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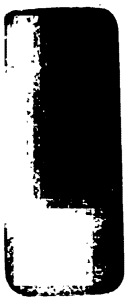

U.S. POLICY FOR THE 1990S: SCIENCE AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

Report of a Symposium

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This report has been reviewed by a group other than the participants according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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The Board on Science and Technology for International Development (BOSTID) of the Office of International Affairs, National Research Council, addresses a range of issues arising from the ways in which science and technology in developing countries can stimulate and complement the complex processes of social and economic development. It oversees a broad program of activities with scientific organizations in developing countries that includes overseas activities, research grants, published reports of studies, advisory committees, conferences and seminars, and outreach activities.

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U.S. POLICY FOR THE 1990s: SCIENCE AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

INTRODUCTION

Key issues in science and technology in United States foreign economic assistance programs for the decade ahead were the focus of a two-day symposium in April 1988 organized by the Board on Science and Technology for International Development (BOSTID) of the National Research Council. The symposium was part of a national project organized by Michigan State University in cooperation with several other American institutions and organizations to study and advise on U.S. policies of economic cooperation with the Third World in the 1990s. A report on the national project, New Challenges, New Opportunities: U.S. Cooperation for International Growth and Development in the 1990s, is available from the Center for Advanced Study of International Development at Michigan State University.

While the BOSTID symposium primarily addressed issues in science and technology in relation to development, the participants also raised broader questions of economic and social development in the Third World. Representatives of several U.S. government agencies, universities, foundations, international organizations, and the private sector contributed their ideas in an informal setting. The objectives of the symposium were to achieve a better understanding of the needs in science and technology in developing countries in order to highlight major issues that should be addressed in the next presidential administration. The participants heard four speakers outline major issues and then divided into six working groups on the topics of basic and applied research, technology development, policy assessment and management, the least developed countries, the advanced developing countries, and mechanisms and institutions necessary for implementing scientific and technological cooperation programs between the United States and developing countries.

The symposium was chaired by Ralph Smuckler, Dean of International Studies and Programs at Michigan State University and chairman of BOSTID. The featured speaker at an opening dinner was David Hopper, Senior Vice President for Policy, Planning and Research of The World Bank, who stressed that developing countries must build up their capacity, especially in human resources, for absorbing the rapid advances in science and technology and making informed choices about them. The four plenary speakers who set the tone for the working group sessions were:

Nyle C. Brady, Senior Assistant Administrator, Bureau for Science and Technology, Agency for International Development (AID), who outlined the issues in basic and applied research in developing countries;

Jordan Baruch, President of Jordan Baruch Associates and former Assistant Secretary of Commerce for Science and Technology, who discussed issues in technology development;

Francisco Sagasti, Chief of Strategic Planning, The World Bank, who spoke on science policy and technology assessment; and

Kenneth Prewitt, Vice President of the Rockefeller Foundation, who described the rationale for the Foundation's program in Africa.

The symposium was held at the National Academy of Sciences in Washington, DC. It was supported by grants from the James S. McDonnell Foundation and the U.S. Agency for International Development (AID). This report is an account of the presentations and working group discussions and does not necessarily represent the views of the Board on Science and Technology for International Development nor of the sponsors.

SUMMARY AND CONCLUSIONS

Symposium participants agreed that science and technology have made vital contributions to development and will continue to do so; that it is urgent that developing countries have the capability to assess their needs, do the research, and apply the results; and that science and technology should be used to encourage the development of environmentally sustainable resources, including human resources. The goal of science and technology for development must be to build indigenous capacity in developing countries, particularly those without an infrastructure or S&T base, to enable those countries to make informed choices about their own problems.

Participants also agreed that the terms "aid" and "development" have lost their urgency and may need to be replaced. A new vocabulary is needed to attract new support. Development problems are global scientific problems and should have the highest international priority. The diversity of nations and the growing inequality between the developed countries, the more advanced developing countries, and the least developed countries calls for a sensitivity in our approach to development problems.

Scientific Research and International Scientific Collaboration

Basic and applied research provides opportunities for collaboration between scientists in developed and developing countries and brings universities into a leading role. American universities are training thousands of developing country scientists and engineers, many of whom face limited opportunities for employment in their home countries. Administrators in American universities must find ways to encourage American scientists and engineers to focus on developing country problems.

Developing country scientists should become more involved in international scientific collaborative activities. Examples of such programs are the International Geosphere-Biosphere Programme - A Study of Global Change (IGBP), the International Decade for Natural Disasters Reduction, and the program to map the human genome.

Cooperative mechanisms for bilateral or international scientific research should be encouraged. In the past, there have been several successful programs, including the National Academy of Sciences' Brazil Chemistry Program, the National Science Foundation's Science and Engineering for Economic Development (SEED) Program, and the BOSTID Research Program. Stable international or regional scientific institutions, such as the Third World Academy of Sciences, the African Academy of Sciences, and the United Nations University are also needed.

Technology Development

The private sector should become more involved in technology development through such mechanisms as the U.S.-Israel Binational Industrial Research and Development (BIRD) Foundation and the U.S.-India Program for Acquisition of Commercial Technology (PACT). Such programs link U.S. and host country enterprises, providing loans and encouraging risk-taking, backed by good management.

Alternative approaches to development, such as micro-enterprises, should be examined. Micro-development produces change slowly and brings about improvements in the infrastructure when their absence impedes development. Micro-development also builds indigenous capacities by training local managers on the job. One advantage of such enterprises is that their failure does not cripple the country, and the risk-takers are not labelled as failures just because the project did not evolve as planned.

To develop technology, an S&T base or infrastructure must be established with technical support facilities, laboratories, etc. Human resources, especially managerial skill, upon which technology development depends, must be strengthened. Technology development must be for the mutual benefit of the United States and the host country, and science policy issues such as intellectual property rights and equal access to information, research facilities, and field sites must be recognized.

Assessment, Management, and Policy Issues

Because countries and regions have differing needs, capacities, and comparative advantages, greater flexibility is required in designing development assistance. The success of culturally-sensitive programs, such as the National Center for Industrial Science and Technology Management Development in Dalian, China, and the state-level technology development effort based in Bangalore, India, underscores the importance of transmitting change through existing socioeconomic structures. The importance of science and technology to policy formulation must be stressed. Early application of rigorous scientific analysis of development problems is necessary to generate a broad range of sustainable options.

Least Developed Countries

In these poorer countries, new programs, new institutions, and new mechanisms are needed to target specific, chronic problems. Traditional humanitarian motives for foreign assistance should be linked with broader and longer-term environmental concerns to halt the degradation of natural resources affecting the quality of life of people in the least developed countries. U.S. assistance programs should be directed at survival needs, such as the supply of basic foods, emphasizing the applied sciences to rebuild the agricultural resource base in anticipation of later economic growth. Governmental or bilateral programs should focus on building infrastructure and human resource capacity and should encourage innovation by the private sector in small-scale, technology-based enterprises in key areas.

Advanced Developing Countries

The United States should create "partnerships" with the advanced developing countries based on mutual benefit and broader, long-term national interests. Through such partnerships, the U.S. government and its technical agencies can strengthen collaborative programs and encourage private sector involvement. The issues of intellectual property rights and equal access to data and other information deserve special attention. U.S. government programs with a given country should not be centralized in one U.S. agency but remain decentralized as they are today. However, Presidential-level programs, such as the Science and Technology Initiatives with India and Brazil, could serve as models where appropriate. The United States and the advanced developing countries might collaborate to solve problems in the least developed countries.

