THE INTERNATIONAL TRANSFER AND ACQUISITION OF TECHNOLOGY

Documentary Review

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THE INTERNATIONAL TRANSFER AND ACQUISITION OF TECHNOLOGY

Documentary Review

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Prepared for:

Bureau for Program and Policy Coordination
Agency for International Development
Washington, D.C. 20523

AID Contract Number: OTR-0092-C-00-2280-00
Project Number: 930-0092
Project Title: Analysis of Technology Transfer Case Studies

March 1983

Submitted by:

Denver Research Institute
University of Denver
Denver, Colorado 80208

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AND
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This report is contained in three separate volumes:

- Executive Summary
- Final Report
- Documentary Review

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PREFACE

As background for an analysis of the technology transfer process for the U.S. Agency for International Development (AID), the Denver Research Institute (DRI) conducted a limited documentary review. This volume includes the results.

We reviewed selected case studies, scholarly literature, commercial and industrial reports and writings, and reports and documents of the international development assistance community. We found the technology transfer literature to be sparse in some fields of particular interest to AID. Primary health care, nutrition, fertility limitation, literacy and numeracy, vocational and technical training have not been viewed extensively from the perspective of their impact on technology transfer within societies nor from the standpoint of the impact of transferred technologies on the specific fields.

By the terms of the contract we omitted a review of agricultural technology transfer. We purposely omitted U.S. domestic technology transfer literature from our review. In the process of conducting the documentary review, we became aware of a large body of documentation on technology transfer. We have included a list of this documentation as a bibliography in the back of this volume.

A HISTORICAL PERSPECTIVE

The practice or process of technology transfer goes back to prehistoric times. Whoever sharpened a stick doubtless demonstrated this to a colleague and thus started a technology transfer transaction.

As Professor Rosenberg reminds us,* Francis Bacon pointed out that three mechanical inventions changed the whole face and state of things throughout the world. Printing, gun powder, and the compass altered literature, warfare, and navigation respectively, and although none had been invented in Europe, it was from that continent that their impact was felt. He goes on to note that: "The capacity to assimilate new technologies whatever their origins may have been as important as innovativeness itself." That is a thought upon which developing country policymakers should reflect.

Historians have long noted the effects of technologies on the course of events, and in our own century there has grown up a discipline of the history and philosophy of science and technology. Thus, scholars now probe the terms and conditions, the cultural environments and societal patterns that have been conducive to the flowering of technology.

We have limited ourselves to recent literature as it applies to the international transfer of technology, and we note that in the last decade or so it has begun to cascade.

The term "technology transfer" became fashionable during the 1960s. A growing belief in developing countries that their nations' economic growth would be conditioned by their ability to effect such transfers stimulated them to press for better terms of technology transfer. In some cases, laws were passed to govern the conditions under which MNCs could do business in their countries. Scholars addressed the need for a scientific and technological base to support technological development, provide guidance in making technological choices, strengthen the developing countries' negotiating positions, and adapt transferred technologies to local factor endowments. Scientists and engineers were convinced of the need for such developing country resources. Development planners and economists were not always so unanimous on the subject.

A theme that has underpinned much of the practical and some of the scholarly consideration of the topic during the 1970s stems largely from the appropriate technology "movement." A very substantial body of work has been devoted to the alleviation of poverty and the misery of that one-quarter of the world's population which lives in constant jeopardy. Much of this work is in simple technologies and their means of

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*OECD, North-South Technology Transfer and the Adjustments Ahead (Washington: OECD, 1982), p. 25.

transfer and is regarded, whether rightly or not, as having its origins in the E.F. Schumacher "small is beautiful"* school of thought. That book codified in a way not previously done the holistic self-help, resource conserving, labor-intensive, local initiative and control philosophy.

The Organization of Petroleum Exporting Countries' actions to increase the price of oil assuredly stimulated the self-reliance aspect of AT in both the developed and developing countries. In addition, it focused attention on energy resources and by extension on all types of resource conservation. Energy is today a major driving force of the AT movement.

More or less coincident to these developments, the international donor institutions and nations, along with the recipient nations, were engaged in a review and analysis of the perceived failure of development to proceed at its expected pace. The results of that analytical effort came to be known by many names but the gist was helping the poorest of the poor. The result was a global turning toward "meeting basic human needs," and one of the favored mechanisms singled out for achieving this goal was appropriate technology--also known as capital saving technology, and by several other names. It will take some time for historians to sift through the results of this shift in emphasis, but it is clear that not all donors or recipients were as charmed by the rhetoric and enthusiasm for this approach to development as were its principal spokesmen and theorists.

From the developing country perspective, the AT movement and meeting basic human needs were described in a variety of ways, some of which were not particularly charitable toward the motives of the donor country advocates of these approaches to development. The literature includes analyses which describe AT as a neocolonialist ploy to keep the developing countries at the low end of the technology spectrum indefinitely. Simultaneously the multinational corporations, which are occasionally described as the most effective agents of technology transfer, were taken to task for their exploitation of the resources, the labor, and the economic impotence of the developing countries. Codes of conduct, the New International Economic Order, and economic analyses of the costs of technology being transferred for allegedly exorbitant prices to the developing countries have all figured in the economic, social, and political analyses of the process of technology transfer.

Over the past two or more decades there has also been a serious body of economic analysis of the technology transfer process as it occurs in agriculture. The question of what makes farmers want to adopt or adapt to new agricultural technology has been asked in many places and in many ways.

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*E.F. Schumacher, Small is Beautiful: Economics as if People Mattered (New York: Harper & Row, 1973).

In addition, there has been a very substantial body of work devoted to the transfer of technology between firms, or as part of an arm's length transaction between buyers and sellers, whether they be private commercial, public, or parastatal entities. This literature tends to concentrate on the value and price of technology, the legal instruments and institutions surrounding technology transfer, and the relationships between the governmental bodies regulating or encouraging foreign investment and the technology producers and sellers. Patents, licensing, subcontracting, co-production, and other arrangements of international trade are analyzed as are the other terms and conditions affecting the global flow of technology. Much of the literature assessing the cases of Japan, Brazil, Mexico, and Korea falls in this category.

What might be called a subtheme of the above is the literature devoted to the concerns of the industrialized nations for their control of the global market for technology and their worries about the "leapfrogging" of high technology from the industrialized laboratory to the newly industrialized country's production facility with its less costly labor and official protection.

A somewhat more recent observation relates to the medium to large firm in the developing country and its need for a culture of acquisition of technology. The twin requisites of engineering skills and management techniques are blended into a highly pragmatic approach to technology transfer that tacitly acknowledges a debt to the MNCs for demonstrating the need for and ways to train people in the rudiments of the global management ethos.

While the AT literature appears to have plateaued, it obviously does not mean that the problems it addresses have been solved. We speculate that this plateau represents a concern that the AT movement has not produced the results its proponents envisioned. The next phase of this part of the technology transfer spectrum may be a concentration on the social technologies. It is our guess that the changing world economy and the recognition that motivating societal change is one of the most difficult technologies to transfer have resulted in a growing understanding of the need to devote more effort to nurturing the creative people in developing societies. Current concerns with stimulating entrepreneurship is an indicator of this trend.

This suggests a point made by the literature devoted to transfer of high technology among the newly industrialized countries. These nations have demonstrated an unswerving determination to acquire the prowess to produce technological products that can compete in the world market. Their goals are an increasing level of self-reliance, a reduction in their dependence on prices set by others for their raw materials and lightly processed resources, and a reduction of the debt burden which is so potentially devastating to their economic future. They want to compete among themselves, and with us.

A very substantial amount of the technology transfer literature being produced today (whether it be academic or commercially oriented)

is devoted to the relationships between firms, and between host governments and firms in the private sector. By contrast much of AID's technology transfer activity is in a realm closer to appropriate technology, meeting basic human needs, infrastructure development, and, of course, agriculture. Our review suggests that AID needs are probably not being adequately met by the academic research and case studies thus generated. The attention being paid to legal, engineering, marketing, organizational, and institutional arrangements is not entirely congruent with the bulk of AID-sponsored technical assistance.

Author Paul Nevin asserts that "it is estimated that 120,000 jobs must be created worldwide every day for the next twenty years to meet the expected employment demands by the end of this century. Of that number only 15 percent will come from the developed nations; the remainder will be needed in the Third World."* That 85 percent to be generated in the Third World translates to 744.6 million jobs, or 37.2 million jobs per year. It is clear that donor programs will make little direct impact on that number. Therefore, it may be to AID's advantage to sponsor research on alternative job delivery mechanisms.

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*Paul F. Nevin, The Survival Economy: Micro Enterprises in Latin America (Cambridge: Accion International, June 1982), p. 1.

A DEVELOPING COUNTRY PERSPECTIVE

Since the 1960s, the transfer of technology from industrialized to developing countries--sometimes said to be from north to south--has drawn official attention. Concerns have centered on: (1) technology "packaging," (2) restrictive controls of the use of technology, (3) inappropriate choices of technologies, and (4) high technology costs. National and regional efforts have been mounted to negotiate and regulate related aspects of the international trade in technology.

In 1974, the United Nations General Assembly proclaimed a New International Economic Order (NIEO), a call to transform the old order of industrialized countries' dominance in world economic affairs and to substitute one of greater economic equality.

Objectives of the NIEO include:

- The lessening of the vulnerability of LDCs to decreasing and fluctuating prices for key LDC exports
- The expansion of external markets for the manufactured goods of LDCs
- The creation of a new international monetary system more responsive to LDC needs
- The improvement in conditions for acquiring, adapting, and applying technology
- A code of conduct regulating international technology transactions
- An international patent system more responsive to the needs of developing countries
- A lessening of dependence of LDCs on developed countries, coupled with more cooperation among LDCs

The countries that hold the NIEO as most critical to their future are often those attempting to build their capabilities through import substitution strategies. Developing countries which compete successfully in international trade and commerce are less enthusiastic in their support for the concept. The OPEC countries have their own agenda. With the developed economies being "cautiously" skeptical, the supporters to NIEO seem to be shifting their emphasis to its less controversial themes, such as technical cooperation among developing countries (TCDC).

The concept of TCDC first emerged at the 1976 Conference of Non-Aligned States in Colombo. The following year, the Group of 77 further evolved the concept in Mexico City. This led to the 1978 Buenos

Aires Plan of Action for promoting and implementing TCDC. Reforms at national, regional, and international levels were recommended to improve the chances of TCDC success.

Some have been hopeful that TCDC-initiated action will lead to greater self-reliance for the developing countries and a significant surge in the documentation of TCDC activities lends some weight to this view.

Reshaping of the international maritime order through the Third U.N. Conference on the Law of the Sea (UNCLOS III) is another issue high on the agenda of many developing countries concerned with reaping the benefits of high technology.

Conventional maritime practice has been based primarily on the principle of the "freedom of the high seas" which, of course, favors those capable of effectively exercising this freedom. The new order ostensibly is designed to strike a balance between competing principles--"freedom of the high seas" versus ocean space as the "common heritage of mankind." In April 1982, the draft convention was voted on for its adoption. The vote was 130 countries in favor, four against, and 17 countries abstained, mostly European and Soviet bloc. The U.S. announced that it would continue to participate in negotiations, but it would support the treaty only if it could be amended to meet six specific U.S. objectives with regard to the deep seabed mining portion of the text. Basically, the U.S. is committed to the position that deep seabed mining is a lawful use of the high seas, the exercise of which must be respected by all states.

