pose direct obstacles to the innovation process. Inflated foreign exchange rates, excessive depreciation allowances and preferential tariffs act to favor capital-intensive, imported technologies. At the same time, high interest rates on domestic loans and inadequate credit systems which do not cushion the risks tied to investments in innovation serve as deterrents to attempts by local entrepreneurs. Further disincentives arise in consideration of the lack of effective market diffusion and product distribution channels. This both dampens demand for the results of innovation and makes return on investments less likely.

This lack of innovation is also evident in the inability to adapt the potential of Western technologies to the particular environment of the developing nations. The ingenuity to provide flexibility in approaching technological problems is lacking. The appropriate technology concept provides a method by which low-cost, adaptive innovation can be fostered. Investment costs are minimal, the technologies are not technically sophisticated but address the problem, and local resources are utilized. Thus the risks involved in innovation and the artificial barriers to it can be circumvented while providing the method by which indigenous innovation can be encouraged to assist in the country's development.

Limitations of Appropriate Technology

Appropriate technology cannot address all the requirements for modernization faced by the developing countries. With respect to the international marketplace, the small-scale nature, the dispersed production sites, and the reliance on unskilled labor make appropriate technologies less economically

efficient than capital-intensive ones. These characteristics reduce the ability of the LDC's to produce on a large scale and develop a broad foreign market. In the industrial nations, capital-intensive technologies utilize resources to provide the maximum output while consuming the least amount of expense per unit produced. Thus, scarce financial resources are used most efficiently and that portion saved can be put to additional use. The production methods provided by advanced technologies are based on efficiency criteria which insure that the output is produced in the least amount of time. Production by advanced technologies is often the cheapest, most efficient way to manufacture in large quantities and thus compete on the world market.

In the development of a national market, additional considerations make capital-intensive technologies more economically desirable. The dispersion of local industries leads to problems with market aggregation and distribution. The underdeveloped transportation and communications networks hinder both the provision of inputs to production as well as the distribution of outputs to the population. Nor are markets aggregated to develop substantial demand for a product (new or otherwise) such that its manufacture is profitable. Labor-intensive technologies do not provide the quality control which can be built into machine-made outputs. Together, these factors often cause the return on investment in labor-intensive technologies to be below that which can be obtained through the utilization of advanced technologies.

Other aspects of the labor-intensive components of appropriate technology argue against its substitution for the use of capital-intensive technologies. As discussed previously, labor is presently expensive in the developing nations. In addition, this labor is largely unskilled, uneducated and located in urban areas. Labor and production management skills are not wide-spread

and most of the expertise is based in capital-intensive methods of production. The increased necessity for effective management techniques arising from reliance on labor-related technologies makes its absence more noticeable. Capital-intensive manufacturing, when combined with training, provides those management and technical skills needed for modernization of the economy of the LDC's.

Thus, in relation to some aspects of development, these conditions cause the economic costs associated with the production of labor-intensive appropriate technologies to be higher than those inherent in capital-intensive, Western technologies. Appropriate technologies cannot compete in the world marketplace because they do not manufacture in large enough quantities, nor do they manufacture efficiently. Poor distribution channels (both national and international), small domestic markets and uneven quality control can serve to prevent a large return on investment. These factors, coupled with the absence of technical education and the problems of national pride and psychological resistance to using what can be described as old, undeveloped, or discarded technologies provide coherent argument against the implementation of appropriate technology -- or the exclusion of advanced technology -- in the developing nation.

Appropriate Technology and the Rich Developing Nations

The situation with respect to appropriate technology within the rich developing nations differs from that of other LDC's. The concept of AT is not as important to their developmental process as it is in the less wealthy LDC's. Possessing the large monetary resources to purchase technology, expertise, assistance, and information, the wealthier developing countries see appropriate technology as a means of retarding industrialization and of preventing their acquisition of advanced technologies. At present, they are

seeking to develop the technological infrastructure so that the purchase of goods and assistance can result in modernization. With their large monetary reserves these countries can purchase most of the factors for development: they can afford replacement costs, technical assistance, expertise, and the improvement of market, transportation, and communications networks necessary for industrialization. Although there is an uneven distribution of wealth, there is enough to provide markets and purchasing power for technical goods and services. Money is also available for educating the public and thus improving the technological infrastructure, the technical skills and the innovative capabilities of these nations.

