Science and Technology for International Development

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About the Book and Author

Science and Technology for International Development: An Assessment of U.S. Policies and Programs
Robert P. Morgan

Since the enunciation of the Point Four Program by President Truman in 1949, the U.S. has supported a variety of efforts to assist less-developed countries in building their scientific and technological capabilities. Most recently, a Science and Technology Bureau has been created in the Agency for International Development, and the National Academy of Sciences is funding research projects in developing countries. At the same time, the U.S. has failed to provide funds to implement a new financing system in science and technology for development within the United Nations, and Congress has been reluctant to establish an Institute for Scientific and Technological Cooperation independent of AID.

Professor Morgan discusses the major issues concerning U.S. programs for promoting science and technology for development, among them bilateral versus multilateral aid, the growing emphasis on military and economic security versus humanitarian concerns, and financial and human resource limitations. He concludes by offering views of his own on what needs to be done to enable scientists and engineers to contribute more effectively to international development efforts.

Robert P. Morgan, professor of technology and human affairs in the School of Engineering at Washington University, St. Louis, is coeditor of *Fuels and Chemicals from Oilseeds* (Westview, 1984).

To Nancy H. Morgan,
who makes all things possible

To the memory of William Eilers

Science and Technology for International Development

An Assessment of U.S. Policies and Programs

Robert P. Morgan

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Robert P. Morgan
August, 1984

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Introduction

In August of 1979, the United Nations Conference on Science and Technology for Development (UNCSTD) was held in Vienna, Austria. Preparations for the conference included reviews of science and technology (S&T) programs and policies by many countries. In the United States, an elaborate planning process involved a variety of individuals from universities, government and the private sector. An inventory was made of United States involvement in scientific and technical cooperation with developing countries and of related U.S. technical assistance efforts. An Institute for Scientific and Technological Cooperation (ISTC) was proposed as a primary new U.S. program initiative that, it was hoped by some, would not add greatly to the cost of foreign assistance efforts. A presidential review of U.S. policy concerning science, technology and development was undertaken and a large U.S. delegation was dispatched to Vienna, headed by Father Theodore Hesburgh, President of Notre Dame University.

In a review of what happened at the conference, Ambassador Jean Wilkowski, Coordinator of U.S. Preparations for UNCSTD, analyzed the issues that were negotiated.[1] The crucial issue, according to Wilkowski, was the creation and financing of institutions within the U.N. system that would implement expanded programs in science and technology for development.[2] In a compromise that saved the conference from collapse, delegates agreed to the creation of an Intergovernmental Committee on Science and Technology, open to all U.N. members, and to the establishment of a $250,000,000 financing system for science and technology, to be supported by voluntary contributions.[3] As of Spring, 1984, the United States had failed to provide any funding for the U.N. financing system. Furthermore, although the chief U.S. initiative, the Institute for Scientific and Technological Cooperation, exists on paper, funds for it have never been appropriated by the Congress.

In the aftermath of UNCSTD, much of the enthusiasm that had characterized U.S. preparations dissipated. Some individuals within the U.S. science and technology community and the government turned their attention to still another U.N. Conference, this one on New and Renewable Sources of Energy, held in Nairobi, Kenya in 1981. Articles appeared now and then, mostly in somewhat specialized journals, analyzing what happened at UNCSTD,[4] but interest in science and technology for development waned. In 1981, a new administration took office, new faces appeared in government agencies, and science and technology programs in the U.S. Agency for International Development (AID) underwent reorganization. News items about poverty and hunger in less-developed countries seemed to appear less often in the United States while articles about increasing U.S. trade deficits, growing unemployment, the worsening international economic situation, and "leakage" or "hemorrhage" of technology to the Soviet Union or to Japan became more frequent. Some countries were no longer "less-developed"; they were "newly industrializing."[5]

The purpose of this book is to examine the status of U.S. policies and programs in science and technology for development since UNCSTD, and to suggest possible future policy directions. An underlying premise is that science and technology, especially technology, are essential components of economic growth and development throughout the world. Their effective utilization requires that countries acquire their own capability to adapt technology acquired from others to suit local conditions, as well as the ability to create their own technology and to innovate. The importance of science and technology has been recognized within the U.S. Agency for International Development. In 1981, a reorganization led to the establishment of a Bureau of Science and Technology within AID, headed by Nyle Brady, an agricultural scientist and administrator, who had been in line to become the first director of ISTC. Technical development, technology transfer and adaption became one of the four main policy thrusts of the Reagan administration's AID program.

I have attempted in this volume to provide an overview of an area that, while absorbing a substantial amount of U.S. taxpayer's money, tends to be little known and little understood. Since the enunciation of the Point Four program by President Harry Truman in 1949, the United States, motivated in part by humanitarian concerns, has supported a variety of efforts to assist less developed countries in building their own scientific and technological capabilities. U.S. participation in technical assistance programs and in cooperative international science and technology activities are of importance to U.S. foreign and economic policy. It is hoped that the information and analyses presented in this volume will prove useful to a broad scientific, technical and political readership, as well as to the public at large.

SCIENCE AND TECHNOLOGY FOR DEVELOPMENT: DEFINING THE FIELD

The theme, science, technology and international development encompasses an extremely wide range of concerns. Its designation as a field of study has probably received the greatest impetus from two United Nations conferences and continuing U.N. activity. Relatively few individuals or organizations in the United States have chosen to organize their professional activities or direct their attention to this particular slice of the universe.

Science is generally concerned with understanding the world around us and the creation of knowledge. It can be basic, i.e., we want to understand something because it is there; or it can be applied, i.e., we want to understand something so that we can do something useful with it. It can be a natural science like physics, chemistry or biology; or it can be a social science such as psychology, anthropology or sociology. In this book, while recognizing the importance of the social sciences, the emphasis will be on the natural sciences.

Technology, according to Michael Moravcsik, is "an activity resulting in procedures for building and creating things, in prototypes and models of products, in gadgets and inventions."[6] This definition tends to be hardware oriented. Sometimes technology includes software, such as management skills, or financial or credit systems. The word technology also can be used to designate the device itself, like an integrated circuit or a solar pump.

Development has at least two distinct meanings. It is used, often in conjunction with the word research, as in research and development, or R&D, to designate an activity in which a device or process is taken from the laboratory stage to a further condition along the road to production and commercialization. Unless accompanied by "research and", this is not the primary sense in which the word is used in this book.

I use development or international development as being concerned with improving the standard of living or the quality of life for people in countries or regions where food supply and nutrition are inadequate for many, where infant death rates are high and life spans short compared with other parts of the world, where shelter and education are inadequate, and where human beings are not able to live up to their full potential.[7] The most commonly used indicator of development, the gross national product per person, while useful, doesn't necessarily take all of these factors into account. Thus development is a somewhat subjective, relative concept. Portions of countries can be "developed" while other portions are not. The concept of basic human needs is helpful in identifying certain minimum requirements for individuals without which existence itself is very difficult. In the least developed countries, significant portions of the population may not have access to even those minimum necessities -- food, shelter, sanitation, pure water and the like.

In summary, science and technology (S&T) for development as it is used in this book is concerned with the application of science and technology to the improvement of the standard of living and quality of life for people in developing countries or regions of the world. As such, it is an integral part of the development assistance programs of the U.S. Agency for International Development (AID) to help low-income countries. In addition, attention will be given to programs of international scientific and technological cooperation with countries that may or may not fall within AID guidelines for assistance.

ISTC: PICKING UP THE PIECES

In the form in which appropriations for the Institute for Scientific and Technological Cooperation were rejected by the U.S. Senate, ISTC was envisioned as separate from AID, with both organizations under the umbrella of an International Development Cooperation Agency (IDCA). Funded with modest amounts of new money, ISTC was also to have taken over responsibility for a variety of existing AID programs, mainly those with a science and technology, or research orientation. Figure 1.1 lists some of the functions proposed for ISTC.

An earlier version of the ISTC concept developed at the Brookings Institution envisioned the creation of an International Development Foundation (IDF) totally independent of AID and somewhat similar to the National Science Foundation. Purposes of the IDF were to include: (1) expanding knowledge of the development process; (2) facilitating the use of U.S. and international research capability to search for solutions to important scientific and technical problems of developing countries; (3) improving developing country access to U.S. research and technical resources; (4) helping nurture the growth of institutional and individual capacity in developing countries for research and experimentation on

Fig. 1.1 Objectives and functions of proposed Foundation for International Technological Cooperation (FITC), (later renamed ISTC).

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(1) Strengthen S&T capabilities of selected less developed country (LDC) institutions through collaborative relationships with U.S. institutions.

(2) Create "centers of excellence" - projects supporting the generators and users of technology in LDCs.

(3) Support collaborative R&D projects between U.S. and LDC institutions, e.g., energy, natural resources, transportation, communication, small-scale industries, and traditional AID areas, e.g., agriculture, contraceptives.

(4) Support collaborative assessment of global problems of mutual concern, e.g., ocean and atmospheric degradation, tropical diseases, urban poor.

(5) Study past failures and successes of bilateral and multilateral aid.

(6) Perform policy evaluations of R&D priorities for U.S., LDCs, and FITC.

(7) Support research on process of technology acquisition, innovation, and international industrial trends.

(8) Orient programs of U.S. and LDC universities, government agencies, corporations, professional and trade associations towards development problems.

(9) Strengthen LDC access to U.S. and worldwide S&T information.

Source: Robert P. Morgan, Science and Technology for Development: The Role of U.S. Universities, (New York: Pergamon Press, 1979) p. 6. (With Ellen E. Irons, et al.) Reprinted by permission.

development problems; (5) encouraging technical cooperation by U.S. institutions with developing country institutions on topics of mutual interest, such as food production, environmental quality and population; and (6) assisting U.S. private voluntary organizations and foundations to make effective contributions to international development.[8]

I have spoken to a variety of individuals about why ISTC was not implemented. Many opinions were offered. Among them were the failure of those within the Carter administration charged with making the case to the Congress to do so effectively; lack of sufficient support from the scientific, technical and industrial community; disagreement among congressional supporters about whether ISTC should or should not be totally divorced from AID; a perception by some that ISTC was to be a windfall for U.S. universities; a worsening economic and trade situation in the U.S.; and the forceful opposition of one determined senator, Dennis DeConcini, Democrat from Arizona.

From the ashes of ISTC, a small amount of new program activity emerged. An Office of the Science Advisor was established which initially reported to the Administrator of IDCA and now reports to the Senior Assistant Administrator for Science and Technology at AID. New program commitments of about $10 million per year for five years were made to the Office of the Science Advisor, with half the money to be passed through to the National Academy of Sciences.[9] A portion of the funds to the Academy are used to support research efforts by investigators in developing countries. Other funds from the science advisor's office are utilized to support a competitive grants program for developing country and U.S. researchers, as well as activities that are not programmed in other parts of AID. (See Chapter 2)

The 1981 AID reorganization symbolized the emergence of science and technology as important elements of the Reagan administration's AID policy. The Development Support Bureau was transformed into the Science and Technology Bureau and Dr. Nyle Brady, an agricultural scientist who was Director-General of the International Rice Research Institute for eight years was hired to head the bureau as Senior Assistant Administrator, the only assistant administrator in AID with "Senior" in his or her title. Brady has been active in trying to convince the AID regional bureaus and overseas missions to pay more attention to the role of science and technology in their programs. He has also pushed vigorously for more of a place for science and technology in the overall AID effort.

THE UNITED NATIONS FINANCING SYSTEM FOR SCIENCE AND TECHNOLOGY FOR DEVELOPMENT (UNFSSTD)

Trying to comprehend the structure of science and technology activity at the United Nations is a challenging task. The United Nations Development Programme (UNDP) is a major element, providing financial support for projects in food and agriculture, health and energy, that run somewhat parallel to U.S. bilateral AID activity. The specialized agencies, such as the World Health Organization (WHO), UNICEF, and UNESCO, have been involved in a variety of projects with science and technology components, including projects on smallpox eradication (WHO), village water supply (UNICEF), and the International Geophysical Year (UNESCO), to name only a few.

The impetus for a new U.N. fund or financing system for science and technology for development came from the Group of 77, an association of more than 100 developing countries that want not only increased financial resources for such activity but also more voice in project selection and funding than they now feel they have in what they perceive as the "donor-controlled" S&T activities of the United Nations Development Programme (UNDP).

As of December, 1982, according to U.N. officials, an interim science and technology fund had received some $40 to $50 million in voluntary contributions and had approved more than 80 projects; including appropriate technology for development in nomad settlement areas in Somalia, carbon fiber technology in Brazil, establishment of a computer software institute in China, and a center for geological cartography in Tunisia. Projects in Africa are concerned primarily with building basic infrastructure,[10] whereas in Latin America and Asia there is more emphasis on linking R&D to production. Funds can be allocated not only to other U.N. agencies for implementation but also directly to national governments. Mechanisms have been created to accommodate and encourage, "non-core" support for the U.N. Financing System for Science and Technology for Development (UNFSSTD), that is, support from governments or other organizations that may wish to target their contributions to specific projects in specific countries. The idea of "non-core" contributions was motivated both by shortfalls in hoped for voluntary "core" contributions, and by a desire to accommodate the U.S., with its current emphasis on bilateralism and on private enterprise in development, as well as its concern about U.S. funds going to unfriendly countries.

In December 1982, by a vote of 137 to none, with nine abstentions, the United Nations General Assembly approved the establishment of long-term arrangements for UNFSSTD that provide for an executive board composed of two-thirds developing country and one-third developed country membership. In a compromise, the overall supervision of the management of the financing system was entrusted to the UNDP Administrator, who is accountable to the executive board. Called for are coordination, cooperation, and sharing of skills and experience between UNDP and the financing system. The U.S. abstained from voting, along with the Soviet Union and its Eastern European allies.[11]

ORGANIZATION OF THE BOOK

This brief, introductory chapter sketches what happened to two main threads of U.S. involvement in science and technology for development stemming from UNCSTD, namely, the Institute for Scientific and Technological Cooperation (ISTC) and the U.N. Financing System for Science and Technology for Development (UNFSSTD). The former relates to bilateral U.S. activity whereas the latter gives some sense of the U.S. posture towards multilateral organizations.[12] In what follows, two different approaches will be utilized. First, the organizational framework for U.S. international science and technology activity will be examined. Chapter 2 outlines the role of science and technology within the AID program of the Reagan administration, with its increased emphasis on the private sector and on military and economic support to selected countries. The programs of other U.S. organizations are examined in Chapter 3, with particular emphasis on recent changes within the international programs of the National Science Foundation. Chapter 4 describes the status of U.S. involvement in the United Nations' S&T agencies and the World Bank.

A second approach is to examine some programs which illustrate different aspects of science and technology in development. Chapter 5 includes discussions of international agricultural research, improved cookstoves, and engineering education for international students, among other topics. Building on these two approaches, policy issues which need examination and debate are described in Chapter 6. Prominent are bilateral versus multilateral aid, the growing emphasis on military and economic security objectives as opposed to humanitarian assistance, and financial and human resource limitations in S&T for development efforts. A final chapter outlines the author's views on what needs to be done to enable U.S. scientists and engineers to

contribute more effectively to efforts to improve the standard of living and quality of life for people in developing countries.

