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9. ABSTRACT
If U.S. business firms are to contribute to development of labor-intensive enterprises in LDCs, A.I.D. needs to devise incentives for them to do so. The same holds true for adaptation of U.S. products for low-income markets in LDCs. Host countries can influence multinational manufacturers by their import tax policies and by reducing factor price distortions in their labor and capital markets. An intermediate technology organization should be established. Its primary function should be to provide in-depth training in the choice and evaluation of appropriate technologies. This training would be provided for LDC government officials and entrepreneurs and for U.S. equipment suppliers, U.S. manufacturing companies, and U.S. consulting firms. The training organization would provide a permanent body of people interested in further dissemination of intermediate technologies to developing countries. It could organize conferences on particular topics, sponsor academic studies, act as an information clearinghouse, and provide experienced consultants to governments and industry. A.I.D., prior to creating such an organization, should visit technology-transfer organizations in other countries and organize an internation conference on the subject. A.I.D. should also experiment with monetary incentives in the form of subsidies of plant designs, grants to equipment manufacturers and consulting firms, and export credits for U.S. firms that export used machinery for use in LDCs.

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THE INDUCEMENT OF U.S. FIRMS TO ADAPT PRODUCTS AND PROCESSES TO MEET CONDITIONS IN LESS-DEVELOPED COUNTRIES

A REPORT TO

AGENCY FOR INTERNATIONAL DEVELOPMENT

BY

MANAGEMENT ANALYSIS CENTER, INC.

under the direction of

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June 8, 1976

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INTRODUCTION

This paper was prepared to assist AID in judging what role, if any, U.S. business can be expected to play in an effort to disseminate appropriate technologies to developing countries.

The first part of this paper presents a brief profile of U.S. foreign direct investment in manufacturing in developing countries.

The second part describes the various strategies used by U.S. companies when they invest abroad. We present the analytical framework of the product life cycle in some detail because it helps in understanding the motivations of U.S. firms going abroad. Two main motivations are examined: (1) investment to serve local markets, and (2) investment to seek low cost labor. This analysis of strategy provides the background for a conclusion as to what circumstances will make it easy and what circumstances will make it difficult to induce U.S. firms to adapt their products and processes to meet local conditions.

The third part takes a look at the various arguments for and against more labor intensive production in developing countries. We include in this part a review of the empirical studies done to date on the matter of adaptation so as to give an indication of how firms actually behave. We also present five cases of actual investment decisions in developing countries by U.S. investors to give a flavor of the problems encountered in technological adaptation.

In the fourth part, we present policy recommendations applicable to developing countries seeking more appropriate technologies in their investments, look at the possible means of technology transfers, and recommend to AID possible approaches to encourage the use of intermediate technologies in developing economies.

I. U.S. DIRECT INVESTMENT IN DEVELOPING COUNTRIES

Direct investment by U.S. companies in developing countries has, typically, always been much smaller than direct investment in the developed countries.[1] Table I shows that, for the years 1968, 1970, 1972, and 1974 U.S. direct investment in manufacturing[2] in the developing countries was either 17% or 18% of the total U.S. foreign direct investment in manufacturing worldwide. Table I also shows that the net outflow of new capital in manufacturing industries invested in developing countries was consistently less than the net capital outflow invested in developed countries, ranging from 33% to 15% of total net capital outflow. Retained earnings, which also represent an addition to foreign direct investment, present a similar picture, where developed countries accumulate four times more retained earnings than do developing countries.

This distribution of foreign direct investment in manufacturing industries can be largely explained by the relative attractiveness of foreign markets to the U.S. investor. Clearly, the developed countries, with their larger and higher income markets, will present more business opportunities to an American firm investing abroad than the limited markets that the developing countries can offer.

If one examines the country distribution of direct investment in manufacturing industries in developing countries, shown in Table II, one notes that the richer countries in this category attract a proportionately larger share of U.S. direct investment. Out of a total direct investment position in manufacturing of $9,122 million in the developing countries in 1974,

TABLE I

U.S. DIRECT INVESTMENT IN MANUFACTURING ABROAD[a]
($ billion)

Direct Investment Position

	1968	percentage	1970	percentage	1972	percenatge	1974	percentage
All Countries	25.2	100%	31.0	100%	38.3	100%	50.9	100%
Developed Countries	20.7	82%	25.6	83%	31.6	83%	41.8	82%
Developing Countries	4.5	18%	5.4	17%	6.7	17%	9.1	18%

Net Capital Outflows

	1968	percentage	1970	percentage	1972	percentage	1974	percentage
All Countries	.9	100%	1.3	100%	1.2	100%	2.7	100%
Developed Countries	.6	67%	1.1	85%	.8	67%	2.1	78%
Developing Countries	.3	33%	.2	15%	.4	33%	.6	22%

Retained Earnings

	1968	percentage	1970	percentage	1972	percentage	1974	percentage
All Countries	1.3	100%	1.5	100%	2.8	100%	3.8	100%
Developed Countries	1.1	85%	1.2	80%	2.4	86%	3.1	82%
Developing Countries	.2	15%	.3	20%	.4	14%	.7	18%

[a] Survey of Current Business, October, 1975, pp. 50, 51

TABLE II

U.S DIRECT INVESTMENT POSITION FOR MANUFACTURING INDUSTRIES IN DEVELOPING COUNTRIES, AT YEAR-END 1974[a]
($ million)

			percentage of total
Developing Countries Total		9,122	100%
Latin America		7,487	82%
Argentina	772		
Brazil	2,502		
Chile	43		
Colombia	375		
Mexico	2,146		
Panama	115		
Peru	156		
Venezuela	609		
Other	766		
Africa		160	2%
Liberia	2		
Nigeria	20		
Other	140		
Middle East		130	1%
Iran	50		
Other	80		
Asia and Pacific		1,344	15%
India	234		
Indonesia	72		
Philippines	340		
Other	699		

[a] Survey of Current Business, October 1975, p. 53.

Latin America had the lion's share, with 82% of direct investment, followed by Asia and the Pacific (excluding Japan, Australia and New Zealand) with 15% and by Africa (excluding South Africa) and the Middle East, each respectively with 2% and 1%.

It appears, furthermore, that it is the richer countries of Latin America which have the greater proportion of U.S. direct investment; for example, Argentina, Brazil, Colombia, Mexico, and Venezuela -- all of which have per capita incomes substantially over $300 a year -- account for more than 85% of the total manufacturing direct investment in Latin America. All the other countries account for only 30% of total U.S. direct manufacturing investment in the developing countries, and only about 5% of total worldwide U.S. direct investment.

A similar picture is given by net capital outflows and retained earnings for developing countries, as shown in Table III. Latin America was, for 1974, the recipient of 83% of net capital direct investment outflows in manufacturing, and had 76% of the retained earnings. Again, one observes that

countries with large markets -- Brazil, Colombia, Mexico and Venezuela -- were the recipients of the bulk of net capital outflow and retained earnings among U.S. manufacturing enterprises in developing countries. Thus, the proportion of U.S. foreign direct investment activity (however measured) in the very low-wage countries, say $300 per capital or lower, is quite small, probably accounting for less than 5% of U.S. foreign direct investment in manufacturing.