Mechanisms and Institutional Issues

Many of the new and rapidly changing areas of science and technology are in frontier fields such as biotechnology, materials science, and manufacturing technologies, but most of the U.S. governmental delivery mechanisms for science and technology assistance have been in place for over a quarter century. U.S. foreign assistance programs should draw the private sector into technology development and should make use of private, intermediate organizations and institutions. A central agency promoting science and technology for development, such as the Institute for Scientific and Technical Cooperation proposed a decade ago, still has merit. Alternatively, the U.S. foreign assistance agency should have a strong division with a central focus on science and technology, while maintaining a sectoral approach to provide expertise. Greater coordination of S&T activities outside AID is needed, possibly along the lines of the Presidential Initiatives with India and Brazil. Multilateral mechanisms for delivering science and technology, such as the World Bank and United Nations agencies, deserve closer attention by the United States.

PLENARY PRESENTATION HIGHLIGHTS

Nyle C. Brady: Although the application of science and technology has brought about accelerated economic and social progress in the industrialized

world, it has not had a comparable effect in the developing world. S&T has had a significant effect on solving basic problems in agriculture, health, and population in the developing countries, however. As we look to the challenges of the future, we must question whether the priorities of the U.S. technical assistance program during the last thirty years are appropriate for the 1990s and beyond. We must be prepared to deal with the increasing problems of urbanization and other social and economic pressures in the least developed countries, as well as find methods for S&T cooperation with the advanced developing or middle income countries.

Jordan Baruch: We must examine alternative models for technological cooperation with developing countries. The micro approach to development, as opposed to the macro approach with large capital projects, should be applied where appropriate. Models such as the BIRD (Binational Industrial Research and Development) Foundation with Israel and the PACT (Program for Acquistion of Commercial Technology) with India should be encouraged. Such programs link U.S. and host country commercial enterprises and provide loans for joint ventures. Some of the advantages of micro-development are that it produces change slowly, brings about improvements in the infrastructure when their absence impedes development, and helps build indigenous capacities by training local managers on the job. The failure of a micro-enterprise does not cripple a country, and the risk-takers are not labelled failures because the project did not evolve as planned.

Francisco Sagasti: We must find ways in which to apply scientific and technological solutions to improving the standard of living in developing countries without incurring tremendous social costs. In the next decades, slower economic growth, coupled with the explosion of demands for housing, health care, and other social services, will create a crisis in developing countries. Particular attention must be paid to technology policy in the process of applying science and technology to these problems. Developing countries face the need for new concepts of economic management and pragmatism. Generalized solutions cannot be applied to developing countries indiscriminately. The United States should not adopt narrow national policies of protectionism, which are counterproductive to efforts in developing countries. The United States should live up to its commitment of ten years ago to contribute to a United Nations financial system for Third World science and technology development.

Kenneth Prewitt: The Rockefeller Foundation's program in Africa is based on the following four premises: (a) that scientists in the developed world must be constantly mobilized to work on developing country problems, (b) that indigenous capacity for science and technology must be created and strengthened, (c) that policy constraints at the national level in the developing countries must be addressed, and (d) that scientists and development planners must understand and overcome the seemingly innumerable barriers that frustrate the development process. In Africa, building indigenous capacity in science and technology requires working with three sectors: scientists and technical personnel, policymakers, and the general population. In African countries, the United States must find ways to work with and link these sectors to create a demand for science-based development strategies.

WORKING GROUP DISCUSSIONS

PURE AND APPLIED RESEARCH

Moderated by Walter A. Rosenblith, Institute Professor at the Massachusetts Institute of Technology and former foreign secretary of the National Academy of Sciences, this group focused on the role of American universities in the training of foreign scientists and engineers and on the benefits of international scientific cooperation. The large number of foreign students in the United States poses a problem of brain drain for the developing countries, but it also offers them the opportunity to create a cadre of highly trained scientists and engineers who will eventually return to their countries, one way or the other, to contribute to their economic development. Successful programs that have fostered cooperation between scientists in developed and developing countries were cited: the National Academy of Sciences' Brazil Chemistry Program, the National Science Foundation's Science and Engineering for Economic Development (SEED) Program, and the BOSTID Research Program. International scientific organizations such as the Third World Academy of Sciences and the United Nations University and global scientific programs such as the Global Change Program of the International Council of Scientific Unions and the program to map the human genome were also discussed as opportunities for collaboration.

Role of the Universities

It was stated at the outset of the discussion that the subject of basic and applied research is so all-encompassing that in effect "nothing is ruled out." Basic and applied research are not discrete entities, but rather a continuum along which different elements are emphasized at different times. In the developing countries as in the United States, research is intimately connected to the universities, and the role of the universities is of great importance. Willingly or unwillingly, the U.S. universities have been thrust into a role vis-a-vis the developing countries, as the United States has become in effect the university of the world.

There has been no official or coherent policy, and no incentives specifically planned for the universities, but universities in the United States are host to a large number of Third World students who are seeking higher education outside their own countries. There are about one million expatriate students in the world. In U.S. universities, there are 350,000 foreign students, the overwhelming majority of whom are from developing countries, including China. Forty percent of them are graduate students, primarily in engineering, management, and science. There are also a large number of postdoctoral fellows and visiting faculty.

It is important to understand better how the development process is coupled to the flow of students. It is easy to see the advantage that is accruing to U.S. universities. Many university departments in engineering and science are dependent upon these foreign students. They fill a large proportion of places

in the classroom, serve as low paid teaching and research assistants, and ultimately fill many faculty positions. Those who study in the United States are generally friendly to this country and when they return home, they form a backbone of pro-American feeling among leaders of the Third World. Many do not return, however, but stay to work in our universities, industries, and government research laboratories.

These students are educated at the frontier of science and technology, and many will no longer fit into the academic or scientific environments of their home countries. Most developing countries simply cannot absorb many PhDs. People with masters degrees fare somewhat better, however, since they are more flexible about career choices. But some other industrialized countries, such as the United Kingdom, do not encourage students to remain after their degrees; there is no work for them and they return home. In the United States there is a general reluctance to enforce the expulsion laws, and professors often expend considerable effort to place their students in jobs here. Therefore, some developing country governments do not consider higher education in the United States as a development tool.

Other countries take a broader view. Emigrant scientists represent a resource that may be tapped periodically or mined at a later date. Many return periodically to their homeland, invest funds, or offer advice based on broad experience in advanced laboratories. There are organizations, like the International Society of African Scientists, which facilitate this process. China has encouraged overseas study despite the danger of brain drain with the philosophy "some will return now, others will return later." This policy may be changing, however.

Similarly, some reports indicate that there are 2,000 Korean engineering faculty in the United States, whom Korea is able to "mine" effectively. There is evidence that the benefit to the American side has also been substantial, since Korean students who return to their country in positions of authority often give lucrative contracts to U.S. firms or universities. These returnees also provide an effective pro-democracy and pro-science lobby in Korean national affairs.

There are other, broader interests served by training large numbers of developing country students in the United States or other industrialized countries. For one thing, great scientists are rare events that may occur anywhere in the world. Their discoveries serve all of mankind when they are given an opportunity to reach their highest capacity, and it is in everyone's interest that they be nurtured. It is also in the broad interest of the United States to develop an indigenous scientific capability in all countries. Basic science provides a foundation for industrial development everywhere, and developing country prosperity benefits the United States in the long run. U.S. foreign assistance is directed toward the strategic countries, however, almost ignoring those countries that need assistance the most.

