APPENDIX
1.

PRM 33

Science and Technology in Developing Countries

I. Context and Definitions

Science and technology are at the same time symbols and engines of modernization. They are therefore subjects of importance and controversy for developing countries, and for those interested in or affected by the modernization of those countries.

As between the two, technology is perceived to be more important because it is more practical. Science is valued for its close relationship to technology as well as for itself.

The shorthand phrase "technology transfer" has become so embedded in the vernacular of international discourse that it is almost impossible to avoid. Yet it suggests a misleading analogy to financial or commercial transactions. Blueprints and know-how may be available for purchase, but technology must be managed, actively received, and adapted. A considerable part of the technology actually applied is generated by the recipient of the "transfer" in almost every case.

Another difficulty in discussing technology is the casual or even implicit use of the modifier "relevant" or "appropriate" without referring to a specific standard of relevance or

appropriateness. There is no solution except to try to be as clear as possible in each instance as to what technology, or what science is meant, and what standards are to be applied.

Science and technology are closely entwined with many aspects of the relationships between the United States and developing countries. Trade, commodities, investment, foreign assistance, for example, all raise important scientific and technical questions, as do food, energy, health, and industrialization. Scientific and technical considerations have important roles to play in policy decisions in these areas, and vice-versa; while there is something to be said about science and technology as such, most policy issues involve science and technology as aspects of other matters.

Among the factors that make a study of science and technology in developing countries particularly timely are:

-- the prominent place technology plays in the formal demands put forward by developing countries.

-- a perception among the U.S. scientific community, in Congress, and elsewhere of wasted opportunities for applying science and technology to our development and other foreign policy purposes.

-- increased awareness in both developed and developing countries of the important relationships of technology choice to achievement of social and economic objectives.

-- a search for ways in which the United States can respond positively to the more advanced developing countries who have particular interest in and capacity for improving their use of science and technology.

-- increased concern about the impact of international changes in scientific and technological capacity on the security and economic strength of the United States.

-- the need to resolve the negotiations in the United Nations Conference on Trade and Development (UNCTAD) on a Code of Conduct for the Transfer of Technology which will come to a head in a conference scheduled for October 1978.

-- preparations for the U.S. Conference on Science and Technology for Development (UNCSTD) scheduled for August 1979.

One of the intriguing aspects of science and technology as it relates to foreign affairs is its combination of the universal and the particular, embracing the interaction of scientific truth with the particular needs and circumstances of one place and one group of people. Moreover, science and technology bear a major part in our efforts to deal with problems that exceed the capacity of any one nation.

Evidence of the interaction is found in a remote sensing satellite that in a single day contributes data to a U.S. agricultural census, helps a Central American country evaluate its national resources, and makes possible the evaluation of drought threats in an African plain. It is found in our need to understand what is happening to the earth's climate, or the resources of the oceans; both of these needs demand continuous and detailed scientific observations at widely scattered places, and thus highly skilled scientists at work in those places.

People everywhere can benefit from fundamental research on the mechanisms of parasitic or enteric disease. The people in one valley in Southeast Asia may need the most sophisticated problem-solving techniques combined with their hard-won special knowledge to solve the problem of doubling rice production in one small area. Yet the persistent shortage of food in that and neighboring valleys may be felt in the prices paid by families in affluent cities on the other side of the world. Similar examples can be found in many fields: energy, natural resources, problems of the environment, population growth, the location and style of human habitation, to name only a few.

Thus an important concept relevant throughout this paper is the opportunity for mutual benefit from science and technology, particularly if approached with the purpose of mutual benefit.

in mind. Developing countries are by no means blind to this fact, although their perceptions of mutual benefit differ substantially from ours because of their relative deprivation. Moreover, they do not want to be dependent on technical solutions that are subject to the manipulation of others.

Enhancement of Developing Country Capability

One of the principal demands that form the New International Economic Order is for increasing the ability of developing countries to do more for themselves in science and technology. They perceive a struggle to reduce dependence by becoming better able to take advantage of competitive possibilities, generate the innovations and adaptations they require, make better choices among alternative technologies, and wring from the international business community the margin of know-how they lack, free from unwanted foreign presence or controls.

All developing countries have a need for enhanced capability, but their specific interests vary widely depending on their existing capacity and their development goals. As in all North-South discussions of technology, the lead is taken by a few of the more advanced countries, whose interests are in professional interchange at a relatively advanced level, in enhancing the relative role of domestic R and D, and improving access to sophisticated foreign information and judgements. While they are not concerned exclusively with technology related to modern

industry, it does have very strong priority.