The Multinational Corporation

The multinational corporation (MNC) is one of the major mechanisms for the transfer of technologies to the developing nations. By establishing manufacturing plants within the LDC's, multinational companies have provided for technology transfers through the importation of machinery and tools used in production. The technical expertise and training made available by the management and employees of these companies play an important part in the transfer of information and skills. At the same time, multinational corporations inject capital and foreign exchange into the economies of their host countries. However, the technologies favored by the MNC's are usually capital-intensive, thus the income derived from the activities of these companies is not widely distributed. The number of employees needed to operate these production mechanisms is small and the wages paid benefit only a particular portion of the population, usually the wealthier, educated segments.

Within the countries of origin of the multinational corporations, labor is the expensive factor of production and the development of labor-saving

technologies is the rational course followed by the large companies. This does not hold true when applied within the LDC's. While in the developing nations labor is more abundant, the MNC's often have no incentive to utilize less capital-intensive technologies. Given th nature of the products and processes these companies are involved in, it is often difficult and costly to alter manufacturing patterns. Familiarity with proven methods of production can form a bias towards continuance of present practices which may be reinforced by a lack of information on alternatives. In other cases, the propensity of multinationals to export high technologies is encouraged by the economic policies of the LDC's. While cheap labor can be an advantage, the MNC's often respond to artificial barriers to the utilization of labor imposed by governments and provide capital-intensive technologies.

Multinational corporations have contributed to the westernization of the markets within the developing nations. The criticisms now leveled concern the question whether these companies are transferring technologies at odds with the economic and developmental environment of the LDC's. The current outlook for economic growth tends to concentrate on the idea that innovation and technology must stimulate demand and employment -- the critical economic issue within the less developed countries. The technologies introduced by the multinational companies are on the whole capital-intensive and do not act effectively to expand employment, innovation, or demand. However, dispersal of the capital depends largely on government policies and priorities. If the capital is used for goods and services which improve education, health care and other social concerns, it can benefit the social development of the countries.

There are various economically sound reasons for the continued utilization of capital-intensive technologies by the MNC's. In the past, there has been a concerted effort by the developing nations to encourage

the involvement of multinationals in order to promote industrialization. The governmental policies described above all contribute to the continuation of the emphasis on Western, advanced technologies. Economically, it is costly for companies to adapt technologies to the collective environment of the LDC's and even more so for adaption to each particular country. Markets are too small to recover large investments and research and development costs for special techniques or processes designed to be labor-intensive or to use domestic resources. Capital-intensive production methods can save scarce monetary resources by consuming less money per unit of output. Also, by operating within LDC's, multinational corporations bring managerial and technical experience and skill which are of benefit to the recipient country and can have future impact on the development of expertise in the working population.

U.S. Government Programs

The concept of appropriate technology is receiving attention in a number of Federal agencies of the U.S. Government. The Energy Research and Development Administration (ERDA), now within the Department of Energy, is developing a program for international AT, the Agency for International Development (AID) is administering one, and the National Science Foundation (NSF) is studying the idea.

AID. In recognition of the potential of appropriate technology, Congress included section 306 in the International Development and Food Assistance Act of 1975 (P.L. 94-161) which amends section 107 of the Foreign Assistance Act of 1961 and mandates a program for AT within the Agency for International Development (AID). A total of $20 million has been made available for FY 1976, 1977, and 1978 for ". . . activities in the field of intermediate technology, through grants in support of an expanded and coordinated private effort to

promote the development and dissemination of technologies appropriate for developing countries." In response to this legislation, the Agency for International Development prepared a plan for a program and submitted it to the Senate Foreign Relations Committee and the House International Relations Committee on June 30, 1976.

The goals of the proposed program are to aid LDC's in creating, utilizing and adapting appropriate technologies while promoting the establishment of an infrastructure equipped to handle the technical environment. As now constituted, the program will spend $10 million annually to involve private groups in AT projects which complement the ongoing efforts of the Agency for International Development. Grants will go directly to private as well as publicly supported groups working within LDC's. An independent, private, non-profit organization has been established to undertake the management of the program. This is seen as providing for better flexibility of operation, less red tape and bureaucracy, and a faster response time. A $1 million grant to set up this group, Appropriate Technology International, was approved June 27, 1977.