TABLE III

U.S. DIRECT INVESTMENT ABROAD IN MANUFACTURING IN DEVELOPING COUNTRIES, NET CAPITAL OUTFLOWS AND RETAINED EARNINGS, 1974[a]

($ million)

		Net Capital Outflows		percentage of total		Retained Earnings		percentage of total
Developing Countries Total		609		100%		705		100%
Latin America		503		83%		534		76%
Argentina	14				-23			
Brazil	221				241			
Chile	-7				-1			
Colombia	14				38			
Mexico	162				185			
Panama	18				8			
Peru	5				-3			
Venezuela	40				47			
Other	37				43			
Africa		9		1%		9		1%
Liberia	3				-4			
Nigeria	1				2			
Other	5				11			
Middle East		13		2%		8		1%
Iran	10				3			
Other	3				5			
Asia and Pacific		84		14%		153		22%
India	1				17			
Indonesia	26				8			
Philippines	16				29			
Other	40				100			

[a] Survey of Current Business, October 1975, pp. 55, 57

Table IV shows the distribution of direct investment abroad in 1974 by industry. One can observe that there is a relatively greater investment in chemicals and allied products, and in primary and fabricated metals in developing countries than in developed countries, and there is relatively less investment in machinery and transportation equipment.

TABLE IV

U.S. DIRECT INVESTMENT POSITION ABROAD AT YEAREND 1974 -- MANUFACTURING INDUSTRIES, BY INDUSTRY[a]

($ billion)

	Total	Food products	Chemicals and allied products	Primary and fabricated metals	Machinery	Transportation equipment	Other manufacturing
All Countries	50.9	4.4	10.1	3.4	13.8	7.7	11.5
percentage	(100%)	(9%)	(20%)	(7%)	(27%)	(15%)	(23%)
Developed Countries	41.8	3.6	7.8	2.6	11.8	6.7	9.3
percentage	(100%)	(9%)	(19%)	(6%)	(28%)	(16%)	(22%)
Developing Countries	9.1	.8	2.4	.8	1.9	1.1	2.1
percentage	(100%)	(9%)	(26%)	(9%)	(21%)	(12%)	(23%)

[a]Survey of Current Business, October 1975, p.55

II. STRATEGIES OF FOREIGN DIRECT INVESTMENT BY U.S. FIRMS

The concept of the product life cycle provides a very useful way to view the growth of U.S. foreign direct investment.[3] We describe the concept in some detail because of the insights that it provide into the various reasons for which direct investment is undertaken.

As a product passes from invention to maturity, its growth in consumption often starts slowly, then increases rapidly for a time, and then slows down as the product becomes "mature." These phases of growth are accompanied by changes in the relative importance of various factors of production; namely, management, skilled labor (including scientific and engineering know-how), unskilled labor, and capital.

In the early stages of introduction, the characteristics and technological specifications of a new product are subject to frequent change. The producer has to be close to the market because of the need of frequent communication with the customers of the new product. As a result, large amounts of scientific and engineering manpower are used, and investments in fixed assets are relatively low.

The innovations of U.S. firms arise as a response to the conditions that are typical of the American market, i.e. the largest high-income market, with relatively cheap capital and relatively expensive labor, and a large supply of scientists and engineers. Innovations have tended to be capital-using and labor-saving, with little attention paid to economizing on raw materials and energy.[4]

During this early stage in a product's life cycle, the innovating country (more often than not, the United States) typically exports the product to the rest of the world, as demand begins to appear in other countries.

If a product survives the introductory stage, then it enters the rapid growth stage, during which mass production techniques are introduced. Production runs are increased and more special-purpose equipment is installed. The ratio of capital to labor rises, and management skills become more important than engineering ability. On the average, the skill level of the labor required is lower than during the earlier stage as fewer scientists and engineers are employed in production. Unit production costs decrease with rising production volume, and the product undergoes increasing standardization. Other competitors enter into the market, which results in a lowering of prices, and, as a result, in a further expansion of the market.

In the other developed nations, meanwhile, the growing market for the product (served through exports from the innovating country) stimulates local companies (often locally based multinational enterprises) to enter into production in their home market. The technology becomes available either through purchase from innovating firms, or through local firms developing their own competitive technologies.

In this stage, U.S. firms find that their market position in the developed countries is threatened by the appearance of local producers. The response of U.S. firms has been, typically, to enter these markets with manufacturing operations in an effort to maintain their dominant position.

Finally, the product enters the mature stage. By now production

specifications are quite standardized, and the technology is fairly stable. Technical manpower and skilled labor are of less importance, while unskilled labor becomes much more important. The market price for the product falls to such a level that the ability to control production costs becomes the basis for competition. The response of U.S. firms to this stage in the product life cycle has been to increase their production runs to lower unit cost by standardizing manufacturing processes, and to produce in countries which have a lower labor cost than the United States.

Recent studies indicate[5] that U.S. firms respond to these changes in the product life cycle and commence production abroad as a defensive measure, when failure to do so would result in an erosion of their market share in favor of competitors. Eventually the manufacture of certain products abroad becomes a necessity if the U.S. firm wants to maintain world-wide competitiveness.

Following World War II, most of the developing countries that have chosen a policy of rapid industrialization have sought to stimulate investment in industries which would manufacture locally those products which are imported. A local producer, or a foreign investor, was encouraged by the government to start local production of an imported item by being offered protection against imports, either by high tariffs or quotas, or by outright import prohibitions. Typically, the market offered by the developing country was only a fraction of the market necessary for economic production. The products which substituted for imports were, therefore, produced at substantially higher costs than the competing imports. However,

the ability of the local manufacturer, or the subsidiary of a U.S. enterprise, to raise prices considerably above the prices of the previously imported items assured adequate profits regardless of the high costs of the operation. The result of these policies was the creation of an industrial base that was not competitive in world markets, but which survived only behind high protective tariff walls.[6]

Another form of foreign investment has begun to appear in developing countries. Certain products require in their manufacture a large input of unskilled labor. As such products become mature, competitive manufacture arises in those countries where labor costs are comparatively low. These products compete on the basis of cost with similar products manufactured in the U.S., so that if imports are free, eventually U.S. manufacture will cease, and the U.S. market will be totally served through imports.

The response of U.S. firms to competing imports of these "mature" products, in the sense of the product life cycle, has been to transfer the part of the manufacturing operations which have a high unskilled labor content, or the whole product, to developing countries where the wage rates are a small fraction of U.S. wage rates. These products are then imported into the U.S. for final assembly, or for direct sale.

Clearly, this form of investment is different in two important aspects from investment carried out in a developing country for the purpose to serve the local protected market. First, the motivation for the investment is to reduce manufacturing costs so as to safeguard the

world-wide competitiveness of the company. Second, the investing firm seeks a low cost resource, labor in this case, which is available only in the developing countries.

A case in point is the behavior of the U.S. electronics industry.[7] U.S. firms faced competition from Japanese imports for certain electronic assemblies and radios. The Japanese firms took advantage of the lower production costs of Japan to compete with U.S. products, in the U.S. market, on the basis of price. As wages rose in Japan, the Japanese manufacturers began to shift production of the most labor intensive components, or of whole products, to countries in the Far East where wages were lower, such as Korea and Taiwan. Faced with this threat in their home market, the U.S. firms had to start manufacturing operations of certain labor intensive production in these lower wage countries in order to retain competitiveness.

A third type of direct investment exists in developing countries, which need not be either an investment to serve a protected market with a high cost production facility, or an investment to seek low cost labor for products sold in high income markets. This type of investment serves either a local market which is large enough to sustain, for a certain product, an economical plant size, or a regional market where, through production rationalization, economical manufacturing volume is reached. The products manufactured are typically in the middle to mature stages of the product life cycle, having fairly standardized characteristics, and requiring a lower input of skilled labor in their manufacture. On the demand side, these products do not require a high income market.