The priority for industrial technology is shared by most developing countries. At the lower end of the capability scale, the needs include: development of educational, research, and dissemination institutions, building government planning and management capability; training at all skill levels; education and growth of technological awareness in the population at large; and early achievement of the capacity to apply technology in areas of high immediate pay-off, for example, to exploit natural resources or produce agricultural exports.

The demand for enhanced capability is one which the United States has welcomed on a number of occasions, both in general and with specific reference to technology for industry. We are in favor of greater self-reliance, and our private companies much prefer to deal with countries that have competence and understanding. On several occasions, in corroberation of our general position, Secretary Kissinger made a series of proposals for new initiatives that would contribute to developing country capacity in science and technology.

This policy is imperfectly reflected on U.S. government programs and actions affecting developing countries. The development assistance program, which touches mainly low income developing countries, places great emphasis on building LDC capacity related to the sectors of AID program concentration

particularly in agriculture. More general science and technology programs are financed by a catchall appropriation along with urban development, shelter, energy and environment, among other things, and according to current policy guidance, "most current AID activity in and consideration of problems in these areas is handled in conjunction with or as part of programs in other sectors, especially rural development." Each development assistance project must also be shown to be of benefit to poor people in the host country. The approach in the few countries receiving Security Supporting Assistance is broader, but overall, as compared with the past, AID gives relatively little assistance in areas such as higher education, training in management, engineering, industrial research and institutional support for industry, where past successful programs have played an important part in the development of such countries as Korea and Brazil. Only one of the U.S. initiatives for bilateral action related to science and technology capability in developing countries has been implemented in the three years since they were floated. (See Attachment D for a detailed status report.)

Multilateral activities we support, notably the United Nations Development Program, and the World Bank, do provide broader capability-enhancing assistance to developing countries, those on our bilateral aid rolls and others. The effort to find

an agreed basis to elevate the status of the United Nations Industrial Development Organization and expand its activities is continuing. Two of the principal US multilateral initiatives, creation of international institutes for industrialization and energy, have been aborted. Others, including an UNCTAD advisory service, and development of a program in the framework of the OAS, are still alive but not yet realized.

As for developing countries not receiving bilateral US assistance, a list which includes many of those most actively concerned with science and technology issues, there is no focussed program. With a few such countries we have bilateral science and technology agreements, sometimes supported by modest funds managed by the National Science Foundation. There is funding for cooperation with Israel in the form of a binational foundation. With these, and other small exceptions (see Attachment II), all efforts to help build capacity/non-aid-eligible developing countries must take place at their own expense through "reimburseable" programs; as part of the program of a domestic US agency, justified according to a domestic US rationale; or as part of a regional activity whose main purpose is to meet the needs of countries receiving bilateral assistance.

In summary, then, US action to help enhance the science and technology capabilities of developing countries consists of:

-- multilateral agency programs.

-- for aid recipients only, considerable help in agriculture, somewhat less in health, population and education, and very little in other fields, all of which must be shown to benefit the poor.

-- for non-aid recipients, primarily inclusion in programs intended for other purposes, or self-financed activities.

As compared with the expressed desires of developing countries as a group, what we are doing bilaterally falls short in two main aspects: in capacity to respond to the more advanced countries, and in limiting the substantive coverage in those countries we do assist to exclude many aspects of high priority to them.

The Foundation for International Technological Cooperation (FITC), which has been proposed by the President, is intended to fill both of these gaps, but the extent to which it will do so is unclear.

The brain drain question, which also appears on the agenda of developing countries, and was the subject of a U.S. proposal at UNCTAD IV, is a somewhat separable aspect of the capability issue. It is being considered at an UNCTAD Committee where the G-77 is taking a rhetorical approach and demanding compensation from receiving countries, and may arise at UNCTAD V. It is also

on the ECOSOC agenda and seems likely to come up at the UNCSTD. The United States has not given serious attention to the brain drain question for some years.

Using the Research and Development Capability of the Developed Countries

An overwhelming share, perhaps 95%, of all research and development is done in developed countries for developed countries. The results may have some application to LDC's but not by design. In reaction, the U.N.'s World Plan of Action for the Application of Science and Technology for Development (1970) proposed that the advanced countries should allocate 5% of all non-military R and D budgets, private as well as public, to the needs of the developing world; claims for a greater share of R and D attention are a regular part of Group 77 demands, were endorsed in the resolutions of UNCTAD IV and appear on the agenda of the UNCSTD.