THE TRANSFER OF COMMERCIAL TECHNOLOGY

Beyond the literature on agricultural technology, much of the concern with transfers--both from the perspective of academicians and development planners--has been with commercial technology and its impact on economic development. We suspect that this results from a belief that if the agricultural and industrial sectors drive development successfully, other sectors will be taken care of in the process.

Because of the importance of multinational corporations in global transfers of technology, we begin this section with a discussion of the nature of the literature on these corporations.

Over the years, a number of theories have been postulated to explain the international movements of technology. These have not been exclusively concerned with firm to firm or interfirm transfers, but the importance of these mechanisms, as well as the role of the MNCs, clearly emerges. Following the introductory discussion of MNC literature, we examine three of the most widely discussed technology transfer theories and make some comparisons among them.

While developing country acquirers of technology have an ultimate responsibility in obtaining and succesfully exploiting technologies, the theories on technology transfers focus on factors external to the acquirer as does most of the literature. We next examine the literature that has focused on the technology acquirer.

The acquirer must be concerned with the appropriateness of technology, and we have provided an overview of two of the most important rationales mentioned in the literature for motivating interest in the appropriate technology concept.

We conclude this section with a survey of literature on effects of national policies on the international transfer and acquisition of technology. This policy environment affects the technology acquirer as well as the transferor.

Multinational Corporations

A recent OECD report noted that MNCs carried out 80 percent of the technology transfer to nonsocialist countries.* With the multinationals operating from such a position of strength, it is not surprising that allegations of their misuse of this strength have been

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*J. Delorme, "The Changing Legal Framework for Technology Transfer: Some Implications," North/South Technology Transfer, The Adjustments Ahead (Paris: OECD, 1982), p. 90.

reported. Much has been written about MNCs requiring that technology must be purchased from their own affiliates. Another commonly noted "abuse" is to restrict exports of the developing country firm receiving a technological capability.* Sometimes multinationals are accused of receiving unusually large royalty payments compared to the industry norm.

Such practices are often reported in a conglomerate form such as: in Thailand, locally owned factories import 65 percent of their raw materials whereas multinational corporations import 76 percent.**

There is also a body of literature presenting the views of MNC officials: for example, an LDC government refusing to permit a subsidiary to pay its bills to the parent company,*** or a lack of appreciation of the indirect benefits that accrue to a country from an MNC's operation such as providing vendor markets and building vendor capabilities, strengthening vocational schools and universities, and building the country's management skills.****

The difficulty with assessing MNC practices in developing countries is that seldom is there adequate knowledge of the total flows of costs and benefits to each party, the parties' objectives, or the alternatives open to each party. Undoubtedly there are occasions where one party to a transfer takes advantage of the other, but in many cases both parties must gain or the transactions would not occur. Many analysts have taken this balanced view***** and a few have attempted to identify and estimate the major economic (and some of the other) costs and benefits

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*Francis Stewart, International Technology Transfer: Issues and Policy Options, World Bank Staff Working Paper No. 344, July 1979.

**Lewis T. Wells, Technology and Third World Multinationals, Multinational Enterprises Program Working Paper No. 19 (Geneva: International Labor Organization, 1982).

***Harvey W. Wallender III, et al., Public Policy and Technology Transfer: Viewpoints of U.S. Business, Volume II, Industry Characteristics (Fund for Multinational Management Education, Council of the Americas, United States Council of the International Chamber of Commerce, and the George Washington University, March 1978), p. 397.

****G.W. Allen and L.A. Howard, "A Model for Introducing Technology into Developing Countries," U.S. International Firms and R,D&E in Developing Countries (Washington: National Academy of Sciences, 1973), pp. 66-71.

*****James Brian Quinn, "Technology Transfer by Multinational Companies," Harvard Business Review, November 1969.

accruing to the parties involved in an international transfer of technology.*

Recent additions to the literature on multinational corporations have examined the activities of a newly emerging force--the developing country-base. multinational.** Some of the characteristics attributed to these MNCs, by comparison with those from the more economically advanced countries, are that the LDC multinationals offer technologies that are often simpler in terms of equipment, but more complex in terms of skills and procedures required of the managers and workers who use the technology.*** Developing country MNCs are said to be more likely to use the locally available materials of their host countries.****

Appropriability Theory

Recognizing the major role played by multinational corporations in the technology transfer process, Stephen P. McGee has illuminated the process through an examination of the motivating forces influencing these corporations.***** McGee refers to this as "the appropriability theory."

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*G.R. Hall and R.E. Johnson, Transfers of United States Aerospace Technology to Japan (Santa Monica: The Rand Corporation, July 1968).

**For example, see Sanjaya Lall, "Indian Technology Exports and Technological Development," and Donald J. Lecraw, "Technological Activities of Less-Developed Country-Based Multinationals," The Annals: Technology Transfer: New Issues, New Analysis, special editors Alan W. Heston and Howard Pack (Beverly Hills: Sage Publications, November 1981).

***Ibid., Lecraw, p. 171.

****Wells, op. cit.

*****Stephen P. McGee, "An Appropriability Theory of Direct Foreign Investment," The New International Economic Order: The North-South Debate, editor J. Bhagwati (Cambridge: MIT Press, 1977), pp. 317-40; "Multinational Corporations, the Industry Technology Cycle and Development," Journal of World Trade, Vol. 11, July 1977, pp. 297-321; "Application of the Dynamic Limit Processing Model to the Price of Technology in International Technology Transfer," Optimal Policies, Control Theory, and Technology Exports, editors Karl Brunner and Alan Meltzer (Amsterdam: North Holland, 1977), pp. 203-224; and "The Appropriability Theory of the Multinational Corporation," The Annals: Technology Transfer: New Issues, New Analysis, special editors Alan W. Heston and Howard Pack (Beverly Hills: Sage Publications, November 1981), pp. 123-135.

This theory suggests that MNCs are specialists in the production of sophisticated technologies. Because of the difficulty in rivaling and copying these technologies, the multinationals reap large profits over a long period of time. These technologies thus have high appropriability for the MNCs.*

The development of technologies with high appropriability requires highly skilled technical staff. As a result, developed countries have a comparative advantage in producing these technologies because of their relative abundance of skilled labor. Similarly, the developed countries have a comparative advantage in exporting and capturing private returns on new sophisticated technologies.

McGee suggests that the most important consideration facing innovating multinationals is their ability to protect the profitability of their proprietary technologies. The more difficult it is to do this, the greater the appropriability problem. As sophisticated ideas are harder to copy than simple ones, the multinationals generate the former.

MNCs prefer to transfer their technology internationally within their firms rather than through the market because there is less likelihood of it being copied and stolen by outsiders.

The appropriability theory suggests that ". . . multinational corporations cannot be counted on to create the types of technology that are most useful for the developing countries." On the other hand, some have argued that the implementation of legal systems, which clearly establish property rights, would lead to an acceptable environment for the international transfer of multinational corporation technology. McGee counters, however, that even under such a system ". . . the legal costs to private firms of appropriating the returns on their R&D investments may be so high that only the government can provide certain types of information efficiently, for example, unskilled labor-intensive technologies. Even 'well-defined' legal rights do not guarantee a socially optimum level of appropriability."**

Induced Innovation

Hans P. Binswanger and Vernon W. Ruttan point out that Sir John Hicks first described and used the term "induced innovation" in The Theory of Wages. Hicks argued that there was no inherent labor-saving bias in technical change. Rather, he said, rising wages could be expected

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*McGee defines appropriability as follows: "The appropriability of an innovation is higher the larger the innovator's profits relative to the value to society of the innovation."

**Ibid., pp. 124-128.

to induce entrepreneurs to seek out labor-saving innovations in order to offset rising labor costs.*

Induced innovation theory suggests that the rate and direction of technical change is the product of economic variables such as factor prices, changes in endowments and income distribution, goods prices, interest rates, sizes of production output, exchange rates, and subsidies. Because a number of these factors may be affected by national will, the theory postulates that the direction and rate of innovation may be influenced by governmental policies.

In examining the relevance of the induced innovation theory for technology produced in developing countries and for technology transfer policies, Binswanger has noted:

> Less developed countries are often characterized by extreme scarcity of capital relative to labor. Most modern technology, however, is capital intensive. If it is true that the high capital intensity of production typical of western market economies came about spontaneously in response to rising labor prices, then perhaps the less developed countries can evolve modern labor-intensive technologies that will offer cheaper sources of growth than those provided by the developed countries' capital-intensive methods.**

The induced innovation theory thus leads to a more optimistic assessment of the possibility of appropriate technologies emerging naturally in developing countries than does the appropriability theory.

The Product Cycle

Raymond Vernon, in his modest fashion, has called attention to a product cycle hypothesis that places less emphasis on induced innovation as an explanation for the international transfer of technology*** and more upon the timing of innovation, the effects of scale economies and of

ignorance and uncertainty in influencing these transfers.* The product cycle hypothesis is more eclectic than the appropriability theory, treating multinational corporation motivations as only one element in the transfer process.

The product cycle hypothesis envisions products, associated with high income markets and those which substitute capital for labor, passing through new, maturing, and standardized product stages. While Vernon does not claim applicability of the hypothesis for the transfer of industrial innovations in general, the class of products covered should correspond fairly well with the sophisticated, high technology products which McGee suggests that multinational corporations will produce as a result of the innovation's appropriability for the corporation.

Vernon proposes that when a new, sophisticated product emerges, it will most likely do so in a country with high average income and high unit labor costs. As the demand for a product expands internationally, a degree of standardization occurs, it becomes possible to achieve economies of scale through mass output, and the product may be said to have matured. During this expansion period there are substantial movements of technology to other economically advanced countries, and at the standardized product stage, the production technology will increasingly be transferred to developing countries. Also during this stage, the originating country may begin to import the product.

In explaining his hypothesis, Vernon noted that the entrepreneur's awareness of and responsiveness to opportunity are functions of ease of communication and that ease of communication is a function of geographical proximity. Markets for products to meet the desires of high income people are most likely to be recognized first by advanced economies' entrepreneurs. Therefore, high rates of expenditure on new product development are more likely to occur in these countries.

Even if this is true, a multinational corporation may choose first to produce a product in one of its developing country facilities. Economic factors could well be such that the induced innovation theory would project this to happen. Vernon argues, however, that this would be unlikely because during the introductory stage the product would be unstandardized and its input and processes subject to change and variation. During this stage producers are "particularly concerned with the degree of freedom they have in changing their inputs." Second, due to the monopolistic-like situation that exists when a product is first introduced, ". . . the price elasticity of demand for the output . . . is comparatively low. Third, the need for swift effective communication on the part of the producer with customers, suppliers, and even competitors

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*Raymond Vernon, "International Investment and International Trade in the Product Cycle," Quarterly Journal of Economics, Vol. 80, May 1966, pp. 190-207.

is especially high at this stage." These considerations tend to lead to sophisticated technologies being employed first near the advanced economy markets they are aimed at serving.

Regardless of where a sophisticated technology first serves a mass market, ". . . some demand for the product begins almost at once to appear elsewhere." As product standardization occurs, the need for flexibility declines. Vernon says that during this stage in the development of a technology, it is likely to be transferred to other advanced economy countries.