Countries such as Brazil or Mexico can offer a market of sufficient size to permit production of such products on an economical scale. Also, trade associations (e.g. the Andean Pact countries) offer the possibility to rationalize production by either manufacturing different products in certain countries for the whole region, or of manufacturing components for the whole market in different countries, and performing the assembly locally for each market. These strategems are aimed at reducing manufacturing costs below what they would be if production were to be done for a single country market. Eventually, such a production could reach world-wide competitiveness as volume rises.

In their operations abroad U.S. firms have at their disposal a wide variety of forms. They can choose to invest with a wholly-owned operation (usually a subsidiary but sometimes a branch), and thus retain full control over their foreign operation, or they can join with foreign partners in joint ventures. These can give the investing U.S. firm a very wide spectrum of control and ownership, going from majority joint ventures, 50-50 joint ventures, to minority joint ventures. Also, the U.S. firm can choose not to invest, but to enter into a licensing agreement with an unaffiliated firm. In this case the transfer of technology typically takes place on the manufacturing level only, with no transfer taking place for management skills. On the other hand, there may be a management contract, which transfers management skills, but no manufacturing technology. Of course, there may be a combination of these, also in conjunction with a policy of joint ventures. For example, a firm might have a minority joint venture,

with a formalized licensing agreement, and a management contract. Finally, there might be supplier relationships, where the investing U.S. firm transfers a certain technology to local suppliers in order to reach a satisfactory quality in the needed inputs.

These various forms of operating abroad have different consequences for the transfer of technology, and for the pressure on the investing firm to choose technologies appropriate to the local conditions, as we examine in the next section.

III. ADAPTATION OF TECHNOLOGY BY U.S. FIRMS IN DEVELOPING COUNTRIES

Critics of foreign investment in developing countries sometimes have accused foreign investors of not adapting technology to utilize the resources of the host country most effectively, but instead investing with capital-intensive technologies that are wasteful of capital and produce a high return for the wealthy few. They point to highly capital-intensive projects, such as steel mills and petroleum refineries, which employ but few workers (many of them with special skills) and tie up large amounts of scarce capital, and which are also often wasteful of capital in that these facilities sometime operate at a fraction of their capacity.

Developing countries have a very different economic environment than the developed countries. Capital is scarce, and obtainable only at high cost. Foreign exchange is available in very limited quantities. The work force, on the other hand, is numerous, but the skill level is very low, compared to Western standards. Unemployment in the cities and underemployment in the countryside presents a serious problem to the planners of the economy.

Proponents of more product adaptation[8] say that products designed for Western markets are not suitable for developing countries. The products have to be designed for local usage and local maintenance. Also, cheaper versions of certain products can be devised to meet local purchasing power. For example, an automobile design could be adapted so as to use simpler parts, manufactured locally. The body could be made up of flat sheet metal,

instead of the more expensive moulded stampings. Tolerances could also be more relaxed. One does not need in a developing country an engine capable of extracting the maximum horsepower from a limited capacity, but an engine that will require the least maintenance and have the longest useful life.

There are certain products, however, which cannot be modified so readily to meet local conditions: these include drugs, chemicals, cement and metals. These products must meet certain well specified standards if they are to be deemed safe for public use. One may not be lax with the quality of a drug or the cleanliness of its manufacturing process. Similarly, cement has to have certain specifications if the constructions are to be safe. Chemicals, also, have to have a certain molecular structure. One may, of course, modify the requirement for purity, but the danger of doing so depends on their end-use.

Much more has been written on the adaptation of manufacturing processes by foreign investors to suit local conditions.[9] We briefly review the arguments made for more adaptation, and the arguments made against. Also, we give a short survey of the results of empirical research done to date on this question.

In a developing country the foreign investor often faces a market too small for an economic scale of production. Local manufacture then becomes feasible only if the market is highly protected. Capital costs locally tend to be high, reflecting the relative scarcity of capital in the country (though there might be some capital available at subsidized rates). Foreign exchange is also scarce, and usually any transaction involving the exchange

market has to be approved by the central bank. Unskilled labor is apparently abundant and cheap, relative to capital, but labor laws, such as minimum wage or severance compensation, might actually substantially raise its real cost. On the other hand, skilled labor and supervisory personnel are few and relatively expensive, as are trained managers and engineers.

Most studies found that firms do adapt their manufacturing process when investing in a developing country, but mostly because of scale. Plant size in developing countries tends to be only a small fraction of plant size in developed countries. This is especially true if the output of the plant serves only a limited national market, protected by high tariffs.

Such an adaptation to scale changes the relative requirements of capital and labor per unit of output. Usually labor requirements go down more slowly than do capital requirements as plant size is reduced. For example, in a chemical manufacturing plant one operator is needed to turn a valve whether this empties a tank of 1000 gallons, or one of 100,000 gallons. Or, in another manufacturing plant, one operator may be needed to tend a machine capable of producing 1000 parts an hour, as one is needed for a machine producing only 100 parts an hour.

This results in smaller plants having relatively more labor per unit output, and less capital per unit of output, than comparable larger plants even if the adaptation is only one of size and does not involve other technological adaptations to different factor costs.

Furthermore, when the volume of production is reduced, many capital-intensive, labor-serving devices become uneconomical due to their low volume of production. Therefore, in smaller plants one typically finds less use of automated equipment. Such equipment is costly, and the depreciation burden has to be allocated over a large number of units in order for unit costs to fall below those which would result from a less automated technique of production. In this instance the reduction in capital per unit of output is due to adaptation to the diseconomies of small scale production. The manufacturing technology becomes in effect more labor intensive, again, not in response to lower labor costs and higher capital costs found in developing countries, but because the volume of production does not justify economically adding to fixed costs.

But even if firms do adapt technology because of smaller scale, one also should address the question whether U.S. firms investing in developing countries adapt their production processes to take into account the differences in the relative costs of capital and labor. Specifically, do U.S. firms investing in developing countries, facing cheaper labor costs and more expensive capital costs than they face in their home markets, change their manufacturing technology to utilize a greater proportion of labor relative to capital per unit of output?

Production theory says that, for a given product, or product mix, and for a given scale of production, an "economic man" — i.e. interested in profit maximization -- will adapt his production process according to the relative costs of the factors of production (capital and labor, in the simplified case).[10]

Thus, given these two situations, the first where the cost of labor relative to capital is higher than in the second, a profit maximizing manager will choose a more capital intensive technique in the first case, and a more labor intensive technique in the second case. This will result, not only in the firm's maximizing its profit, but also in the most efficient utilization of both capital and labor in the production process (if, in fact, the cost of capital and the cost of labor reflect the relative scarcities of these factors of production).

Proponents of utilizing "appropriate" technologies in developing countries argue that more labor intensive methods of manufacture (keeping scale, product mix, product quality, and material inputs constant) will result in a better utilization of the resources of the country, absorbing large quantities of labor, which is relatively abundant, and economizing on capital, which is relatively scarce. In addition, they argue that profits should be higher for the entrepreneur using a labor intensive technology than for one using a more capital intensive technology.

However, since it is not always the case that a more labor intensive technique is more profitable than a capital intensive one, economists have argued that in certain developing countries labor costs and capital costs do not reflect their relative scarcity.[11] This is the result of price distortions, both in the labor market and the capital market. These distortions, however, can be corrected in a profitability analysis to reflect the actual costs to the economy of using labor and capital by the use of "shadow prices" instead of market prices. Typically, in developing countries

labor costs are higher than the true cost to the economy of employing one additional worker, because of labor laws, such as minimum wage laws, and lack of labor mobility. Capital, in addition may be subsidized by the state so that it is available at a lower cost than its relative scarcity would justify. For example, many schemes to attract foreign investors involve "preferential" rates of interest for local long-term debt. Therefore, an adjustment using shadow prices usually shows that there should indeed be more adaptation toward more labor intensive methods of production than actual market prices in developing countries would warrant for a more efficient utilization of resources.