Experience has shown that many developing country problems do require additional research specifically aimed at developing country applications. US foreign aid programs have devoted rising sums (unfortunately no useful statistics are available) to research and development activities of this kind. This has been most significant in the field of agriculture, where such activities have been given additional impetus in recent years by Title XII

of the Foreign Assistance Act. The initiative of the Ford and Rockefeller Foundations in applying US. and other international research capabilities to developing country food production problems through the International Agricultural Research Institutes is well known, and these Institutes now command broad international support. Although these research programs have been conceived with LDC interests mainly in mind, they have also brought benefits to the United States, as witnessed, for example, when a major prize for research benefitting US agriculture was awarded for work done on sorghum under AID contracts.

After an arduous review of the field, the National Research Council, in its World Food and Nutrition Study, found that there were many major research questions, for example, in human nutrition and plant productivity, with a common relevance to food production or consumption both in the United States and developing countries. This finding provided the conceptual basis for a recommended expansion of research by US institutions, often in collaboration with LDC scientists. So far, this concept is being implemented on a small scale through a new competitive grants program at USDA (which is in appropriations trouble), and AID's collaborative research grants program, for providing shared AID-University financing of research in specified subject areas.

A more recent NRC study prepared for the UN Conference on Science and Technology for Development has found similar needs for a common research program in such fields as disease control, improved methods of contraception, and the development and use of energy.

The US response to developing country interest in mobilizing our research capacity on their problems has thus been quite good in agriculture, though still far short of the potential. It has been less extensive in other fields, better in health and population which are other fields of AID concentration than elsewhere. Nothing has been done to encourage the business sector to devote a share of its R and D effort to developing country problems, although there is evidence that R and D of this sort does take place. Changes in US tax regulations, as they interact with LDC practices, have in fact somewhat discouraged this kind of corporate activity.

This general subject is also on the agenda of the proposed FITC.

National and International Regulation of Transactions Involving Technology

With their strong concern to control the application of technology for social and economic purposes, the developing countries give high priority to the subject of regulation. At both the national and international levels regulation applies

to all types of technology but this subject is most important in relation to proprietary technology, and to technology for application in industry. While developing countries vary widely in their readiness to make use of foreign industrial technology, to provide the necessary capital, or to attract investments that bring technology with them, they generally agree that industrial development is a necessary element of modernization and independence, and in the long run the only means of providing employment for their growing populations. All have an interest in acquiring technology. Their attitudes also vary considerably, however. The spokesmen in international forums on this question tend to be the more advanced and radical countries such as Brazil, Mexico, and India; other relatively advanced LDC's, such as South Korea and Singapore practice a much more market-oriented approach, but they and the less advanced developing countries give support to the G-77 leadership on this issue apparently more for reasons of solidarity than perceived immediate interest.

The developing countries tend to approach the issue as if fighting for a greater share of a fixed resource. They seek additional financial and other concessions. Recognizing that choices of technology involve key social decisions on matters such as wage and tax policy, they believe that this choice should be made under the close control of their governments, unhindered by outside pressures. The international system, and the strength

of multinational corporations, appear to restrict their freedom. They would like to be able to choose what they want of foreign technology, at reasonable cost, and without significant restrictions on how it should be employed. The more active of the LDC's try to use every bargaining advantage they can in order to achieve early and favorable access to the technology they feel they need.

The United States position starts from the realization that if developing countries are to make economic progress and particularly find employment for their populations, they acquire massive investment and the technology to make that investment effective. We believe that movement in this direction by the developing countries is important to our interests, and are confident that our own economy can prosper as it takes place, although significant and sometimes painful adjustments will be necessary. There is, however, a growing undertone of concern about the harmful effects of particular transfers of technology, that has shown itself in the attitudes of organized labor, and in legislative provisions initiated in the Congress that require proposed overseas investments or export financing to undergo a test for possible adverse impacts on domestic employment.

We think an open, competitive, market system is the most efficient means of handling transactions involving proprietary

technology, and that under suitable economic and social conditions, such a system can benefit developing country goals. The market for technology seems to be increasingly favorable from the point of view of the more advanced developing countries. The techniques available are generally ready and proven, and can usually be had--in near alternative if not exact form--from several sources. International business seems to be adjusting to new rules, moving away from insistance on 100% ownership of subsidiaries, and exhibiting greater willingness to license processes than in the past.