NOTES

1. Jean M. Wilkowski, Conference Diplomacy II, A Case Study: The U.N. Conference on Science and Technology for Development, Vienna, 1979 Institute for The Study of Diplomacy, Georgetown University, Washington, D.C. 20057 (1982).
2. Ibid., pp. 39-40.
3. Ibid., p. 42.
4. See, for example, Jack N. Behrman, "A Post-Mortem on UNCSTD," Technology in Society 1, No. 4 (1979) pp. 339-352; Klaus-Heinrich Standke, "The Prospects and Retrospects of The United Nations Conference on Science and Technology for Development," Technology in Society 1, No. 4 (1979) pp. 353-386; Frederick Seitz, "Reflections on UNCSTD, Bulletin of the Atomic Scientists 36, No. 5 (May, 1980) pp. 48-51; Miguel S. Wionczek, "UNCSTD Was Not a Technical Failure," Bulletin of the Atomic Scientists 35, No. 10 (Dec., 1979) pp. 50-53. For a recent assessment of various aspects of UNCSTD, ISTC and U.S. policy, see David Dickson, The New Politics of Science (New York: Pantheon Books, 1984) Chapter 4.
5. Included in this category of newly-industrializing countries (NICs) are Hong Kong, Singapore, South Korea, Taiwan, Argentina, Brazil, Mexico and India. See Neil McMullen, The Newly Industrializing Countries: Adjusting to Success, British North-American Committee, Washington, D.C. (November, 1982).
6. Quoted in Robert P. Morgan, Science and Technology for Development: The Role of U.S. Universities, (New York: Pergamon Press, 1979) p. xviii (with Ellen E. Irons, et al.). See also Michael J. Moravcsik, Science Development: The Building of Science in Less Developed Countries, (Bloomington, Indiana: PASITAM, 1975).
7. Robert P. Morgan, "Sharing Science and Technology," Bulletin of The Atomic Scientists 39, No. 5 (May, 1983) p. 23.
8. Interim Report: An Assessment of Development Assistance Strategies, The Brookings Institution, Washington, D.C. (October 6, 1977).
9. Or, more precisely, the National Research Council (NRC), the operating arm of the National Academy of Sciences and the National Academy of Engineering. The Institute of Medicine also participates in NRC efforts.

10. Improving scientific and technical research and training facilities, increasing the number of trained personnel, etc.

11. This subsection was adapted from Robert P. Morgan, "Science, Technology, The U.S. and The United Nations," Chemical and Engineering News 61, No. 9 (February 28, 1983), pp. 4, 46.

12. Bilateral assistance refers to programs in which the U.S. provides assistance to countries on a one to one basis. Multilateral assistance involves a mechanism such as the United Nations Development Programme (UNDP) in which more than two countries -- and in some cases many countries -- participate.

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2 Science, Technology and U.S. AID

The Agency for International Development (AID) is the primary U.S. government organization concerned with bilateral technical assistance. Other U.S. organizations, both public and private, active in science and technology for development often derive some or all of their financial support from AID. Thus, an understanding of AID's programs and policies is essential for our purposes. In this chapter, we consider both the broad outlines of science and technology activity in AID programs, and the larger policy context in which this activity is carried out.

SCIENCE AND TECHNOLOGY IN AID PROGRAMS

Table 2.1, taken from AID's Congressional Presentation for Fiscal Year (FY) 1983, summarizes AID's estimates of its spending on science and technology, and on research. AID's science and technology programs were expected to average $417 million per year during FY 1981 through FY 1983, compared with $287 million in the last full year (FY 1980) of the Carter administration.

Few details are given as to criteria for including an activity under the S&T rubric. According to the AID report:

> Activities identified as science and technology are those principally concerned with discovering new knowledge or better ways of doing things, test or pilot application, disseminating knowledge and technology to users, and building the capacity of institutions and training individuals to perform these functions. Work on science policy, efforts to apply high technology to development problems, and programs to develop capital saving technology are included.[1]

TABLE 2.1
Science and technology in U.S. A.I.D. programs (dollars in thousands)

	Science and Technology			Research		
	FY 1981 ACTUAL	FY 1982 ESTIMATE	FY 1983 PROPOSED	FY 1981 ACTUAL	FY 1982 ESTIMATE	FY 1983 PROPOSED
Agr., & Nutrition	242,031	280,265	270,947	100,556	100,722	102,940
Population	31,066	28,645	28,275	14,919	12,570	12,670
Health	31,283	21,300	21,207	15,956	18,219	13,180
Education	14,166	16,326	19,607	1,220	1,660	1,350
Energy	48,880	72,532	73,476	6,654	20,165	15,366
Other	23,534	13,400	11,950	15,164	13,164	11,375
	390,980	432,668	425,462	154,478	166,723	156,881
Agriculture & Nutrition						
Africa	91,636	116,236	90,658	26,995	24,947	16,142
Asia	42,390	48,748	50,717	830	980	4,540
LA & Caribbean	28,866	17,791	30,497	9,041	3,375	3,136
Near East	11,455	14,179	15,190	193	100	132
Total Regions	(174,347)	196,954)	(187,062)	(37,059)	(29,402)	(23,950)
Central Programs	67,684	83,311	83,885	63,497	71,620	78,990
Total Agr., Nutrition	242,031	280,265	270,947	100,556	100,722	102,940
Energy						
Africa	11,035	12,571	11,462	1,917	5,231	5,660
Asia	5,770	27,836	33,745	990	5,036	3,440
LA & Caribbean	17,928	19,947	17,648	3,190	8,695	5,195
Near East	2,794	1,425	1,350	—	—	—
Total Regions	(37,527)	(61,779)	(64,205)	(6,097)	(18,962)	(14,295)
Central Programs	11,353	10,753	9,271	557	1,203	1,071
Total Energy	48,880	72,532	73,476	6,654	20,165	15,366

Source: U.S. Agency for International Development, Congressional Presentation, Fiscal Year 1983, Main Volume, p. 188.

The Reagan administration evidently wishes to emphasize the science and technology content of its AID program. If it is assumed that the figures in Table 2.1 include funds classified as Development Assistance and exclude money from the Economic Support Fund,[2] science and technology constituted 23% of total estimated development assistance funding for FY 1983. For that year, the regional bureaus within AID administered more than two-thirds of the agriculture and nutrition S&T funds and almost 90% of the energy S&T funds. The centrally funded Science and Technology Bureau administered all or nearly all of the rest. The money for the international agricultural research centers (see Chapter 5) is considered bilateral aid and comes out of the S&T Bureau budget. The one program labeled "Science and Technology" in the agency has a budget of $10 million per year, administered by the Office of the Science Advisor.

Table 2.1 also indicates that "Research" is not synonymous with "Science and Technology." Research spending (actual, estimated and proposed) averaged over FY 1981 to FY 1983 was $159,000,000 per year or 38% of total S&T activity over the same period. According to the AID congressional presentation, "The research subcategory covers research projects, support for research programs and assistance for building research capacity in developing country institutions."[3] Food, agriculture and nutrition is the most prominent sector, accounting for 64% of S&T activity in FY 1983 as well as 66% of research activity. The S&T Bureau funds three-quarters of the Agency's research budget in food, agriculture and nutrition. In energy, a field which grew rapidly within AID into the late 1970s and early 1980s, "nearly all of the Agency's energy projects involved the application of science and technology. Research averages about 20% of the energy program."[4]

The AID numbers for total S&T and R&D spending are not that far removed from those developed by Schlie in a study performed as part of U.S. preparations for UNCSTD.[5] At that time, estimates were made of U.S. spending for S&T for development in an apparent effort by the United States to come to the conference with data in hand indicating the extent of U.S. involvement in S&T assistance and international collaboration. However, perhaps because U.S. expenditures were well below U.N. targets which were established in connection with the Second U.N. Development Decade, spending levels for S&T were not stressed by the United States at the time of UNCSTD. As the economic situation worsened, it became apparent that the United States was not prepared to support major new initiatives involving substantial increases in financing for foreign aid in general and for science and technology in particular. Just prior to UNCSTD, proposed budgets for ISTC were

continually being revised downward. Much of the growth of the AID budget during the last four or five years appears to have been in the Economic Support Fund, not in Development Assistance; the latter has not grown significantly. Increases in S&T activity within development assistance programs have been accomplished at the expense of other activity, assuming that the accounting which goes into determining what is and what is not science and technology activity is consistent.

THE RECENT AID POLICY CONTEXT

In a November 10, 1982 speech to the Committee for Economic Development, AID Administrator M. Peter McPherson described the key policy elements of the Reagan administration's program.[6] First, the rationale for U.S. involvement was outlined as a mixture of concern for unfortunate people coupled to enlightened American self-interest. The United States is becoming increasingly dependent upon developing countries as sources of raw materials and markets for exports. Non-OPEC less-developed countries (LDCs) were cited as now accounting for almost 30 percent of total U.S. exports and as being the fastest growing markets for U.S. products. Also, LDCs borrowed an increasing share of American bank assets; thus their economic health is of growing importance to the United States.

According to Mr. McPherson, "Economic development must be viewed as a long-term process, with the objective of increasing production and incomes while assuring that the benefits from growth are widely spread."[7] However, urgent short-term problems, e.g. balance of payments, sometimes cause difficulties which can affect long-term performance. Effective use of AID funds should focus on production and economic growth; human effort, tools and materials are essential. Or in other words, LDC capacity to produce, or economic growth, depend on the advancement of human skills, accumulation of physical capital, and growth in productivity. McPherson then goes on to stress the development of human resources, or "human capital" as being vital to development, including more efficient education systems. Among the most important in increasing the rate of capital formation are the profitability of private sector investment, the rate of private domestic savings, entrepreneurship and risk-taking, and government policies. Productivity growth can be spurred by technological improvements which result from introduction of new processes, techniques and equipment, as well as improvements in management. Sectoral constraints which may inhibit production growth, such as lack of basic infrastructure or specific skills, need to be overcome.

Certain aspects of Peter McPherson's address indicate shifts in policy from the previous administration. For one thing, there is more emphasis on the private sector. For another, there is a shift away from transfer of capital resources towards more concern with technical skills and human resources, a shift consonant with restricted AID budgets; although this trend was evident prior to 1980, there is now more emphasis on technical skills and technology. Finally, there is little said about "basic human needs," a policy mandated by the U.S. Congress which was a strong focal point for the Carter administration's AID efforts, one which Mr. McPherson has reaffirmed his support for in other settings. Increased emphasis on science and technology fits well with the directions outlined here.

AID's development assistance activity is generally organized into functional categories such as agriculture (by far the largest), health, population, human resource development and energy. Overlaid across this structure are four new policy thrusts, which have become the cornerstone of Mr. McPherson's AID policies, namely policy dialogue; institution building; technology development, transfer and adaptation; and private enterprise initiative.

Policy Dialogue

According to Mr. McPherson, AID attaches "great importance to conducting a 'policy dialogue' with aid-recipient countries to bring about reforms we consider necessary for the promotion of economic development."[8] Such reforms might include changing government policies that set prices too low for food commodities, and therefore reduce incentives for farmers to grow more food. This emphasis on internal developing country policy is not new and deals with some of the constraints to technical development. It also illustrates the political aspect and influence of U.S. AID programs.

Institution Building

AID has had a long tradition of helping to create and strengthen institutional capacity in LDCs, including training to upgrade managerial and technical skills, as well as financial assistance for physical facilities and agricultural research capacity. In the 1950s and 1960s, AID was heavily involved in efforts to build agricultural and engineering colleges in a variety of countries. Institution building, which faded somewhat in the 1970s as AID's "New Directions" policy emphasized direct assistance to the poor, now appears to be making a comeback.

Technical Development, Technology Transfer and Adaptation

This policy initiative is central to understanding AID's current emphasis on science and technology. Technical development implies the development within a developing country or elsewhere of some process, device, or plant species which is directly usable in a developing country setting. Technology transfer refers to the utilization in a developing country of a technology developed elsewhere and "transferred" to the developing country by one or more mechanisms. Much of this activity is carried out through commercial business circles. Finally, adaptation implies that changes in a technology need to be made so it will be suitable for the local setting in which it is to be applied. Thus, this policy initiative is a broad, comprehensive one, which supports not only the development of indigenous capacity in the LDCs for technological development and innovation but also research to aid in accomplishing such technical development.

According to Peter McPherson, "it is crucial that a country have the indigenous capacity both to develop and apply a continuous stream of innovations", if broad, sustained economic growth is to occur. The U.S. has this capacity and can produce technological breakthroughs. Building indigenous LDC capacity for developing and adapting technology is important "because few technological breakthroughs can be readily adapted and efficiently applied under the vastly different conditions present there."[9] Also, in view of the importance of market forces; "We intend to strengthen our efforts to support indigenous producers who create and adapt suitable tools and equipment. Collaborative arrangements between American and developing country businesses ... we hope will result in increased flows of useful technologies to developing countries."[10]

Five examples of innovative research supported by AID are then cited which illustrate aspects of technical development, technology transfer and adoption. They include:

-- New methods of plant improvement to develop crops that tolerate adverse soils and climatic conditions, insects, and diseases.

-- Research to increase the efficiency of using irrigation water.

- -- Systems for the production of several crops per year in the humid tropics.
- -- Methods of animal disease control to remove such serious problems as the tsetse fly in Africa, which prevent agricultural production in vast areas of potentially productive lands.
- -- Solar energy projects in several countries of the Sahel region of Africa which indicate potential competitiveness with energy generated from fossil fuels. Solar devices have already been adapted for use in food drying processes.[11]

Private Sector Initiative

AID intends to rely more heavily on the private sector as a vehicle for carrying out development activities because countries that emphasize market forces and private initiative have, in Peter McPherson's words, "a superior performance record."[12] Efforts are being made to encourage government policies that foster open competitive markets, to leverage modest public funds to attract larger private sector resources, to use AID projects to support projects designed by indigenous and U.S. private sectors, and to strengthen AID's Trade and Development Program which provides feasibility studies to stimulate U.S. exports and promote development in critical sectors such as energy. Thirteen countries have been singled out for private sector emphasis;[13] in addition, the overall AID program will focus more on private sector activities.

AID AND THE UNIVERSITIES

U.S. universities have had a continuing relationship with AID programs since AID's inception.[14] Universities have served as a training ground for AID-sponsored students from many countries. U.S. faculty members have helped to build educational institutions overseas, have collaborated on international research projects, and have served as consultants to AID and developing country organizations. Individuals from U.S. universities have moved into important positions at the international agricultural research centers (see Chapter 5). There has been heavy involvement of U.S. universities in AID-based science and technology efforts, particularly in agriculture. Although there

appeared to have been a shift away from overseas institution building in the AID programs of the 1970's, more recent developments indicate a swing back, again heavily oriented towards agriculture.

In a speech before the National Association of State Universities and Land Grant Colleges in St. Louis, Missouri on November 8, 1982, AID Administrator Peter McPherson shed light on the AID-university relationship as well as on the agency's evolving policy towards science and technology.[15] A central development in that relationship was the passage by Congress of the Title XII program, which established a Board for International Food and Agricultural Development (BIFAD), and which gave the land-grant universities important inputs to and leverage on AID's food and agriculture programs. Under Title XII, a series of Collaborative Research Support Programs (CRSPs) and University Strengthening Grants were initiated in the late 1970's.[16] Peter McPherson served on the BIFAD board during that period, prior to becoming AID Administrator.