The effective use of science and technology in development has been evident in the advanced developing countries (often referred to as "NICs," or newly industrialized countries). By and large they have followed a common path to development. They sent large numbers of students abroad and provided

incentives for them to come back. They imported technology, improved the design, and adapted it to their own industrial capability and situation. With some protection in the home market, they were able to lower prices and compete effectively with the original technologies. Only when the industrial base was secure did they begin to emphasize basic research. The Japanese are the prototypical example of successful application of this strategy.

Why is it that most developing countries are unable to repeat this experience and profit from their returning scientists? In many developing countries, the science departments are decades out of date, both in terms of facilities and technical equipment and libraries and information resources. Scientists there do not have the opportunity to remain at the forefront of their fields.

It was observed that the United States also does not make maximum use of the potential application of science and technology to development. U.S. universities are at the forefront of our research efforts, but they are not used effectively in the foreign assistance program. There are few incentives for U.S. universities to get involved in development work. The "impedence mismatch" is so great that universities should get together, approach this problem cooperatively, and decide how they could be better used, what they want, and how to make it more "legitimate" for American scientists to work on development problems. It is easier for American universities to justify working with the advanced developing countries, where the mutual benefit is more apparent. The U.S. private sector also has a role to play in international training and research, especially in providing opportunities for postdoctoral fellowships.

International Scientific Cooperation

Science is important to development beyond the training of technical personnel. Many of the most serious problems affecting developing countries, such as malaria, child mortality and low crop yields in tropical soils, are unsolved not only because few resources are devoted to them, but because the scientific bases of the problems are poorly understood. Yet most scientists work in advanced countries and most of their efforts are dedicated to industrialized country problems. The scientific communities of all countries must be mobilized in the effort to solve the problems of the Third World.

Three successful examples of international scientific cooperation were noted: the National Academy of Sciences' Brazil Chemistry Program, which was organized in the 1960s; the National Science Foundations's Science and Engineering for Economic Development (SEED) program; and the BOSTID Research Program, which brought U.S. resources and technical assistance to Third World scientists working on their own problems in their own countries. All three have been phased out or abruptly cut. There are other cooperative mechanisms at work in agriculture, such as the Collaborative Research Support Program (CRSP) in which AID supports collaboration between U.S. universities and developing country institutions, but not in most other fields.

The existence of stable international institutions that foster science development is likewise important. One example is the Third World Academy of Sciences. Although it is headed by Nobel Prize winner Abdus Salam of Pakistan, it has had difficulty attracting the attention of Third World governments, or for that matter advanced country governments, with the exception of Italy. Unfortunately the United States government does not have a mechanism for interacting with the Third World Academy. BOSTID, however, has collaborated successfully with the Academy in identifying ways to strengthen basic research on soil science in Africa. Another useful entity for fostering research and international cooperation is the United Nations University, with which the United States is minimally involved.

Scientists in developing countries should be encouraged to participate in global scientific programs such as the International Geosphere-Biosphere Program of the International Council of Scientific Unions. This program will involve scientists around the world in the study of the phenomenon of "global change." The work will require close cooperation among scientists in different countries on problems such as the hole in the ozone layer and the greenhouse warming of the globe, which affect all countries and peoples. Other problems that must be attacked on a global scale include species extinction and AIDS. The program to map the human genome, which is an effort to analyze our genetic heritage, is another excellent opportunity for international cooperation.

However, for understandable reasons, many developing countries do not give high priority to these problems. They cannot take an active role and contribute what is necessary without adequate resources and an active scientific community. On the other hand, for political reasons, they cannot be used as passive laboratories where foreign scientists can come to do their research. The dilemma will become acute as international scientific efforts develop, and action must be taken at an early date to prepare all countries to contribute to research activities.

There are multinational centers for training Third World researchers. Foremost among them has been the International Center for Theoretical Physics in Trieste. It has played an active role and become a significant center of advanced research itself, with generous support of the Italian government. Four additional centers in different fields are planned, with continued support from the Italians. The Germans also have a major program to host developing country scientists in German laboratories. Why does the United States government not do as much? In the past the U.S. government helped create institutes of technology in India and has cooperated with scientific institutions in Latin America. The Agency for International Development does little institution building in general, however, and almost none in the scientific field.

Global scientific problems, including development problems, should have the highest international priority. Perhaps the terms that are used have worn out their immediacy, and a new vocabulary should be employed to attract new support. Biodiversity should be called "species extinction." Instead of deforestation, we should say "soil loss and water shortages." The term geosphere-biosphere should be replaced with "global change." Even the words "development" and "aid" have lost their urgency and need to be replaced with a term such as "development cooperation."

DEVELOPMENT OF TECHNOLOGY

Moderated by Dale Corson, President Emeritus of Cornell University, the working group discussed the need for more private sector involvement in the development process and various models were cited as mechanisms for technology development. Concern was expressed over issues such as intellectual property rights and equal access to information. To develop technology in the developing countries, the United States must help establish an S&T base or infrastructure through technical support facilities, laboratories, etc. Strong educational systems are also needed. The United States should look to models such as the international agricultural research institutes and the Institute for Scientific and Technical Cooperation (ISTC), proposed a decade ago. The group stressed that U.S. technological cooperation with developing countries should be of mutual interest and benefit and that programs must be tailored to a country, a region, or a sector--and not be all-encompassing. In the advanced developing countries, emphasis should be placed on private sector activities and relatively little money spent on bilateral S&T programs.

Several issues were identified at the outset of the discussion: the nature of the help that the United States can give to the developing countries and whether we are able to attract the best people in the process; private efforts as well as official or public assistance to developing countries; humanitarian versus commercial interests; whether the United States should focus on the less developed or the advanced developing countries; and the recognition that there is a growing gap between the technologically capable countries and those less capable. Those who have the greatest capability will benefit the most. We are dealing with a changing situation. The economic growth rates will be less than those of the past thirty years, yet there will be an explosion of social needs as the population expands, and we will have to learn how to deal with these problems.

During the course of the discussion, several points were made:

- Any collaboration and cooperation should be of mutual interest and benefit.
- U.S. activities have to be tailored to a country, to a region, or to a sector; we cannot devise an all-encompassing program that operates from one place with one set of rules.
- Traditional U.S. foreign aid has little prospect of increasing in the next five to ten years because of the mood of the country and the high budget deficits.
- Development assistance should be separated from economic and military assistance. Within the small development assistance budget available, the United States should emphasize science and technology programs.

- It is in the broad self-interest of the United States to help developing countries progress. We live in a global world and should be concerned with the other 90 percent of the world's population.

- The definition of "sustainable development" as stated in the report of the symposium organized by the World Resources Institute was accepted: development must be sustainable in terms of resources and environmental impact. Added to that should be an assurance of the environmental suitability of technologies that are transferred.

- Successful family planning programs in some Asian countries should be examined for applicability to Africa. The United States could assist by providing the training for those who implement the programs.

- Risk-taking is critical in development programs, and decision-making must be in the hands of people in the developing countries. Entrepreneurs in developing countries and the United States must each recognize that economic development will serve their self-interests.

- Recipients of development aid must improve their own technological capabilities if the aid is to have lasting impact. The United States must be prepared to support an assistance project until it reaches a take-off point.

The group put particular emphasis on the importance of more private sector involvement in development, particularly given the likelihood of limited official development assistance in the near future. One appropriate program might be an international parallel to the Small Business Innovative Research program (SBIR) in the United States, in which funding is set aside in all government agencies. Another possibility would be to create a brokering agency that would bring together entrepreneurs from the developing countries with individuals in the United States who are eager to develop innovative research programs in other countries. This agency could also assist with transfer of appropriate technologies.