We therefore generally oppose constraints that limit the movement of technology in response to market efficiency; as we neither encourage nor discourage US investment abroad, we take the same neutral position on transactions involving technology. Since use of US technology abroad is frequently associated with US investment, it would be very difficult to take different approaches to the two. Moreover, our confidence in the ability of the US economy to adjust to change is based in large part on allowing economic efficiency to determine whether a particular transaction occurs or not.

At the same time, we have interests--developmental, economic, and security--in the choices of technology made by developing countries. An open system will not automatically induce technology choices that are suitable from the point of view of our

interests or of developing country objectives. Moreover, the market is seriously distorted by such things as lack of adequate information, misperception of risks and inadequate means of discounting such risks. Many developing countries are unable to take advantage of what is available because of insufficient capability.

These considerations lead to US willingness to intervene in various ways to improve the efficiency of the market, to a recognition that we need to exert some regulation of the movement of US technology abroad, and to the expectation that developing countries will seek to control inflows in their own interests. In addition, we support appropriate international standards and rules.

In the area of international regulation, there are two issues of principal importance currently:

1. Negotiations for changes in the conventions governing patents and trademarks, being conducted in the World Industrial Property Organization. These negotiations will not come to a head until late in 1979. While revision of the international patent system is a major plank of the G-77 position, the expectation is that these negotiations can be concluded without doing serious damage to the effective protection of industrial property of raising very difficult issues for the United States.

2. Discussions of a Code of Conduct for the Transfer of Technology being conducted at the United Nations Conference for Trade and Development (UNCTAD). A negotiating conference on this topic will be held under UNCTAD auspices beginning in October of this year. Long preliminary negotiations have not produced the outlines of agreement. Should the negotiations fail, the issue would undoubtedly be addressed at UNCTAD V in May 1979 and could spill over into the UNCSTD the following August.

The issues posed for the United States, and addressed in this PRM, are how far we should go in order to seek agreement on a Code, and what course of action we should take to mitigate the political impact in the event negotiations fail.

National regulation by LDC's has gone quite far, with many of the countries that are most active in the international technology market having enacted detailed codes of their own. These have forced major changes in the behavior of companies doing business in the countries concerned, and there are important difficulties:

-- refusal by some developing countries to recognize payments for research and development done in home laboratories as a legitimate expense. As this ruling intersects with present US. tax practice, it results in punitive taxation of such expenditures.

-- national legislation in such places as Mexico and the Philippines threatens the patent protection of any technology transferred to those countries.

In general, however, enactment of such legislation does not appear to have hampered the overall technological development of the countries involved. Moreover, there is a discernable trend for those countries to respond to experience by loosening or adjusting their rules on foreign investment and technology as experience reveals difficulties. The policy issue that arises for the United States is what concerted action, if any, we should take to try to deal with the expansion of developing country regulations concerning technology transactions.

Our own regulation of the flow of technology abroad has also shown a tendency to increase in recent years. Our first concern is security, and here we have longstanding procedures to control military and dual-use technology, in order to prevent it from being acquired by potential adversaries. In terms of its impact on friendly developing countries, this means procedural delay and sometimes controls on re-export of technologies, a proviso that has been a considerable irritant to some developing countries. In the nuclear area, we control exports of technology in accordance with our non-proliferation policy. In both the general security and nuclear fields, we seek the cooperation of

other countries possessing the technology involved to make sure that our controls are effective. There is no proposal in this PRM to make any change in these procedures. The only issue considered is whether export of dual-use technologies to friendly developing countries may undermine the objectives of our policies for the control of conventional arms exports.

While they do not involve control of technology as such, it is worth noting the increasing numbers of restrictions on related actions in the investment area, notably the human rights and US economic competition restrictions on the programs of the Export-Import Bank and the Overseas Private Investment Corporation.

Definitions of "Science" and of "Technology"

Distinguishing between "science" and "technology" is easy only for extreme examples of each.

"Science" has come to mean something like "systematized knowledge of the physical world; it connotes knowledge verified under the scrutiny of the larger scientific community and having predictive power. Allied with it are a host of fields under the rubric "the social sciences" (and other activities at even farther remove, such as "the managerial sciences"). Science may be pursued for its own sake out of intellectual curiosity, or it may be pursued to enhance applied endeavors (as "materials science" is currently attempting to construct theoretical underpinnings under hitherto poorly-integrated descriptive knowledge of how materials behave).