McPherson, in his November, 1982 address, stated that administrative mechanisms were now in place for rapid implementation of Title XII. Swift progress was made in the past year because:

> Technology development and transfer, and institutional development are the major foci of our international development effort. This is logical and appropriate given our smaller funding levels in relation to larger international donor institutions, our comparative technical advantage, and our extensive field mission infrastructure. Due to severely constrained personnel levels the need for university support has never been so immediate and urgent. It is clear that the time has never been more appropriate for structuring our relationships to ensure a long term and continuous collaboration.[17]

McPherson then summarized the internal steps he had taken to give AID a leading role in technology and institutional development, including: (1) reorganization; (2) appointment of Nyle Brady as Senior Assistant Administrator for Science and Technology; (3) establishment of six S&T sector councils in Agriculture, Nutrition, Population, Health, Human Resources, Energy and Natural Resources; (4) establishment of better coordination within AID's Central Washington operation and between Washington and the field; (5) upgrading of scientific and technical leadership within the S&T Bureau, and; (6) upgrading of the network of outside expertise AID can call upon, including the National Science Foundation (NSF), the National Academy of Sciences (NAS), BIFAD and the universities.

A variety of planning activities were outlined by Mr. McPherson in which AID was reassessing and reordering research priorities, as well as developing plans to implement new initiatives in science and technology. In addition, the Science and Technology Bureau was "to review all projects and country strategy statements in terms of science and technology."[18] These activities indicate an increasing role for the Science and Technology Bureau as well as an increasing consultative role for universities. An objective of these exercises was to "make AID and the U.S. the leading technological innovator in the development field."[19]

McPherson also reported the following progress concerning AID-university interactions:

(1) Host country contracting policies were modified to "promote more realistic administrative procedures for servicing contractors -- particularly university contractors."[20]

(2) An operations manual was approved for establishing a Joint Career Corps and the 1983 budget contains funds for professionals from up to 25 universities to serve in new AID positions, mostly overseas. Corps members would be university employees who agree to spend about one-third of their time with AID.

(3) Procedures for developing "joint enterprises" were approved which seek to involve small institutions more effectively in AID projects. BIFAD will advise AID in the process.

(4) Memoranda of Understanding (MOU's) were signed with two universities (Colorado State and Florida) and are being negotiated with three others. These MOUs are being developed to provide long-term planning and continuity for university involvement. At least one of the initial MOU's will be outside the Title XII - food framework.

(5) The Strengthening Grants Program, in which U.S. universities are supported to develop capabilities for overseas collaborative research and training, was evaluated. Work is underway to "more clearly identify the subject and geographic areas where most strengthening is needed."[21]

McPherson concluded by providing new challenges to the universities over the coming years. He called for collaboration between universities and private enterprise. He called for simplifying and streamlining AID - university proposal and project procedures. He was convinced that there was now "in place a series of mechanisms which will institutionalize an effective, long-term collaboration between AID and those universities willing to commit themselves to support AID programs."[22]

It would appear to this observer that U.S. state universities and land-grant colleges have developed a close working relationship with AID through the BIFAD mechanism and Title XII legislation. At first, AID was resistant to sharing certain aspects of decision-making with the universities but with time, some of the differences appear to have been smoothed out and collaborative research support grants and institution strengthening have brought a substantial infusion of new money to U.S. universities. However, they have required universities to share the costs of programs. In addition, efforts like the joint career corps require a degree of coordination and collaboration between AID and the university which is in a sense comparable to that of the agricultural extension activity here in the United States. Some universities may not want to make that kind of commitment.

That Peter McPherson values the university input to AID programs is clear. At hearings held by the House Foreign Relations Committee in Spring of 1983, he cited a collaborative university research program on small ruminant animals, sheep and goats, as an example of AID's commitment to its basic human needs mandate. However, the extent to which this new infusion of support for universities results in substantive accomplishments remains to be evaluated. As Vernon Ruttan has commented:

> Experience thus far seems to indicate that the lessons of the 1960's -- that the comparative advantage of institutions in developed countries lies more in the training of scientists from less-developed countries than in technology-oriented research for the less-developed countries -- will have to relearned.[23]

Independent evaluation of current AID-university efforts is needed. Also, fields other than agriculture and universities outside of the land-grant framework generally seem to be neglected. A final caution is that as AID's demands on the universities in the name of efficiency became greater, portions of universities risk becoming extensions or appendages of AID, and innovative, unsolicited, unplanned inputs may become more difficult to identify and accommodate.

APPROPRIATE TECHNOLOGY

Appropriate technology became prominent within AID programs in the 1970s. The concept and its implementation within AID, the World Bank and elsewhere was one of the few new inputs of a technological nature to science and technology for development activity at that time, resulting in new programs, emphases, institutions and controversy.

Definitions of appropriate technology abound.[24] On one hand, there are the more philosophical definitions, stemming from the writings of E. F. Schumacher[25] who stressed the need for an intermediate technology which would improve peoples' lives but would be small-scale and ecological. On the other, there are those who use the phrase to connote anything that will work in a given local situation -- that is, anything which is "appropriate". The FY 1984 AID Congressional Presentation stress the idea of "capital-saving technology":

> tools, production processes and delivery systems that use relatively little capital per workplace created or beneficiary reached and that: are compatible with the local cultural, economic, environmental, political and social context in which they are embedded and with which they interact; involve the local community or otherwise are physically and financially accessible to the poor; can be maintained and repaired by relying on locally available labor skills, spare parts and organizational capacity; are widely replicable; and above all, are economically efficient.[26]

AID estimates that in FY 1983, $164 million of development assistance obligations were for capital-saving technology; in FY 1984, $158 million was requested.[27]

AID has come a long way in its acceptance of appropriate technology as an integral part of its program. The concept fits well with the basic human needs emphasis and the New Directions policy that still, at least in theory, govern AID's activity.[28] Although appropriate technology's identification in the minds of some, particularly in developing countries, with hand-me-down, second-rate technology has earned the phrase some disapproval, its objectives appear laudable enough. Furthermore, Colin Norman's plea for one billion new jobs in the developing world by the year 2,000 seems difficult to even attempt to comprehend

unless there is emphasis on capital-saving, employment-generating activity in poor, populous countries.[29]

The implementation of appropriate technology or capital-saving technology activity within AID has continued to receive attention. AID provides support for A.T. International, a private organization which has undergone recent changes in program focus (see Chapter 3). Other AID activity in appropriate technology goes on without any conspicuous identification. It would appear that such activity is a desirable and integral part of AID's overall program. Among AID's objectives are to increase income and employment for the poor, especially in agriculture and non-farm, labor-intensive business; to provide improved health care, education, and population planning services to the poor at affordable prices; and to strengthen the ability of private and public sector decision-making to select, develop, adapt and disseminate useful capital-saving technologies.[30] Some appropriate technologies in the renewable resource area examined as part of U.S. preparations for UNCSTD include windmills for water-lifting and irrigation, improved cookstoves, solar grain dryers, and building materials from agricultural wastes and natural fibers.[31]

OFFICE OF THE SCIENCE ADVISOR

Created in the wake of the UNCSTD Conference, and originally conceived of as reporting to the head of the umbrella International Development Cooperation Agency, the Office of The Science Advisor now occupies a more modest position within the AID hierarchy, reporting to the Senior Assistant Administrator of the Science and Technology Bureau. Its primary responsibility is to administer a Program in Science and Technology Cooperation (PSTC). The first grant out of PSTC was made to the National Academy of Sciences (NAS) and was initially conceived of as being $36 million over five years but this amount was subsequently stretched out to seven years. Thus, the academy program (see Chapter 3), amounts to about half of the annual $10 million appropriation for the Office of The Science Advisor.

Principal objectives of the PSTC are:

(1) To stimulate and support <u>new and innovative research</u> approaches to current or emerging development problems;

(2) To assist less-developed countries (LDCs) in building the scientific and technical capacity needed to attack such problems themselves; and

(3) To involve LDC scientists and scientific institutions more directly in priority setting, science planning, information exchange and technology transfer.[32]

The establishment of this Program represents part of the U.S. response to LDC concerns expressed at the 1979 United Nations Conference on Science and Technology for Development (UNCSTD). The Program is currently implemented by a system of competitive research grants which undergo scientific peer review.[33]

Although this competitive program started with little advertising, a substantial number of proposals were received, growing from 120 to 680 annually over a three-year period from fiscal years 1981 to 1983. Proposals from LDCs are strongly encouraged although U.S. proposals are not excluded, provided there is a strong LDC linkage. During FY-1981 and FY-1982, proposals were funded over a wide range of areas, including epidemiology and public health, plant improvement and agronomy, energy and engineering, and agriculture and marine science. Many of the proposals seem to run in the $100,000 and $200,000 total range over two or three years.

As the program is evolving, there appears to be a shift from encouraging a broad range of research areas to a more narrowly defined set, supportive of AID interests. As of Spring, 1983, research proposals were sought in four main groupings: (1) increased food supplies and improved nutrition (including biotechnology applications in agriculture, biological nitrogen fixation, and aquaculture); (2) health and population (including biotechnology and epidemiology); (3) energy, terrestrial resources and physical science (including seismology, meteorology, renewable energy and reforestation); and (4) communications, computers and education.[34] Emphasis is given to research in new areas and rapidly emerging technologies. Planning and policy studies, and social science research are discouraged. More emphasis appears now to be placed on getting proposals from developing country investigators who are encouraged to submit proposals through their local AID mission.

The PSTC would appear to represent a more flexible, experimental source of support for science and technology for development efforts than exists in other parts of AID.[35] Defining specific problem foci may keep it from becoming a catchall for what won't fit elsewhere in the agency, but it may also result in openness and innovativeness being stifled. An underlying problem is the relatively modest amount of funding which would appear to be insufficient to make

effective use of a substantial portion of the resources and interest which exist within the U.S. scientific and engineering community.

NOTES

1. U.S. Agency for International Development, Congressional Presentation: Fiscal Year 1983, Main Volume, p. 186.
2. Economic support funds include large amounts of money for Egypt and Israel. In general, less detailed information is available on how these funds are spent than on development assistance funds. Some economic support money is spent on science and technology activity.
3. U.S. Agency for International Development, Congressional Presentation: Fiscal Year 1983, Main Volume, p. 186.
4. Ibid., p. 13.
5. Theodore W. Schlie, The Quantification of United States Scientific and Technological Activities Oriented Towards the Developing Countries: A Feasibility Study, Report Contract SRS77-27991, University of Denver, Denver Research Institute, (July 1978) (with Laurie N. Adler, Melinda Cain).
6. M. Peter McPherson, Remarks to the Committee for Economic Development, (New York, N.Y., November 10, 1982).
7. Ibid., p. 1.
8. Ibid., p. 4.
9. Ibid., p. 5.
10. Ibid.
11. Ibid.
12. Ibid., p. 6.
13. The countries are Costa Rica, Egypt, Indonesia, Ivory Coast, Jamaica, Kenya, Pakistan, Sri Lanka, Thailand, Zimbabwe, Peru, Haiti and Sudan.
14. For a comprehensive analysis of the role of U.S. universities in AID-sponsored and other S&T for development activity, see Robert P. Morgan, Science and Technology for Development: The Role of U.S. Universities, (New York: Pergamon Press, 1979) (With Ellen E. Irons, Eduardo A. Perez, Theodore N. Soule and Ava K. Fried).
15. M. Peter McPherson, Remarks to the National Association of State Universities and Land-Grant Colleges, (St. Louis, Missouri, November 8, 1982).
16. The CRSP's involve U.S. universities and overseas institutions in collaborative reearch built around specific crops, animals, or development problems, such as sorghum and millet, small ruminant animals, and management of tropical soils. The strengthening grants provide support for U.S.

universities to strengthen their capacity for international involvement. See, Board for International Food and Agricultural Development, and Agency for International Development, A Guide to Title XII and BIFAD, (November, 1983).

17. M. Peter McPherson, Remarks to the National Association of State Universities and Land-Grant Colleges, p. 1

18. Ibid., p. 2.

19. Ibid., p. 3.

20. Ibid.

21. Ibid., p. 6.

22. Ibid., p. 8.

23. Vernon W. Ruttan, Agricultural Research Policy, (Minneapolis: University of Minnesota Press, (1982) p. 118.

24. See for example, Robert P. Morgan, Science and Technology for Development, p. 226.

25. E. F. Schumacher, Small Is Beautiful: Economics as if People Mattered, (New York: Harper and Row, 1973)

26. U.S. Agency for International Development, Congressional Presentation, Fiscal Year, 1984, Main Volume, p. 193.

27. Ibid.

28. AID's "New Directions" policy seeks to give priority to projects and undertakings which would be of direct benefit to the poorest people in developing countries and to increase their participation in development activities. The policy was articulated in the Foreign Assistance Act of 1973. See Elliott R. Morss and Victoria A. Morss, U.S. Foreign Aid, (Boulder: Westview Press, 1982) pp. 24-30.

29. Colin Norman, The God That Limps: Science and Technology in the Eighties, (New York: W. W. Norton, 1981), p. 151.

30. U.S. Agency for International Development, Congressional Presentation, Fiscal Year 1984, Main Volume, p. 193.

31. Robert P. Morgan and Larry J. Icerman, Renewable Resource Utilization for Development, (New York: Pergamon Press, 1981), (With Elizabeth S. Andrews, et al.).

32. Office of The Science Advisor, Agency for International Development, Program in Science and Technology Cooperation (PSTC), Washington, D.C. 20523 (undated) p. 1.

33. Ibid.

34. An April 1, 1984 PSTC announcement indicated some shift in priorities. Annual supoprt will be available on the order of $1 million for each of five research modules: biotechnology/immunology; plant biotechnology; chemistry for world food needs; biomass resources and conversion technology; and biological control of selected schistosomes and viruses. A total of $1 million will be available for annual support of research in engineering technology; genetic resources; and atmospheric, ocean and earth sciences. (Agency for International Development, Office of the Science Advisor, Program in Science and Technology Cooperation, PSTC, Washington, D.C., April 1, 1984).

35. The Office of The Science Advisor also has made grants that appear to deviate somewhat from the framework of the competitive grants program. For example, a two-year, $450,000 grant to the International Foundation for Science was made whereby the foundation can award small grants to LDC researchers. See John Daly, Front Lines, (Washington, D.C.: U.S. AID, October 1982) p. 19.

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3
Science and Technology for Development: Other Players

In this chapter we focus primarily on the activities of four organizations which are active in science and technology for development. Although the sum total of their budgets for science and technology efforts directed towards developing countries is about an order of magnitude less than AID's level of science and technology effort, they represent at least two important facets. The National Science Foundation (NSF) and The National Academy of Sciences (NAS) are involved in activities which would seem to be oriented towards basic or applied science whereas Volunteers in Technical Assistance (VITA) and A.T. International (ATI) have emphasized appropriate technology, small enterprise development, and field-oriented technology applications. Other U.S. organizations will also be briefly considered.

THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent U.S. federal agency established by act of Congress in 1950 to promote and advance scientific progress in the United States. It is unique among federal government agencies in that it funds scientific and engineering research in a wide variety of fields,[1] as opposed to emphasizing one specific mission, such as energy or defense. As of 1983, the foundation accounted for about 27 percent of federal support to academic institutions for basic research. Policies for NSF are set by a 25-member National Science Board, within a framework of policies made by the president and Congress of the United States. The board, the director of NSF, and five other high NSF officials are appointed by the president with the advice and consent of the Senate. The foundation's fiscal year 1984 budget request to the Congress was for $1,292,300,000.[2]

The legislative mandate for international involvement of NSF has been summarized as follows:

> The National Science Foundation is authorized and directed 'to initiate and support basic scientific research and programs to strengthen scientific research potential and science education at all levels and to appraise the impact of research upon industrial development and the general welfare.' There are no reference to international science in the original mandate. However, in July 1968, PL 90-407 was passed which authorized the Foundation to initiate and support specific scientific activities in connection with matters related to international cooperation, national security, and the effect of scientific applications upon society...[3]

International cooperation does not appear to be strongly emphasized throughout the history of the National Science Foundation, at least until recently. When NSF's Program of Research Applied to National Needs (RANN) was launched in the 1970s, there was essentially no international component. With the subsequent establishment of the Division of International Programs in a new Directorate for Science, Technology and International Affairs, international activity within the foundation had a focal point and became more visible.