A technology will begin to be transferred to developing countries when its product becomes highly standardized, the production process requires significant inputs of labor, there is a high price elasticity of demand for the product, and the production process need not rely heavily on communication with markets in other countries. Vernon suggests that this will occur despite the overall scarcity of capital in developing countries because international investors do not weigh the full range of possibilities calling for capital, but only a very restricted range of alternatives, such as the possibilities offered for establishing a technology of interest elsewhere. Also, within developing countries capital is often available at very attractive rates for investment in economic sectors which the country has decided to promote. Finally, public international lenders tend to lend foreign currency at near-uniform rates, irrespective of the going rate of interest for such currency in the banks of the borrower's country.

> Accordingly, one may say that from the entrepreneur's viewpoint certain systematic and predictable imperfections of the capital markets may reduce or eliminate the capital shortage handicap which is characteristic of the less developed countries, and, further, that as a result of the reduction or elimination such countries may find themselves in a position to compete effectively in the export of certain standardized capital intensive goods.

This view of the availability of capital for developing country investments seems somewhat counter to Binswanger's view, mentioned earlier, that due to the extreme scarcity of capital relative to labor in LDCs, the entrepreneurs in these countries might evolve labor-intensive technologies, thereby offering cheaper means of developmental growth than those provided by developed countries' capital-intensive methods. Perhaps we are only witnessing a difference in perspective here, but it is one worth being aware of. On the one hand, the nature of the international capital market can help explain the transfer of advanced technologies to developing countries, such as Korea's acquisition of the most recent technological advances in its integrated steel mill.* On the

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*Dahlman and Westphal, op. cit., p. 23.

other hand, once a relatively capital-intensive technology is located within a country where capital is dear in comparison with labor, one often finds that numerous small innovations are incorporated which make the process more labor intensive.*

A final argument of Vernon's product cycle hypothesis is that entrepreneurs are more likely to transfer technology in reaction to threats than to take advantage of opportunities. When one entrepreneur transfers a technology abroad, it threatens the status quo. Other entrepreneurs see their share of the market as being imperiled. Their ability to estimate the production-cost structure of their competitor, ". . . operating far away in an unfamiliar foreign area, is impaired; this is a particularly unsettling state because it conjures up the possibility of a return flow of products . . . and a new source of price competition, based on cost differences of unknown magnitude. The uncertainty can be reduced by emulating the pathfinding investor and by investing in the same area; this may not be an optimizing investment pattern and it may be costly, but it is least disturbing to the status quo."

McGee has disagreed with an aspect of Vernon's hypothesis, saying ". . . the appropriability model suggests that industry age--and not Vernon's product age--is the key to understanding international technology flows." He goes on to say:

> So long as the innovating firms in an industry maintain their technological lead over emulating firms, the industry will remain young and produce new products. When appropriability mechanisms break down . . . emulators in the United States and abroad reduce the profitability of innovations so that the industry's product line shifts to older more standardized products.**

In his classic article on stretching the product cycle,*** Levitt noted that by (1) promoting more frequent usage of the product among current users, (2) developing more varied usage of the product among current users, (3) creating new users for the product by expanding the market, and (4) finding new uses for the basic material through further product development, innovating firms can stretch a "technology cycle" while sales for individual products continue to rise and fall. It seems possible that an innovating firm could remain "young" by both stretching the technology cycle and by developing new technologies. At

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*For example, see: Young W. Rhee and Larry E. Westphal, "A Micro Econometric Investigation of Choice of Technology," Journal of Development Economics, Vol. 4, 1977, pp. 205-238.

**McGee, op. cit., pp. 124-125.

***Theodore Levitt, "Exploit the Product Life Cycle," Harvard Business Review, November-December 1965, pp. 81-94.

the same time, if the firm's marketing and financial officers are as innovative as its engineers, they will also find ways to increase the firm's income by transferring early phases of a technology's cycle abroad for a price.

Vernon noted that ". . . in an area as complex and 'imperfect' as international trade and investment, one ought not anticipate that any hypothesis will have more than a limited explanatory power."* One could just as easily substitute "technology transfer"--or for that matter, "human endeavors"--for "international trade and investment."

Technology Acquisition

The scholars of the transfer of commercial technology discussed so far have focused primarily on factors external to the developing country acquirers. Indeed, until recently, relatively little seems to have been written about the transfer of technology from the perspective of developing country entrepreneurs, technicians, and managers who acquire technology or of the nature of the governmental, legal, scientific, and technological infrastructure needed to support them.

In 1976, Mohammed Brahimi noted that "technological capital is not something that can be passively received by the people of the Third World, it has to be acquired."** More recently, Howard Pack has said ". . . that recipients of technology cannot be passive but must undertake purposive action to increase the ability to identify their needs, to learn about those technologies that might be particularly useful, and, especially, to operate them successfully."*** Still, there have been few analyses of the technology acquisition process in developing countries.

In one such analysis of five cases of technology acquisition in developing countries,**** one of the authors of this study, Ronald P. Black, found that linkages between different levels of technology within

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*Vernon, op. cit., p. 198.

**Mohammed Brahimi, "The Transfer of Technology," El Moudjahid/Economique, February 3, 1976, reported by J. Delorme, "The Changing Legal Framework for Technology Transfer: Some Implications," North/South Technology Transfer: The Adjustments Ahead (Analytical Studies) (Paris: OECD, 1981), p. 90.

***Howard Pack, "Preface," Technology Transfer: New Issues, New Analysis, op. cit., p. 7.

****Ronald P. Black, "Considerations in Selecting Appropriate Technology Projects," Warta: Pengelolaan Penelitian dan Pengembangan, Vol. 1, No. 5, 1980, pp. 18-23.

a country were often important. Allen and Howard have also noted the importance of linkages.*

In the cases Black examined there were examples where a country's scientific and technological infrastructure, represented by an applied research institute, was important in the technology acquisition process. In another case an international research institute played an important role.**

Frances Stewart says there are three "powerful arguments" for developing research and development capabilities in less developed countries.

> First, some technological capacity may be necessary to make efficient use of imported technology. . . . Second, relying on Northern technology may mean relying on increasingly inappropriate technology. . . . Third, there is the belief that technological dependence is a critical part of the generally dependent relationship between North and South; some degree of technological independence is then a necessary condition for achieving a more equal relationship.***

Dahlman and Westphal have speculated that the cumulative sequence of technological changes following the acquisition of a technology in a developing country ". . . may have a greater impact on the productivity of employed resources than that produced by its initial establishment."****

In 1972 the United Nation's Conference on Trade and Development (UNCTAD) Secretariat reported capabilities required to obtain commercial technologies. These were to:

- Conduct feasibility studies, market surveys, and other preinvestment services

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*Allen and Howard, op. cit., p. 71.

**Black, op. cit., pp. 19, 22, and 25.

***Frances Stewart, "Arguments for the Generation of Technology by Less-Developed Countries," Technology Transfer: New Issues, New Analysis, op. cit., p. 101. Much of the literature on scientific and technological infrastructure-building is not conventionally considered a part of the technology transfer literature although the existence of such infrastructure can be critical to efficient transfer and use of technology as Stewart suggests.

****Carl J. Dahlman and Larry E. Westphal, "The Meaning of Technological Mastery in Relation to Transfer of Technology," Technology Transfer: New Issues, New Analysis, op. cit., p. 24.

- Determine the range of technologies available and to chose among them
- Design and engineer industrial processes
- Construct industrial plants and install production equipment
- Train technical and managerial personnel
- Manage and operate production facilities
- Carry out market research and conduct market surveys
- Improve processes and product designs*

Other capabilities that could be included in such a list are the ability to:

- Perceive a venture
- Negotiate with sources of finance
- Negotiate necessary licenses and agreements with government officials
- Negotiate with international sources of technology

When looking at the checklist for the developing country entrepreneur, Black** suggested that international development assistance often fails to provide hoped-for benefits because it seldom encompasses the whole chain of needed capabilities. Advantages gained in one stage through technical assistance are often lost through the inefficiencies of later stages.

Black proposed the establishment of a center staffed with experts who could provide developing country entrepreneurs assistance through the entire process of technology acquisition. He proposed that a systems approach to development assistance for technology transfer offered high potential benefits for the investment, and that developing country technological skills would be most efficiently and effectively developed through on-the-job training.

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*UNCTAD Secretariat, Guidelines for the Study of the Transfer of Technology to Developing Countries (New York: United Nations, 1972), p. 5.

**Ronald P. Black, "Mechanism for the Efficient Transfer of Technology to Developing Countries" (Menlo Park: Stanford Research Institute, 1972).

Dahlman and Westphal also state ". . . mastery of almost all the tasks involved in project execution . . . requires extensive learning by doing. Only for preinvestment feasibility studies does formal education alone suffice to impart the skills required."* Observers with experience in preinvestment feasibility studies suggest that proficiency in this area also is likely through on-the-job training.

Hall and Johnson have described how on-the-job training during co-production of aircraft was an effective method for an acquiring company to obtain technological mastery. They were also able to demonstrate, as perhaps would be expected, that the time required to master a technology is proportional to the gap between the technology being transferred and the most advanced technology previously being produced by the acquirer.**

Appropriate Technology

A concern of the developing country acquirer of technology must be how well the acquired technology fits his or her needs. A body of literature has been produced which considers the appropriateness of technologies although the question of appropriateness is often examined from the perspective of society rather than that of the acquirer. This body of literature was initiated under the rubric of "intermediate technology."

Intermediate technology was rather precisely defined by E.F. Schumacher in terms of the cost of creating a "job place."*** Critics perceived that technology with low cost per job place may not always be the most appropriate, as it may not be economically viable in a given developing country situation. It may require demeaning labor, it may put women out of work, and it was even declared to be a developed country ploy to maintain technological superiority.

A later term, "appropriate technology," also presented problems: Appropriate for whom? Most developing country technologies are appropriate to someone. If they were not, they would not exist. Appropriate when? A technology appropriate for Korea in 1960 may not be appropriate for that country in 1980. Appropriate where? A technology appropriate

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*Carl J. Dahlman and Larry E. Westphal, "The Meaning of Technological Mastery in Relation to Transfer of Technology," Technology Transfer: New Issues, New Analysis, special editors Alan W. Heston and Howard Pack, op. cit., p. 18.

**G.R. Hall and R.E. Johnson, op. cit.

***E.F. Schumacher, Small is Beautiful: Economics as if People Mattered (New York: Harper and Row, 1973), p. 169.

today in Taiwan may not be appropriate today in Indonesia, or in Nigeria or Peru.

U.S. Representative Clarence Long popularized the term "capital saving technology" and defined it similarly to Schumacher's intermediate technology. Richard Stanley, formerly with the Arusha Appropriate Technology Project, speaks of technology which is "applicable and tenable."

Two rationales underlie the appropriate technology movement. First, simple mathematics will demonstrate that there is insufficient capital available within the developing countries to employ their growing populations if job places cost as much to create there as they do in the industrialized countries.*

Second, most of the commercial technologies employed today in developing countries are classified as mature industries, which for the most part were developed decades ago for environments with different relative costs of labor to capital investment. Beyond this, science and engineering have evolved from where they were when today's mature technologies were originated. Conceptually, if these industries were redesigned with today's science and engineering for an environment with different economic parameters, they would be different from those which exist today.

The first rationale mentioned for motivating the AT movement, i.e., lack of availability of investment capital to employ everyone with expensive job places, is a mathematical fact. Unless the New International Economic Order has successes beyond even those hoped for by its most ardent supporters, this will also be a fact tomorrow.