Dictionaires usually have "technology" meaning "the application of knowledge to practical purposes," or "the totality of the means employed by a people to provide itself with the objects of material culture" (Merrian-Webster, third edition). The former is both imprecise and overreaching (is economics "technology"?) and the latter risks excluding such endeavors as medical technology. It is probably better to have "technology" denote something like "physical means for modifying the human being or his physical world /including aspects of the social world/". The problem with this

kind of definition is that it tends to be granted enormous breadth; for example, the Congressional Research Service's publication, Science Policy: A Working Glossary (1976), asserts that "...technology encompasses all basic and applied research, all Edisonian inquiry, all manufacture and use of products, all knowledge rationally applied to agriculture, biomedicine, applications of sociology and other behavioral sciences, and any other rational human actions toward intended results."

Semantics aside, the key points germane to the questions implied by the problem of definition assigned to this section include the following:

-- Technology is embodied in many forms, including published, proprietary, and unpublished information; material products of experimentation, agriculture, and manufacture; and the knowledge and craft of skilled people;

-- The evaluation and adaptation of technological options often require resort to the body of knowledge and analytic techniques of the basic sciences (such as thermodynamics or crystallography);

-- The development of practical technical solutions often hinges on the effectiveness of general management, materials-supply scheduling, quality control, information management, and other such

techniques--so much so, in fact, that these techniques are often included in definitions of particular technologies (as, for example, computer software, command procedures, and materials-quality control techniques are essential aspects of space technology).

II. Other Issues

A. Role of Multilateral Organizations

In science and technology, as in other areas, there are circumstances where a multilateral approach has advantages over a bilateral approach, notably when there may be suspicion on the motives of individual donor countries, or where the expertise of technology required are more easily available or are of greater relevance to the developing countries in the context of the programs of UN specialized agencies. In some instances political considerations make a multilateral approach preferable. It is our policy to meet developing country needs through multilateral means whenever practicable. We recognize there are instances where our interests are such that only bilateral approaches are appropriate and practicable.

Largely because of the diversity of UN operations in science and technology and because of the inherent difficulties mentioned below, there has been no extensive US evaluation of the scientific and technological capacity of the UN system. In connection with the 1979 UN Conference on Science and Technology for Development (UNCSTD) the UN Office for Science and Technology (OST) is currently preparing a report on S&T activities carried out in the UN specialized agencies. A serious difficulty in identifying and evaluating resources allocated for science and technology activities is that there is no widely accepted definition within the UN of what constitutes

an S&T activity within the system.

Despite the difficulty of making a detailed quantitative assessment, however, comparable data are available of resources allocated across the system for activities directly or indirectly related to S&T. The 1977 report of the UN Administrative Committee on Coordination (ACC) contains tables of estimated S&T expenditures by the various UN specialized agencies. According to the report, in 1977 nearly $65 million were devoted to S&T activities related to the specific mandate of these agencies (in the WMO, for meteorology; in the IAEA, for atomic energy; in UNESCO, for technical scientific and engineering training and education, etc.). In addition to activities more directly related to S&T, many other UN programs and activities, such as agriculture (FAO), health (WHO), and industry (ILO) also have significant scientific and technological components. It is US policy to continue to support the UN Development Program (UNDP) as the major channel through which the technical assistance programs of the UN system should be financed.

In an attempt to coordinate and evaluate S&T activities in the UN system, the Economic and Social Council (ECOSOC) established in 1972 the Committee on Science and Technology for Development (CSTD) which was to be the focal point for continuing evaluation and assessment of the UN policy in science and technology. Another UN body, the Advisory Committee on the Application of Science and Technology

for Development (ACAST), established in 1963, is responsible for keeping under review progress in the application of science and technology to development and for proposing practical measures for such application for the benefit of the less developed countries. The members of ACAST are selected on the basis of personal expertise in problems of development, not as representatives of governments.

The ongoing restructuring exercise of the ECOSOC will consider whether CSTD and ACAST are to be preserved or whether they should be discontinued. If it is decided to eliminate one of these bodies, or both, the US should urge that its, or their, functions be preserved in the ECOSOC in whatever form will be most appropriate.

The US is opposed to the creation of a new UN program on science and technology similar to the structure and operations of the UN Enviornment Program, and to any assisgnments through the UNCSTD to agencies and other bodies in the UN system which are controlled by their own governing bodies, board or councils. We are prepared, however, for a general discussion of ways to strengthen the use of science and technology in the development programs of the UN system, and to review the merits of any proposal that the developing countries may make for regional mechanisms or centers that would permit them to pool their resources, or benefit jointly from scientific

and technological facilities that are not likely to become available at the national level.