In pursuit of innovative projects in appropriate technology, the AID proposal outlines five program areas under which activity would be conducted. These are as follows: (1) communications and coordination-information and modeling programs; (2) national priorities for AT-efforts to encourage AT-oriented policies within LDC's; (3) appropriate technology projects in LDC's; (4) educational programs; and (5) U.S. business involvement in AT projects in the developing nations.

ERDA. The Office of International R&D Programs within ERDA's Office of International Affairs (now in the Department of Energy) is developing a new

program in which appropriate technology will be an important component. To be titled the U.S. Program for International Energy Development with Less Developed Countries the overall program objectives will be to: (1) improve the quality of life in the LDC's; (2) reduce the dependence on oil in the developing nations; and (3) provide nonnuclear alternatives to those countries which have expressed interest in nuclear power.

In addition, ERDA is in the process of finalizing a General Agreement with the Agency for International Development to develop a basis by which the two agencies can work and transfer funds. Realizing the potential for cooperation, it is assumed that through this mechanism, ERDA can make available the technical expertise required by the AID foreign assistance programs. To this end, a Memorandum of Understanding between ERDA and AID was approved November 15, 1976.

NSF. In House Report 95-98 to accompany H.R. 4991, a bill authorizing FY 1978 appropriations for the National Science Foundation, the Committee on Science and Technology expressed its interest in NSF's involvement in the issues surrounding appropriate technology:

> . . . it is recommended that the NSF encourage research and development directed specifically at appropriate technologies in the International programs and in the Policy Research and Analysis program where it appears that such direction is feasible. (p. 25)

The Foundation was also requested to present within six months a report to the appropriate House and Senate committees on future plans and programs in AT.

At the present time, there are no specific, separate programs to address the concept of international appropriate technology within either the Policy Research and Analysis Division or the entire Scientific, Technological, and International Affairs Directorate (STIA) of the National Science Foundation. However, there is an effort underway to encourage consideration of AT and AT

concepts in future proposals and programs. The Policy Research and Analysis Division within STIA is working on a draft program plan for the research community which includes the concept of appropriate technology. An International Policy Research and Analysis Working Group has been established within the Division but has not funded any studies up to this point. Other programs have components which fit the criteria of appropriate technology although not labeled as such including the International Science Studies Program and the Transnational Issues Program. The Scientists and Engineers for Economic Development Program, funded by AID and administered by NSF, provides for applied technology projects abroad which involve appropriate technologies.

The Science for Citizens Program of the Science Education Directorate in NSF has provided a grant to the American Academy of Arts and Sciences to conduct a symposium on "Social Values and Technology Choice in an International Context" to be sponsored by the U.S. Pugwash Committee. Planned for the spring of 1978, this conference will discuss numerous aspects of the issue of appropriate technology. The participants from both the industrialized nations and the developing countries will consider whether the choice of alternative technologies can effect the attainment of social and economic goals. Also, to be discussed are whether the concept of appropriate technology meets the requirements of the public within the developing countries and whether the growth model of the industrialized nations is the one that should be followed by the LDC's.

Concluding Observations

The basic question the developing nations face -- and those who are interested in providing assistance -- is which path is the best to insure economic growth in concert with national goals, character, and ideologies.

The appropriate technology approach to this dilemma is that the utilization of indigenous resources, both labor and material, will stimulate innovation through a reliance on local developmental technology and provision of goods and services. Basic to the idea of appropriate technology is the concept of choice; the idea that the technology best suited to the immediate needs of the environment as well as beneficial to future development should be generated or promoted. However, critics of AT have pointed out difficulties in the application of the appropriate technology concept. There are various economic inefficiencies associated with AT including the resulting fragmented market and supply systems, non-competitive costs arising from labor-intensive production and acceptance problems rooted in the LDC's self-image and indigenous vested interests. Thus, in practice, the most effective route to modernization may well prove to be a mixture of technologies, some which are advanced and some which are scaled to the specific requirements of the country in question.

If appropriate technology becomes a more accepted concept, the perspective of foreign aid may be expected to change. With an emphasis on the development of new technologies and the redesign of old ones, there would be a greater number of appropriate technologies to choose from. Technical assistance will reflect an awareness of the impact of technology on economic, social and political resources, and on the requirements of the country in terms of short-, mid-, and long-term planning, growth, and development.