One alternative to having a thousand shoeshine persons for each industry executive is to find more labor-intensive processes for everything from building roads to running cement plants.

As McGee has pointed out, the multinational corporations with their high concentrations of technical expertise have little incentive for re-engineering mature industries with state-of-the-art technical expertise for developing country factor endowments.** Vernon has

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*For example, see Howard Pack, "Appropriate Industrial Technology: Benefits and Obstacles," Technology Transfer: New Issues, New Analysis, op. cit., pp. 27-40. As Vernon pointed out in his product cycle hypothesis, however, capital for attractive ventures is often obtainable from international sources regardless of the capital intensiveness of the venture. Such capital is not drawn from the developing country's "pot."

**McGee, op. cit., p. 124.

explained why MNCs will transfer mature technologies producing standardized products.* And there is evidence that the MNCs will to some degree adapt these mature technologies to take advantage of differences in local factor costs.**

It is unlikely that in developing countries one would find state-of-the-art technical capability to totally re-engineer technologies to new factor proportions. It is feasible, however, to assemble technical capability which can understand mature technological processes and adapt them to local conditions. For example, the Korea Advanced Institute of Science and Technology (KAIST), by understanding process technologies, has been able to assist local industry in negotiation for technologies, with resulting reductions in fees originally sought for the technologies. Many examples exist of local firms adapting imported technologies so that they were more efficient.*** In fact, this ability to adapt may be the sine qua non of successful technology acquisition.

As noted earlier in this review, the appropriate technology movement appears to be plateauing. Some adherents went beyond engineering and economic arguments and developed an AT philosophy. The philosophy stressed self-help, local initiative and control, and resource conserving, labor-intensive technologies, and the application of appropriate technology seemed at times to have acquired a value in and of itself. Is it possible the fervor with which some have advocated AT has resulted in discrediting the concept somewhat despite the valid underlying economic and engineering reasons for considering the appropriateness of any technology applied to meet economic and social objectives?

Developing Country Technology Transfer Policies

Developing countries have written laws and policies to assist in the acquisition of technology, and a large segment of the literature on the transfer of commercial technology is devoted to these policies. Some policies are oriented toward stimulating the development of local industries; others are more concerned with increasing the bargaining power of host countries when dealing with foreign suppliers of technology.

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*Vernon, op. cit., p. 203.

**Howard Pack, "Appropriate Industrial Technology: Benefits and Obstacles," Technology Transfer: New Issues, New Analysis, op. cit., p. 34.

***For examples of some, see Stewart, op. cit., p. 102.

A recent study by E.M. Graham* has examined laws and policies aimed at reducing costs and increasing benefits to the local economy when technologies are imported. Representative of these are the Andean Common Market (ANCOM) regulations which apply to foreign firms operating in or selling technology to these nations. This genre of rules and regulations to be administered by government bureaucracies is often associated with Latin American countries although it is also used in other countries such as India and the Philippines.

Graham postulates criteria for evaluating the success of these governmental interventions:

- Has the intervention significantly reduced direct and indirect costs of imported technology?
- Has it significantly reduced the willingness of suppliers to transfer needed technologies to these nations?
- Has governmental intervention resulted in the importation of more appropriate technologies?
- Have local research and development activities been stimulated as a result of the intervention?

While Graham summarized that ". . . the basis for drawing firm conclusions does not exist," in most of the individual cases that he examined he raised significant doubt about the value to date of the efforts at intervention by host nations.

Gustav Ranis** and others have made the following argument:

> As a country begins its development process, it undoubtedly must, to a great extent, look inward. This is partially the result of a need to protect the beginning entrepreneurs and give them a chance to develop their skills. It also results from the need to encourage saving to create investment capital rather than having this frittered away on consumer goods from more advanced countries.
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> To fuel the development process, however, a nation needs foreign exchange currencies to buy raw materials and capital

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*E.M. Graham, "The Terms of Transfer of Technology to the Developing Nations: A Survey of the Major Issues," North/South, op. cit., pp. 55-83.

**Ranis has made this argument on numerous occasions. For example, see Gustav Ranis, "Technology Choice and the Distribution of Income," Technology Transfer: New Issues, New Analysis, op. cit., pp. 41-53.

goods for its further development. There will not be sufficient of these available from grants and soft loans from more advanced countries and international finance organizations. Therefore, at some point, a country is forced to take the plunge into the world economy to generate funds based on exports to quicken the pace of its development. But it is not only for the purpose of such funds that this should be done. Without doing so, entrepreneurs will not have the competition they need to further develop their capabilities. There will be little incentive for product improvements in the national economy unless competing products have at least some access.*

It is in this stage that there begins to be a pay-off on the investment in industrial research institutes. As entrepreneurs cut costs, to integrate local materials into their products and processes, and to improve them, they have for the first time a need for the services of a research institute.**

Ranis suggests that if governments shift to export-oriented policies, where their control over scarce inputs such as foreign exchange and credit is diminished, their role becomes catalytic rather than interventionist. Taiwan and Korea are often held up as examples of countries having catalytic policies. He argues that a catalytic policy rather than a directly interventionist one ". . . materially improves the chances that millions of dispersed decision-makers in both sectors of the economy will be motivated to search for more appropriate technological choices." Such policies are much more likely to lead to more equitable distributions of income.***

By contrast, Simon Teitel has written that:

> . . . the initial export orientation of the Asian semi-industrialized economies, while predicated on cost and quality competition in selected product lines, may have been undertaken from a not sufficiently broad industrial base--compared with the Latin American countries, or India, which favored import substitution strategies--and more critical yet, without the background support of a sufficiently large stock of experienced engineers and technicians to perform the R&D activities demanded for adaptation of technologies across a broad industrial spectrum.

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*Ronald P. Black, "Considerations in Selecting Appropriate Technology Projects," op. cit., pp. 23-24.

**Ibid., p. 24.

***Ranis, "Technology Choice . . .," op. cit., p. 52.

It is suggested that this situation will present the Asian countries significant problems in the future.*

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*Simon Teitel, "Creation of Technology within Latin America," Technology Transfer: New Issues, New Analysis, op. cit., p. 149.

TRENDS IN OTHER AREAS OF DEVELOPMENT LITERATURE DEALING WITH TECHNOLOGY TRANSFER

In addition to the subject areas previously mentioned, the authors felt that areas in development literature most relevant to AID and its mandate should also be examined for the purposes of this study. We found, with the exception of agriculture, the technology transfer literature to be sparse in these fields.

Health

Health technology transfer literature concentrates on three major areas: family planning technologies, the use of technology to improve the physical environment (sanitation and water systems), and on primary health care and disease eradication. The term technology includes the use of new medical and engineering devices and improvements as well as the transfer of knowledge in the utilization of such devices and improved medical and engineering practices to enhance the overall health conditions of the poor in developing countries.

Striking examples of technology transfer have occurred in fertility control, where contraceptive technologies, family planning expertise, and information campaign strategies have been transferred. A recent study by the Office of Technology Assessment (OTA) considers the probable impacts of specific fertility planning technologies on population growth.*

One of the report's findings is that fertility is declining in most LDCs, but population growth is continuing at high levels because of the momentum initiated by the high birth rates and rapidly falling infant mortality rates of the recent past. The decline in fertility is associated with technology transfer: provision of a broad range of contraceptive methods, population and family planning information, education, and communications efforts that effectively reach all sectors of the population.**

While the use of fertility planning technologies can and does substantially lower birth rates, their availability and acceptability

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*Office of Technology Assessment, World Population and Fertility Planning Technologies, The Next 20 Years (Washington: OTA, 1982).

**Ibid., p. 8-9. See also such works as The Futures Group, The Impacts of Population Growth on LDCs, report prepared for OTA, Washington, D.C., 1980; and P. Demeny, "The N-S Income Gap: A Demographic Perspective," Population and Development Review, Vol. 7, No. 2, June 1981, pp. 297-310.

vary. Technology transfer lessons learned include the observation that delivery systems may be inadequate or culturally inappropriate, thus making family planning services effectively unavailable. Contraceptive methods used may not be the ones preferred, but the ones available. Without adequate follow-up or planning, people may become dissatisfied and discontinue available methods because of side effects, the need for repeated application, costs, contraceptive failure, and concerns about long-term safety.

Empirical evidence has suggested the importance of providing contraceptive technologies appropriate for local conditions so that individuals have access to at least one method that meets current needs. It is useful to introduce continually improved and new technologies which enhance family planning effectiveness and efficiency by reducing side effects, permitting easier administration, and simplifying delivery system requirements. Sensitivity to and knowledge of the role of sociocultural factors that motivate people to adopt family planning is critical. Multifaceted programs that address social, economic, and health needs along with delivery of family planning services are those most likely to be successful.* These lessons learned in the field, provide insight into more effective technology transfer generally.

As LDC needs became more clear, the direction of fertility control programs changed with greater concentration on rural populations, heavier reliance on private sector delivery systems, increased integration with other components of health care, and decentralized approaches to meeting community needs.

In fertility control, major developed country technology transfer policy issues have centered on governments' key role in support of reproductive and contraceptive R&D and on regulations of the drug and medical devices industries. Much of the concern has related to the desire to diffuse technologies to countries that may have different risks or perceptions of risks.

The literature on water supply, sanitation, and waste disposal systems in developing countries, acknowledges substantial possibilities for improvement of conditions through the transfer of technology. Recently, the work of the World Bank and AID in codifying the technological and socioeconomic requirements for adequate water supplies and sanitation has embodied recognition of both the transfer problems and the local control, maintenance, and support requirements.

Education and Communication

The areas of educational literature of importance to technology transfer include the development of higher education, training of

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*Ibid., p. 15-16.

professionals, vocational and technician training, and the flow of information. Technology transfer issues of importance include: (1) the role of the universities in development and the ability of developing countries to absorb technical expertise; (2) the problems that developing country universities, research institutes, and libraries face as a result of the rapid transfer of advanced technology and the adoption of curricula and research agendas of developed countries; and (3) the role and influence of the gatekeeper and the importance of person-to-person communication networks in the international transfer of technology and technological information.*

Construction and Building Materials

As population expands and development occurs, the construction and building materials industries have assumed greater importance in developing countries. For the modern subsector, technologies used in developed countries can be appropriate: Witness the growth of urban high rises in LDC capitals. However, in rural and urban fringe areas, production on a small scale and with a lower degree of mechanization is more appropriate. Studies on the transfer of building technology have indicated the importance of the development of the manufacture and use of local materials and of industrial and agricultural wastes.**

The literature has directed attention to the choice and transfer of technologies more appropriate to the promotion of economic development and the welfare of local people. Some of the problems with utilizing appropriate technology in the construction industry are exemplified by the official shelter provision standards for developing countries. Criticisms of standards that govern the transfer of technology used in construction have included: (1) indifference to local experience, (2) lack of reference to the local resource situations, (3) irrelevance to local culture, (4) urban bias, and (5) the lack of relation to the local economy.***

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*See, for example, K.N. Rao, Collaboration in Science and Technology. An Inter-American Perspective, IIE Report No. 4 (New York: Institute of International Education, 1975); Michael Z. Sincoff and Jarir S. Dajani, "The Role of University Faculty in the Transfer of Technological Information," paper presented at the annual meeting of the National Conference of the American Society for Public Administration, Washington, D.C., April 1976; and T.J. Allen, et al., Technology Transfer to Developing Countries: The International Technological Gatekeeper (Cambridge: MIT, 1971).