Other arguments in favor of adaptation of production processes in developing countries are that, from a social point of view, it is better to have a large employment of the often unemployed urban populations. Labor intensive techniques employ more workers per unit output than do capital intensive techniques. A study[12] showed that several industries in Indonesia in order to produce the same output, plants using intermediate technologies employed twice as many workers as the most advanced plant, and the most labor intensive plant employed about ten times as many workers.

In addition, it is argued, labor intensive techniques can make better use of local inputs and raw materials, since a more labor intensive manufacturing process can be more easily adapted to use local inputs. Tolerances can be relaxed as a worker has more discretionary control in less automated machines. Also, simpler machines do not require rigid specifications for the quality of material inputs.

Furthermore, the servicing and maintenance of more automated machines is more difficult than for simpler machines. Local mechanics often do not have the training to deal with sophisticated equipment, and the factory has to maintain a full-time technician for this purpose. Parts have to be imported, causing delays in production, and resulting in a foreign exchange cost to the country. For less automated machines, on the other hand, parts can often be manufactured locally, as they require less rigid specifications as to material quality and tolerances.

Automatic features on equipment frequently baffle local operators. A study on manufacturing plants in Indonesia[13] found that in a textile mill which had highly automated equipment, most of the automatic functions had been disconnected. It was explained that the workers were not familiar with this equipment, and, as the automatic features broke down, they would simply be shut down so that the equipment would operate without them.

Empirical findings on technological adaptation suggest that foreign investors in developing countries do little adaptation of technology in response to relative labor and capital costs. Also, there seems to be little significant difference between U.S. investments and many local investments in the amount of adaptation done, once differences such as scale and price competition (which we discuss further on) have been taken into account.

As an example, one study compared two different technologies for sugar refining in Ghana.[14] The process which was actually used, the vacuum-pan process, is more capital intensive than the competing open-pan process.

A comparison between these two processes was made using Ghanaian factor prices. The result was that the more capital intensive process which was actually used had an internal rate of return of 6.5 percent per year, while the more labor intensive process would have resulted in an internal rate of return of 12.0 percent per year. The authors of this study conclude that little adapation is done because plants destined for developing countries are designed by engineers in developed countries. Perhaps only two or three variants to the basic design are submitted to a discounted cash flow analysis, and the best one is used. Yet many more appropriate technologies may never have been considered.

Many authors[15] have recognized that often engineering considerations are competing with economic considerations in determining which technologies are suited for investment in developing countries. It appears that, when economic constraints are relaxed, other criteria enter the choice of technology other than profit maximization.

An early study[16] found that the degree of price competition had a significant effect on the amount of adaptation done by U.S. firms investing in low wage countries. Those firms which did not compete on the basis of price, but on the basis of quality and brand names, were found to adapt much less to low labor costs than did those firms which did compete on the basis of price.

Another study[17] examined foreign owned and locally owned enterprises in Indonesia and found that firms which were competing on the basis of a brand name, and were therefore able by it to charge higher prices, adapted less to local labor costs than did those firms which competed on the basis of price.

Research in progress[18] discovered that a U.S. firm investing in textiles in a developing country was sensitive to local capital and labor costs when planning its manufacturing facility. On the other hand, managers of a U.S. paper and pulp manufacturer stated that they adapt only to scale, and that relative labor and capital costs had no effect on the choice of technology. It is likely that the textile manufacturing firm has to face a more price competitive environment than the manufacturer of paper and pulp. Also, labor costs are a smaller fraction of total costs for a paper and pulp manufacturer than for textile manufacturers, so that possible savings from adaptation to a more labor intensive technology would affect total costs little.

Once freed from the economic constraints of price competition through the enjoyment of some monopolistic advantage, engineering and managerial objectives often push investors toward the choice of more capital intensive technologies than would be considered appropriate for a developing country. Sometimes managers and engineers prefer a plant with "modern" equipment in order to satisfy their sense of being up to date on the latest technology, but other reasons also are offered.

In addition, proponents of capital intensive techniques for developing countries claim that these are necessary in order to produce goods of acceptable quality, which generally means goods of quality comparable to competing imports from the developed countries. In one study,[19] however, it was found that flashlight batteries produced in a developing country by the most advnaced technique and flashlight batteries produced by an intermediate technique were of totally comparable quality. The ones pro-

duced by the advanced technique, however, were able to claim a premium price because of their U.S. brand name.

Another argument given by proponents of capital intensive investment is that, for certain products, there just are no economic alternatives to capital intensive production. They cite as examples industries such as petroleum refining and chemicals. Technological specifications -- e.g. temperatures, pressures-- and dangerous materials do not permit adaptation to a more labor-intensive production process. This is a question which has to be explored in greater depth, but there are indications that there might be more scope for adaptation in such industries than previously thought. Many firms in these industries do adapt to low labor costs in peripheral activities, such as unloading, packaging and conveying. Often, a gang of men with wheelbarrels will do as satisfactory a job as will a conveyor belt, at a fraction of the cost.

Managers of capital intensive factories in developing countries often claim that they can better respond to fluctuations in demand than if they employed a more labor intensive technology. If demand drops, they simply run the plant at a lower rate. On the other hand, slowing down a labor intensive plant would mean laying off a considerable portion of the workforce; and usually this cannot be done easily--labor laws or customs in developing countries often do not permit dismissal because of reduced production rates.

Furthermore, managers claim that too many workers present problems of management. It is more difficult to handle a large labor force than machines.

A large labor force also requires a greater usage of the scarce resources of managers and supervisors. It is argued that managers can be more profitably employed in the economy than taking care of the problems that workers have with industrial discipline.

Furthermore, some economists argue that industrialization would proceed more rapidly if there are large returns to capital. The argument goes like this: if most of the returns accrue to capital, a large portion will go into savings, which will further increase in the economy. If, on the other hand, a good part of these returns go to labor, these will be spent in current consumption and not add to total savings, since workers in developing countries are believed to have a very low, or possibly zero, propensity to save. This argument might have some validity in terms of capital accumulation (though it ignores the multiplier effect of workers' expenditures) but it ignores social reality. The development of a highly industrialized sector, with large returns to the few, in a sea of unemployment or underemployment, is not a formula for long term social stability.

Investment by U.S. Firms in Developing Countries

U.S. firms that invest abroad have already developed certain technologies. Adapting these technologies almost on a case-by-case basis to the different factor costs encountered in a variety of countries would involve a great investment of managerial and engineering time. Uusually a U.S. firm in a developing country maintains an oligopolistic position because of its technology or its brand name, and is, therefore, able to avoid direct price competition with local firms. Furthermore, the U.S. firm often is protected against imports by tariffs or quotas. Under these conditions there is little

incentive for the U.S. firm to reduce manufacturing costs by adapting to a more labor intensive technology.

Also, U.S. firms might often face factor price distortions that actually raise the relative cost of labor to capital. Labor legislation, dealing with minimum wages, dismissal compensation and fringe benefits, raises the cost of labor to the investor. In addition, U.S. firms typically pay higher wages than local firms. On the other hand, a U.S. firm usually faces lower capital costs than do local firms, because of their greater ability to borrow outside of the host country. Furthermore, there might be government schemes for subsidizing investment, such as low interest rates on local capital and tax holidays, all which contribute to lowering capital costs.