NSF's legislative mandate would seem to provide sufficient justification for expansion of its international S&T role, subject to the approval of the Secretary of State, should it choose to do so. For example, the 1977 NSF Authorization Act directs the foundation "to assist in the resolution of critical and emergency problems with significant scientific and technological components, such as the world food and population problems".[4] However, in the past, its main international cooperative science activities have been with the developed countries. In NSF's 1979 budget submission, of the $10.6 million requested for international cooperative science activities, 58 percent was for cooperative science programs primarily with developed or wealthier developing countries; 31 percent was for scientific organizations and resources, the largest single part of which was the U.S. contribution to the budget for The International Institute for Applied Systems Analysis (IIASA), located in Austria.[5]

Since 1979, the National Science Foundation's international activities directed towards developing countries have had a difficult time. A reasonably successful program called SEED (Scientists and Engineers for Economic Development) funded by AID was terminated; the SEED program provided support for U.S. scientific and engineering faculty to teach or carry out research at developing country institutions.[6] A program entitled, Science for Developing Countries (SDC), started at about the time of UNCSTD, has received very little in the way of funding; components were to include support for dissertation research by developing country students in the U.S., for short courses, and for cooperative research projects. Annual budgets for the SDC program have been a few hundreds of thousands of dollars.[7]

The National Science Foundation has a special role to play in connection with so-called AID-graduate or middle-income countries, that is, those countries in which the per capita gross national product exceeds AID guidelines. More than thirty bilateral agreements for scientific and technical cooperation are administered for the United States by NSF and are centered in the Division of International Programs of the Directorate for Scientific, Technological and International Affairs (STIA). A two-million dollar item in the NSF 1984 budget submission was for a new bilateral program of scientific and technological cooperation with India in the wake of Mrs. Ghandi's summer, 1982 visit to the United States.[8] Among the areas to be studied in the India program are monsoon dynamics, nutrition-related blindness, fuelwood research and materials research.

The National Science Foundation participated in efforts to inventory U.S. science and technology activity as part of U.S. preparations for UNCSTD. Subsequently, the foundation and the National Science Board assembled information on the extent of NSF international involvement; NSF's international activity clearly goes well beyond that administered by the STIA Directorate.[9] For example, in 1981, the Physics Division of NSF gave 431 awards of which 112 (26 percent) contained some international activities. Ten of the awards included support for foreign citizens and twelve had elements of cooperative projects. However, the countries most frequently involved, in descending order, were the industrialized countries of Switzerland, France, Italy, Japan and Germany (FRG).[10]

A study of NSF's FY 1980 international activities by R. W. Brainard indicates that "Developing nations were most frequently involved in STIA awards whereas advanced countries were primary for the other directorates as a whole."[11] Brainard also found that:

(1) about one out of five of NSF's grants for FY 1980 "had some kind of international implication." Forty percent of the awards were for foreign travel only;

(2) less than 20 percent of the awards were for cooperative projects with foreign organizations;

(3) advanced industrial nations were involved in about 40 percent of international grants; developing countries accounted for about 25 percent;

(4) international activity was primarily in the environmental and life sciences; engineering and the physical and social sciences were well behind those areas;

(5) two parts of NSF, STIA and The Directorate for Astronomical, Atmospheric, Earth and Ocean Sciences (AAEO) have substantial international activities; AAEO grants were mainly for "big science" and STIA for "little science"; and

(6) The STIA Directorate was a major factor in grants related to formal U.S. bilateral science and technology cooperative agreements, in science and technology international activity and in countries generally not emphasized elsewhere in NSF.[12]

The Policy Context for Programs of International Scientific and Technological Cooperation at NSF

The following excerpt from the Reagan administration's 1981 Annual S&T Report to the Congress sets the context for the administration's international science and technology policy:

> "The guidelines that shape the international components of the Administration's science and technology policy are substantially the same as those that apply to its purely domestic components. International cooperative programs supported by the Government must be consistent with the President's commitment to maintain fiscal responsibility in the public sector and enhance incentives for private sector investment. They must be characterized, on the U.S. side, by a clear distinction between appropriate public and private sector roles. International research projects will be subject to criteria of excellence and mutuality of benefit. International applied research projects will also be subject to the criterion of pertinence to national economic and social goals and needs."[13]

The report goes on to state that although the U.S. is preeminent in many S&T areas, it no longer dominates all fields, and can benefit from healthy competition and cooperation. Further, the administration encourages more international S&T cooperation outside of federal sponsorship. Citing President Reagan's address at the International Meeting on Cooperation and Development in Cancun, Mexico in October 1981, the administration places emphasis on the development of indigenous policies and S&T capabilities in developing countries, and the application of these capabilities to the solution of urgent international problems in food, energy, natural resources and health.[14]

In September of 1982, the National Science Board adopted a statement on Science in an International Setting. The board states that the U.S. is at a critical point in its international scientific relationships as indicated by five developments:

(1) U.S. scientists no longer lead in all fields and U.S. industry faces significant challenges;

(2) many scientific problems are global in nature, their resolution can influence the future well-being of the U.S., and they require increased international cooperation and a coherent approach for successful study;

(3) modern scientific projects are large, complex and costly, requiring facilities and operations which suggest that international coordination, sharing and cooperative funding may prove useful in some cases;

(4) foreign policy considerations are increasingly important in the conduct of international science; and

(5) science and technology are becoming increasingly independent, and "national security implications of technology transfer have led to increased discussion of the need for additional controls on the international scientific communication process itself."[15]

With this as background, the board goes on to stress the importance of international scientific cooperation:

> There are certain fields in which international cooperation and access are essential to the effective conduct of research because the scientific

questions being addressed are inherently global in nature. Examples include research related to climatology, oceanography, space applications, health, population and resource studies, acid rain, carbon dioxide buildup and heating of the atmosphere.[16]

The National Science Board's rationale for developing country involvement by U.S. science is part of a view that sees the maintenance of the vigor of the U.S. research effort as requiring a "broad world-wide program of cooperation with outstanding scientists in many nations." Developing countries are viewed as having a corps of well qualified scientists and "unique possibilities for access to scientifically important territories and environments. Moreover, international scientific cooperation may offer economic, diplomatic and other policy benefits going beyond the immediate needs and interests of science per se."[17] Bilateral agreements which provide continuity of effort are viewed as important; scientist-to-scientist cooperation within this context is called for.

To facilitate international scientific cooperation, the NSF is urged by the National Science Board to take the initiative, along with the Department of State and other agencies as appropriate, in bringing together potential international partners to plan and implement international sharing or collaboration in fundamental (emphasis added) science and engineering research. The foundation is urged to use multilateral channels such as The International Council of Scientific Unions (ICSU) where possible;[18] The National Academy of Sciences is also singled out. The board statement concludes with a plea for openness of scientific communication on campuses of U.S. colleges and a call for the NSF's organization and management procedures to reflect the principles of building the international dimension into all aspects of its programs.[19]

More recently, in 1984, the international programs of the foundation seem primarily to be justified by the beneficial effects that they will have upon U.S. science. As the Committee on International Science of the National Science Board puts it in a statement endorsed by the board:

> The central premise ... is that since the foundation best serves the national interest by discharging its mandate to promote the progress of science, it must assume a more active leadership role in supporting those aspects of international scientific cooperation that bear directly on the health of American science.[20]

Or as the foundation states in their FY 1985 budget submission:

> International Cooperative Science Activities fosters cooperative research and related activities between American and foreign scientists and institutions for the purpose of strengthening the endeavors of the U.S. science and engineering community and. in the course of that strengthening international relations as well.[21]

The emphasis is on scientific cooperation, not science and technology for development, and on cooperation that benefits U.S. science. Furthermore, basic or fundamental research is to be the main focus, not applied research.

On The NSF-STIA Budget and Responsibilities

Some questions and concerns arise about the FY 1984 National Science Foundation budget request to the Congress, particularly that portion of the budget allocated to the Directorate for Scientific, Technological and International Affairs (STIA).[22] In a year in which the total NSF budget request for FY 1984 was 17.8 percent above the FY 1983 Current Plan, STIA's budget was reduced from $44.2 million to $36.8 million, a reduction of 16.7 percent. Whereas in FY 1983, STIA accounted for 4.2 percent of the total NSF Research and Related Activities Appropriation, i FY 1984 that figure fell to 2.9 percent.[23]

The rationale for this reduction in the STIA budget was set forth both in NSF budget documents and in a memorandum from the NSF Director, Edward A. Knapp, to the NSF Executive Council dated January 12, 1983.[24] In that memo, programs included in the STIA sphere are characterized as being special programs which are stated to have not been viewed, implicitly at least, "as being as central to NSF's mission as the research directorates."[25] Concluding that the responsibilities of the research directorates have been too narrowly defined, and that the special programs have not had sufficient resources to have an appreciable impact, Dr. Knapp articulates a new management philosophy in which the research directorates "must have sole responsibility for receiving, evaluating, and decision-making on all proposals (with the obvious exception of education)."[26] STIA will continue to exist but it will primarily serve an agency-wide coordinating role. Furthermore, STIA's FY 1984 budget request, according to the NSF Budget Summary to the Congress, is "an apparent decrease of $7.4 million"; however, "an estimated $22.1 million within the Foundation's discipline oriented research activities will bring the effective total of the various NSF programs shown in this activity to 58.9 million" -- an increase of $14.7 million or 33.3 percent.[27]

There are three issues requiring attention which arise from these changes. The first concerns the efficacy of the new management plan -- that is, will it work as intended? The second focuses on the foundation's ability to carry out its international program responsibilities. The third deals with the apparent decline of interest within the foundation in interdisciplinary, problem-oriented, socially-relevant research.

The New Management Scheme. One premise upon which the scheme is based is that a more optimal program will result if the research directorates assume responsibility for decisions on proposals which heretofore were in the special program category, while STIA assumes a coordinating role. Because of this expanded responsibility, the research directorates will take more interest and the net result will be an even greater involvement overall within the foundation in STIA-type program activity, or so the scenario goes. To ensure a successful transition, minimum spending levels for STIA-type activity within the research directorates will be set.

If the above works as intended, it could be a good thing. However, will it? For one thing, many details need to be worked out. The research directorate-STIA interface is likely to be more complicated than heretofore. Furthermore, unless there are some personnel changes which result in the research directorates becoming more sympathetic and sensitive to STIA-type activity, there may very well be problems. The FY 1984 budget request for program development and management within NSF showed an increase of only 1.1 percent and the number of full-time equivalent staff was projected to fall from 1,218 to 1,194.[28] This reduction would not seem to augur well for implementation of a new, somewhat complicated management scheme.

International Programs. In FY 1982, International Cooperative Scientific Activities was the biggest line item in the STIA budget at $11.6 million. It slipped to $9.9 million in FY 1983 New Obligational Authority and, as requested in the administration's FY 1984 budget submission, falls to $5.0 million in FY 1984, a 1983 to 1984 drop of almost 50 percent. It would then be a poor third behind Industrial Science and Technology Innovation ($16.5 million) and Research Initiation and Improvement ($6.5 million).[29] However, two new items appear within the research directorates; an additional $5.9 million for International Cooperative Research Activities, and $2 million for a new U.S.-India Joint Program.[30] Thus, in the NSF Press Release on the FY 84 budget, a total program for International Cooperative Scientific Activities of $12.9 million is shown, as is a percent change from FY 1983 to FY 1984 of plus 30.3 percent.[31]

Will the new management scheme have the intended multiplier effect on international cooperative science at NSF? It seems likely to me that certain kinds of activities may benefit, namely highly specialized areas of relevance to advanced industrial countries and those compatible with the present interests of the research directorates. On the other hand, NSF activity related to less developed countries and of a more applied nature may suffer. This could very well be the case if the pattern of international activity within NSF indicated by Brainard[32] is not altered, say by enforcement of minimum floors for spending on developing country activity within the research directorates.

In my opinion, cooperative international programs involving developing countries, including middle-income ones, have been far less than they could have been in the past at NSF. That being the case, it is certainly conceivable that the proposed change in program management and control will be for the better. However, I remain skeptical. Scientific and technological cooperation with developing countries has elements associated with it that require priorities, skills and insights which may be missing in the research directorates. Somewhere, a strong, knowledgeable presence in tune with the requirements for cooperation with developing countries is required. A strengthened STIA with increased resources for developing country activity rather than a weakened STIA is an alternative worth considering.

Interdisciplinary Research. The proposed reduction of the STIA budget and STIA's lessened role compared to the research directorates has a certain analogy with what is going on in U.S. universities. In the 1960s and 1970s a variety of problem-focused interdisciplinary programs arose centered around key problem areas facing society -- energy, environmental quality, health care, international development to name a few. At NSF, there was a program of Interdisciplinary Research on Problems of Society (IRPOS), followed by Research Applied to National Needs (RANN), and now there is STIA.

Within the past three or four years, there has been a swing back towards the disciplines and away from interdisciplinary activity. The NSF-STIA situation is an important part of that trend. The NSF Director, Edward Knapp, who headed the Mathematical and Physical Sciences Research Directorate at NSF prior to becoming director, upon observing that "unfortunately, these special programs typically have not had the resources to have an appreciable impact," could have concluded that what needed to be done was to give the special programs more control of more resources. He didn't. Disciplinary programs may suffer from some of the same maladies attributed to the special programs -- lack of impact and service only to special interests, i.e., the scientists within the respective disciplines.

In a broader sense, the NSF budget changes discussed here can be viewed as another step away from the kind of interdisciplinary research on problems of society, which became prominent in the 1960s and 1970s, towards a more narrow conception of science as it existed before then. Such a development is occurring when the need for interdisciplinary research and problem-focused activity is greater than ever. It is particularly relevant to scientific and technological cooperation with developing countries because many development problems with technical components require a broadly-based approach, involving non-technical factors to bring about solutions and improvements.

THE NATIONAL ACADEMY OF SCIENCES

The National Academy of Sciences (NAS) describes itself as "a private, honorary society of scientists and engineers, dedicated to the furtherance of science and its uses for the general welfare."[33] Membership in the NAS or in the parallel National Academy of Engineering (NAE) or Institute of Medicine (IOM) is by election by existing members, representing the elite of U.S. science, engineering and medicine. "Although the Academy is not a federal agency, it is called upon by the terms of its 1863 charter to examine and report on any subject of science or technology upon request of any department of the federal government."[34] The National Research Council (NRC) is the operating arm of the academies; the programs to be described in this section are carried out under NRC auspices; however, identification with the National Academy of Sciences is often made in deference to the oldest of the three organizations (NAS, NAE, IOM).

In 1969 a Board of Science and Technology for International Development (BOSTID) was established within the academy structure to be responsible for programs with developing countries. According to its literature:

> Participants in BOSTID activities work with counterpart groups in developing countries. This joint effort is directed towards strengthening local scientific and technological capabilities related to agriculture, environmental planning, energy, forestry, health, natural resource management and conservation,nutrition, water supply and quality, and other areas. Overseas activities also address the national organizational and planning capabilities needed in applying science and technology to development. Studies examine specific development problems and suggest possible scientific and technical solutions.[35]

BOSTID's work depends upon the voluntary participation of experts who contribute their time while serving on study panels and participating in overseas activities. A permanent BOSTID professional staff supports these efforts and ensures continuity.