**Appropriate Technology in the Construction and Building Materials Industry (Budapest: UNIDO, 1978).

***SCOPE, Shelter Provision in Developing Countries (John Wiley & Sons, 1978).

The Housing Investment Guaranty Program of USAID, as the principal means by which the U.S. provides shelter assistance to developing countries, has introduced low-cost shelter approaches (e.g., core housing, sites and services, low-cost units, and squatter upgrading projects). Since 1973, AID has made progress in bringing the program under the "new directions" emphasis of the Congress on aid to the poor majority. However, these approaches require time to demonstrate success and be endorsed and repeated by developing countries.* Thus, it is difficult at this point to assess the relative effectiveness of such transfers.

Private Voluntary Organizations

For several decades the work of PVOs has been important to the U.S. Government's development assistance program and PVOs serve as a vehicle of technology transfer to LDCs. Initially characterized by its humanitarian and relief focus, the work by PVOs now is concentrated on economic and social development.

With some exceptions, private voluntary organizations describe themselves as being good at reaching the poor, as using participatory processes of project implementation, as being innovative and experimental, and as carrying out their projects at low cost. Although these claims have been disputed by some analysts,** it is recognized that PVOs do provide development assistance distinctive from that provided by public agencies.

With regard to technology transfer, the PVOs have been quick to support the need for more appropriate technology and local participation in choice and use of technology. A variety of organizations have provided directories, manuals, and guidebooks on appropriate or low-cost technologies and systems. PVOs tend to stress the promotion of self-reliance and self-help technologies which recipients can use to their own advantage without reliance upon outside assistance for use and maintenance.

Both scholars and the Congress have concluded that PVOs have been constructive in providing improved access to alternative technologies through the person-to-person communication networks, and publication of directories, manuals, and reports. The proliferation of PVO materials and activities have in many cases led directly to effective technology transfer or improved use of more appropriate technologies in many local situations.

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*AID's Housing Investment Guaranty Program (Washington: U.S. Government Printing Office, 1978).

**See, for example, Turning PVOs into Development Agencies: Questions for Evaluation, AID Program Evaluation Discussion Paper No. 12, April 1982.

Agriculture

A review of the technology transfer comments provided by rural sociologists and agricultural extension agents regarding the adoption of new and improved farm practices indicates that a great deal of attention has been paid to communication variables and to personal and social characteristics of the farmer. However, psychological factors, the farm organization, community norms, and institutional factors have almost been ignored.*

It has been proposed that agricultural economists and rural sociologists be involved in choosing innovations recommended to farmers, and most importantly, farmers be involved in the selection of innovation to be introduced to farmers.

It has also been suggested that some of the failures in technology transfer and attempts to improve farming systems in the Middle East and North Africa may be related to problems in communication between expert and farmer, with the role of the farmers being underestimated in the transfer process.**

Other lessons learned from agricultural technology transfer include the following:***

- Technologies introduced have tended to accrue more benefits to those who owned land, had access to power, etc., thereby widening the gap between economic groups.

- From an evaluation of the applicability of green revolution technology, there is a growing awareness that its appropriateness depends upon the farming area's natural resource base, available inputs, and agricultural prices.

In evaluating the experience in agricultural technology transfer, new trends in transfer are noted.**** These include:

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*See, for example, Erasmus D. Monu, "An Appraisal of the Contribution of Rural Sociological and Agricultural Extension Research to the Transfer of Technology to Small-Scale Farmers in Niger," paper presented at the Rural Sociological Society meetings , Ithaca, New York, August 19-23, 1980.

**Brian and Lynne Chatterton, "Failures in Technology Transfer," Food Policy, May 1982, pp. 141-155.

***AID Experience in Agricultural Research: A Review of Project Evaluation (Washington: USAID, 1982).

****Ibid.

- The need for improved communication between farmers, researchers, and extension agents

- The need for a longer duration of time in assessing results from projects (e.g., to avoid expecting too much too soon from projects in terms of institutional strengthening and the generation of practical research results)

According to Ruttan, the picture that emerges from a review of the evidence on the initial impact of the green revolution can be summarized as follows:*

> A technology that is essentially neutral with respect to scale has been introduced into environments in which the economic, social, and political institutions have varied widely with respect to their neutrality. In the words of Wolf Ladejinsky, when all is said and done, it is not the fault of the new technology that the credit service doesn't serve those for whom it was originally intended; that the extension service is not living up to expectations. . . ."**

Where the technology has been introduced in areas characterized by a reasonable degree of equity in the distribution of resources, the effect has been favorable both in terms of productivity and equity. When the technology has been introduced in areas characterized by great inequality in the distribution of resources, the productivity impact has been weak and the pattern of inequity has been reinforced. The differential impact of the technology on income growth has apparently been greater among regions than among social classes within regions. Our point in delivering this selected evidence from the agricultural literature is to lend credence to one of our principal observations, that effective technology transfer is as much a function of the human factors as the technological elements.

AID Evaluations

The impact of the AID evaluation literature on technology transfer is difficult to assess because of its newness and the uncertainty in the audience and users of the material. Because the evaluations do not appear in the traditional economic references used in development literature, it is also difficult to assess its impact on scholars. However,

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*Vernon W. Ruttan, "The Green Revolution: Seven Generalizations," International Development Review, Vol. XIX, No. 4, 1977, pp. 16-23.

**Wolf Ladejinsky, "The Green Revolution in the Punjab: A Field Trip," Economic and Political Weekly, Vol. 4, June 28, 1969, pp. A73-A83.

we speculate that the AID evaluation reports will be of increasing importance to development professionals and practitioners in the technology transfer process.

THE TECHNOLOGY TRANSFER COMPONENT OF SELECTED AID PROJECTS, POLICY DECLARATIONS, AND EVALUATION DOCUMENTATION

As part of this review PPC asked us to discover what AID has been and is now telling itself about technology transfer. We have approached this part of the task by reading policy documents, reviewing the "lessons learned" sections of evaluation documents, talking to AID staff, and reading the work of selected external project evaluators.

Much of the actual technology transfer funded by AID takes place in the context of projects where technology transfer is either ancillary or implicit, a sub-goal, or a peripheral bonus. In other projects, where the technology transfer component is well recognized, it may still be subsidiary, but being recognized, it is subject to analysis and post-project evaluation as a sub-set of the project. In a very few cases, technology transfer is the raison d'etre of the project.

We have not attempted to quantify this hierarchy of AID technology transfer involvement. Depending on how one defines technology transfer and what one perceives as the first and second order goals of any project, it would probably be possible to derive any desired array of figures in such an exercise. Rather more to the point, in our view, is an understanding that the technology transfer component is likely to be present in a very substantial fraction of AID projects and as such it can be the subject of policies for the expenditure of project funds. This being the case, it is appropriate for AID to ask itself whether centrally directed policy can assist a project officer in managing technology transfer.

Some Historical Perspectives

A good 30 years ago President Eisenhower offered the developing world a form of technology transfer that seemed at the time too good to be true, "Atoms for Peace." This was a substantial project designed to transfer technology for cheap electric power. Coupled with a parallel program of bilateral agreements to implant nuclear reactors in developing countries with a view to acceleration of development. Some experimental reactors were built, substantial libraries were shipped to developing country recipients, and nuclear engineers were trained. Some use was made of radioisotopes for medical and occasionally industrial use, and the projects eventually fell into disuse as a result of fears about proliferation and the concerns of Congress for U.S. technological give-aways.

As time passed and both the developing and developed worlds became more sophisticated, we collectively went through phases of "applying science and technology to development." In the late 1950s we tried to build the faculties of developing country universities. Training in engineering, medicine, and all sorts of agricultural, fisheries, and

other technical curriculums were bolstered by expatriate teachers and funded by AID and the major foundations. By 1963 the United Nations held its first Conference on Science and Technology for Development (with about the same relative degree of success as the latest version in 1979), and we moved through the decade of enthusiasm for vocational education and such exotic programs as technical books and journals for developing country university libraries.

These examples are selected for their variety, not their comprehensiveness. The goals of U.S. foreign aid from the beginning have encompassed massive amounts of technology transfer--among the vast array of other objectives--and the dedication of those who envisaged and designed each project or program is neither questioned nor held to account in retrospect. Development, and technology transfer as one of its many components, are among the most difficult of undertakings, especially if the participants are in a hurry as it seems they must be.

The point of delivering even this truncated historical note is that today's policies must be construed against the backdrop of the past and in the light of the experience of people who have lived and recorded that past. A similar observation can be made looking at AID from the viewpoint of the institutional historian. Because the agency has a history of shifting priorities and philosophies, and because it is characteristic to move personnel from field to Washington and back with two- to four-year frequencies, there is a tendency to forget the historical backdrop against which current events are played and projects funded. To some extent this organizational amnesia is reciprocated by host countries where coups, elections, upward mobility of educated and ambitious people, as well as the lures of international agencies, diplomacy, and global trade result in human migration.

Without trying to enumerate or illustrate in great detail AID's past policy vis-à-vis technology transfer, it is possible to step back ten years and view the agency's mission through the eyes of its then director, John Hannah. In January 1973, PD-51 was issued as a "Guidance Statement on Selected Aspects of Science and Technology." Excerpts follow:

> Experience has demonstrated that comparatively little U.S. technology can be transferred to LDCs without significant adaptation. . . . The problem of technological choice is growing in significance as unemployment and urbanization increase in the developing countries. . . . As these shifts proceed, the need for policies and technologies which increase productive employment in the urban industrial and service sectors as well as in the rural sector will grow.
>
> While selection of technologies is largely a matter for private entrepreneurs, LDC technological institutions can

play an important role through their influence on macro-economic policies of the Government, advice to entrepreneurs on availability of alternative technologies, and supporting services to industry. Included in these services is the network of industrial research, extension, and standards institutes throughout the LDCs. Generally, AID will sponsor collaboration between U.S. and LDC technological institutes that work with private industry. Particular attention will be paid to stimulating commercially viable small-scale industry, which tends to use more labor and less capital per unit of output.

In 1975 the AID Handbook declared:

> AID will continue to stress the importance of science and technology transfers in support of development. . . . It is AID policy to help LDCs generally to:
>
> 1) Develop national policies and institutions which permit them to make and implement effectively better technological choices. . .
>
> 2) Improve their capabilities to assess the location, nature, and magnitude of their natural resources. . .
>
> 3) Increase the cost effectiveness of their public expenditures for such economic infrastructure as energy, transportation, communications, and housing so as to free public funds for other LDC development needs.

In 1978 Representative Clarence Long defined "light capital technology" for AID inter alia, and stipulated:

> A useful approximation of light capital technology is $100 per worker employed. The $100 figure is intended to be an order of magnitude, rather than a precise figure. . . . Even a cost of $100 per worker would mean that $100 billion would be required to finance the employment and increased production of the world's one billion working poor--a far larger sum of money than would be available for economic development even over a number of years.

Critics of AID assert (whether rightly or not we cannot determine) that the $100 figure and the "New Directions" initiated by the Congress resulted in unfortunate discontinuities in AID policies and programmatic activity. It is alleged that Congress was overly enthusiastic about its policy guidance and that AID overreacted in response. In any event, two recent reports to the Congress, on "Delivery Mechanisms--Capital Saving Technology" (March 1981) and the "Progress Report on Capital Saving Technology" (July 1981), set matters straight, explaining in substantive detail the difficulties of promoting and delivering capital saving technology, and by describing the way AID was adjusting

its sights to Congressionally imposed policies and to the realities of relatively decreased funding.