Although the main factors affecting the choice of technology in U.S. investments in developing countries remain scale and the competitive environment, for certain investments factor cost differentials may play an important role. If, for example, the market is large enough for economical manufacture, either because of a domestic market of sufficient size or because of regional integration, the scale of operation may reach a competitive volume. In addition, if imports are freely permitted (or with a low tariff) the U.S. subsidiary will have to compete with the products from the most economical plant in the advanced countries. Here a manager of a U.S. subsidiary might want to utilize the advantages of low cost labor so as to compete against such imports on the basis of price. The manager will, therefore, be more likely to adapt the production process to take advantage of the cheaper labor.

In another form of investment, a U.S. enterprise sets up a manufacturing facility in a low wage country in order to specifically take advantage of lower production costs. One would expect in this case a great deal of adaptation in the manufacturing process. The U.S. electronics companies that set up assembly plants in Taiwan in order to compete with Japanese imports into the United States want to take full advantage of the inexpensive labor. It is price competition which forces such firms to seek low cost overseas production facilities in the first place, so the manufacturing control system will pay particular attention to minimizing production costs.

Cases

Following are five cases that illustrate different forms of U.S. investment in developing countries and the adaptation in the manufacturing processes done in response to local conditions. They cover a variety of industries and countries -- auto assembly in Asia, corn milling in Africa, fertilizer packaging in Indonesia, electronics in Taiwan, and furniture in South America.

Case 1, Auto Assembly in Asia[20]

Michigan Motors (a disguised name), a U.S. automobile manufacturer, planned to set up in 1967 an automobile assembly operation in an Asian country which we call "Asiana." The tax and tariff structure of Asiana was such that an assembled automobile from Michigan Motors' European factory costing $1,288, c.i.f. Asiana, would cost in Asiana after taxes, duty and other charges, some $4,560. A CKD (completely knocked down)

unit, on the other hand, would cost $1,017, c.i.f. Asiana, and, after taxes, duties and assembly costs, would cost only $1,933.

A company manager, Mr. Adams, was sent to Asiana by Michigan Motors to study the feasibility of purchasing the assembly facilities of the local distributor (who wanted to retire). Mr. Adams estimated the funds needed to convert this facility into one conforming to the standard design used by Michigan Motors overseas and drew up a proposal which he presented to corporate management. This trial proposal met with opposition from the corporate financial staff, which considered the estimated after-tax return on investment too low.

Mr. Adams then asked the design engineers to revise the standard design used previously in other countries in order to see if they could reduce the investment in Asiana, even though more plant labor might be required. The engineers responded with a new design that reduced the investment in fixed assets by almost $1 million. This in turn decreased depreciation and tooling amortization more than enough to offset the costs of the additional workers, whichwere estimated at $1,000 a year per worker. Thus, the projected profit increased, although the amount of the investment required was lower. Even though there would be less consistency in the product from assembly operations, additional work could be performed that would give the products an acceptable level of quality for the local market.

The revised proposal was still opposed, though not so strongly, by the corporate financial staff, which continued to point out the political and economic uncertainties which they said "typify those of other low-volume, underdeveloped markets." In addition, they mentioned the likelihood that the volume projections would not be realized because of strong Japanese

competitors, who had increased their market share in Asiana from 4 percent to 26 percent in the last four years. Adams, however, with the support of the International Division management, prevailed. The president of Michigan Motors approved the project, and subsequently the board of directors did too. A further drop in the market share to 15 percent in 1966 from 19 percent in 1965 had helped Adams to sell the proposal to the president.

Case 2, Corn Milling in Africa[21]

The Maize Milling Company (a disguised name) is a large U.S. manufacturer of maise products: oil, gluten, fiber and starch. The manufacturing process uses well-known technologies and the equipment of the firm's plants is usually brought from outside suppliers.

In 1972 Maize Milling was considering the invitation from an East African country to set up a corn milling facility locally to serve the East African market. Market studies indicated that an appropriate plant size would be one capable of processing 35 tons of maize per day. The most efficient plant of Maize Milling in Europe was capable, on the other hand, of processing 2000 tons per day.

The decentralization of the investment decisions and of the engineering of the production facilities made local differences in the production process more likely. There is no central policy at Maize Milling as to which techniques to use. The central office functions only as a consultant to the country engineer, who is responsible for the design of the facilities.

As an illustrative example of the implementation of an investment proposal, one can consider the case of an investment in Maize Italiana,

the Italian subsidiary of Maize Milling. The engineer of Maize Italiana collects all the information he requires, and presents the proposal to the Director of Manufacturing and Engineering at the European headquarters. The director convenes a committee to review the project. The proposal is analyzed, on a consultative basis, by the committee who makes suggestions to the Italian engineer, and provide additional information. The Manufacturing and Engineering group, however, function only as a staff position, the final authority in engineering remains with the engineer of Maize Italiana, who presents the project for approval to the Executive Committee. An unfavorable opinion of the Manufacturing and Engineering group can be overruled by the engineer of Maize Italiana.The president is then to decide whether to go ahead with the project or not.

After the presentation to the Manufacturing and Engineering committee the Italian subsidiary makes an economic analysis of the project. All cost figures are determined by the Italian subsidiary. After this has been done the project is sent to the Manufacturing and Engineering department for a risk analysis. This is done through a simulation model developed by the parent company in the United States which examines the influence of enviornmental parameters on the profitability of the project. Such factors as costs, prices, and exchange rates are varied and the sensitivity of profits to these variations is tested. The most sensitive variables are then isolated, and an analysis is carried out on these for their maximum, minimum, and break-even values.

For minor investment projects a discounted cash flow approach is used. The cost of capital to be employed in the evaluations is given by the U.S. parent for all projects.

In developing countries, in addition to adaptation to volume of output, there is also adaptation to product quality, since the local industrial users do not require the same grade of material as the users from developed countries. In the case of the East African investment, the government wanted a facility for import substitution production, and had no interest as to quality.

Maize Milling wanted to invest the least amount of capital possible so in this case it sent used machinery from the Beligan affiliate to Afric There was no effort to adapt to low wages. Management, also, expressed concern that too many workers pose problems, especially if they are not used to industrial discipline.

Case 3, Fertilizer Packaging in Indonesia[22]

In 1969, Gulf Oil Corporation and Pertamina, Indonesia's state-owned petroleum company, entered into a joint venture to operate a plant for bagging locally imported bulk fertilizer. Gulf had 51 percent of the shares and management control.

Previously, fertilizer was being imported in Indonesia already bagged. The Indonesian government, however, saw that some savings in foreign exchange could be gained by importing fertilizer in bulk form and performing the bagging operation at dockside in Jakarta.

The plant design was commissioned to Mr. Myers, an American engineer who had designed similar plants before. Mr. Myers traveled to Indonesia to acquaint himself with the local conditions (he also made an effort to learn the language). He realized that labor was relatively cheap, with the unskilled wage being approximately $.08 an hour, but also that it was difficult to lay off workers. Long-term capital could be available from state-owned banks at 12 percent a year, while working capital could only be had at 24 percent per year. Inflation was around 10 percent a year at that time.

The bagging operation could be broken down into five steps:

1. The unloading of the bulk fertilizer from the vessel and transferring it to bulk storage;
2. Removal from bulk storage;
3. The bagging operation;
4. Transfer to bagged storage; and
5. Shipping to customers.

For each of these steps, Mr. Myers considered both capital intensive and labor intensive technology. He performed an analysis to determine the operating costs per ton of each of the alternatives (there were 20 possible alternatives). He chose, in the end, to adapt technology to low labor costs in the bagging operation only, selecting a semi-automatic bagging technology instead of a fully automatic one.

With this solution, the total investment cost of the project was $281,000, and operating costs were estimated at $.60 per ton. Had he chosen the fully automatic bagging technique, instead of the semi-automatic one, the total investment cost would have risen to $549,000, and operating costs would have increased to $.78 per ton.