Two other existing mechanisms were discussed: the U.S.-Israel Binational Industrial Research and Development (BIRD) Foundation with Israel and the Program for Acquisition of Commercial Technology (PACT) with India. The BIRD model might be appropriate in a wide range of countries, but with modification and a reduced level of risk. The PACT requires an infusion of funds from AID which might not be available for many countries. Also, U.S. venture capital firms could be used to identify technology opportunities and match them with small companies.

In response to the discussion on the role of U.S. small business in development, two comments were made. First, there should be a range of activities involving the macro-, moderate-, and micro-sized businesses. People who know how to analyze markets are required, especially those who are able to think not only of U.S. markets but consider world markets as well. It was

suggested that the U.S. private sector should become involved in development at both the regional and national level abroad. Consideration should be given to creating a Trade and Development Institute, with funding by the private sector and offices located abroad.

For successful technology development activities to occur in a developing country, a scientific and technological base is needed. The United States can help develop the S&T infrastructure in developing countries through support of institution-building, education and training, and development of S&T policies. Those policies include consideration of intellectual property rights and information access. Countries also need policies to encourage local innovation and develop managerial talent. Management and administrative skills were singled out as areas in which the United States has an edge and could make an impact.

Education is a big factor in all these considerations and any development program should have education as a large part of the activity. Current demand in developing countries is for more hands-on training rather than long-term academic training. Therefore, in the future, the immediate needs should define the areas where training efforts should be directed. For example, emphasis should be on practical training rather than academic training in many instances. The link between basic science and payoff in the Third World is tenuous and has no connection with economic productivity. It was cautioned, however, that the developing countries need a strong academic system to produce home-grown technicians and scientists. Also, some problems can best be solved with cutting-edge technologies.

Since the international agricultural research institutes have been so effective, the United States should look into the possibility of establishing similar institutions, focused on other problems, such as health, population, energy efficiency, or the environment. In addition, perhaps it is time to reevaluate the concept of the Institute for Scientific and Technical Cooperation (ISTC), proposed a decade ago.

In the advanced developing countries, emphasis should be placed on activities with heavy private sector involvement and relatively inexpensive bilateral S&T interactive programs. In the least developed countries, particularly in Africa, the United States should help strengthen institutions and train people on a long-term basis, both in the countries themselves and in the United States.

Finally, in any future foreign assistance program, the name "AID" should be changed and the word "development" should be dropped.

ASSESSMENT, MANAGEMENT, AND POLICY

Moderated by John H. Gibbons, Director of the Office of Technology Assessment, U.S. Congress, the group examined the present U.S. foreign assistance program in light of its tangled and often contradictory history. The group attached particular importance to the linkages among science, technology, and economics, as well as to the need for greater sensitivity to the cultural and environmental context. Because different countries and regions have differing needs, capacities, and comparative advantages, greater flexibility is required in the design of development assistance. The success of more culturally sensitive programs, such as the National Center for Industrial Science and Technology Management Development in Dalian, China and the state-level technology development effort based in Bangalore, Karnataka, India, underscores the importance of transmitting change through existing socioeconomic structures, rather than attempting to transform or Westernize those structures.

In the policy area, the group felt that in many instances AID had little comparative advantage and that a new mechanism for assistance with S&T policy was needed. Specific mention was made of the proposed Institute for Scientific and Technical Cooperation (ISTC). The importance of science and technology to policy formulation was stressed, citing the need for early application of rigorous scientific analysis to development projects to generate a broad range of sustainable options. The group also explored issues regarding the commercialization of technology and financial aspects of development.

The participants discussed the fact that the history of U.S. development assistance is a tangled, often contradictory history, variously driven by altruism and self-interest, as well as by paternalism and a growing sensitivity to issues of cultural integrity, economic mutualism, and environmental quality. Current interest in sustainable development reflects concern for the widespread failure of earlier development strategies, dissatisfaction with the use of economic correlates in determining the quality of life, and movement toward a better informed, science-based approach to the problems of the Third World.

The participants attached particular importance to the linkages among science, technology, and economics, as well as to greater sensitivity to cultural and environmental context. It was stressed that different countries and regions have differing needs, capacities, and comparative advantages. For donor organizations, this necessitates greater flexibility in the design of development assistance. Some programs and projects require long-term continuity; others can simply be catalytic in nature. Some existing socioeconomic structures are receptive to conventional development activities; others are not. In some countries, external funding for certain types of undertakings is essential; in others, for the same type of activity, such funding might be unimportant or even detrimental.

Examples of flexible, more culturally-sensitive programs were drawn from the People's Republic of China and India. In the Chinese example, at the National Center for Industrial Science and Technology Management Development in Dalian, Liaoning Province, management specialists from the United States worked together with Chinese counterparts to develop a system of management that is compatible with Chinese culture, ideology, and priorities. Unlike similar ventures in other developing countries, in which Japanese and German experts attempted to impose their own systems of management, this program has been well received and highly successful. In addition to its practical benefits, the Dalian program has generated goodwill and a basis for future collaboration. In India, AID supported a state level technology development effort based in Bangalore, Karnataka. Although the AID officer responsible for the project was trained in community development and knew relatively little about private enterprise or technology, he nevertheless spent a year calling small meetings, drawing in experts from the United States as appropriate, and generally nurturing the initiative. By the end of the year, Indian scientists and administrators had assumed responsibility for the initiative and had adapted it to their needs.

The success of these efforts underscores the importance of transmitting change through existing socioeconomic structures, rather than attempting to transform or Westernize those structures. Against this background, the discussions regarding the very low level of United States support for technology management assume new meaning. It would appear that the level of support is less important than the compatibility of the support with the social, economic, political, and environmental structures and processes.

The group felt that in many instances AID had little comparative advantage in the area of policy formulation. The character of the agency lends itself better to the development of constructive working relationships than to involvement in direct policy dialogue. The group felt that a new mechanism for foreign assistance policy was needed. Particular importance was attached to the creation of a policy-oriented institute to guide assistance efforts, such as ISTC. It was noted that as science moves toward technology, nationalism asserts itself and new, often unfamiliar, policy issues arise. This is reflected, for example, in concern for intellectual property rights.

It was noted that in many instances effective programs require efforts encompassing more than one economic sector. In such instances, bilateral assistance is often viewed as internal interference. It was also noted that the controversial nature of certain efforts, such as the Narmada Basin Development Programme in India, render policy dialogue on a bilateral basis politically awkward. It is appropriate that multilateral agencies, rather than bilateral agencies such as AID, assume leading roles relative to the involved national governments. This implies that United States foreign assistance policy should perhaps be more sensitive to low-risk options afforded through collaboration with multinationals in an increasingly interdependent world.

The discussion of the Narmada Basin Development Programme also underscored the importance of science to policy formulation. Historically, river basin projects have been plagued by poorly informed political decisions based upon hopeful economics. Assessments of water quality, soil types, proposed management systems, and projected cropping patterns indicate that the Narmada program will yield few long-term benefits, will result in widespread environmental degradation, and will adversely affect the human populations of the Narmada basin. The early application of rigorous scientific analysis to the development of the basin could have generated a broader range of sustainable options for decision makers. A sound understanding of environmental process is basic to successful development planning. It is essential that policy be reconciled with environmental process, rather than being more narrowly formulated on the basis of political considerations or incomplete economic analysis.