Some of the evidence presented in these two reports follows because it is as clear an explanation of 1982 policy and strategy for technology transfer as our literature search has encountered. From the report on delivery mechanisms:

> The Committee [on Appropriations] asked AID to prepare a report on how a program strengthening the delivery of capital saving technology could be developed. AID's report, which emphasizes the potential role of U.S. small business firms, is organized according to three principal kinds of capital saving technology delivery mechanisms which are now in use. They are:
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> 1. Public sector or administrative systems which usually serve either small-scale farmers or small-scale businessmen;
>
> 2. Delivery mechanisms based on the work of private and voluntary organizations (PVOs), either U.S. or indigenous; and
>
> 3. The commercial market, whether involving U.S. or indigenous firms. . . .
>
> AID has been actively involved in promoting public sector delivery systems for decades. . . .
>
> To be effective, an extension system must be part of a larger effort involving research and education as well as extension itself. It must be concerned with the delivery of a suitable and profitable technology and it must be staffed by competent extension agents. Participation by beneficiaries also is an essential feature of an effective extension system. Participation usually consists of two elements: (1) prior consultation with beneficiaries regarding their perceived needs and problems, and (2) feedback to all parts of the system regarding beneficiary experience with the new technologies. . . .

From the progress report:

> All AID projects which involve the delivery of capital saving technology must be particularly sensitive to the means by which commercial markets can be encouraged to take over the function of delivering that technology to prospective users. A policy environment which offers appropriate price incentives remains the single most important requirement. . . .
>
> AID's experience with capital saving hardware has taught that, with few fortuitous exceptions, the process of creating, adapting and disseminating tools, machinery and equipment for widespread use in developing countries is both difficult and costly. A

sustained and enlightened effort is required, one based on highly interactive systems involving the prospective users, the manufacturers, the designers and all the other people and institutions required for effective dissemination of appropriate hardware. Few of the thousands of pieces of hardware "designed for development" have been, or could be, put through this complex process successfully. . . .

The concept of capital saving technology depends crucially on both the ability and the willingness of decision makers to make selections among alternative technologies. Multiple technologies must exist and must be available. Clearly, the process by which one among several alternative technologies is selected depends on the exercise of will. Political, social, cultural, environmental and economic factors all influence the decision maker in exercising the will to choose. The choice may be "wrong" by some standards; in any event, the existence of a choice suggests that suitable policies can be devised to influence the selection of desirable, and capital saving, technologies.

The academic literature analyzing the choice of technology has explored at least three different sets of non-price forces which can bias the selection of an available technology in significant ways. First, the literature on the political economy of technology choice notes that the "modern" sector, in which capital intensive technologies are prevalent, often represents the interests of the political elite. The international relationships binding these elites to the industrialized nations further reinforce a bias favoring the selection of capital intensive technology. Second, the literature on the "modernizing" influence of engineers suggests that sophisticated machinery and high quality final products often are ends in themselves. The influence of the "engineering man" bias is especially pronounced in monopolistic or oligopolistic markets. Third, the literature on the role of donor agencies suggests that considerations of importance to the donor may bias technology choice against more suitable capital saving alternatives.

AID's portfolio of research activities on the analysis of technology choice is tightly constrained, as is AID's entire research effort, by severe financial limitations. The research which does exist usually is closely linked to AID's project activities.

Central to AID's interests in technology choice is the policy framework in which that choice is made. There are two different kinds of policy involved in technology choice. They are (1) developing country macroeconomic policy, by which the economy is broadly directed; and (2) sector level policy, by which particular sectors are directed.

In general, AID does not have much influence on the macroeconomic policy decisions of most developing countries. . . .

AID has been quite successful in pursuing particular development policy view on the sectoral level. . . .

The choice of technology at the level of the firm is based in part on the existence of suitable delivery mechanisms. The most efficient for most kinds of transactions is the market system; other delivery mechanisms include governmental allocation systems, such as agricultural extension systems, and those private allocation systems which do not rely on the profit motive as a driving force. . . . But all delivery systems presume that a decision is being made to adopt a single selection from a range of equally well-known alternatives. That presumption usually is incorrect on at least two accounts. First, the range of alternatives is highly limited, particularly on the end of the range dealing with capital saving technologies. Second, it is often more difficult for potential users of capital saving technology to learn much about less well-known and often capital saving technologies.

Current AID Policy Guidance

In May 1982 AID began issuing a series of papers designed to articulate agency policy in key areas. One of the most significant papers with respect to technology transfer is on "Food and Agricultural Development." That topic, as we have pointed out, is not strictly within the purview of this study; however, the institutional style and pace set by AID attention to food and agriculture is such that a brief summary of those portions directly related to technology transfer seems in order.

Beginning with a reiteration of the basic AID mission:

The overall objective of the United States bilateral economic assistance is to stimulate in developing countries broadly based, self-sustaining economic growth that promotes international peace and stability and that assists people to conquer poverty, hunger, illness and ignorance.

The report states:

A main thrust of the policy is on the development of a domestic human and institutional capacity that permits a country to develop and apply food and agricultural science and technology. This recognizes the location-specific requirements for the effective application of improved agricultural technology. However, the policy also requires a more vigorous effort by AID to support the identification, transfer and adaptation of existing appropriate technologies, as well as the carrying out of food and agricultural research and application of improved technologies through U.S., international, regional and national institutions.

AID will therefore give special emphasis with a sufficiently long-term commitment to helping countries develop the institutional capacity for food and agricultural planning and policy analysis; basic and adaptive research, education and training; and disseminating improved technology and related information in a cost-effective manner.

AID will develop mechanisms and processes to facilitate the involvement of the U.S. private business community in food and agricultural development, including technical assistance and training as well as direct and joint investment.

The AID policy paper on "Domestic Water and Sanitation" approaches technology transfer more along the conventional lines of broad technical assistance.

Among the factors that will guide the design of AID-supported domestic water and sanitation projects designed to improve health are the following:

-- selection of a technology that can be maintained and operated easily and is acceptable within the local culture;

-- training of community level workers and of personnel at the regional and national level in the maintenance, operation and repair of water supply and sanitation systems;

-- technical assistance or training, as required, to improve the administration of water supply and sanitation systems.

In the selection of technologies for water supply and sanitation programs, planners should also pay attention to "software" components. These might include training, technical assistance, the development of host country institutions, hygiene education, the promotion of community participation, the support of complementary nutrition and health activities, and the development of national and regional water and sanitation policies and plans. AID does not and should not support water supply and sanitation programs where these essential software elements have not been adequately considered in the design of the project.

On the selection of a suitable technology, the paper continues:

Experience in many developing countries has shown that the selection and adaptation of technologies suitable to the local setting is crucial in finding a balance among desirable characteristics of water and sanitation systems: convenience, reliability, costs and, in water systems, quantity and quality. There is some evidence that utilizing LDC private sector enterprise for the manufacture and installation of water and sanitation systems is not only cost-effective, but also stimulates the private sector and promotes employment.

There are now a large number of alternatives to Western-style water and sanitation systems, including pit latrines and water-sealed latrines (pour-flush commodes). Selection of a suitable technology should take into consideration local preferences as well as social and cultural factors, the repair and maintenance support systems, availability of labor and management, appropriate institutional structures, the level of investment and recurrent cost implied, and the willingness and ability of beneficiaries to cover the expected costs. Although the selection process is not an easy one, the factors discussed in this section should serve as a guide.

The local manufacture of parts and equipment can significantly ease the operation and repair of the system, and often with substantial cost savings.

The Agency's guidelines for the promotion of appropriate technologies for water and sanitation projects include the following:

-- AID-supported water supply and sanitation programs should encourage LDCs to use efficient technologies that can be maintained and operated easily and are acceptable within the local culture.

-- AID should investigate the potential of private firms in LDCs to develop and operate efficient water and sanitation systems.

-- AID should stimulate local manufacture and field testing of simple equipment. In specific instances (where local capacity is not adequate or where a small market is involved), manufacture on a regional level may be preferable.

-- Instead of introducing a new system, AID should support the improvement of traditional systems, where local preferences or cost considerations indicate system upgrading is the most desirable approach.

-- AID recognizes that success of water and sanitation programs depends in large measure on the ability and commitment of people to use, operate, and maintain the system properly. Thus, AID should also support programs to train maintenance and other personnel and to educate current and potential users of the services.

-- AID should promote standardization of water and sanitation equipment and parts, even while seeking technologies in which hardware can be produced efficiently on a small scale. AID's efforts to eliminate wastage and maintenance failure currently caused by a proliferation of mechanical designs and specifications will necessitate closer coordination among donors and local private investors, and may on occasion require a procurement waiver.

The policy paper on private and voluntary organizations, while stating that overseas programs of PVOs will absorb over $600 million of AID-administered resources in FY 1983, is silent on the substance of PVO activity and the guidelines by which such activity will be influenced and assessed. This appears, inter alia, to be possible tacit admissions that (1) PVOs, because they are private and voluntary, are regarded as intrinsically exempt from AID direct control; (2) that PVOs accomplish their self-directed missions with sufficient skill and integrity to obviate need for further government direction; and (3) that PVOs may have sufficient domestic political influence by virtue of their constituencies, their purposes, or their singular appeal, that increasing direction could be regarded as counterproductive.

In the March 1981 report to the Congress on "Delivery of Capital Saving Technology" noted above, considerable attention was devoted to enhancement of the PVO delivery mode because a significant fraction of AID-sponsored technology transfer is in fact the delegated responsibility of the PVOs. The further articulation of technology transfer policy as it applies specifically to PVOs may not be needed or desirable (especially after the Agency-wide technology transfer policy paper is issued); however, AID may consider whether a synthesis of the technology transfer methods and knowledge accumulated by the PVOs and an appreciation of its subtleties might prove useful to host country and donor agency managers of larger and more visible projects.

The watchword of current AID policy is private enterprise. Thus it seems fitting that AID has two policy papers on this topic. Agency-wide policy is stipulated in the paper entitled "Private Enterprise Development," and it includes a lengthy rationale for the premises upon which the policy is based:

> This policy paper is based on the premise that greater reliance on private enterprise in third world development is essential to the effective and efficient achievement of AID's central objective. AID's central objective is to assist recipient countries meet the basic human needs of their poor majorities through sustained, broadly based economic growth.

The paper also relates AID's four new strategic emphases:

> A renewed emphasis on private enterprise for development, as directed by the President, is directly responsive to AID's four new strategic emphases: (1) economic policy reform; (2) institutional and human resource development; (3) private sector initiatives; and (4) technology development and transfer. For private enterprise to flourish there needs to be: . . .
>
> - a constant stream of new technologies that leads to both increased productivity and increased employment. . . .
>
> Private enterprise is by far the largest source and repository of new technology, particularly for industry. However, virtually

all new technology is produced by and for the already industrialized countries. Many of these technological innovations are appropriate to business conditions in developing countries, but many more are not. Firms in developing countries often lack the capacity to enable them to choose or adapt the best technology from a range of available options or lack the ability to generate a continuing stream of innovations on their own. Section 601 of the FAA states that it is the policy of the United States to encourage the efforts of other countries ". . . to improve the technical efficiency of their industry, agriculture, and commerce. . . ." Section III below offers some recommendations for expanding the role of private enterprise in the transfer and application of new technology.