For the transfer to bag storage, Mr. Myers chose to employ a fork-lift truck instead of using the more labor intensive technique of hand stacking. Here the extra investment cost was $25,000, but operating costs for this operation were $.11, whereas they would have been $.15 for hand stacking.

Case 4, Electronics in Taiwan[23]

In 1967, the manager of the Consumer Electronics Division of Systek Corporation (a disguised name), manufacturing original equipment automobile radios, became alarmed at the trend of manufacturing costs for certain smaller type radios. For some of these low volume items such as "foreign AM radios" (radios for imported cars) and tractor radios the profit margins had all but vanished. The only possibility of restoring profitability for these lines was to reduce labor costs.

The manufacturing process contains three major operations. First, a number of electronic components are assembled onto a printed circuit board. Then, the connections are automatically soldered and cleaned, and then tested. Second, the printed circuit boards, with a tuner, transformers, and other components, are assembled onto a chassis. Third, the radios are tested, assembled into a housing, and prepared for shipment. Most of the operations on the printed circuit boards involve assembly line

work with unskilled operators using only a small pair of pliers. In contrast, the testing and trouble-shooting stages demand considerable skill and experience.

In order to cut production cost for the "foreign AM radios" and tractor radios it was decided to set up an assembly facility in Taiwan to take advantage of the low cost labor (as other U.S. and Japanese electronics firms had already done).

Mr. Harlan, previously a factory manager with the Consumer Electronics Division, was appointed operations manager of Systek Taiwan, as the new facility was to be called, with responsibility for plant design and construction, as well as for all aspects of production, procurement, and quality control.

In the U.S. plant, more than half of the assembly of printed circuit boards were performed automatically by the "autosert" machine, which required only three operators, but cost around $400,000; also the machine was troublesome mechanically and hence difficult to maintain. The manual assembly was performed at work stations arranged along a conveyor belt. The conveyor could be one of two designs: (1) it could have racks, which would hold the printed circuit board horizontally so that the components which are inserted by the operators would not slip out; or (2) it could be just a simple rubber belt on which the printed circuit boards would be carried at random. If a rubber belt were to be used, the operators had to crimp the end wires of each assembled component so that it would not slip out of the board. The conveyor with the racks was $15,000 more

expensive than the rubber belt conveyor. In the case of Taiwan it was clear that the lower capital cost and decreased maintenance requirement of the rubber belt would easily offset the potential saving in operator time, and it was decided to use rubber belts for all lines.

From the assembly lines, the boards were transferred to a "touch-up" line, where they were inspected and missing components added. Then they were taken to testing stations. The diagnosis of the defective boards required experienced trouble-shooters equipped with electronic test equipment. In the United States, this equipment included a number of voltmeters and ammeters of the visual-needle type, and the operators were highly skilled in observing several readings rapidly. For Taiwan it was decided to eliminate this type of meter as far as possible, using instead a "go - no-go" indicator light set for the desired control limits.

In planning the labor requirements for the Taiwan plant, the operations and methods used in the U.S. were utilized as a standard, and no major modification was considered necessary. The experience of other U.S. companies manufacturing in Taiwan was that Taiwanese operators were highly dextrous and very willing workers, and in several instances more productive than their U.S. counterparts.

The relative costs of producing printed circuit boards in the U.S. and in Taiwan were the following: AM radio printed circuit board costs $6.00 per unit in the U.S.; the same board manufactured in Taiwan would cost $4.97 per unit, meaning a savings of $1.03 per board.

Case 5, Furniture in South America[24]

The International Furniture Manufacturing Company (IFM Co.), a disguised name, was set up in Ecuador by an American enprepreneur, Mr. Alder, for the purpose of shipping high quality Ecuadorian furniture to the United States. The furniture would be shipped in parts to be assembled at the New York plant of the parent company of IFM.

Ecuador possesses very fine craftsmen in woodworking and Mr. Alder saw that he could make use of their special skills in furniture manufacturing to produce high quality pieces for the higher income end of the U.S. furniture market. Prior to making the investment Mr. Alder visited many U.S. furniture manufacturers and suppliers of equipment in order to get ideas that would enable him to design the best plant layout and to buy the most suitable equipment for his purpose.

The distinctive operation of the process was the carving of the parts, which took place in the Ecuadorian plant. The carving operation was performed by carving-copying machines. These machines were equipped with several units of carving tools, every one of which automatically followed the movement of a master unit actuated by the operator of the machine. Depending on the size of the model, every carving machine could easily carve 24 identical pieces at the same time. Machine carvings, however, were far from perfect with the equipment available, and every part would have to be hand finished by a skilled operator.

Assembly and finishing took place on a rudimentary line basis that required several unskilled workers to move units along the line.

Subassemblies were moved manually, and assembled units were placed on wheelracks that were pushed through the finishing department to shipping. (The plant manager, however, said that a conveyor was going to be installed to make assembly and finishing easier.)

One of the main sources of problems was the procurement of materials and supplies. Most of the things had to be imported: for example, tools, machine parts, finishing materials and abrasives. The majority of these imports came from the United States. There were problems also in production scheduling, with some instances when a machine was idle and some instances when it became a bottleneck. Particularly important was the loading of the copying-carving machines, a key operation in the process. These machines worked three shifts, and their operation required a highly skilled mechanic. Set-up took six hours.

A comparison of the IFM factory with another major furniture factory in Ecuador shows that the IFM factory was much more capital intensive. The other company was Bonanova S.A. (name disguised), which served the Ecuadorean and Andean markets. Bonanova was a smaller company than IFM, with monthly sales of $40,000 compared with the monthly sales of IFM of $250,000. On the other hand, Bonanova employed 100 workers, to the 140 workers employed by IFM. The total investment of Bonanova was $320,000, compared with the $2.24 million that IFM had invested in Ecuador. Thus, only $3,200 of capital was required for each Bonanova job, whereas $16,000 was required for each IFM job.

The equipment of Bonanova consisted of general purpose machines of German manufacture. Mr. Fabra, the general manager and owner of Bonanova,

said that the majority of furniture manufacturers in Ecuador and other Latin American countries used general purpose equipment imported from European countries, mainly Germany. He considered that these machines were very strong, required very limited maintenance, and their versatility enabled wide ranges in product lines. The total investment necessary was substantially smaller than if special purpose equipment were used, and the resale value of the machines was higher than the resale value of the special purpose equipment. Also important was the fact that Ecuadorean carpenters were more familiar with general purpose machines than with special purpose, and therefore training was easier. Finally, Mr. Fabra pointed out that the equipment suppliers had sales agencies in Ecuador or Colombia where, if necessary, replacement parts were easy to find.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Product Adaptation

Most of the products (except for the traditional ones) that one finds today in developing countries originated in developed countries, and underwent little change as manufacture eventually started in the developing countries. Most of these products manufactured locally are considered "mature" according to the product life cycle sequence. For example, one might find in a developing country a substantial market for non-leakproof batteries and inexpensive motor scooters, two products which have been declining in consumption in the U.S. and in Europe. Typically, such products are manufactured either by locally-owned companies or by investment from other developing countries. U.S. investors typically do not compete primarily on the basis of price but on the basis of product quality and brand names, so products manufactured by U.S. subsidiaries tend to be comparable with similar products manufactured in the developed countries or in developing countries by non-U.S. based multinational enterprises.[25] The local consumer is very conscious of "Western" quality standards through imported goods, so that products manufactured locally for the same market have little scope for extensive product adaptation.