Finally, the working group explored issues regarding the commercialization of technology, practical and philosophical aspects of cost sharing, debt swaps, and the general need to think in new ways about the financial aspects of international development. AID's flexibility in these areas is constrained by restrictions contained in foreign assistance legislation. The need to reassess creatively international development in a rapidly changing world argues further for the creation of an ISTC-like institution.

THE LEAST DEVELOPED COUNTRIES

Moderated by Robert Morgan, Professor of Technology and Human Affairs at Washington University, this group discussed the rationale for U.S. assistance to the approximately 40 countries with GNP per capita below $500 concentrated in Africa and South Asia. Because many of these countries are experiencing environmental degradation, traditional humanitarian motives for foreign assistance should be linked with broader and long-term environmental concerns to halt the degradation and restore the quality of life. Various types of development assistance programs were discussed.

In general, it was agreed that assistance to the least developed countries should be directed at survival needs rather than economic growth, emphasizing the applied sciences to rebuild the resource base. Governmental, or bilateral, programs should focus on building infrastructure, including S&T capacity through strengthening universities and national research institutes, building research networks through regional programs, and involving scientists in global scientific programs. Utilizing the private sector to introduce S&T into small-scale, technology-based enterprises in key areas was recommended. Funding for S&T development programs in these countries was judged grossly inadequate and may be further impaired by the attitudes of leaders in developing countries who do not place a high value on science and technology in the allocation of their limited resources. New programs, new institutions, and new mechanisms specifically aimed at the chronic problems in these countries are needed.

Nature of the Countries

The meaning of "least developed" was discussed. While the United Nations has a specific definition, the participants considered various alternatives. From a narrow economic standpoint, there are 40 countries with GNP per capita below $500 according to World Bank statistics. In view of their higher capacity to absorb both science and technology, several of the large, technologically advanced Asian countries in this set (India, China, and Pakistan) were eliminated from further consideration. The remaining countries are mostly in Africa, and they share a number of characteristics, often landlocked, resource poor, and faced with problems threatening basic human survival.

Since many of the least developed countries (hereinafter designated as "LLDCs") presently include unassimilated tribal populations, and since their original societies had been disrupted during the recent colonial period, some group members felt that it was especially important to consider the social impact of past and future technologically-driven development on populations in these countries.

Rationale for Cooperation

It was argued that traditional humanitarian motives should be key to programs of assistance in the LLDCs, and there is reason to believe that the public (and thus Congress) would be especially supportive of such programs. In addition, many of the LLDCs are in Africa where environmental degradation and erosion of the natural resource base has been severe. For this reason, food supplies are generally inadequate and the quality of life for many, but especially for the urban poor and rural populations, is declining. The group felt that scientific understanding of processes driving environmental change would be essential to assist local people in the restoration of these environments.

In recognition of rising public awareness of global interdependence (see the World Environment Commission's report on "Our Common Future"), participants felt that in addition to short-term humanitarian aid (emergency food relief, for example) the public would also support long-term efforts to halt environmental degradation in the LLDCs. Consequently, the group concluded that the basic humanitarian rationale should be linked effectively to broader environmental concerns.

Since long-term commitments are needed if one is to discuss cooperation realistically involving science and technology, consideration should also be given to including in the rationale economic, political, and cultural components (e.g. the interest of Black Americans in African development) that would broaden the base of popular support for longer-term development programs including those that would draw upon science and technology.

Types of Programs

There was consensus on the need to increase substantially the effectiveness of development programs in this particular set of countries where

large AID programs commonly do not work well in contrast with people-to-people efforts. It was suggested that LLDC programs should be focused primarily on survival needs such as the supply of basic foods. Consequently, it seemed important to learn from past successes with agriculture and to place emphasis on those applied sciences needed to rebuild the agricultural resource base in anticipation of later economic growth. In view of rapid population growth in many of the LLDCs, it was further agreed that more external assistance will be needed just to hold the line.

Regarding bilateral programs, government to government assistance was thought to be most useful for building infrastructure. It was agreed that, even in the LLDCs, infrastructure building must include programs to strengthen S&T capacity although these programs could be small and carefully selected. It was suggested that even one percent of the existing development assistance budget could be very useful in building important elements of S&T capacity in some of these countries.

Small-Scale Programs

The group observed that grass-roots approaches to development are working well in many areas but that these approaches do not usually include S&T. Since there is evidence of Congressional interest in promoting more small-scale programs, it was felt that an attempt to include S&T programs explicitly under the banner of these grass-roots approaches might be successful. For example programs might be developed to involve private sector entrepreneurs in the promotion of small, technology-based businesses in key areas such as health products, food processing and storage, and construction materials.

Participants felt that universities and national research institutes in the LLDCs should be strengthened in order to be able to provide trained personnel to advise local entrepreneurs in the establishment of small businesses that would make good use of local materials and craftsmen.

Global Change Program

The international global change program, organized by the International Council of Scientific Unions (ICSU) was discussed. Involving the poor nations in this program seems justified both because desertification and tropical forest destruction in these countries are damaging the natural resource base and because the poor will suffer most with the consequences of rapid climate change. The group thought that the LLDCs might best participate in the program through their membership in multilateral institutions. There was some feeling among the group that the increasing pollution from industrialization in some LLDCs points up the need for involvement by the private sector as well as the governments.

Programs to Build the Human Resource Base

Participants agreed that long-term programs to build the human resource base, especially in science and technology are needed in the LLDCs. Local

capacity is needed for both basic and applied research. Universities, research institutes, and other institutions of higher education may be linked by computer networks and other communications technologies so that geographical isolation should not be an impediment to education.

In order to consider which of the successful past efforts in countries such as Brazil and India might be applicable to the LLDCs in the 1990s, the group discussed U.S. experience with mechanisms for building research capacity such as the NSF program in Science and Engineering for Economic Development (late '60s), the National Academy of Sciences' Brazil Chemistry Program (early 70's), and the BOSTID Research Program. It was generally believed that programs that place U.S. researchers in developing country institutions are of lasting benefit when good matches are made. It was suggested that such matches often occur when the research involved has an important field component such as agricultural or ecological research.

This review highlighted the importance of bringing in outside personnel to help build research institutes by training local students and by transferring the culture of science as well as scientific knowledge. In contrast, training in the United States was thought to be useful only in selected fields and then only at advanced levels that can help build professional networks among LLDC scientists and engineers; in addition, the need for enrichment and life-long learning was noted. It was stressed that every training program supporting LLDC students or professionals in the United States needs to consider the absorptive capacity of the recipient country if the trained individuals are expected to return.

The problem of convincing young American faculty to spend time in LLDC institutions was discussed. Field research, especially in applied disciplines such as restoration ecology, might be an enticement. It was suggested that a new program would be needed to bring important skills to bear on the problem of scientific institution-building in the LLDCs and in selected regional institutions especially in Africa. Regional programs linking researchers at work on common problems were considered important. The possibility of increasing the science emphasis in the Fulbright program was also mentioned.

Funding

The group considered both economic and political realities that affect funding for development programs. It was agreed that funding for S&T related to development in the LLDCs has been grossly inadequate. In particular, it was noted that there had been a distinctly unfavorable change in the prevailing attitude of developed countries toward support for scientific exchanges that would benefit the LLDCs. Because of the short-term perspective of Congress and most aid agencies, even the meager funds that are available for development are not being used to address chronic problems including the need to strengthen S&T. In the present economic environment, funding problems are further compounded because of the bureaucratic tendency to cut budgets across the board rather than to decide which are the most critical programs.