In the areas of industrial and proprietary technology, we continue to favor raising UNIDO to the status of a specialized agency, the establishment of an UNCTAD advisory service, and continued support of the UN Center for Transnational Enterprises.

The World Bank and the regional development banks are in the first rank of the multilateral institutions engaged in the transfer of technology and the development of indigenous S&T capabilities. Their loan operations now emphasize such project components as agricultural research, project-related training, and the choice of appropriate technologies. As chairman and co-sponsor of CGIAR, the World Bank plays a central role in mobilizing grant-financing for international agricultural research. Several of the World Bank's economic research projects have made important contributions to the development of technologies which make greater use of indigenous resources. The International Finance Corporation serves as a catalyst promoting the transfer and adaptation of proprietary technology. Education programs are an important aspect of the operations of the International Development Association and the Inter-American Development Bank. It is thus in the US interest to support an expansion of S&T activities by these banks, particularly stressing increased application through bank projects of new and adapted technology shown to have promise in

meeting LDC needs.

This positive US stance should be moderated by two constraints:

-- The core activity of the banks comprises their development loan operations. With strong US support, internal management criteria have placed emphasis on keeping staff down. We should recognize that there is an apparent conflict between this criterion and an expanded role for the banks in science and technology.

-- Some developing countries regard the banks with a degree of suspicion as agents of the industrialized countries. US support for expanded bank activities in S&T would have a greater chance of success if we proceed deliberately, stressing the need for greater cooperation between the banks and the UN agencies, particularly UNDP, in specific activities.

The OECD should be encouraged to mount a program of analysis and assistance that would focus on the needs of the rapidly industrializing developing countries, who are not too far removed on the economic scale from several OECD members. The program would draw on the experience of those OECD members, and involve representatives from developing countries in assessing that experience in relation to their own. It should also be linked to a consideration of the adjustment of interests and sharing of responsibilities between OECD members and the rapidly industrializing developing countries.

B. Technology Choice:*

Economic conditions in developing nations differ in a number of respects from those of the industrialized nations. Typically developing nations have rather large ratios of unskilled to skilled labor. Likewise, the mix of skills within the skilled labor force often differs; some developing nations having larger proportions of general skill craftsmen and relatively fewer persons with highly specialized technical skills. Most developing nations also have a low rate of capital formation, so that they are characteristically capital-poor. Thus unit labor costs in these nations are generally lower than those in industrialized nations, both in absolute terms and relative to capital costs.

These conditions have led many to espouse the need to develop and use labor-intensive and/or capital-saving technologies in developing countries. Such technologies are sometimes referred to as "appropriate," but this usage can be misleading.

"Appropriate technology" as the term is used here means technology that is optimal for a particular situation in a particular developing nation, given that nation's economic and social conditions and goals. For example, if a nation's overriding goal is to maximize national income, the technologies used should be those that are most efficient, given relative factor costs within the nation.

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*This discussion is adapted from a report of the National Academy of Sciences, U.S. Science and Technology for Development; A Contribution to the 1979 UN Conference, 1978.

If, on the other hand, national goals stress creating jobs over maximizing national income, more labor-intensive technologies might be chosen. Indeed, for many nations this would imply technologies that are capital-saving and/or labor-intensive compared to corresponding technologies used by industrialized nations. It would also imply technologies that are relatively easily learned by workers with no prior industrial training or experience, and technologies to produce goods that are less specialized, simpler to use, and more versatile than similar products made in the industrialized nations. The manufacturing processes implied by these "appropriate technologies" do not necessarily have to be small in scale.

It is not at all clear that highly labor-intensive technologies are appropriate for all industrial sectors even in developing countries. For example, it is hard to imagine a simplified, labor-intensive process to manufacture petrochemicals. In the textile industry, where numerous variations on basic spinning and weaving technology exist, it has been shown that the most efficient technology for even the least developed nations is one that is capital-intensive relative to many known techniques, but labor-intensive relative to the spinning and weaving techniques that would be optimally employed in a highly industrialized nation. Moreover, in some basic industries capital-intensive investments may be the most effective way to promote more rapid growth of small

and medium-sized industry and establish the conditions for maximum overall employment in the economy.