The examples of product design by U.S. investors to fit low income markets are few. An oft cited case is the development of special low cost automobiles for developing countries by Ford and General Motors -- the so-called people's car. Although Ford and General Motors both are producing and marketing in developing countries a low-cost vehicle capable

of different passenger/cargo configurations,[26] the long-run competitive outlook for these vehicles vis-a-vis Italian or Japanese cars is still not clear. For example, would a car designed specifically for the varied road conditions found in Brazil compete successfully with the locally built Fiat 127, of which more than one million units have already been manufactured in Italy?

Product innovation by multinational enterprises in the development of new foods of a high nutrition content for developing countries has been less than successful. Often these foods tend to be more expensive than the nutritionally less valuable staple foods they are meant to replace. Also, the marketing of new foods has proven difficult in poor countries, where the products were not accepted by the population segment that needed them most. Furthermore, multinational companies concentrate their efforts on foods for the higher income end of the market because of the scarce profitability in producing for the lowest income levels. In this case an argument can be made for government subsidies to make the manufacture of such low-income, high-nutrition foods profitable.[27]

Clearly the problem of product adaptation requires more investigation. Studies should focus on how much product adaptation is done through corporate research and development efforts of large multinational firms, and how much product development is done at the level of the host country. Also, studies are needed on the dissemination of new low income product technology from design centers in developed countries to developing

countries. The development of simplified, but modern products, specifically designed for low income markets might prove a very fruitful ground for small engineering firms. However, the development of such products by large multinational enterprises seems much less likely, for these firms are more interested in concentrating on developing new products for high-income markets.

B. Process Adaptation

We suggested earlier that adapting to a more labor intensive manufacturing process in developing countries often is more appropriate than simply transferring capital intensive technology (adjusted for scale) from developed nations. However, at this stage of our knowledge of the problem, it would be wise not to make generalizations, but to approach each investment decision on a case-by-case basis, as is suggested by Chudson and Wells.[28] Most foreign investors, including the U.S. multinational enterprises, have a preference to use their own technology rather than adapt it to meet local conditions. Thus, some presence or inducement is likely to be needed to achieve adaptation. And, the larger the firm, the greater an inducement must be before it will become important to the firm.

Host countries are vitally concerned with the choice of technology and are likely to play a major role in achieving adaptation to meet local conditions. Hence, we spell out some actions that would be appropriate for them. An analysis of each major investment would be desirable, albiet time-consuming. Such an analysis would involve the calculation of both

the private profitability of the investment for the foreign investor and the social profitability for the host country -- the latter calculation is commonly referred to as "social cost-benefit analysis." If the social profitability, calculated using shadow prices, does not meet certain criteria, then the host country should ask the prospective investor to modify his proposal in the direction of more labor intensive technologies. However, we believe that knowledge of techniques to determine social profitability and knowledge of alternative technologies are not widespread in less developed countries.

In addition to this direct influence on investors, developing countries could take a number of actions (one specific and several general in nature) that would exert indirect influence on investors to choosemore appropriate technology.

First, the host government could facilitate the importation of second-hand equipment or equipment from other developing countries. Often governments of developing countries are loath to spend scarce foreign exchange on second-hand equipment since they feel they are getting "second-hand technology." Such an attitude biases investments towards a more capital intensive production because in newer equipment from the United States, Europe, or Japan, capital is substituted for labor (by increasing fixed capital per unit output, and reducing the number of operatives).

Second, developing countries could reduce factor price distortions in labor markets and capital markets. We have seen that relative factor prices have little effect on the choice of technology when investing

firms are able to avoid price competition, but, if the economic environment is more competitive, relative factor costs influence the choice of technology. The elimination of subsidies to capital for investors would be a step in the right direction. This should be accompanied by the elimination of tax holidays so that the calculated return on investment by the foreign investor would be made on an after-tax basis. This would add pressure towards cost reduction, and hence toward a more appropriate production technique. Also, duty free (or preferential tariff) importation of capital equipment should be discontinued, thus making the import of expensive machinery more burdensome for the investing firm. On the other hand, subsidies for employment should be offered to offset the difference between what the firm pays for labor and what the true cost of the labor is to the economy.

Third, the business environment could be made more competitive, so that investors will need to pay more attention to costs, and therefore will feel more pressure to adapt technology towards reducing manufacturing costs. This can be done by decreasing the degree of protection from imports, and also by seeking to enlarge the market, possibly through regional integration. Furthermore, a more attractively sized market can be offered to the investing foreign firm if the number of competitors in the industry is kept low. This might seem a contradiction to the recommendation to increase competition, but it has been the experience of many developing countries that a large number of producers in one industry, when the market is limited, actually results in higher prices. Effective competition could come from imports, and the degree of competitive pressure may be adjusted through the variation in import tariffs.

Fourth, a host country could take steps to facilitate foreign investment that is intended to serve export markets by taking advantage of low labor costs. These firms have a built-in competitive pressure to adapt their manufacturing process to local wages. Here the host country need not worry about increasing the competitive climate in order to bring about more adaptation, since this kind of investment seeks to reduce costs through full utilization of low wage labor.

Fifth, the host government could give very clear indications to prospective investors as to what its policy is on imports of foreign technology. Often, different ministries send out different signals to investors, which cause conflicting responses. For example, the ministry of industry might have a preference for "modern" investment, and the creation of a highly industrialized leading sector in the economy. The ministry of labor, on the other hand, might pressure the investor for maximum employment.

C. The Mode of Transfer

When technology is transferred together with equity investment, it is difficult to separate manufacturing technology from management technology. Indeed, often the host country is not aware of the alternatives. The foreign investor presents for approval to host governments a complete package, indicating few, if any, alternatives to the production process. The employees of ministries who review this project proposal are often not familiar with the industry.

But when technology is purchased via licensing agreements or in the form of equipment, this separation is made clear. Thus, technology not

packaged with an equity investment may offer more alternatives to choose techniques that are more appropriate to the local environment. Unfortunately, not all technologies that a developing country might need are available through licensing or equipment purchase, because U.S. multinational enterprises tend to prefer equity investments to pure licensing arrangements.

Though licensing permits the local entrepreneur or government a wider choice, the transfer of skills is, however, more limited than with an equity investment. In certain developing countries, for example, there might be no local firm capable of effectively making use of licensed technology. Joint ventures offer a good means of transferring modern industrial skills, while at the same time involving a local entrepreneur who might ask pertinent questions about the manufacturing process used. Still, some review of technology by the local government is probably desirable because the local partner might favor capital intensive technology (since this partner shares in the benefits of non-price competition) and thereby not pressure the foreign partner for more adaptation.

To be sure, studies have pointed out that U.S. multinational firms possessing exclusive technologies, which are held only by a few firms in the industry, do not readily enter into joint ventures as do firms in industries which have more mature technologies.[29] But this need not unduly handicap developing countries in encouraging technology transfer via equipment purchase, licensing, or joint ventures (or some combination thereof); because products and processes that are appropriate for developed countries are likely to be mature and hence are often available through licensing.[30]

D. Detailed Recommendations

The key conclusions upon which our detailed recommendations rest are:

1. U.S. multinational enterprise -- those large firms that account for most U.S. foreign direct investment -- base their corporate strategies on the products and processes they develop for use in the United States and other economically advanced countries. They have preferred not to change these products and processes unless pressured to do so, either by the direct influence of a government or by indirect influences such as strong competition.

2. The host governments should be the organizations most concerned with the use of appropriate technology, and are likely to play a major role in inducing firms to adapt products and processes to meet local conditions. Yet officials of local governments lack knowledge in achieving such adaptation.