The funding situation is even more grim when attitudes in the LLDCs themselves are considered. In general, LLDC policymakers see little or no value in S&T. This has caused despair among the S&T communities there. The lack of support for science can be traced in part to the failure of the LLDCs and their partners to articulate a compelling strategic plan for applying S&T to LLDC development. The issues of how to allocate extremely limited internal resources and of how to direct dwindling external resources have not been addressed adequately. Should health come before agriculture or environment before alternative energy for rural development? How important are environmental concerns? The latter are invisible to LLDC economic ministers who do not want to see "green conditionalities" placed on economic development schemes. These strategic issues are considered in more detail in the next section.

With regard to the vagaries of funding and the tendency in the United States of both the executive branch and the Congress to "fiddle" with development assistance, the group felt that consideration should be given to the need for a government funded foundation that would support S&T for meeting both the short and long-term development needs of the LLDCs. In the absence of a special program, it seemed hard to imagine how support could be maintained for the kind of steady and often unspectacular approaches that will be required to solve chronic problems characteristic of the LLDCs. A suggestion was made that a high-visibility cooperative program be established at the National Academy of Sciences to involve also the Soviet academy and draw upon Japanese intellectual and financial resources.

Strategic Planning and Analysis

The group examined the way decisions are made on cooperative S&T programs with the LLDCs. Since the LLDCs generally lack technically trained personnel, such programs are often directed by outside interests. Moreover, these programs are sometimes poorly conceived because the development agencies lack people with the capability to analyze S&T problems in LLDCs. There was a consensus on the need to build this capability into our development assistance agencies. It was also agreed that priority setting must come from within and that local people should be trained and brought into the process of analysis and strategic planning. Further, participants agreed that capacity to conduct environmental analyses is especially important to guide program decisions. In this regard, it was noted that no internationally supported center for training in S&T policy and analysis exists; consequently, a program to help build capacity for analysis and S&T policy formulation would help meet this important need. In those countries currently torn asunder by civil war, a program to train expatriates for future planning might be considered.

Because of its strength in systems analysis, it was thought that the United States could make a special contribution to programs designed to build capacity for strategic planning. A program to support U.S. specialists working in LLDCs for two to three years or more was suggested. It was thought that the land grant institutions on islands in the Caribbean and the Pacific could be better used for tropical ecosystem analysis.

The group did not have time to consider the specific contribution of appropriate technology to LLDC development or the particular role of important groups such as American universities, the advanced developing countries (through trilateral approaches), the private sector and multinational corporations, and the local people who need to be given prominence, status, and a sense of participation in their own development.

Summary

The key rationale for applying science and technology to development in the least developed countries links humanitarian interests to environmental concerns. Programs should focus on human resource building where the United States has particularly good experience. Funding has been grossly inadequate. New programs, new institutions, and new mechanisms specifically aimed at the chronic problems in these countries are needed. Also needed are communications networks linking isolated institutions and programs to build indigenous analytical capacity that is required to guide policymakers on the use of S&T. Working closely with the leadership in the recipient countries, planners must decide what kinds of institutions are needed. They must be prepared to fund them well and to make strong efforts to identify and attract the best people to these institutions.

THE ADVANCED DEVELOPING COUNTRIES

Moderated by Deborah Wince, Deputy Director of the White House Office of Science and Technology Policy, the group discussed the rationale for U.S. scientific and technological cooperation with the middle income or advanced developing countries (ADCs). Because S&T activities are directly linked to broader national economic and trade interests, the United States should recognize that there are long-term benefits of S&T cooperation with the ADCs. The United States should develop "partnerships" with the advanced developing countries, which take into account American concern for intellectual property rights and equal access to information and resources. Although such partnerships cannot be applied to the private sector, government policies can facilitate the involvement of U.S. companies in the programs. Closer links should be encouraged between professional associations in the United States and the ADCs and exchanges of scientists promoted. Official governmental collaboration should not be centralized in one U.S. agency but rather implemented in the current decentralized mode, with technical agencies making decisions on programs. The United States should consider collaboration with the ADCs on programs that would benefit science and technology development in the least developed countries.

The purpose of the working group was to develop recommendations for U.S. science and technology cooperation with the advanced developing countries on the basis of the long-term national interests of the United States. Rather than define or categorize the advanced developing countries, the participants acknowledged that all countries are developing along a continuum and that the United States could interact with different countries in different ways.

Two questions were raised: (1) How can we deal with the growing specter of protectionism in R&D? In other words, how can the United States maintain an open science and technology system in its universities and national laboratories when this open system may be used by our competitors in a negative economic sense? and (2) How many export-driven economies such as Korea and Taiwan can the world economic system tolerate? This seems to be the model that so many developing countries want to pursue.

It was observed that our S&T activities are directly linked to our broader economic and trade interests as a nation. Our future economic security is very much related to how we maintain our leadership in science and technology, generate advanced technologies, and introduce them into the marketplace. We have to keep in mind how to balance our cooperation with potential economic competition and strain. Do we want to encourage the advanced developing countries to develop and pursue the Japan model? Recent governmental negotiations with Japan over issues of reciprocity, balance, two-way flow of information and people, and symmetrical access were difficult. Such problems arise when a balanced relationship is not created in the beginning with a country with which we have significant economic interests. It was pointed out that while the United States leads the world in basic science, Japan is the leader in applied technology. The close relationship between the government and the private sector is an important element in Japan's success.

U.S. National Interests

Several broad national interests that should be taken into account as the United States develops S&T cooperation with advanced developing countries are:

- Reciprocal access to resources and data. The recent negotiations with Japan, the difficulties in obtaining data on monsoon research under the U.S.-India Science and Technology Initiative, and tense discussions with Brazil over the issue of research by U.S. scientists in the Amazon under the presidential initiative program were cited as examples of this issue.

- Intellectual property rights, which are becoming increasingly troublesome because some developing countries have no patent or copyright laws.

- Existing models for S&T collaborative programs, such as the Presidential initiatives with India and Brazil, the U.S.-China Joint Commission on Science and Technology, and the innovative AID S&T assistance program with Thailand, should be studied carefully for possible application to other countries. An example of a different type of situation is Turkey, in which there is no AID program nor is there sufficient interest on the part of U.S. technical agencies to warrant a presidential initiative.

- The role of private organizations and institutions and international agencies should be examined, especially for their multilateral dimension.

The group accepted the definition of "sustainable development" contained in the report of the World Resources Institute symposium, which implies a balance between the desire for economic growth and protection of the environment. The question was raised whether certain areas in the Third World could be set aside as environmental preserves.

The remaining discussion centered on defining a rationale for U.S. science and technology cooperation with the advanced developing countries. It was agreed that the rationale should be based on our broad national interests and the potential benefits to the United States. The rationale should be that cooperation with these countries advances our overall foreign policy objectives and our economic interests, our S&T interests, and ultimately our security interests.

Criteria for Collaboration

For future cooperative programs, we should design "partnerships" between the United States and the advanced developing countries, which include the concepts of protection of intellectual property rights and reciprocal or equal access to resources, data, and facilities in basic and applied research in the public sector. Although such partnerships cannot be applied to the private sector, government policies can facilitate the involvement of the U.S. companies in the programs. Long-term benefits from the partnerships will accrue to the United States and to the world as a whole, especially in areas of basic and applied research on global problems or issues.

Programs such as the U.S.-Israel Binational Industrial Research and Development (BIRD) Foundation should be encouraged. The BIRD program was initiated with money from the governments of the United States and Israel, and only the interest is used to give loans to private companies. The AID program entitled PACT (Program for Acquisition of Commercial Technology) is also a possible model. It was suggested that a public/private foundation be established as a catalyst for cooperation.