During the first decade of its existence, a variety of studies focusing on development problems were carried out under BOSTID auspices, many of which were supported by government agencies. One set of studies of "The Winged Bean: A High Protein Crop for the Tropics" and other innovative uses of plant materials has received a great deal of attention. BOSTID has also convened many workshops and seminars, both here and abroad, on development topics. It also has sent teams to several countries to help them to define policies for science and technology and to set up organizations for this purpose. A large program to improve chemistry in Brazil was carried out in collaboration with a Brazilian agency.[36] Much of BOSTID's support comes from U.S. AID.

The academy represents a mechanism for involving elite U.S. scientists and engineers in workshops and panels concerning science and technology for development. However, its makeup somewhat precludes involvement of and outreach to younger scientists and engineers as well as to a broader segment of the science and technology community. If it could somehow broaden its approach and perspective, it could very well play an expanded role in science and technology for development activity. The Research Grants Program is, in a sense, such an expansion.

Research Grants Program

BOSTID's activity took on a new dimension when a Research Grants Program was established with AID funding in 1981. The program appears to have been created in the wake of the failure to get ISTC underway. It was started at the tail end of the Carter administration during the period in which Frank Press, President Carter's science advisor, left that position and went on to become president of the National Academy of Sciences. About $36 million in AID funds were earmarked, first for a five year period, then spread out over seven years for the academy, of which about $2 million per year are being used for grants, averaging about $100,000 each, made directly to developing country investigators and institutions.

As of Spring, 1983, grants were being made in the following specific areas: (1) grain amaranth; (2) fast-growing, nitrogen-fixing trees; (3) biological nitrogen fixation; (4) mosquito vector field studies; and (5) rapid epidemiologic assessment. A sixth area of research on acute respiratory infections was subsequently added. By January 1, 1984, projects totaling $6 million were being supported, spread over the six research areas and over a wide range of countries. A Committee on Research Grants (CRG) headed by Dr. Frederick Seitz oversees the Research Grants Program for the academy.[37]

The Research Grants Program can be broken down into two broad categories: (1) agriculture and forestry and (2) health, with three projects falling into each category. The amaranth area emphasizes agronomic and processing studies of a plant with seeds of high protein content and leaves which are eaten in many parts of the world. Biological nitrogen fixation work seeks new knowledge and species which can restore soil fertility; tropical tree projects, in addition to interest in nitrogen-fixing varieties, seek to identify species which can grow on saline and other marginal soils. Mosquito vector field studies strive to understand mosquito behavior and to develop methods of mosquito control. Rapid epidemiologic assessment projects focus on developing methods for quickly and inexpensively obtaining reliable information about health conditions in developing countries. Understanding the extent to which LDC children are affected by acute respiratory infections is the newest research area.

The Research Grants Program only makes awards to individuals and institutions in less developed countries or in middle-income countries in which the research will be of benefit to less developed countries. Thus, grants have been made to institutions in Haiti and Senegal as well as to Malaysia and Brazil. No money is available to U.S. researchers, unless they are employed as consultants by the developing country institution. One problem faced by the BOSTID-CRG staff has been that it was difficult at first to identify and cultivate researchers and good research projects in developing countries; however much progress has been

made. U.S. university professors and other contacts are useful in this regard. For each project area, coordinating meetings are held to allow researchers from different countries to interact; a grain amaranth newsletter is being published.

The academy appears to be functioning in some sense as an appendage of an operational AID program, with AID having some input into defining the program parameters; in the Spring of 1983, at AID's prodding, several planned new research areas were abandoned. This may very well serve to prevent duplication with other AID supported efforts and to permit more in-depth concentration and progress on a limited number of topics. The Research Grants Program is also restricted by law from making grants in certain countries, although the restrictions are somewhat less severe than for AID programs.[38]

The academy venture into making research grants is not far enough along to be fully evaluated; at this writing, evaluations by both the academy and AID are in the process of getting underway. It appears to this observer that a great deal of effort and care by BOSTID-CRG staff has gone into developing what promises to be a viable program. In the long run however, is this a role the academy wishes to continue? Are there not other mechanisms suitable for the research grants activity? The grain amaranth work, for example, would appear to bear some similarity to that undertaken on other plants at the CGIAR sponsored international agricultural research centers (see Chapter 5) although in the academy program the emphasis appears to be on national research investigators. On the other hand, the academy is not AID and its standing with the scientific community does provide it with some degree of independence; the academy should also be in a better position to appreciate what is involved in scientific and technological research.

VOLUNTEERS IN TECHNICAL ASSISTANCE

As the 1950s came to an end, a group of scientists and engineers in the Schenectady, New York area, many of whom worked for the General Electric Company, held periodic luncheon meetings under the auspices of the Mohawk Chapter of the Federation of American Scientists. The topics for discussion ranged over a variety of issues; one concern was the role of science and technology in helping to improve the standard of living and quality of life for people in less-developed areas of the world. They tried to estimate the financial resources being devoted to such technical assistance activity by the United Nations and other organizations, and found that those resources were less than the payroll of the General Electric Company in Schenectady. It was concluded that if individual scientists or engineers would donate some small portion of time to help solve technical problems faced by people in less developed countries, international technical assistance activity could be greatly enhanced. And so Volunteers in Technical Assistance (VITA) was born.[39]

Technical problems were sought from foreign nationals, missionaries, development workers and others. A mail-order answering service emerged which responded to a variety of problems, many of which were at the grass-roots or village level. With the advent of the Peace Corps, VITA's correspondence expanded as the many idealistic liberal arts majors in the Peace Corps ran into the variety of practical situations for which they sought advice. Inquiries expanded and a small professional staff was hired to supplement and assist the volunteers. Early accomplishments included publication of a Village Technology Handbook which was widely requested and distributed in several languages. An effort to develop and disseminate a solar cooker met with less success.

The VITA idea has persisted and flourished. The roster of volunteers has grown to several thousand as have the annual requests for information. The organization is a major source of information and expertise on a wide variety of technologies, including agricultural implements, renewable energy sources, low-cost construction and small enterprise development. In the 1970's, VITA interacted easily with the growing appropriate technology movement in the U.S. and elsewhere but it kept its identity centered on technical skills and expertise as opposed to more philosophical leanings.[40] Its value was increasingly recognized by AID and other public and private donors. A multiyear effort in renewable energy technology funded by AID along with other new initiatives has resulted in a major expansion of VITA. Overseas VITA representatives have been stationed in several countries and volunteers take part in technical panels and make site visits. The activities of VITA have changed somewhat; there is now a sizeable full-time professional staff with substantial technical credentials and an annual budget which in 1983 exceeded four million dollars. However, the idealism that lead to VITA's creation is still present and some of the founders of VITA still take part in its activities.

VITA represents the nearest thing to a grass-roots effort by scientists and engineers in the United States and elsewhere to address a problem that was not receiving adequate attention by government and industry, namely, the plight of poor people in developing countries and their need for technical assistance. It provides a means by which volunteer scientists and

engineers can participate to some extent in development activity without abandoning their careers. Although legally a non-profit U.S. organization, in a sense it is international in scope, with both international volunteers and some international board members. As VITA's full-time professional staff component has expanded, it has provided employment for young scientists and engineers in a field in which job opportunities are limited in number, due in part to the policy of some organizations to hire only "experts" with many years of experience.

VITA periodically does a great deal of soul-searching. The kind of issues which were discussed at a May 1983 VITA Annual Board and Corporation Meeting and elsewhere include: (1) is VITA having the impact overseas that was envisioned for it? Would a "for-profit" subsidiary increase that impact by increasing the chances that promising technologies would be more effectively disseminated? (2) is VITA's movement into high-tech information activity (computerized information systems, satellite broadcasting) likely to shift its focus from the poor who have traditionally been the target of its efforts? (3) is VITA's heavy present dependence upon AID for funding likely to cause problems for VITA in the long run? These and other issues continue to be grappled with by VITA at a time of rapid growth and major new program initiatives. In 1984, VITA began to move towards the development of profit-making enterprises which could generate support for its traditional programs of assistance to those in need.

A.T. INTERNATIONAL

A.T. International is a private, non-profit corporation which was brought into being in response to the U.S. government's desire to expand activity in appropriate technology in the 1970s.[41] Funded at the outset by a multiyear, $20,000,000 agreement with AID, its initial objectives included "the development and application of technologies that result in increased employment and income among the poorer members of developing nations."[42] A broad range of activities in food and nutrition, shelter, health care and education were envisaged, with the unifying theme the concept of appropriate technology. Emphasis was placed on overseas field activities and on identifying indigenous organizations and projects which would be self-renewing and have a multiplying effect. In some respects technology played less of a role in early A.T. International thinking than organizational, management and business questions.

It is this author's impression that A.T. International got off to a rocky start. There were tensions between the more philosophical and more pragmatic elements of its appropriate technology adherents; tensions also arose because of this private organization's desire to maintain a substantial degree of independence from its primary funder, AID. In the early 1980s, there was considerable uncertainty about the future of A.T. International; both the Reagan administration and the Congress seemed less committed to the concept than was true in the 1970's.

In the Spring of 1983, a new course was set by and for A.T. International, in consultation with AID. Under new leadership, the organization is focusing on three specific technology areas, namely the processing of agricultural products, farm related technology and the development of local mineral resources. Efforts are being concentrated on small and micro enterprises to commercialize and disseminate appropriate technology and "on field projects that promise to produce positive direct effects on employment, income, savings, capital formation and/or productivity of the poor."[43]

The creation of A.T. International has permitted a major infusion of support for activity in appropriate technology, with an annual budget in the several millions of dollars. From 1979-1982, A.T. International granted almost $9 million for 213 projects, or about $42,000 per grant. Future plans call for fewer but larger grants to organizations with large followings, like the 2,000,000 people of the Sarvodaya Shramadana Movement in Sri Lanka. An example of a future project involves a grant to an African association to plan and implement a project to enable 5,000 families to increase their incomes by 20-40 percent by learning how to maintain and fabricate spare parts for more than 430 small-scale village palm oil presses which have fallen into disrepair.[44]

The new directions of A.T. International may not satisfy some of its early, more zealous supporters. The organization now appears to have been rationalized as one piece in U.S. AID's science and technology for development puzzle which fits neatly alongside other pieces. However, the flavor of planned projects would appear to be consonant with appropriate technology objectives and the changes may greatly strengthen A.T. International's ability to operate effectively.

ASSESSMENT

The four organizations described in this chapter do not exhaust the resources in the United States involved in science and technology for development activity. There are U.S. universities that play a major role in education and training and in cooperative linkages, consulting organizations that serve as AID

contractors, professional organizations such as the American Association for the Advancement of Science, and mission-oriented U.S. government agencies like the National Institutes of Health, the Department of Energy and the National Oceanographic and Atmospheric Administration. Multilateral organizations will be dealt with in the next chapter. There are also organizations in other industrialized countries which are active in science and technology for development.

Bilateral science and technology for development activity outside of AID and centered in the organizations described in this chapter probably amounts to several tens of millions of dollars per year, a very modest amount. These efforts fall into two categories: (1) a research oriented, basic or applied science (as opposed to technology) component, in the National Science Foundation and in the Research Grants Program of the National Academy of Sciences; and (2) a more technology oriented, field-oriented component in A.T. International and VITA. These activities have generally been rationalized so as to be in support of or at least not to conflict with mainstream AID science and technology activity in agriculture, population, health, etc. With the exception of NSF with its focus on international cooperative science, all the other activity is heavily funded by and to varying degrees responsive to AID. The NAS Research Grants Program as well as AID's Program in Science and Technology Cooperation (PSTC), described in Chapter 2 place considerable emphasis on the biological sciences and biotechnology.

The question of the impacts of these activities in developing countries is difficult to answer. Some of these activities (the NAS Research Grants Program, AID's PSTC program) are only a few years old. The functions of some of them (NAS Research Grants, AID-PSTC, Science for Developing Countries at NSF) were envisaged as part of the Institute for Scientific and Technological Cooperation proposed at the time of UNCSTD. That they exist is encouraging. Whether they can survive, grow and become increasingly effective in their somewhat fragmented pattern and with their current relationship to U.S. AID remains to be seen and evaluated.

NOTES

1. Note that in this section, as in NSF's title, the word "science" is meant to encompass a broad range of scientific and technological activity. In 1984, some changes were made to NSF's legislative mandate to give more prominence to engineering. In the same year, Edward Knapp resigned as President Reagan's first

Director of NSF to return to physics research at Los Alamos National Laboratory, one of the nation's premier weapons laboratories; he was replaced by Eric Bloch, a Vice President from IBM. Roland Schmitt, a Vice President from General Electric, was elected Chairman of the National Science Board.

2. U.S. National Science Foundation, *Budget Summary to The Congress, Fiscal Year, 1984,* Washington, D.C., pp. A-3, NSF-1.

3. Robert P. Morgan, *Science and Technology for Development: The Role of U.S. Universities,* (New York: Pergamon Press, 1979) p. 7 (with Ellen E. Irons, et al.).

4. Ibid.

5. Ibid., p. 306.

6. Ibid., p. 162.

7. Robert P. Morgan, "On the NSF STIA Budget and Responsibilities," in *1984 National Science Foundation Authorization Hearings on H.R. 2066,* (Washington: U.S. Government Printing Office, 1983) p. 649.

8. Eliot Marshall, "U.S.-India Project: Bold Plans, Few Dollars," *Science* 220 (May 13, 1983), pp. 694-695.

9. A particularly useful compendium in this regard is: *Discussion Issues, 1982: Science in the International Setting, Vol. II, Background Material,* National Science Board, Washington, D.C. 1982.

10. Ibid., Section E, Subsection M-1, p. 15.

11. R. W. Brainard, "International Activities of NSF," in *Discussion Issues, 1982: Science in the International Setting, Vol. II,* Section E, Subsection B-13, p. 5.

12. Ibid., pp. 1-5.

13. U.S. Office of Science and Technology Policy, *Annual Science and Technology Report to the Congress: 1981,* in cooperation with The National Science Foundation, (Washington, D.C.: U.S. Government Printing Office, 1982) p. 52.

14. Ibid., pp. 53-54.

15. *Statement on Science in The International Setting* as adopted by The National Science Board at its [illegible]th Meeting on September 16-17, 1982, p. 1.

16. Ibid.

17. Ibid., p. 2.

18. Members of ICSU include national research councils or academies of many countries. Among its activities, it facilitates and coordinates the work of international scientific unions in the natural sciences, enters into relations with governments to promote scientific research via its national members, and maintains relations with the United Nations and its agencies. *Encyclopedia of Associations, 1984,* Vol. 1, Pt. 1, Denise S. Akey, Ed., (Detroit: Gale Research Co. 1984) p. 543.

19. *Statement on Science in The International Setting,* p. 1.

20. Committee on International Science, National Science Board, *Roles and Responsibilities of the National Science Foundation for Aspects of International Cooperation Related to the Health of American Science,* Washington, D.C., May 11, 1984, p. ii.

21. "National Science Foundation Budget Submission to Congress: Fiscal Year 1985," National Science Foundation, Washington, D.C. 20550, p. STIA-2.

22. Material in this subsection is identical, with slight modification, to a written statement (See Note 7) I submitted to the House Committee on Science and Technology in March, 1983, in connection with the NSF FY 1984 budget authorization hearings.

23. U.S. National Science Foundation, *Budget Summary to the Congress: Fiscal Year 1984,* Washington, D.C., pp. NSF-37, 38.

24. *The Management of NSF Programs,* Memorandum from Edward A. Knapp (NSF Director) to NSF Executive Council, January 12, 1983.