3. The transfer of technology via purchased equipment, licenses, or joint ventures rather than through arrangements in which U.S. firms have 100 percent ownership will facilitate the adaptation of technology to meet local conditions.

The two key tools upon which our recommendations rest are: (1) educational programs and (2) monetary incentives.

1. Educational programs

Establish an "intermediate technology organization," perhaps a separate institute, with the primary function of providing in-depth training in the choice and evaluation of appropriate technologies. This

training would be provided for government officials and enterpreneurs from developing countries and for U.S. equipment suppliers, U.S. manufacturing companies, and U.S. consulting firms.

Although a number of viable formats could be developed, an illustrative one would be to have a "core" program in which the participants study individual cases of technology transfer to obtain better knowledge about the problems and opportunities involved, and also to learn about cost-benefit analysis so that differences between the view of the investor and the view of the nation are made explicit. The "core" program could be followed by a "practice" program, in which the participants visit U.S. firms engaged in the development of equipment, processes and products in order to insure that the U.S. entities are aware of the needs of, and exposed to opportunities in, host countries.

As an illustration of one possibility, officials in charge of the textile industry in less-developed countries and local entrepreneurs interested in textiles could visit U.S. manufacturers of textile equipment for a sufficiently long time to meet two goals: (1) the U.S. manufacturers would know local requirements; and (2) the persons from the less-developed countries would know the capabilities of the U.S. firms and become familiar with U.S.-made equipment. The net result would be greater exports of U.S. equipment, equipment that would be appropriate for the host countries.

Although the initial experience involved in starting the program would help in deciding upon future participants, we believe that it will prove important to involve officials of less-developed countries and U.S. equipment manufacturers. These two groups would have much to gain from the programs.

In addition to providing these "core" and "practice" programs, creation of a training organization would provide a permanent body of people interested in further dissemination of intermediate technologies to developing countries. Such a permanent body could:

a) organize conferences on particular topics concerning the problems and opportunities offered by intermediate technologies;

b) sponsor academic studies on appropriate technologies, and develop an archive of research cases drawn from various industries in several developing countries;

c) act as an information clearing house for U.S. technologies that would be appropriate for developing countries, and keep extensive permanent files open to all interested parties;

d) publicize its role of information dissemination, through circulars and advertisements in trade publications and by publishing a journal; and

e) provide experienced consultants both to governments and industry.

Prior to the creation of a formal organization, AID should take two steps to help insure that the creation will be successful:

1. Visit organizations in other countries, especially France, Japan, and the United Kingdom,[31] that are interested in technology transfer. Although none of these organizations are identical with the one recommended by us, something useful can be learned by visiting them. These visits should last a number of weeks in order to provide thorough knowledge.[32]

2. Organize an international conference on the subject of appropriate technologies for developing countries. Such a conference should last for a minimum of ten days. Its purpose would be three-fold:

a) educate decision-makers concerning the benefits of more labor intensive technologies for developing countries;

b) make these decision-makers aware of the analytical tools -- e.g. social cost-benefit analysis -- to soundly evaluate investment proposals;

c) discuss the establishment of the "intermediate technology organization."

The participants to such a conference should be:

a) officials from developing countries -- these officials should be employed in the ministries that evaluate foreign investment proposals, and should have themselves participated in such evaluations (AID could ask the governments of developing countries, through the American embassies, to submit suitable candidates for such a conference; the cost could be borne totally, or in part, by AID);

b) entrepreneurs from developing countries or their engineering personnel -- these should be persons responsible for equipment selection;

c) officials from countries that have a program of attracting foreign investment for export industries -- such as Indonesia, Korea, Malaysia, Taiwan, Singapore, Mexico and the Bahamas;

d) U.S. equipment manufacturers -- these could be attracted through appropriate advertisements of the conference plus correspondence and contacts with trade associations;

e) engineers from U.S. firms involved in the design of plants for developing countries -- advertisements and correspondence should be used;

f) personnel from U.S. consulting firms interested in less developed countries -- again, advertisements and correspondence should be used;

g) managers of U.S. multinational enterprises with an interest in seeking better technologies for less developed countries;

h) managers of U.S. firms in industries that suffer because of competing imports, and that would benefit from off-shore investment or procurement -- e.g. textiles, garments, shoes; and

i) scholars who have studied the problems of appropriate technology for developing countries.

2. Monetary incentives

Although we believe that the educational programs are likely to prove the most cost-effective method of obtaining results, some experimentation with monetary incentives should be worthwhile. Some examples of actions that AID could take include:

a) Ask U.S. investors about to invest in a less-developed country to develop a new design of plants that would employ more labor and use less capital than their customary plant designs. If the investor, after having developed a new design decided not to use it, AID would pay for the extra

expenses incurred in making the design (a limit on the expenses provided would be set in each case) and would obtain the rights to the design so that it could be made available to other firms. If on the other hand, the new design were to be adopted by the firm that developed it, no reimbursement would be due.

b) Give grants to U.S. equipment manufacturers to encourage the development of appropriate technologies for less-developed countries. The reward system might be similar to that discussed above under (a); i.e. the firm is paid for the design if it does not use it, but not paid if it does.

c) Give grants to consulting firms to encourage the coupling of foreign investment opportunities with U.S. companies; for example, a U.S. consulting firm could survey one or two low-income countries for investment opportunities and then encourage U.S. firms to exploit these opportunities by using appropriate technology. To illustrate: There are opportunities for investments in food-canning facilities in some African countries such as Kenya; a U.S. consulting firm could locate these opportunities and then form a company composed of a U.S. equipment manufacturer, a U.S. food company, and local entrepreneurs to start a factory utilizing appropriate technology.

d) Give special export credits for U.S. firms that export used machinery for use in less-developed countries.

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1 The definitions of developing and developed countries are from Survey of Current Business, October 1975, p. 53. The developed countries are: Canada, the countries of Europe, Japan, Australia, New Zealand, and South Africa; the developing countries are: the countries of Latin America and Caribbeau area, the countries of Africa, the Middle Eastern countries, and the countries of Asia and the Pacific, excluding those defined above as developed countries.

2 This is defined as book value of equity and long-term debt of U.S. enterprises in foreign companies which are more than 25% owned by U.S. companies.

3 For example, see Raymond Vernon, "International Investment and International Trade in the Product Life Cycle," Quarterly Journal of Economics, LXXX (May 1966), 190-207; Raymond Vernon, Sovereignty at Bay, (New York, Basic Books, 1971), Ch. 3; and Louis T. Wells, Jr. (Ed.), The Product Life Cycle and International Trade, (Boston, Division of Research, Harvard, 1972).

4 See Raymond Vernon, Sovereignty at Bay, op. cit., Chapter 3.

5 Robert B. Stobaugh, et al., Nine Investments Abroad and Their Impact at Home (Boston: Harvard Business School Division of Research, 1976); a summary of the findings appeared in "U.S. Multinational Enterprises and the U.S. Economy," Part II of U.S. Department of Commerce, The Multinational Corporation: Studies on U.S. Foreign Investment, Vol. 1 (Washington, D. C., U.S. Government Printing Office, 1972).

6 For a case in the automobile industry, see Stobaugh, Nine Investments Abroad and Their Impact at Home (Boston: Harvard Business School Division of Research, 1976); Chapter 2.

7 For a case example, see Stobaugh, Nine Investments Abroad and Their Impact at Home (Boston: Harvard Business School Division of Research, 1976); Chapter 5. For a discussion of the subject, see Robert B. Stobaugh, "The Economic Effects of the United States Electronics Industries Use of Item 807.00 Tariff Schedules of the United States," Hearings Before the United States Tariff Commission, Washington, D.C., May 14, 1970.

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32

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