U.S. technical agencies now engaged in collaborative programs with advanced developing countries should forge closer links with the Foreign Commercial Service of the Department of Commerce and with the commercial offices of U.S. states abroad. It was pointed out that the International Development Office of the National Governors Association might be a useful resource. The technical qualifications of U.S. commercial officers abroad should be strengthened. Likewise, the role of the U.S. science attaches in advanced developing countries should be strengthened.

U.S. scientific and technical collaboration with advanced developing countries could benefit the lesser developed countries in areas of agriculture, health, environment, etc. and could possibly follow the CGIAR (Consultative Group on International Agricultural Research) model.

S&T cooperation between the United States and advanced developing countries should not be administered by one U.S. government agency. Rather, the pluralistic opportunities found under existing programs within the technical

agencies should be encouraged and expanded. Where applicable, the India and China models could be adopted, in which overall policy coordination is vested in one agency but implementation resides with individual agencies. Another option is to create a Presidential Commission to study U.S. S&T collaboration, especially the policy aspects, with the advanced developing countries.

Closer links between professional societies in the United States and the advanced developing countries should be encouraged to promote exchanges, meetings, and exchange of publications.

U.S. scientists and engineers should be trained in the languages and cultures of developing countries. Specifically, a "Section C" should be added to Title VI of the Higher Education Act of 1965 to add support for international science and technology programs. Similarly, recommendations in the recent study published by the National Academy of Engineering entitled Strengthening U.S. Engineering Through International Cooperation (1987) should be implemented. Among the recommendations were calls for federally-sponsored fellowships and university support for U.S. engineering graduates to spend a year or more abroad, and establishment of links between engineering schools and other campus units specializing in international economic and cultural affairs.

In conclusion, the group recommended that the success of current or future collaborative programs with ADCs be measured by the degree to which they become self-sustaining and are integrated into mainstream domestic research and development programs in each country.

MECHANISMS AND INSTITUTIONAL ISSUES

Moderated by Ralph Smuckler, Dean of International Studies and Programs at Michigan State University, the group considered delivery systems used by the United States government in S&T assistance and cooperation. It was also concerned with mechanisms to enable private resources to play an important role as well. While many of the new and rapidly-changing areas of S&T are in frontier fields such as biotechnology, materials science, and manufacturing technologies, most of the governmental delivery mechanisms have been in place for over a quarter century. Technology development needs greater emphasis and the role of private organizations in technology development and intermediate institutions such as the International Centre for Insect Physiology and Ecology (ICIPE) in Africa, is extremely important. The idea for a central institution such as the Institute for Scientific and Technological Cooperation (ISTC) put forward a decade ago still has merit. Even if no new institutes were created, the U.S. foreign assistance agency should have a strong division that gives a central focus to science and technology, and it should retain its sectoral approach to S&T as a means of giving focus and providing expertise. There is need for better coordination of U.S. government activities in science and technology outside AID; an interesting mechanism in this regard is the Presidential Science and Technology Initiative with India. Multilateral mechanisms for delivering S&T, such as the World Bank and the United Nations agencies, deserve closer attention by the United States.

The task of this working group was to consider the delivery systems used by the United States in scientific and technical assistance and cooperation with the developing countries. Clearly, the range of such activity is very wide, from poor, largely agrarian countries in Subsaharan Africa or South Asia to industrialized, scientifically sophisticated countries of East Asia or Latin America.

Because the focus of the symposium was on science and technology in foreign aid, the deliberations of the group naturally centered on the governmental apparatus for funding, implementing, and facilitating programs to increase scientific and technological understanding of development-related problems and applying this knowledge effectively. Yet it is clear that much of the related information and experience is in nongovernmental organizations, and that a key role of government must be to devise a range of mechanisms that will enable these private resources to play an important role in applying science and technology to development needs.

Programs for economic and social development will not realize their greatest potential unless they are designed to be sustainable. The group agreed that in the context of their discussions, sustainable programs are those that are environmentally sound, that are acceptable socially and culturally, that provide incentives for being continued beyond the active involvement of outside donors or technical assistance groups, and that build local capabilities in sciences and technology.

Many areas of science and technology of great relevance to development needs have experienced almost explosive change over the past decade. In biotechnology, materials science, information science, and other fields, the applications to food production, health, population control, manufacturing technologies, and other areas are of enormous significance to developing countries. Yet many of the principal governmental mechanisms for planning and conducting programs of cooperation and assistance in science and technology for development have been in place for a quarter century.

At the beginning of the 1980s, an analysis was made of U.S. mechanisms for promoting the use of science and technology in development. During the preparations for the 1979 UN Conference on Science and Technology for Development in Vienna, a proposal was put forward to establish an Institute for Scientific and Technical Cooperation (ISTC) as the U.S. government agency to fund research on development problems and engage in a variety of cooperative, capacity-building activities with developing countries in science and technology. The ISTC was never funded by Congress, however, and although some of its functions were addressed by several new programs in the Agency for International Development, major new mechanisms have not been established.

Nonetheless, the working group strongly emphasized its belief that science and technology are critical elements in the effort to achieve economic progress and to improve the quality of life of people in developing countries. The United States has a comparative advantage in the quality and depth of its scientific and technological resources and thus should give emphasis to these resources in its foreign aid programs.

Science and technology, however, are necessary but not sufficient elements of the development process. They are important instruments for meeting development needs, but so are good management, investment, physical infrastructure, and human resources. As one participant put it, "If a country's most pressing need is for a road to a port, then build the road!" All countries need good scientific and technological capabilities, however, whether for generating original research or for making good decisions about the value of imported technologies.

The group felt that active programs in science and technology are also in the long range best interests of the United States. Working toward global economic and political stability is a key objective of foreign policy that promotes our own trade and national security concerns. With the poorer developing countries, improvements in health, agriculture, population rates, or natural resources management ultimately benefit the entire global community. With the advanced developing countries, we have much to learn as well as to contribute in science and especially in technology development. In advancing these relationships, the scientific community offers a ready-made channel of communication that can be useful.

Special note was made of the importance of employment issues in considering the role of science and technology in development. Most of the developing countries must give high priority to the creation of jobs for their young and growing populations; for example, a participant said that in the next twenty years the number of new jobs that will be needed in Africa is equal to the entire labor force of Western Europe.

Technology Development

The need to stimulate the application of technology in developing countries deserves more emphasis than it presently receives in U.S. foreign aid programs. Many technologies are available for use, but what is often lacking is a mechanism that will help match local entrepreneurs with the technologies. Incentives are needed that will encourage healthy risk-taking, backed with good planning and management. The marketplace provides clear indications of the success of a particular technology development project, but it is important to realize that projects that fail teach important lessons as well as those that succeed.

The role of private organizations in technology development is very important. Illustrations of several successful private initiatives were discussed by the other working groups in this symposium. Other examples were cited of organizations established entirely with private funds, such as the Rockefeller Brothers Fund, which has been instrumental in establishing a privately-funded initiative to support biotechnology projects in developing

countries. Another approach has been the R&D limited partnership, in which private capital is involved but government or donor agencies help with loans.

It is critical that ways be found to stimulate industrial productivity in developing countries, and it was pointed out that this is just as true for centrally-planned, state-owned systems as for capitalist economies. Productive enterprises make practical use of the fruits of science and technology and provide incentives for continued local technology development and entrepreneurial activity. The barriers to development of these productive enterprises frequently are not in the science or technology, but in how to get the activities into the economy.