25. Ibid., p. 1. The NSF research directorates include: (1) mathematical and physical sciences; (2) engineering; (3) biological, behavioral and social sciences; and (4) astronomical, atmospheric, earth and ocean sciences.

26. Ibid., p. 3.

27. U.S. National Science Foundation, *Budget Summary to the Congress: Fiscal Year 1984*, Washington, D.C., pp. NSF 20, 21.

28. Ibid., p. NSF-22.

29. Ibid., p. NSF-40.

30. Ibid., p. NSF-21.

31. "Statement of FY 1984 Budget," *National Science Foundation News,* NSF PR83-6, Feb. 1983, Chart 9.

32. R. W. Brainard, "International Activities of NSF."

33. National Academy of Sciences/National Research Council, Informational brochure, *The Board on Science and Technology for International Development, BOSTID,* Commission on International Relations, Washington, D.C. (Undated) p. 1.

34. Ibid.

35. Ibid.

36. Robert P Morgan, *Science and Technology for Development: The Role of U.S. Universities,* p. 148-149.

37. Much of the factual information in this section is gleaned from printed matter available from the BOSTID Research Grants Program. The author has been a member of the Committee on Research Grants since the summer of 1983. Further information can be obtained from the BOSTID Research Grants Program, National Research Council, Washington, D.C. 20418.

38. For example, congressional legislation forbids U.S. assistance to countries which have expropriated U.S. assets without compensation. On the other hand, the academy is able to make grants to certain countries that do not fall within the normal AID guidelines, provided that research supported in these "middle-income" countries will be of benefit to low-income countries.

39. VITA was incorporated on June 20, 1960 in the State of New York. Its original name, Volunteers in International Technical Assistance was changed about a decade later to Volunteers in Technical Assistance. Much of this section is based upon the author's more than 20 years of association with VITA. VITA's present address is 1815 N. Lynn Street, Arlington, VA. 22209. VITA's current board chairman in Jean Wilkowski, former coordinator of U.S. preparations for UNCSTD. Henry Norman is VITA's executive director. My colleague at Washington University, Dr. Robert Walker, a physicist, was a VITA founder who served as its first president and continues to take an active interest.

40. VITA has also become a member of the community of private voluntary organizations (PVOs) working in international development, such as CARE and Save the Children Federation. VITA's technical skills and focus have proved to be a useful resource for other PVOs.

41. U.S. Agency for International Development Proposal for a Program in Appropriate Technology, Revised Edition, (Washington, D.C.: U.S. Government Printing Office, 1977).

42. Donald D. Evans and Laurie Nogg Adler, eds., Appropriate Technology for Development: A Discussion and Case Histories, (Boulder: Westview Press, 1979) p. 70.

43. A.T. International II: New Directions, (undated). See also Appropriate Technology Bulletin, No. 1 (June 1984). A.T. International, 1331 H Street, N.W., Washington, D.C. 20005.

44. Ibid.

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4
Multilateral Involvements

In this chapter, multilateral organizations involved in science and technology for development in which the United States participates will be examined. Principal attention will be paid to activity within several portions of the United Nations and in the World Bank. The issue of U.S. non-participation in the United Nations Financing System for Science and Technology for Development has been introduced in Chapter 1; additional information on UNFSSTD's activities will be provided here.

U.S. SUPPORT FOR MULTILATERAL ORGANIZATIONS

U.S. support for multilateral organizations may be divided into three categories: (1) contributions to the United Nations and its specialized agencies, and other regional organizations which represent the U.S. share of costs and/or fulfillment of treaty or other obligations; (2) voluntary contributions to international organizations and programs; (3) contributions to the development banks, including the International Development Association (IDA) of the World Bank. The latter two categories represent multilateral assistance activity which falls within the scope of the U.S. International Development Cooperation Agency (IDCA). However, the U.S. Treasury Department retains control over U.S. contributions to the development banks, in spite of previous efforts by some in the Carter administration to transfer this responsibility to IDCA. The first category of contributions, which is included in the U.S. State Department budget authority, goes primarily for paying the U.S. share of running organizations and is not usually thought of as supporting technical assistance, although some of these funds are undoubtedly spent for that purpose.

Obligatory Contributions to International Organizations

Table 4.1 provides a ten-year history of U.S. obligatory contributions to international organizations, as has been authorized by conventions, treaties or specific acts of Congress. The drop in funding from 1980 to 1981 and the large proposed increase from 1983 to 1984 represent a decision to return to full fiscal year funding after a period of deferred assessments to eleven organizations.[1]

TABLE 4.1
U.S. contributions to international organizations and conferences: a ten year history

Year	Amount	Year	Amount
1975	$203,903,000	1980	$411,500,000
1976	217,853,000	1981	375,941,000
1977	325,846,000	1982	398,240,000
1978	390,106,000	1983	436,204,000
1979	386,033,000	1984 (est)	525,773,000*

Source: U.S. Department of State, The Budget in Brief: Fiscal Year 1984.

*In The Fiscal 1985 budget, this 1984 estimate is changed to $520,515,000 (appropriation). The 1985 estimate is $525,570,000.

Table 4.2 indicates the organizations supported by the United States in this category along with 1983 actual expenditures, 1984 budget estimates and 1985 budget requests. A significant number of these organizations support work in areas which fall within the science and technology for development rubric. Of current interest is the sharp drop in the UNESCO budget from 1984 to 1985 which reflects the U.S. decision to withdraw from that organization.

TABLE 4.2
U.S. assessed contributions to international organizations

Program and Financing (in thousands of dollars)	1983 actual	1984 est.	1985 est.
Program by activities:			
United Nations and affiliated agencies:			
1. Food and Agricultural Organization	35,069	45,698	49,323
2. International Atomic Energy Agency	8,779	17,956	18,528
3. International Civil Aviation Organization	3,641	6,103	7,211
4. International Labor Organization	30,193	31,407	32,393
5. International Maritime Organization	326	529	548
6. International Telecommunication Union	2,537	2,958	3,327
7. United Nations	153,309	168,723	186,913
8. United Nations Educational, Scientific, and Cultural Organization	40,002	50,770	25,403
9. Universal Postal Union	458	455	460
10. World Health Organization	45,084	58,619	61,146
11. World Intellectual Property Organization	175	567	529
12. World Meteorological Organization	2,844	3,717	4,617
Subtotal	322,417	387,502	390,398
Inter-American Organizations:			
1. Inter-American Indian Institute	103	103	103
2. Inter-American Institute for Cooperation on Agriculture	11,319	12,010	12,625
3. Organization of American States	46,452	44,641	43,433
4. Pan American Health Organization	28,567	33,087	33,087
5. Pan American Institute of Geography and History	285	294	303

(continued)

TABLE 4.2 (continued)
U.S. assessed contributions to international organizations

Program and Financing (in thousands of dollars)	1983 actual	1984 est.	1985 est.
6. Pan American Railway Congress Association......	25	25	25
Subtotal.................	86,751	90,160	89,576
Regional Organizations:			
1. Colombo Plan Council for Technical Cooperation.....	9	11	11
2. North Atlantic Assembly...	306	306	336
3. North Atlantic Treaty Organization.............	16,699	15,675	17,477
4. Organization for Economic Cooperation and Development	7,907	18,225	20,286
5. South Pacific Commission..	502	572	578
Subtotal.................	25,423	34,789	38,688
Other International Organizations:			
1. Bureau of International Expositions...............	14	13	20
2. Customs Cooperation Council..................	1,306	1,288	1,433
3. General Agreement on Tariffs and Trade.........	1,356	3,347	3,516
4. Hague Conference on Private International Law.	111	39	42
5. International Agency for Research on Cancer........	1,028	809	897
6. International Bureau of the Permanent Court of Arbitration...............	7	7	8
7. International Bureau for the Publication of Customs Tariffs..................	34	34	38
8. International Bureau of Weights and Measures......	266	275	309
9. International Center for the Study of the Preservation and Restoration of Cultural Property......	374	405	405

(continued)

TABLE 4.2 (continued)
U.S. assessed contributions to international organizations

Program and Financing (in thousands of dollars)	1983 actual	1984 est.	1985 est.
10. International Cotton Advisory Committee........	138	146	167
11. International Hydrographic Organization.............	41	41	47
12. International Institute for the Unification of Private Law..............	44	48	54
13. International Natural Rubber Organization.......	157	170	206
14. International Office of Epizootics...............	40	36	36
15. International Organization for Legal Metrology................	44	43	46
16. International Rubber Study Group....................	41	35	37
17. International Seed Testing Association.......	4	4	4
18. Interparliamentary Union..	242	268	293
19. Lead and Zinc Study Group.....................	20	22	24
20. Maintenance of Certain Lights in the Red Sea.....	17	16	19
21. World Tourism Organization.....................	213	229	204
Subtotal.................	5,497	7,277	7,805
Adjustment.....................	....	4,273	....
Total obligations.........	440,088	524,451	526,467
Financing:			
Offsetting collections from: Non-Federal sources............	-3,884	-3,936	-3,897
Budget authority (appropriation)...........	436,204	520,515	522,570

Source: <u>Budget of the United States Government, FY 1985,</u> Appendix, pp. I-P 7, 8.

Voluntary Contributions to Multilateral Organizations

Table 4.3 provides a summary of voluntary U.S. contributions to international organizations and programs from 1982 to 1985. As the pattern of administration requests and congressional appropriations indicates, the Reagan administration has sought to cut budgets for agencies such as UNDP, UNICEF and UNEP, while the Congress has tended to resist such cuts during this period. These specific agencies, and especially UNDP, play an important role in science and technology for development activity. The administration's approach seems to be to reduce the emphasis on multilateral assistance in part by reducing voluntary contributions.

The rationale for U.S. voluntary contributions to the specialized agencies of the United Nations and to the Organization of American States is set forth in the IDCA FY 1985 Congressional Presentation. U.S. contributions:

> serve to advance American ideals and ideas affecting the evolution of the international system; provide tangible demonstration of American support for humanitarian activities, assure a Western influence in geographic areas of strategic importance; encourage the acceptance of international responsibilities by other nations; and complement U.S. bilateral assistance programs, often serving U.S. purposes in areas too sensitive for, or outside the reach of, U.S. bilateral aid.[2]

U.S. financial support for these programs:

> can help stabilize and improve our existing relationships and blunt the attacks of adversaries regarding general political and economic issues within these multilateral organizations. In addition, U.S. opposition to technical assistance and other forms of program growth in the regular (assessed) budgets would be severely undermined in the absence of continued substantial U.S. contributions to UNDP and other voluntarily funded development assistance activities.[3]

The levels of the Reagan administration's budget request seem to be a compromise between U.S. budgetary constraints and benefits to be derived from U.S. contributions. For example, in the case of UNDP, U.S. support is justified because it promotes international stability, helps to create a favorable trade and investment climate, and provides direct benefits to the U.S. economy in the form of contracts for U.S. equipment, jobs for U.S. consultants, and fellowships for study in the U.S.[4] Interestingly enough, the international organizations in this category such as UNDP and UNICEF seem to be more in favor than others such as UNESCO. Both UNDP and UNICEF have U.S. administrators and UNICEF in particular has broad-based U.S. public support. Yet the fact that contributions are voluntary and hence reducible without violating some formal international obligations makes these organizations prime targets for budget cutting; hence the persistent efforts by the Reagan administration to reduce the requests from prior years.

Multilateral Development Banks

Multilateral development banks finance a variety of projects in developing countries. The emphasis in the 1950s and 1960s was on large infrastructure projects such as transportation systems, power systems and ports. More recently, there has been a shift towards projects in agriculture, rural development and energy, as well as more concern with equity and with projects which more directly benefit poor people.[5,6] Science and technology play a role in bank projects and programs.

Perhaps the organization in this category of most significance for poor countries is the International Development Association (IDA), the concessional loan flow window at the World Bank. The U.S. reduced its annual contribution to the IDA-VI replenishment (the sixth pledging period) at the start of the Reagan administration and stretched out its total contribution from three to four years. As a result, funds for IDA-VI for the three-year period from FY 1981 to 1983 fell 30 percent short of original targets ($8.9 billion vs. $12.4 billion), a situation which was expected to have a strong negative affect on India and countries in sub-Saharan Africa.[7] Furthermore, the U.S. has refused to pledge more than $750 million per year to the IDA-VII replenishment, which sets the three year IDA-VII pledge at $9 billion rather than at the $16 billion recommended by the World Bank. In addition, FY 1985 and FY 1986 budget projections made in 1983[8] would seem to indicate that the United States wishes to continue to reduce its support for IDA at a time when pressures for increased financing have increased, in part due to the entry of China into the World Bank.

TABLE 4.3
U.S. voluntary contributions to international organizations and programs
Budget authority ($000)

Organization or Program	Request FY 1982	Appropriations Bill FY 1982	Request FY 1983	Appropriations Bill FY 1983	Request FY 1984	FY 1984 Estimated	FY 1985 Request
UN Development Program (UNDP)	120,000	128,186	106,800	140,000	120,000	160,000	120,000
UN Children's Fund (UNICEF)	32,500	41,500	26,000	42,500	27,000	52,500	27,000
International Fund for Agricultural Development (IFAD)	(39,600)**	—	(65,400)**	40,000	(50,000)**	50,000	50,000
International Atomic Energy Agency (IAEA)	12,750	12,750	14,500	14,500	18,500	18,500*	20,500
OAS Development Assistance Programs (OAS)	13,500	16,000	15,500	15,500	15,500	15.500	15,500
World Meteorological Organization/Voluntary Cooperation Program (WMO/VCP)	2,300	2,300	2,300	2,300	2,300	2,300	2,000
UN Capital Development Fund (UNCDF)	2,000	2,000	2,000	2,000	2,000	2,000	2,000
UN Educational and Training Program for Southern Africa (UNETPSA)	1,000	1,000	1,000	1,000	1,000	1,000	1,000
UN Environment Program (UNEP)	2,000	7,850	3,000	7,850	3,000	10,000	3,000
UNIDO Investment Promotion Service	—	—	—	—	—	—	100
Convention on International Trade in Endangered Species (CITES)	150	138	150	138	150	150	200
UN Voluntary Fund for the Decade for Women (VFDFW)	500	—	500	—	500	500	500
UN Institute for Namibia (UNIN)	500	500	500	500	—	500	—
UN Trust Fund for South Africa (UNTFSA)	—	343	—	343	—	343	—
UN Fellows	—	449	—	449	—	449	—
UN Institute for Training and Research (UNITAR)	—	422	—	422	—	422	—
FAO World Food Program (FAO/WFP)	2,000	2,000	2,000	2,000	2,000	2,000	—
PAHO Revolving Fund	—	—	—	—	—	1,686	—
Total	189,200	215,438	173,250	269,502	189,950	317,850	241,800

*$14,814 thousand currently appropriated; an additional $3,686 has been requested as a supplemental appropriation.

**IFAD budget authority was not included under International Organizations and Programs until 1984.

Sources: U.S.Agency for International Development, AID's Congressional Budget Presentation: Fiscal Year 1984.
U.S. International Development Cooperation Agency, Congressional Presentation, Fiscal Year 1985, International Organizations and Programs.