Finally the paper discusses a number of means by which technology transfer may be accomplished:

> Clearly, the transfer of modern, productive, and appropriate technology to LDCs is vitally important. The U.S. is the major producer of new technologies; most of these new technologies are developed by U.S. private enterprises. The topic of technology transfer is a subject for a separate policy paper. What follows is a partial listing of the ways in which AID can facilitate the creation, transfer, adaptation, dissemination, and use of technologies that will raise the productivities of LDC workers, reduce costs to consumers, and make investments more profitable. . . .
>
> A number of activities involving both private and public institutions appear promising:
>
> Businesses, consumers and other users of technology need to be able to assess correctly the value of technologies that are available; missions may consider support for the establishment or strengthening of institutional capacity for technology assessment. Private sector approaches are preferred and to be encouraged in this area. Some effective public institutions, such as the Korean Institute of Science and Technology (KIST), have had strong ties to private enterprise, and have been run largely on a fee or contract basis.
>
> - New technologies must be developed, technologies that can be adapted to the conditions in which they are used; missions may consider supporting research and development institutions in selected fields. Again, private institutions should be encouraged.
>
> - Demonstration programs which stimulate the dissemination of technologies by identifying market demand may warrant support.
>
> - Increased subcontracting and cottage industry approaches can expand productive employment, increase efficiency, and encourage

technology transfer; missions may wish to support projects that incorporate these approaches.

- U.S. business firms increasingly are involved in selling unbundled technologies through licensing arrangements, royalty fees, or management contracts. Many older technologies have a market value in the LDCs. New marketing channels are emerging. In the U.S., rapidly growing numbers of "technology middlemen" are establishing businesses which bring together potential buyers and sellers of technology, particularly involving small- and medium-scale firms. Even relatively large firms may cooperate with each other to form their own technology sales business. An example is the non-profit British Technology Transfer Group, established by 10 British companies. This non-profit group was able to establish useful contacts in developing countries; the individual companies, not readily recognized outside Great Britain, had not been able to do so. AID could stimulate the establishment of similar private technology transactions organizations for U.S. corporations.

- AID also could stimulate increased collaborative arrangements between U.S. and local professional (e.g., chemical engineers), industrial (e.g., plastics), commercial (e.g., retail sales), and general business (e.g., chambers of commerce) organizations through visits, conferences and the like. Commercial appropriate technology trade fairs bring together U.S. suppliers of technology with prospective buyers from developing countries. Consultants such as the retired executives from the International Executive Service Corps transfer much needed U.S. management technologies.

By contrast, the "Bureau for Private Enterprise Policy Paper" declares:

> The goal of the Agency's new private sector initiative is to foster the growth of productive, self-sustaining, income and job producing private sectors in developing countries using the financial, technological, and management expertise of the U.S. private sector, indigenous resources, multilateral institutions and Agency resources where appropriate.

and stipulates one of its three objectives to be to:

> Bring together investment opportunities in developing countries, U.S. and host country capital and experienced management, thereby transferring technical, managerial and marketing expertise from the U.S. to the developing countries.

The Private Enterprise Bureau approach is experimental, limited both as to the countries in which it may be tested, and the type of investment considered suitable. It is investment-oriented and places a premium on financial management and host country receptive factors.

The AID Policy Paper on "Population Assistance" devotes a paragraph to technology transfer:

> One of the strengths of the U.S. population assistance program has been the transfer of U.S. scientific and technological know-how to LDCs implementing family planning programs. The U.S. has led the way in developing, testing and disseminating the most widely used contraceptives and family planning delivery systems. AID is increasing the amount of its support for the development of promising new contraceptive methods and for research on the safety and effectiveness of contraceptives tested under actual LDC conditions. In addition to the transfer of technology directly applicable to the delivery of contraceptives, AID has sponsored the development and dissemination of a variety of technologies for analyzing and demonstrating the impact of rapid population growth on economic progress, making these tools available to LDC governments as they examine their policy and program goals. Demand from LDCs for technologies developed by the U.S. continues to be high. Our ability to transfer technology appropriate to various country needs has given the U.S. a long-standing leadership role in this field.

While the policy papers on "Nutrition," and on "Recurring Costs" are essentially silent on technology transfer, as is the policy paper on "Basic Education and Technical Training," the latter offers a rare glimpse into the difficulties of writing policy on an ubiquitous topic.

Other AID policy papers are yet to be delivered, and there are nine strategy statements being developed by the Bureau for Science and Technology.

AID Evaluation Documentation

Policy is delivered in many ways other than by explicit written statements. AID, because it is organized largely along project-oriented lines, has devoted considerable attention to the need for and methodology of evaluating projects. In recent years this effort has gained substantial stature, and the evaluation "products" delivered both internally and by contractors can shed considerable light on what went right and what went wrong in given circumstances.

We have examined a few of the reviews of AID projects. Some, including the PPC/Evaluation series, were quite properly invited to our attention, others we happened upon. Uniform quality is not one of their attributes, but they are uniformly interesting.

It is not suggested that the "lessons learned" sections of project evaluations should necessarily become a source of policy guidance; however, it is possible that the lessons learned, particularly from projects that have continued for many years, represent a sort of

distilled practical wisdom that may have great applicability in the field, especially if environments and conditions are comparable.

We have drawn from what we hope is a reasonably representative sample of different AID projects and offer below some of the views that seem to have a breadth of applicability about them. Once again it seems germane to cite from evaluations at the core of the AID enterprise, and we begin with "AID Experience in Agricultural Research--a Review of Project Evaluations."

> A principal lesson learned is that the technology promoted in the past often did not overcome or alleviate many of the constraints faced by small farmers, who are the developing countries' major food producers. These constraints include resource limitations (land, labor, and capital) as well as the need to assure subsistence food supplies, reduce the risk of crop failure, and balance resource expenditures against those needed for alternative sources of income. The failure to alleviate these constraints was the major reason for the low rates of technology adoption experienced. Both agricultural researchers and policymakers have increasingly accepted the premise originally proposed by Theodore Schultz in the early 1960s: "Small farmers are efficient in the utilization and allocation of available resources among known technologies if they have been farming under stable conditions for some time.". . . When farmers were slow to adopt a new technology, it was usually because there were inadequate price or production incentives to do so, or because the technology itself was inappropriate.

Moving from agricultural research and technology to "Community Water Supply in Developing Countries: Lessons from Experience, Evaluation Summaries and Conference Findings (AID Program Evaluation Report #7):

> Technology:
>
> The technology should be maintainable by the institution and should provide an improvement over present sources of equipment supply. Local manufacture of equipment should be encouraged, and necessary materials procured locally.
>
> The Relationship of Technology to Benefits and Reliability:
>
> The use of an appropriate technology is an important issue in determining the reliability of a system. One view of appropriate technology is based on its simplicity. This view holds that simple systems are appropriate and therefore reliable while complex systems are inappropriate and therefore unreliable. This is often the case. Complex systems are sometimes not manageable where they are installed.

On the other hand, simple systems without pumps or distribution systems may have little effect on improving the availability and convenience of water for the community. Such systems are seldom valued by the community and do not receive the necessary support.

Community Concerns about Technology:

While there are a number of factors that set upper limits on the sophistication of the technology, serious limits are also set on the lower level by the desires of the communities and AID. There seems to be a Gresham's Law of Water Systems. Each improved system must represent an increase in convenience and reliability or it will be driven out by traditional sources of equal reliability and convenience. No system will be successful unless it is an improvement over existing conditions and is perceived to be so by the community. The field evidence for this statement is overwhelming.

Policy Recommendations in the Area of Technology:

1. Appropriate technology should be defined as the most cost-effective, feasible, and acceptable means to provide community water supply and sanitation services that the users and appropriate authority can afford and are willing and capable of operating and maintaining.

2. AID should contribute to increased indigenous capacity for operation, maintenance, and repair of water systems. The probability of project success will be increased by stressing host-country standardization of equipment. When it is not possible to manufacture this equipment within country, AID should relax its source and origin requirements.

3. AID should encourage, through financial incentives if necessary, host-country ministries to provide training and to develop and improve their capacity for inspection, collection, and evaluation of consumption and operating data (which could lead to system redesign and improvement).

4. In the approval of projects, AID should stress the importance of selecting appropriate technologies which provide reasonable improvement in the accessibility and reliability of water systems. These factors are generally more important than improved water quality in community acceptance and project viability.

5. Hardware development for improved water systems should be carried out in host countries and be limited to their priority needs.

The total systems approach to technology transfer is exemplified with great precision in the "Rural Roads Evaluation Summary Report" (AID Program Evaluation Report No. 5).

> Although each developing country is unique, we can begin to derive from the research several characteristics of more effective rural road projects. The project should be carried out by an institution whose principal mission is the construction and maintenance of lower volume rural roads. The project should include measures for strengthening the capacity of the institution and its staff in construction and maintenance. The organization and its road activities should be decentralized to provincial and local levels. Local village involvement in route selection, construction, and maintenance should be substantial. Local participation occurs more easily through the use of improved labor-based construction and maintenance.

These excerpts from AID evaluation studies suggest that experience in basic needs development activity has demonstrated the importance of the systems approach and recipient orientation for effective technology transfer. Evaluations performed by contractors for AID tend to bear out these conclusions.

For example, the American Public Health Association evaluated 52 AID-assisted primary health care projects. The resulting report* describes features of the programs:

> The establishment of peripheral, community-based health services which are financed, in part, by local resources. A key feature of community-based services is the use of a community health worker (CHW) who has been trained to provide basic curative and preventive care, and of a village health committee charged with initiating health-related activities and financing certain aspects of community health care. The development of community health activities, which are shaped by community members, delivered by community members, and partly financed by beneficiaries, is the most innovative component of the AID-assisted PHC [primary health care] programs reviewed here and an essential part of their design.

Under the title of "Support Services" the study found that:

> Providing essential support services (supervision, drugs, transportation, community organization work etc.) to numerous and scattered health service points--characteristic of community-based programs--has been the major problem of the projects. . . . actual service delivery often flounders from lack of adequate support services. Government management capabilities generally are weak. . . .many PHC projects are expanding too fast for support services to keep pace. . . .

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*Margaret Burns Parlato and Michael N. Favin, Primary Health Care, Progress and Problems--an Analysis of 52 AID-Assisted Projects (Washington: American Public Health Association, 1982).

Limited national funding is another cause of management problems. . . .

In most countries, the PHC programs are being implemented through a highly centralized administrative structure, and decentralization and other necessary administrative reforms are taking place slowly. . . .

The design of PHC programs, which emphasizes numerous service points at the periphery, makes them extremely dependent on good, cheap ground transportation and gasoline for supervision and drug distribution. Traditionally, however, dependence on vehicles has posed problems for ministries of health, because of poor maintenance systems, poor road conditions, and difficult geographic and climatic conditions. . . .

Poor systems to manage and supply drugs in most countries constitute a serious impediment to PHC projects. . . .

Many projects have been unable to provide adequate supervision to community health workers. . . .

When considering costs and government financing the study concluded:

This study yielded little evidence to indicate whether the stated goal of the AID-assisted programs to provide low-cost, affordable health care is being achieved.

AID-sponsored evaluation of a PVO is also relevant to this review of technology transfer. Mary B. Anderson was asked to review Volunteers in Technical Assistance (VITA).*

VITA addresses problems such as:

-- The ability or inability of science and technology to "solve" problems. . . .