There is a tendency to blame unemployment on the use of "inappropriate" technologies, in the sense that they use too little labor and too much capital for any particular level of output. The argument is that technologies are available or could be found that would employ more labor and produce the same levels of output at the same or lower cost. Undoubtedly, there are examples of mistaken choices of technology in developing (and developed) countries. However, technology assessment is a very inexact art, and circumstances change. Prior analysis would probably not prevent some mistaken choices, even if development goals and the criteria for selecting technologies are clearly established. In any case, there is little, if any, evidence indicating that the employment problems of the developing countries are primarily due to mistakes in the choice of technology.

Nevertheless, there are examples that indicate that a greater sensitivity is needed to the effects of technological choices. Even when the technological change substantially increases output, it may have negative effects on employment and other aspects of the economic and social structure (for example, when tractors are introduced into grain production systems in areas with a surplus supply of labor). In other cases technology of an advanced sort, such as an intensive care unit, may produce expensive benefits for a few, whereas a completely different use of the same amount of money for health technology could meet important needs for a great many.

It should also be recognized that the choice of technology in developing countries can be affected by policies adopted to protect labor or to provide incentives for investment. Minimum wage laws, social insurance programs, and unions all have important justifications, but their impact can increase the effective cost of labor and thus create incentives to substitute capital for labor. Investment incentives that lower the price of capital have a similar effect.

How to develop technologies that are "appropriate" to the goals of developing nations is the subject of wide controversy. It is unlikely that enterprises in developed nations will voluntarily invest substantial resources in the creation of new technologies designed primarily for use in small foreign markets. For this reason, new technologies suited to developing nations are most likely to be created by local business firms which would then have a stake in the outcome. Thus the kind of assistance activities best suited to promoting wise technology choices are those which are primarily designed to enhance the capabilities of developing nations to create and use their own technologies and would also serve indirectly to stimulate the creation of "appropriate technology."

However, local firms in developing nations, both publicly and privately owned, must have incentives to develop the capabilities to create their own technologies. For numerous reasons, present

incentives are inadequate. Investment in new technology is risky, and the magnitude of investment required to meet a specified goal is uncertain. Often the domestic market is too small for a firm to obtain a return that would justify substantial investments in the creation of new technologies. Both of these problems could be reduced if effective regional markets are created among developing nations. However, only the developing nations themselves, using their own capabilities, and sometimes adapting institutional experience from abroad, are best qualified to create the incentives necessary to induce local enterprises to invest in new (and "appropriate") technology.

C. Requirements for Data:

Among the policy issues associated with private technology transfer are the impact of technology transfers on the trade and domestic employment of the U.S., and the role of technology transfers in the development process. A reasonable analysis of these and other issues requires accurate information on the scope and magnitude of technology transfers abroad.

Information collected for the USG in the past has generally been incomplete and inadequate for arriving at conclusive statements on the economic impact of technology transfers. The Bureau of Economic Analysis has heretofore been chiefly concerned with collecting data on royalty and fee flows, in connection with their traditional responsibility for gauging the impact of such transactions on the balance of payments. Royalty and fee figures are commonly recognized as very imperfect measurements of technology transfer. Studies have also been contracted to external consultants, whose resources have usually proven limited in the amount they can learn at a reasonable cost.

A first step toward better USG information in this area is embodied in the International Investment Survey Act of 1976, which gave permanent and unambiguous authority to the President to collect data on international direct investment in a broad range of activities, including technology transfer. Pursuant to the Act,

a Benchmark Survey of U.S. Direct Investment abroad was initiated in 1977. The Survey will obtain responses for U.S. direct investors on several aspects of technology transfers.

One shortcoming of the Benchmark Survey, however, is that it will only collect data on technology transfers associated with direct investment activities. Specifically, transfers from an entirely domestic U.S. corporation to a foreign purchaser of technology are not considered. Another problem is that the survey will approach the issue of transfers of technology in fairly broad terms, and will not be suitable for much detailed analysis.

The Act does provide for special surveys and studies as are necessary to examine specific aspects of international investment. One or more such studies on technology are being contemplated for the future. Also, several legislative initiatives in Congress would call for greater examination of technology transfers. These and other possible efforts will be topics for consideration by a new Technology Subgroup of the Interagency Committee on International Investment Surveys. The Committee is chaired by the Office of Federal Statistical Policy and Standards of the Commerce Department.

Beyond what can be accomplished by direct US government activity, consideration should be given to providing support for U.S. academic centers to develop expertise on the flow of technology to developing countries, its size, nature, importance to the US

economy and to developing countries. Centers of this kind would meet a need in private industry as well as a public one, and should be able to secure outside financing.