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP): THE GLOBAL AND INTERREGIONAL PROGRAMME

The United Nations Development Programme (UNDP) has been a major focal point for science and technology activity within the U.N., although some of the U.N. specialized agencies are also heavily involved in science and technology efforts. Projects within the UNDP Global and Interregional Programme are directed towards fields similar to those found in AID's bilateral programs, namely agriculture, health and energy. The emergence of the U.N. Financing System for Science and Technology for Development (UNFSSTD) could represent competition to UNDP for scarce resources for science and technology activity within the United Nations at a time when financial contributions to UNDP programs from donor countries are not growing in accordance with UNDP's desires or needs, and when the strong value of the U.S. dollar is putting additional stress on UNDP's activities.[9]

The Global Programme of UNDP has been broken down into three phases: (1) a period from 1972-1976 with a budget of $15.5 million; (2) a second programming cycle from 1977-1981 at $52.9 million; and (3) a third period from 1982-1986 with an "illustrative global indicative planning figure (IPF)" of $114.8 million.[10] The Global Programme supports projects that are research-oriented and that address development issues of high priority with potentially wide impact. The Programme seeks to mobilize "scientific and technical talents and resources in support of research efforts in areas of vital concern to the developing world"... and "to correct the disproportionate concentration of research capacity and resources in and for developed countries..."[11]

To date, two-thirds of the Programme's resources have been devoted to the agricultural sector; most if not all of these activities have been carried out within the Consultative Group on International Agricultural Research (CGIAR) which is sponsored by UNDP, the Food and Agricultural Organization (FAO) and the World Bank (see Chapter 5). High priority has been placed on:

> development of agricultural research and training as essential elements in any strategy for increasing agricultural productivity. Attention was to be directed not only to basic research aimed at developing higher-yield crop varieties, but also at strengthening economic research, at a deeper knowledge of farming systems, farmers' economic problems, storage and marketing systems, as well as pre- and post-harvest technologies.[12]

Work has been carried out on maize, rice, sorghum and millet, roots and tubers, biological nitrogen fixation, livestock diseases, and other agricultural problem areas.

Health is a second major priority area in which two large projects were started in 1978-1979. UNDP, together with the World Bank and WHO is sponsoring research aimed at control of six major tropical diseases: malaria, schistosomiasis, filariasis (including onchocerciasis), trypanosomiasis (both African and American), leishmaniasis, and leprosy. A separate project, with WHO, is concentrating on research on vaccines and drugs.[13] Still a third major area, energy, is emerging with initial work on small-scale, solar-powered water pumping systems, jointly with the World Bank.[14]

An evaluation of UNDP activity sponsored by UNDP itself was generally supportive. The UNDP takes credit for mobilizing through the CGIAR mechanism some $120 million per year for agricultural projects and more than $70 million for the Program for Research and Training in Tropical Diseases. According to the UNDP:

> The principal lesson, confirmed in the 1977-1981 cycle, is that UNDP global projects are a successful means of solving significant scientific and technological problems facing the developing world. At the same time, the majority of problems tackled to date evidently require a sustained effort before scientific research can produce solutions, and before those solutions can be translated through regional and national institutions into growth and development at the farm and village levels. Scientific research is costly and the establishment of international cooperative financing mechanisms to permit cost-sharing has to be considered... A related conclusion is that the global programme is likely to take the form of a relatively small number of large projects.[15]

The Global Programme is singled out for its promotional and catalytic role and its role in institution building.

The 1981-1986 programme will continue to stress agriculture, health and energy, in that order. Within health, an initiative on safe rural drinking water and sanitation is being implemented.[16] In energy, new and renewable energy sources, conservation and information are singled out for attention.[17]

The Interregional Programme of UNDP is concerned with regional or country (sub-global) projects primarily in fisheries and trade. Funding for the three cycles defined previously runs $22.4 million, $31.8 million and $73.5 million, respectively.[18]

Discussions with UNDP Global Programme officials in 1983 indicated concern about the funding situation. Support for agricultural programs was not growing as planned and the health area was considered to be badly underfunded. The latter view was expressed at a time when the AID FY 1983 budget request contained a sharp decrease in funding for U.S. bilateral aid programs in health.[19]

UNITED NATIONS FINANCING SYSTEM FOR SCIENCE AND TECHNOLOGY FOR DEVELOPMENT (UNFSSTD)

A major recommendation of the UNCSTD Conference was that the U.N. General Assembly establish a financing system for science and technology for development in support of a broad range of capacity strengthening activities in developing countries and in support of the Vienna Programme of Action.[20] Complementary to existing bilateral and multilateral science and technology programs and supportive of national developing country efforts, the financing system was to be established, taking into account:

> a) the asymmetry of the technological capacity between developed and developing countries; b) the need for predictability and continuous flow of resources; c) the need for substantial resources in addition to those that now exist within the U.N. system; d) the need for untied external resources for the scientific and technological development of the developing countries.[21]

An interim fund to be administered by UNDP was established in the wake of UNCSTD with a target of no less than $250,000,000 in voluntary contributions for the two-year period of 1980 and 1981.

An introduction to the current status of UNFSSTD has been presented in Chapter 1. According to Wilkowski, "The U.S. Congress refused to appropriate the $50 million which had been envisaged as the American contribution (but which the U.S. delegation - fortunately - had not been authorized to pledge)."[22] However, regardless of the letter of what happened, there have been some negative effects of our failure to contribute. For one thing, according to one U.N. financing system official, U.S. allies in Japan and Western Europe who were persuaded to go along with the U.S. in working out a consensus on the financing system at UNCSTD, and who in some cases had been very supportive of the financing system -- for example some Scandinavian countries -- were reported to be very upset at the U.S. refusal to contribute. For another,

developing countries were also upset because pledges to the financing system have been much less than envisaged.

Because UNDP is a major source of support for what we have defined as science and technology activity within the United Nations, the question arises as to why expansion of science and technology activity within the U.N. system did not take place through UNDP. A likely answer is that The Group of 77, an organization representing more than 100 developing countries, view the UNDP as being "donor controlled" -- that is, they believe that decisions on project selection and funding are essentially made by or strongly influenced by those who contribute.[23] UNFSSTD was to have decision-making reside primarily with the developing countries. This was assured by the December 1982 General Assembly action establishing an Executive Board for UNFSSTD to be composed of 21 directors, one-third from developed countries and two-thirds from developing countries, "reflecting an appropriate balance between donors and recipients."[24] However, the same action urged cooperation and coordination between UNFSSTD and UNDP; it also gave over-all supervision of the management of the financing system to the UNDP Administrator, who is Bradford Morse, former U.S. Congressman from Massachusetts.

The question of financial support for the UNFSSTD is crucial. Contributions to the original $250,000,000 target set at UNCSTD for 1980 and 1981 fell far short. To encourage support, financing system administrators have pioneered within the U.N. in seeking donations from countries tied to specific projects in specific countries, so-called "non-core" contributions. By May 1983, a total of $83 million had been pledged for 79 projects, including substantial support from the Government of Italy for projects which require some purchase of Italian goods. Because until now Italy did not have a substantial bilateral aid program, UNFSSTD represented a way to gain entree to the technical assistance field on favorable terms. However, the flexibility shown by UNFSSTD in accepting tied projects is not appreciated by some within the U.N. who view it as an undesirable departure from previous practice.

A meeting of the U.N. Intergovernmental Committee on Science and Technology for Development in May of 1983 resulted in a statement that called for a target of "core" resources of at least $300 million over three years starting in 1983, including at least $50 million in contributions from July 1983 to June 1984.[25] The December 1982 General Assembly resolution calls for a three-year total of $600,000,000, both core and non-core, for the financing system for 1983-1985. If such an amount were to be made available, it would make UNFSSTD a major factor in science and technology for development, comparable to U.S. AID or UNDP. However, prospects for achieving such support or even a relatively small fraction of it seem very dim at this writing.

Table 4.4 lists some examples of projects supported by UNFSSTD. A broad range of projects are being financed, both high and low technology, over a wide range of organizations and countries, both low and middle income. The funding pattern clearly differs from that of the Global Programme of UNDP, with its emphasis on international centers and networks. Of the first 83 projects, 28 were in Africa, 20 in Asia, 18 in Latin America, 11 in Arab States and 6 were inter-regional; financial support for these groupings was 34 percent, 24 percent, 22 percent, 13 percent and 7 percent of the total, respectively. 35 percent of the projects were for strengthening research and development activities, 24 percent for strengthening science and technology infrastructure, 24 percent for search, choice, negotiation and adaptation of technology, 11 percent for development of human resources, and 6 percent for science and technology information systems.[26]

UNITED NATIONS CENTRE FOR SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

The Centre is a direct outgrowth of UNCSTD; its main purpose is to aid in implementing the UNCSTD (Vienna) Plan of Action. It reports to the U.N. Intergovernmental Committee on Science and Technology and has an advisory committee which was formed from a previous U.N. advisory committee on science and technology (ACAST). The Centre is organized in three branches; (1) Policy Analysis and Research; (2) Coordination and (3) Liaison with Non-Governmental Organizations (NGOs). As of Fall, 1983, the policy analysis and research division was examining two areas: (a) the integrated application of emerging and traditional technologies and (b) management of science and technology in developing countries. Panels and workshops were being held on these topics in the Philippines and Kuwait, respectively. Panels were also planned for Tunisia on the role of NGO's and professional societies in popularizing science and technology, and for Peru on commercialization of research and development. Thus, Centre studies tend to focus on broad, general topics. A second role of the Centre is to understand and coordinate science and technology activities within the U.N. system.[27]

In 1983, the Centre launched an Advance Technology Alert System (ATAS) which appears to be based upon the idea of technology assessment that emerged in the U.S. in the 1960s. ATAS seeks to be of benefit to

TABLE 4.4
Some examples of projects approved by the U.N. Financing System for Science and Technology for Development (as of December 31, 1982)

Country	Project Title	Executing Agency	Amount (US$)
Malawi	Scientific & Technological Development in the Tea Industry	Govt	655,000
Senegal	Senegalese Institute for Agricultural Research	Govt	1,000,000
Swaziland	Strengthening the Faculty of Science at the University College of Swaziland	UNESCO	667,000
Regional	Strengthening the S&T Capacities of the African Regional Centre for Technology	Govt (ARCT)	300,000
Jordan	Building Materials Research Centre	Govt	1,016,000
Tunisia	Centre for Earth Science & Geological Cartography	Govt	1,550,700
Laos	Strengthening the National Meteorological Service for Agriculture, Phase I	WMO	325,600
Pakistan	Development Centre for Silicon Technology	UNIDO	1,435,000
Jamaica	Upgrading the Scientific and Technological Capabilities of the Jamaica Bauxite Institute	UNIDO	1,074,800
Ghana	Symposium on the State of Biology in Africa	UNESCO	34,000
Ivory Coast	Medical Research of Haemotosis in Black Africans	Govt	200,000
Regional	Improvement of Wood Stoves in the Sahel	Govt (CILSS)	110,000

(continued)

TABLE 4.4 (continued)
Some examples of projects approved by the U.N. Financing System for Science and Technology for Development (as of December 31, 1982)

Country	Project Title	Executing Agency	Amount (US$)
Sudan	Cellulose Chemistry and Technology Research Unit	UNIDO	731,000
Philippines	Industrial Chemicals from Indigenous Carbohydrates Raw Materials	UNIDO	1,121,000
Brazil	Development and Optimization of Carbon Fibre Technology	UNIDO	1,527,994
Inter-regional	Strengthening Capabilities in the Use of Agricultural Information Systems	FAO	994,000
Inter-regional	Application of Modern Techniques in Physics to Development	IAEA (ICTP)	367,224
Lesotho	Development of Solar Energy and Bio-Gas Production	UNESCO	339,000
Tanzania	Technology Transfer in Zanzibar Fisheries	FAO	608,500
Bangladesh	Strengthening the Institute of Natural Drugs Research and Development	WHO	1,130,000
Paraguay	Post Graduate Training & Research in the Chemistry of Natural Products	UNESCO	339,000
Regional	Appropriate Technological Advancement in Rural Sectors of the Least Developed Arab Countries	ILO	170,000
Regional	Establishment of a Data Base on Arab Emigrant Professionals	Govt/Arab League	135,000

(continued)

TABLE 4.4 (continued)
Some examples of projects approved by the U.N. Financing System for Science and Technology for Development (as of December 31, 1982)

Country	Project Title	Executing Agency	Amount (US$)
China	Establishment of the Beijing Institute for Software Research & Training	OPE	1,306,500
Cuba	Development of Mineral Processing Technologies	UNIDO	59,000

Source: U.N. Financing System for Science and Technology for Development, UNFSSTD-Approved Projects (As of 31 December 1982).

developing countries by giving them early warning of potentially beneficial impacts of new and emerging technologies as well as possible negative effects.[28] Initial activities include establishment of a network of interested researchers and institutions and publication of a bulletin. The first bulletin issue is devoted to tissue culture technology.

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO)

The Reagan administration's decision to have the U.S. withdraw from UNESCO on January 1, 1985 has focused considerable attention on this specialized agency of the U.N. The policy issues associated with U.S. withdrawal will be discussed briefly in Chapter 6. Here, UNESCO's science activities will be outlined.

The UNESCO budget adopted for the two-year period of 1984 and 1985 is $374.4 million; the U.S. share was to be roughly 25 percent. Of the total UNESCO budget, $30.5 million is designated for research, training and international cooperation in the sciences and their application to development; $31.2 million is for activity on the human environment and terrestrial and marine resources; and $7.6 million is for work on science, technology and society. Other scientific aspects may be found in programs which deal with education, communications and information systems.[29]

Robert Maybury has described two aspects of UNESCO's work in science that sometimes conflict with each other. UNESCO started as an organization to promote global cooperation among nations, implemented by scholars. However, in the 1960s, it took on another aspect, namely that of a development agency providing technical assistance to developing nations, a mission that, according to Maybury, it has never been restructured to handle.[30]

According to Roger Revelle, UNESCO plays a major role in oceanography research and mapping, with a relatively modest annual budget of $9 to $13 million, roughly 4 percent of the annual budget of the U.S. Scripps Institute of Oceanography.[31] UNESCO also supports students from developing countries on fellowships to study in the U.S. and elsewhere; 22 percent of some 3,000 fellowships are in science and technology.[32]

OTHER UNITED NATIONS AGENCIES

Specialized U.N. agencies such as the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), support activities in which science and technology are significant; the U.S. contributes 25 percent to the budgets of such agencies through assessments. In addition, the U.S. sometimes makes additional contributions such as $2 million in FY 1984 to support the Tropical Disease Research Program of WHO. U.S. voluntary contributions also go to support organizations such as the U.N. Environment Program (UNEP) and the U.N. Fund for Population Activities (UNFPA).[33]

THE DEVELOPMENT BANKS

Within recent years, science and technology activity has received more focus and attention in the development banks. A Science and Technology Unit, created within the World Bank in 1972 to provide scientific and technical advice and inputs to bank projects, has helped the bank to define activity in appropriate technology. The unit has been carrying out a training program for individuals from developing countries on science and technology for development.

Although the World Bank focuses primarily on projects in particular sectors like agriculture, it also participates in cross-cutting activities. The bank houses the Executive Secretariat for the Consultative Group on International Agricultural Research (CGIAR); it performs a similar coordinating function for the WHO

Tropical Diseases Research Program. It also sponsors, along with UNDP, energy sector assessment and management programmes.[34] There would appear, therefore, to be some coordination with bilateral AID programs as well as U.N. technical assistance activity.