-- The relationship of knowledge and technique to social, economic, and political power.

-- The understanding that technologies are more than mere value-free techniques but include also systems of knowledge and institutional arrangements.

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*Mary B. Anderson, The Provision of Technical Information and Assistance to Developing Countries: An Evaluation of the AID Institutional Support Grant to Volunteers in Technical Assistance (VITA), AID Contract No. PDC-0100-S-00-2025-00, February 1982.

-- The style, size and complexity of technologies as they relate to socio-cultural milieu and resource base (giving rise to the "appropriate technology movement").

-- The misfit of technologies which originated in one environment when they are applied to another and the necessity for adaptation.

The most effective users of VITA's information are probably those people with some technical knowledge and some experience and/or capital which makes it possible for them to benefit from the information. Frequently these people use the information in a way which has a spread effect, reaching beyond their own immediate advantage and helping others who are poorer and more marginal.

It is important to continue to provide information to the simplest requestor because it is he/she who really has no alternative access to information of this kind whereas "transmitters" might well find the information elsewhere if VITA did not exist.

Very little is known, on the other hand, about how people become technologically adept. . . . VITA is in a unique position to learn more about technology transfer at the individual or small-scale level.

For the most part, the effect of VITA's information is to help people make a decision and acquire knowledge.

To conclude this brief excursion through the project evaluation documentation, we cite from two National Research Council reports which present a somewhat different perspective on evaluation and on some aspects of technology transfer. From the report entitled "An Evaluation of Fishery and Aquaculture Programs of the Agency for International Development."*

Immediately following World War II, U.S. foreign assistance in fisheries was directed mainly toward the development of modern commercial fisheries as a means to strengthen the economies and rapidly increase the food supply in countries with serious food deficits. This effort involved large-scale programs to provide boats, gear, harbors, and processing equipment and to retrain local fishermen and fisheries workers in the use of modern equipment. Usually AID was directly responsible for hiring experts and supervising programs. Large-scale programs in Korea

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*National Research Council, An Evaluation of Fishery and Aquaculture Programs of the Agency for International Development (Washington: National Academy Press, 1982).

and India followed this pattern, as did a number of smaller programs in other parts of the world.

During the late 1960s, U.S. foreign assistance began to be directed more specifically toward the poorest people in developing countries. Large industrial fisheries development programs were curtailed in favor of ad hoc projects, generally tied to agricultural development programs. AID attached a lowered priority to fisheries during this period and most of the agency's own expertise in fisheries was lost. AID did serve as the lead U.S. agency in a domestic program largely carried out by the Bureau of Commercial Fisheries (now the National Marine Fisheries Service) during the late 1960s to develop a process for production of fish protein concentrate. The program was a failure and further reduced AID interest in marine fisheries as a target for development assistance. . . .

More recently there has been increased interest in fisheries within AID, much of it directed toward aquaculture. However, fisheries activities are accorded a relatively minor position within the administrative structure of AID, and funding for fisheries programs constitutes only a small portion of AID's expenditures for enhancement of food production techniques. . . .

At least three factors justify an expanded fisheries program within AID:

-- Congressional support for such an increase is indicated by the inclusion of Sea Grant Colleges within the Title XII revision of the Foreign Assistance Act and by the inclusions of fisheries as a priority area of food production.

-- Limitations in agricultural production are becoming apparent in the decreasing amount of land available for agriculture and in the increasing marginal cost of agricultural production. Fisheries assistance often has been suggested as an economical alternative to enhancement of agricultural production.

-- Developing countries are expressing increased interest in exploiting and controlling the resources within their recently acquired 200-mile exclusive economic zones, and the United States has an interest in gaining access to these zones for trade, scientific research, and for defense purposes.

Speaking of one of the case studies used in the evaluation, the report makes the following statement:

The Korean program was quite successful and probably was a major factor in the reemergence of Korea as one of the world's leading fishing nations. Success appears to have been achieved in part through the strong, continuing support from AID and through

effective supervision and the employment of experts with considerable field experience. Success was due also to the enthusiastic involvemnt of Koreans at all levels in the program and the willingness of fishermen and others in the industry to accept change. The postwar conditions in Korea and a large U.S. presence, both physically and financially, also had a good deal to do with the success of the program. Another important factor was the existence of an office for fisheries in AID at that time and the availability of fisheries expertise within the AID central organization, which provided strong management support to field operations.

The report concludes that:

> Successful AID fisheries programs examined . . . have been distinguished by major U.S. financial backing, long-term commitments, broad integrated programs encompassing all aspects of the fishery from capture to market, expert advisers with practical experience (domestic and overseas), working relationships with local institutions, and flexible program administration that reflects the fundamental nature of fisheries. Successful programs have occurred in regions with good resource bases, traditional importance of fish in the local diet and economy, and strong recipient government commitments to fisheries development.

The report, entitled "Marine Technical Assistance to Developing Countries: The U.S. Role,"* not only comprehends the systems approach to technical assistance and its component technology transfer, it puts it in a broad geopolitical context.

> By providing technical assistance to developing countries in the assessment, development, and management of the marine resources off their coasts, the United States not only fulfills important humanitarian obligations but also can derive economic, scientific, and other benefits as well as political advantage. Potential economic benefits from technical assistance cannot be predicted with certainty but could include the creation of markets for marine equipment, services, and expertise. Economic benefits also could come from joint development of resources in the exclusive economic zone and from fostering conditions favorable to future investment by U.S. industry. To the extent that marine technical assistance promotes economic growth and is seen as assistance rather than exploitation, it can contribute to international political stability as well as build support for U.S. policies in international forums. . . .

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*National Research Council, Marine Technical Assistance to Developing Countries: The U.S. Role (Washington: National Academy Press, 1982).

The scientific returns on technical assistance and cooperation include access to coastal waters of developing countries and the research contributions of colleagues familiar with local ocean conditions and phenomena. Exclusive economic zones, occurring on the ocean boundaries of land masses, include many unique oceanographic features. Joint operations with scientists from coastal developing countries hold the potential for mutual benefits for all participants.

Cooperative data collection and analysis further such shared interests as navigation, weather and climate prediction, marine fisheries management, and environmental protection. Technical cooperation programs also offer a way for researchers from developed nations to provide for coastal state participation, and data sharing will be required under the Law of the Sea Treaty. . . .

The principal involvement of U.S. industry in marine-related assistance is through joint ventures with companies in developing countries. Joint-venture agreements by U.S. industry can provide for the progressive transfer of new, technology-based industries to the host country. However, the success of such industries depends largely upon the continued availability of managers and technical personnel, which requires an extensive training system that may not be part of the joint-venture agreement. Joint ventures can be highly effective ways to enhance technological development and could be encouraged through complementary training programs and federal insurance protection for participating U.S. industries. . . .

The desired outcome of U.S. marine assistance is scientifc and technical self-sufficiency in recipient countries. Rational management and exploitation of marine resources requires training and education for personnel ranging from technicians to managers. Moreover, effective resource management requires scientific understanding of the ecosystems to which the resources belong.

Without belaboring the obvious, the point of including this last set of evaluative comments is to invite attention to the spacious stage on which AID-sponsored technology transfer plays its sturdy, but limited role.

Reflections on AID Programs and Documentation

When we began this task we wondered briefly why AID felt compelled to articulate a policy for technology transfer at this time. It has been suggested that each administration needs to enunciate its policies afresh, and that answers the query. On reflection, however, we can discern several other reasons for policy articulation:

- To improve the quality of development investment decisions

- To guide technical investment decisions in the competition for scarce resources

- To accelerate the dissemination of technologies deemed truly needed in developing countries

- To illuminate the technology transfer process in ways that will reduce the magnitude and numbers of misadventures

- To facilitate technical decisions designed to achieve specific responses

Doubtless there are more reasons than these.

As we look back at the record, it is clear that AID has for some years had policies, guidelines, call-them what-you-may, directed at a range of activities frequently subsumed under the rubric of applying science and technology to development. Many of these declarations apply to technology transfer as one of the key elements of technical assistance. The current documentation and the evaluative materials we have seen, as well as the interviews we have conducted, suggest that the broad institutional perception of the need to diffuse western technology continues today in the historical pattern which evolved as agriculturalists, engineers, medical doctors, and scientists captured the attention of economists. Administrator Hannah's remarks in 1973 are as apt today as they were then, and a careful reading of today's policy documents suggests that this is fully apreciated by current authors. It is still manifest that technology transfer takes place in highly specialized environmental circumstances and that the conditions for effective diffusion of technology must be created by people.

What is different about some of today's declarations appears in two distinctly different forms: one is the rhetoric about the importance of private enterprise. The other form, almost subliminal by comparison, is the steady accretion of acknowledgements, mostly in the evaluation literature, that human factors are of comparable importance to technical factors in technology transfer. This acceptance, by donor agency practitioners of development assistance, seems to us to have very substantial policy implications.

Current documentation also differentiates implicitly the types of policies needed for the transfer of industrial technologies (i.e., those relating to legal, financial, entrepreneurial, and like matters) from the policies needed for transfer of basic needs technologies where community engagement and the public infrastructure are of such vital importance.

We have also been made aware of important moves within AID toward greater understanding of the entrepreneurial urge, the ways by which small and medium-sized businesses develop, and are helped to mature, and the importance of examining the development potential of new

technologies such as microcomputers. These developments appear to be germane to the policies AID may generate for technology transfer. A possible lynchpin between technology transfer and private enterprise may be the renewed interest in management training and education. All of these aspects of immediate AID activity are so fresh as to be beyond the scope of much of the documentation we have been able to review.

Having dwelt longer than the reader might have chosen on what is in AID literature, it may be in order to take note of what the documentation appears to omit.

As we have noted above, the policy guidance vis a vis private voluntary organizations (PVOs) does not offer direction as to the substance of PVO work. We are perplexed as to how AID managers of PVO projects with substantial technology transfer elements provide PVOs with substantive assistance, if not direction?

Another question revolves around the technology transfer element in participant training. AID brings some 7,000 to 8,000 people to the USA each year for participant training programs ranging from short exposure to new topics or refresher sources, to full-fledged advanced degree programs. Trainees are selected by AID missions and dispatched to acquire knowledge useful to development. Looked at in one light, this involvement with people is AID's largest technology transfer effort and has been for over 25 years. Yet, as far as we can tell, while the participant trainees are acknowledged to be long-term carriers of technology--even permanent agents of transfer--there is no body of policy or operational guidance on how to select them for their technology transfer capabilities, or how to enlist their sustained collaboration once they return to their home country. Recognizing AID's reluctance to appear to demand a quid pro quo for what is in essence a philanthropic act, we are still perplexed by this posture.

We have also missed a careful analysis of the relationship between the donor agency and the intermediate technology acquisition and delivery institutions. Much has been written about the industrial research laboratory, the coop, the credit union, the community development organization, village health committees, and the like. There is also a body of accumulated data describing the ways these institutional entitites integrate with the local support and client systems they are designed to serve. The missing element seems to us to be an analysis of what the donor institution has to do and be to work effectively with such institutions over time.

An AID contractor and external observer has put it nicely:

> We the "rich," foreign academic and professional "experts" have rarely had to deal with poverty directly. . . . We are

part of the environment of poverty, not independent of it, and we may properly focus attention upon ourselves as parts of the problem . . . .*

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*Simon Fass, The Economics of Survival.

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