These issues need to be addressed within the United States because of our combination of national and international concerns. But the credibility of results would be much greater for a high quality, apolitical international program of research and research training on the relationships among industrial growth, technology choice, national development and world production and trade patterns, as suggested by the National Academy of Sciences. The various means of mounting such a program, as proposed by the NAS, should be explored.

D. Brain Drain:

The brain drain has evoked a great deal of concern, constroversy, and rhetoric over the years among development economists. The movement of persons from residence in one nation to residence in another affects the supply of professional skills available in both places. Professional manpower is a scarce, necessary and valuable resource for any nation, but especially so for LDC's.

The concern is legitimate, but has at times been exaggerated. It has often been carried to an extreme that labels the brain drain as a major cause of underdevelopment and a factor in the gap between the rich nations and the poor. This overstates the case. The brain drain is not a central development issue. However, it is often viewed as one by LDC's.

It is worth devoting some attention to the brain drain now because an UNCTAD group of experts is proposing that the developed countries take unilateral measures to counteract the flow of skilled manpower and compensate the LDC's that lose skills through the brain drain. The same viewpoint dominates a report which the summer session of ECOSOC has forwarded to the General Assembly. There are signs that the issue may be prominent at the UNCSTD.

It is important to put the matter in prospective:

--The nature and extent of the brain drain are quite diverse among nations. It is not a universal problem for all LDC's, and the range of the effects can be wide. For some the magnitude may be small or the exodus (or non-return) may act as a safety valve in releasing pressure by unemployed groups. In no case can it be considered the cause of a nation's underdevelopment. In all cases the unique characteristics of each nation's migration pattern must be considered.

-- Rather than being a cause of pressing problems, marked emigration of professionals from a country may be a symptom of them. It may point to basic and underlying problems that require attention.

An interesting and relatively new aspect of the brain drain is the flood of developing country professionals who have been drawn, mostly from poorer Moslem countries, to work for the oil-rich Arabs. Some developing country governments seem to regard the remittance income as more valuable than keeping their brains at home.

USG responsibility in this matter can never be considered as great as that of the country of origin. We must, however, make sure that other policies we develop do not work at cross-purposes to LDC objectives for building a viable work force of professionals.

The causes of the brain drain have been exhaustively identified. They are the result of factors in the developing country "pushing" the professional out (lack of satisfying jobs and attractive working conditions, relatively lower salaries, absence of political and social opportunities, lower standard of living, etc.) The causes are also the result of factors "pulling" the skilled person to the developed country which are in many cases almost the reverse of the above. Obviously, some of the factors are inevitable and no policy measures can effectively remove the causes, or could not without distorting basic human rights. Part of the U.S. responsibility in this area may be to demonstrate to and work with the country of origin to identify the particular combination of factors that are "pushing" their professionals out (or preventing their return in the case of those who are educated in DC's and remain there).

Beyond assisting the LDC's individually and continuing to enhance training capacity in the LDC's themselves, there may be additional options for U.S. government action which can ameliorate the brain drain while also responding to other concerns expressed by developing countries in the preparations for UNCSTD. These include:

-- incentives to U.S. institutions and faculty members to provide educational and research opportunities for the large number of LDC students in the United States more closely related to the problems and needs of developing countries.

-- working with U.S. industry to provide on-the-job opportunities for LDC trainees that may lead to employment in the private sector at home.

Our recent changes in rules concerning immigration of doctors should have some favorable impact. It may be timely to look at migration patterns into the United States to determine whether any other adjustments in our laws or regulations are appropriate.

It has been suggested that a small group under State leadership should be assigned to prepare a current evaluation of the brain drain as it affects the United States and the LDC's, including the role of international organizations; to consider whether any program initiatives are warranted and whether any change in regulations should be proposed, and to establish a firm basis for dealing with the issue in international forums.

E. Old Initiatives (To be provided later)

(It is frequently remarked that most of the science and technology initiatives announced by Secretary Kissinger at the UN General Assembly, UNCTAD IV, and the OAS have languished, thus creating a credibility gap for U.S. spokesmen in this field. OMB has suggested that an interagency group should review the status of these initiatives and finally dispose of each of them. OES is working on a survey of the status of these initiatives. The results may well show that the policy decisions mooted in this PRM, together with past decisions and the passage of time, will have reduced the number of open old initiatives to zero or almost to zero. Completion of this section will await the final results of the OES review.)