Intermediate Institutions

The discussion on technology development institutions led to a more general discussion of the kinds of institutions that promote science and technology for development. The International Center for Insect Physiology and Ecology (ICIPE) in Africa was cited as a regional institution that does important research of great practical benefit to the region, but also maintains strong links to the international scientific community. The International Agricultural Research Centers clearly have made a vital contribution to world food production. Organizations like Interciencia (South and North America) or the African Academy of Sciences contribute to cooperation among scientists on important regional matters. In the United States, groups like BOSTID involve American scientists in development-related activities.

India was discussed as an example of a country where AID is using a variety of mechanisms for scientific and technological interaction. Science receives support through a range of cooperative activities involving different U.S. institutions. Technology development is given attention through a Center for Technology Development established in south India, drawing on the U.S. experience with state-level cooperation among state governments, private industry, and universities.

The point made was that there is an important role for intermediate organizations to play in focusing science and technology on development problems. Such organizations are smaller than the government foreign aid agencies and have a sharper topical or geographic focus. They sometimes are established with government help, but operate privately. They can provide expertise, flexibility, and continuity that are very important in programs of technical assistance or scientific cooperation. Moreover, they can often provide a degree of insulation from the vagaries of political change or funding fluctuation. Government agencies should support more programs using this mechanism.

Bilateral Relationships

During the course of the discussion, participants clearly expressed the view that there is no single prescription for scientific and technological

assistance and cooperation that fits all cases. There are tremendous differences among the approximately 140 countries usually categorized as "developing." Even within countries, the climatic and cultural and economic variations may be great. The United States, therefore, should extend assistance and cooperation with a full realization of the need to consider carefully the cooperating country's own analysis of its development objectives and needs.

While the reality is that governments must be involved to some extent in planning and conducting bilateral programs in science and technology, there is a need to involve a variety of public and private institutions on both sides to the greatest possible extent. The kind of intermediate institutions described earlier as useful mechanisms for carrying out assistance and cooperation can be equally useful on the developing country side and should be encouraged.

Building local capacity of both people and institutions is the great need in developing countries. Through this approach, the developing countries can participate as full partners in the search for solutions to some of the pressing problems that affect all countries, developing or industrialized, and choose scientific and technological objectives that fit their own aspirations and national goals. To assist in the capacity-building process, the United States must have programs that provide continuity of effort. Programs must also be tailored to different needs. In the least developed countries, for example, there may be a need for long-range help with education and with the strengthening of key scientific and technical institutions, while the advanced developing countries may provide the opportunity for cooperative research and many interactive projects that will be of mutual benefit and will establish a broad array of institutional linkages with the United States.

Centralized Programs

Although many programs in science and technology will involve bilateral relationships, there are important development-related problems that simply cannot be addressed effectively on this basis. For example, many problems of agricultural production, disease, or environmental management affect large numbers of countries and will benefit from research efforts or other interventions that are carried out with central support and direction. Thus there will continue to be a need for U.S. foreign aid programs that are organized and administered centrally and take a global view.

Many in the group felt that the idea of an Institute for Scientific and Technical Cooperation (ISTC) put forward a decade ago still has merit. Government-supported but quasi-autonomous organizations to foster research on development-related problems and carry out cooperative programs in science and technology with developing countries have worked well in Canada, Sweden, Australia and elsewhere. [In Canada, for example, the International Development Research Centre (IDRC) is a large agency with both Canadian and overseas offices that covers the full range of projects in science and technology for development. The Australian effort is much more narrowly focused on agricultural problems through the Australian Centre for

International Agricultural Research (ACIAR).] Those countries also have government foreign aid agencies that deal with more traditional aid activities. There was not a consensus among the group, however, that creation of such an organization in the United States is an urgent priority.

The group did feel that the U.S. foreign aid agency should have a strong division that gives a central focus to science and technology. Given the nature of AID's programs and personnel structure, its overseas staff have to function as development generalists and often do not have expertise in areas of science and technology. Moreover, staff members rotate to new assignments every few years so that it is difficult to have the continuity that is critical for good science and technology projects. A strong central science and technology division can assist country and regional units with needed expertise, whether internal or from outside the agency, can organize and support research on critical problems of importance to many countries, and can provide much-needed continuity. The central focus on science and technology established in AID eight years ago is commendable, but needs to be strengthened and continued in some form in the future.

The group discussed the current sectoral approach to science and technology in AID in the context of whether this is an effective way to deal with the complex issues involved. There was a feeling that the sectoral approach has certain constraints, but that they tend to be marginal. Moreover, science and technology are so specialized that sectoral organization offers benefits in giving focus and providing expertise. There clearly are important intersectoral considerations, however, such as management and social context. In addition, the evolution of technology and the importance of related trade and foreign policy interests indicate the need for mechanisms to address programs outside the usual sectoral approach when appropriate.

Government Programs outside AID

Many important programs in science and technology with developing countries are carried out by U.S. government agencies other than AID. To mention only a few examples, the National Science Foundation, National Institutes of Health, Environmental Protection Agency, and Department of Agriculture all have active international programs, and many more could be cited. In general, these programs must be justified in relation to the ongoing domestic activities of an agency, and it would be useful for the agencies to have a clearer legislative mandate to cooperate in development-related activities.

The group felt that there is a need for better coordination of U.S. government activities in science and technology, especially with key developing countries. An interesting mechanism has been the U.S.-India Science and Technology Initiative (STI), in which the NSF has been the coordinating body for a group of government agencies involved in cooperative research activities with Indian counterparts. The Indian side has a similar coordinating mechanism.

Interesting funding mechanisms have been established with several countries that support interactive projects with a variety of U.S. institutions, both public and private. In Portugal, for example, the Luso-American Development Foundation, funded with U.S. rental payments for airbases in the Azores, supports interchanges including science and technology. In India, surplus PL 480 rupees have been placed in a fund to support similar cooperative activities. Although these sources of funds will not be available for many countries, such innovative funding mechanisms should be established wherever possible.

Multilateral Mechanisms

Although focusing its discussion primarily on U.S. programs, the group took cognizance of the fact that this country is a major supporter of multilateral development programs through organizations such as the World Bank and UN agencies. Some of the multilateral institutions have had big programs in science and technology, at a scale larger than AID. These organizations can have certain political advantages over bilateral programs. Their programs in science and technology tend to get relatively little attention both inside and outside the organizations, yet they could easily devote more resources in this area. The United States should examine the possibilities more closely.

U.S. POLICY FOR THE 1990S: SCIENCE AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

AGENDA

Plenary Session

Welcome and Introductions
Ralph Smuckler
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Issues in Basic and Applied Research in Developing Countries
Nyle C. Brady
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Issues in Technology Development
Jordan Baruch
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Discussants: Hyung Ki Kim, Henry Norman, Cyril Ponnamperuma

Science Policy and Technology Assessment
Francisco Sagasti
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A Strategic View of Science and Technology for Development
Kenneth Prewitt
Vice President
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Discussants: Cathryn Goddard, Fitzhugh Green, Charles Weiss

Working Groups

Basic and Applied Research
Chairman: Walter Rosenblith

Technology Development
Chairman: Dale Corson

Assessment, Management, Policy
Chairman: John Gibbons

Least Developed Countries
Chairman: Robert Morgan

Advanced Developing Countries
Chairman: Deborah Wince

Mechanisms and Institutional Issues
Chairman: Ralph Smuckler

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