According to Charles Weiss, the World Bank is a major force in science and technology for development that has had significant impact even though its science and technology activity is not as visible as other aspects of its work. The bank is active in:

> (i) technical assistance to its member countries in the choice, implementation and operation of technology in the development projects it finances, and in the development of overall local technological capacity; (ii) project lending for training, research, innovation, development of scientific and technological capacity, and diffusion of scientific and technological information; (iii) support to international research programs; and (iv) internal research and policy analysis concerning the technological dimension of development.[35]

Among the bank's lending for 1975-1983 were about $2.6 billion for scientific and technological education.[36]

A Program of Training and Studies on Scientific and Technological Aspects of Development within the World Bank seeks to aid developing countries in improving their ability to make scientific and technological decisions, to improve their science and technology capacity and link that capacity to the productive sector.[37] The program involves developing country officials in a year-long, in-service training course to help improve skills in decision-making on science and technology for development issues and problems. Subject matter for the program includes case studies drawn from bank experience in various sectors (rural-road construction, forestry, fisheries, textile production, steel-mill implementation, etc.) and focuses on choice of technology and government policy. Technological policy and planning at both the enterprise and government level are examined.[38]

The Inter-American Development Bank estimates that as of 1979, it has contributed directly $900 million to the scientific and technological development of its member countries in Latin America and the Caribbean as well as substantial indirect support. "Rarely do its loan or technical cooperation activities fail to contribute new scientific and technological know-how, either directly or indirectly. These are provided mainly through goods and services by Bank loans."[39] Nearly $300 million has gone to support higher education, much of it oriented towards engineering, the natural sciences and health. Similar activity is supported in other parts of the world by the Asian Development Bank, the African Development Bank, and the African Development Fund.[40]

NOTES

1. U.S. Department of State, The Budget in Brief: Fiscal Year 1984, p. 37.
2. U.S. International Development Cooperation Agency, Congressional Presentation, Fiscal Year 1985, International Organizations and Programs, (1984) p. 1.
3. Ibid.
4. Ibid, p. 7.
5. IDA In Retrospect: The First Two Decades of the International Development Association, published for the World Bank by Oxford University Press, (New York, 1982) p. xv.
6. The World Bank Annual Report 1982, The World Bank, Washington, D.C. 20433 (1982), p. 3.
7. Remarks by Robert Ayres at the International Development Conference, Washington, D.C., May 18, 1983.
8. The Budget for Fiscal Year 1984: International Affairs, p. 5-20. Estimates of budgetary authority for 1984, 1985, and 1986 were $1.618, $1.269, and $1.215 billion, respectively.
9. Countries pledge to UNDP in their own currencies. The UNDP converts contributions to dollars to carry out its programs. As the dollar strengthens relative to other currencies, the latter loses value so that actual dollars available to UNDP fall short of expectations.
10. United Nations Development Programme, Country and Intercountry Programmes and Projects: The Global and Interregional Programme, 1982-1986, Governing Council Report DP/524, March 12, 1981, p. 3.
11. Ibid.
12. Ibid.
13. Ibid., p. 7.
14. Ibid.
15. Ibid., p. 9.
16. Ibid., p. 11.
17. Ibid., p. 18.
18. Ibid., p. 19.
19. Subsequent budget information indicates that this proposed U.S. AID health budget cut was restored.
20. The United Nations Conference on Science and Technology for Development, The Vienna Programme of Action on Science and Technology for Development, (New York: United Nations, 1979).
21. Ibid., p. 34.
22. Jean M. Wilkowski, Conference Diplomacy II, A Case Study: The U.N. Conference on Science and Technology for Development, Vienna, 1979, Institute for the Study of Diplomacy, Georgetown University, Washington, D.C. 20057 (1982) p. 42.

23. The view of the UNDP as a "donor-controlled" organization is not widely shared within the industrialized countries. In general, UNDP funds are allocated to countries by a simple formula based upon per capita GNP. Specific UNDP programs may be subject to other requirements.
24. Long-term Financial and Institutional Arrangements for The United Nations Financing System for Science and Technology for Development, United Nations Resolution 37/244 (December 21, 1982), p. 310.
25. Establishment of the Long-Term Financial and Institutional Arrangements for the United Nations Financing System for Science and Technology for Development (May 4, 1983).
26. U.N. Financing System for Science and Technology for Development, Summary Fact Sheet, March, 1983, pp. 2, 3. For further information on UNFSSTD, see Rustam Lalkaka, Science and Technology for Development Within The United Nations System, paper presented at Annual Meeting of the American Association for the Advancement of Science, (New York, May 26, 1984).
27. Based on conversations with M. Anandakrishnan, U.N. Centre for Science and Technology for Development (New York, December 20, 1982).
28. United Nations Centre for Science and Technology for Development, Advance Technology Alert System, Memo ATAS/CR2/6.83 (New York: United Nations, 1983).
29. Malcolm G. Scully, "Is UNESCO Worth Saving? If It Is, At What Price?," Chronicle of Higher Education, Vol. XXVIII, (February 29, 1984) p. 27.
30. Robert Maybury, Remarks at the Annual Meeting of the American Association for the Advancement of Science (New York, May 27, 1984).
31. Roger Revelle, Remarks at the Annual Meeting of the American Association for the Advancement of Science (New York, May 27, 1984).
32. Arthur Solomon, Remarks at the Annual Meeting of the American Association for the Advancement of Science (New York, May 27, 1984).
33. Nyle Brady, Remarks at the Annual Meeting of the American Association for the Advancement of Science (New York, May 26, 1984).
34. A Progress Report: The Joint UNDP/World Bank Energy Sector Assessment Programme and Energy Sector Management Programme (November, 1982).
35. Charles Weiss, Jr., Science and Technology at the World Bank, paper prepared for delivery at the Annual Meeting of the American Association for the Advancement of Science (New York, May 26, 1984), p. 1.

36. Ibid., p. iii.

37. Mario Kamenetzky and Robert Maybury, A Prospectus: Program of Training and Studies on Scientific and Technological Aspects of Development, (Washington, D.C.: World Bank, October, 1982).

38. In August of 1984, some thought was being given to eliminating the science and technology unit within the World Bank, which had been merged into a new Office of Environmental and Scientific Affairs in 1981. See Wil Leprowski, "World Bank May Eliminate Its Technology Advisory Function," Chemical and Engineering News 62, No. 32, (August 6, 1984) pp. 14-17.

39. Antonio Ortiz Mena, The Inter-American Development Bank and Science and Technology in Latin America, address before the United Nations Conference on Science and Technology for Development (1979) p. 2

40. For further discussion of the multilateral development banks, see Jonathan E. Sanford, U.S. Foreign Policy and Multilateral Development Banks (Boulder: Westview Press, 1982); and Robert L. Ayres, Banking on the Poor: The World Bank and World Poverty, (Cambridge: The MIT Press, 1983).

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5
Science and Technology for Development: Some Illustrative Examples

In this chapter, some examples of international development activity involving science and technology will be described. These examples have been chosen using three principal criteria. First, in the author's opinion, they represent cases in which science and/or technology have either had a significant positive impact or have the potential for doing so. Second, they illustrate a broad range of S&T for development activity. Third, they are topics in S&T for development that the author is most familiar with.

This chapter is not meant to be all inclusive. For example, relatively little attention is paid to activity in the health field, although the elimination of smallpox and the potential elimination of other diseases may very well represent some of the most significant accomplishments within the S&T for development rubric.

Since the late 1970s, AID has been issuing impact evaluation reports on some of its programs. These reports have helped meet the need that exists for readily available written evaluations of development projects. In addition, the FY 1984 and FY 1985 AID Congressional Budget presentations each contain a section entitled "Success Stories" which present highlights of AID projects the agency deems successful.1 The impact evaluations do begin to provide some useful information, although they have not been utilized to any extent in this study. Much more attention needs to be given to evaluation of S&T for development activity, including evaluations performed independently of the sponsoring agency.

INTERNATIONAL AGRICULTURAL RESEARCH: THE GREEN REVOLUTION REVISITED

In the fall of 1982, in informal conversations I had with a variety of individuals concerned with development at AID and elsewhere, international agricultural research was often singled out as the leading example of successful application of science and technology to international development. That this response was forthcoming should not be surprising. Agriculture has been the largest component of U.S. development assistance efforts, overshadowing activity in health, population and energy. Perceptions of the world food problem have shifted throughout the years. At one time, it was not believed possible to grow enough food to feed burgeoning populations. Now, the problem is perceived by some to be one of inequity in distribution; poor people do not have enough resources to purchase necessary food supplies. Still others feel that government policies that neglect agriculture and that stifle incentives for farmers and for the market system are to blame. This shift in perceptions can be attributed in part to "The Green Revolution" -- the introduction of new, high yielding varieties of wheat and rice that, along with fertilizer and irrigation, has led to greatly increased cereal yields.

One of those who took part in the work of the green revolution is Nyle Brady, former director of the International Rice Research Institute (IRRI) who is now Senior Assistant Administrator and head of the Bureau of Science and Technology at AID. Brady's views are set forth in his 1982 D. W. Brooks Lecture presented at the University of Georgia, entitled "The Unstoppable Agricultural Revolution."[2] Based on his 30 years of observation and experience in research and education in developing countries, Brady cites this quote from Richard Critchfield as expressing the essence of the current situation: "One can now confidently say that a quiet agricultural revolution has begun in the Third World that is likely to have more dramatic effects on more human beings than any revolution that has gone before."[3]

This optimism is the latest in a series of moods which seem to pervade international agricultural development periodically. In its earliest manifestation in the late 1960s and early 1970s, the green revolution held out hope of contributing, along with population planning programs, to the alleviation of hunger and famine, then very prevalent concerns, through greatly increased crop yields. Work at the International Rice Research Institute (IRRI) in the Philippines and at the International Center for the Improvement of Maize and Wheat (CIMMYT) in Mexico was a major factor in generating these rising expectations, and additional centers focusing on other agricultural crops were established throughout the world.[4]

As word of the green revolution spread, the inevitable back reaction set in. Critics pointed out that wealthier farmers would be more able to afford the new

varieties along with needed fertilizer and water. Furthermore, new varieties of a single strain or culture grown over large areas were more likely to be wiped out by pests or diseases than small plantings of more heterogeneous varieties. Doubts were expressed as to what proportion of increased grain supplies was attributable to the new varieties and what proportion was due to improved weather. Concerns about the green revolution, both pro and con, then seemed to fade from view as the 1970s progressed.

Brady, in 1982, articulated the case anew for the green or the "Post-Green Revolution" as follows. Although the world food situation is still of great concern, food yields have been much better than predicted. In spite of large population increases, food output per person is up slightly over the past 20 years everywhere except in parts of Africa; cereal output is up dramatically. In India in 1981, wheat production was triple that of the early 1960's; notable successes have also occurred in Pakistan and Brazil. Rice production has continued to rise. Yields in the Philippines and Colombia have increased steadily since 1972; progress in Indonesia and Burma has been outstanding since 1978. The only exception to this picture is Sub-Saharan Africa which has had a lack of appropriate technologies, trained personnel and proper pricing policies.[5]

The key to developing increasing food yields involves agricultural research and field testing within the region in which the crops are to be grown. Scientists from countries within the region must participate; new skills must be developed and personnel trained. A suitable system of extension, technical support, and equipment and outreach needs to be created to ensure that the small farmer can make use of the results of the research. Credit and financing also need to be available on reasonable terms. Continuous efforts are required to ensure that improved varieties stay ahead of pests and disease. All of this takes financial resources, long-term commitment and continuity.

New post-green revolution concerns for a more ecological agriculture that is less resource intensive and more beneficial to poor farmers have emerged. Paul Harrison states the case as follows:

> A revolution in the revolution was urgently needed - a second green revolution, bringing benefits to the groups that the first one neglected. The small farmer, the poor regions, had to be brought into the picture, not just because it was their right to benefit from progress, but even to keep food production growing ahead of population. That second green revolution is now in full swing, and

has begun to breed a new generation of super-plants: plants that can do well on the poor soils and in the hostile climates that marginal farmers have to contend with; plants that cost less to grow, that need less fertilizer because they are biologically more efficient; that need less insecticides and fungicides because they are immune to many pests and diseases; that are more ecologically sound, because they minimize pollution and use of scarce resources; plants that will produce more food and raise the incomes of the poor.[6]

A major portion of international agricultural research activity is carried out at the international agricultural research centers, supported by the Consultative Group on International Agricultural Research (CGIAR, see Figure 5.1). Organized in May, 1971, the CGIAR is sponsored by FAO, the World Bank, and UNDP and is comprised of some 45 countries, international and regional organizations, and private foundations. In 1981, 34 donors provided some $140 million to the 13 international centers and programs.[7] According to Roger Lewin:

> Established in 1972 and run with a degree of informality unusual in the arena of international organizations, the CGIAR is meant as a complement to national research programs in developing countries. Its most outstanding achievements so far include the development of high yielding varieties of wheat and rice and new technology that has allowed extensive adoption of the potato as an important crop. Warren Baum, the group's chairman, notes that increased production of wheat and rice through the use of high yielding varieties is sufficient to feed 300 million people annually.[8]

Lewin's article indicates that budgetary constraints, inflation and the strong U.S. dollar are keeping the CGIAR budgets from growing at the rate desired by the CGIAR. The U.S. contributes one dollar for every three from other sources. Pledges for 1983 totaled $162 million; although this represented an increase of 9 percent over 1982, it was not sufficient to permit plans for a new international research center on water management and irrigation to be implemented.

The international agricultural research center model seems to have emerged as a leading model of how to conduct international S&T research. Key ingredients are a critical mass of resources, skills and continuity. It seems reasonable to hypothesize that if the model works for rice and wheat, it will work for fast-growing trees or nitrogen-fixing plants or other things that grow. Coordination of donor support and

FIGURE 5.1 International agricultural research centers supported by the Consultative Group on International Agricultural Research (CGIAR)

Centro Internacional de Agricultura Tropical (CIAT)
(International Center for Tropical Agriculture)
Apartado Aéreo 6713
Cali, Colombia

Centro Internacional de la Papa (CIP)
(International Center for the Potato)
Apartado 5969
Lima, Peru

Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)
(International Center for the Improvement of Maize and Wheat)
Londres 40
Mexico 6, D.F., Mexico

International Board for Plant Genetic Resources (IBPGR)
Crop Ecology and Genetic Resources Unit
Food and Agriculture Organization of the United Nations
Via delle Terme de Caracalla
00100 Rome, Italy

International Center for Agricultural Research in the Dry Areas (ICARDA)
P. O. Box 114/5055
Beirut, Lebanon

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Patancheru P. O.
Andhra Pradesh 502 324, India

International Food Policy Research Institute (IFPRI)
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036, U.S.A.

International Institute of Tropical Agriculture (IITA)
P. O. Box 5320
Ibadan, Nigeria

International Laboratory for Research on Animal Diseases (ILRAD)
P. O. Box 30709
Nairobi, Kenya

International Livestock Centre for Africa (ILCA)
P. O. Box 5689
Addis Ababa, Ethiopia

(continued)

FIGURE 5.1 International agricultural research centers supported by the Consultative Group on International Agricultural Research (CGIAR) (continued)

International Rice Research Institute (IRRI)
P. O. Box 933
Manila, Philippines

International Service for National Agricultural Research (ISNAR)
P. O. Box 933 75
2509 AJ The Hague, The Netherlands

West Africa Rice Development Association (WARDA)
E. J. Roye Memorial Building
P. O. Box 1019
Monrovia, Liberia

Source: Consultative Group on International Agricultural Research (CGIAR), Washington, D.C., 1980.

systematic research are called for. It is not clear however, that this model will work for areas of industrial or proprietary concern; nor does it seem to allow for some of the unplanned breakthroughs that might come along.

Vernon Ruttan has raised the following points about the international agricultural research system.[9] First, it is unrealistic to expect the dramatic successes in productivity growth in wheat and rice from research at CIMMYT and IRRI to be rapidly repeated at some of the newer agricultural research centers where the research base was much less adequate at the start. However, these centers still represent choice research investments compared with other alternatives. Second, there will be a tendency for some to want the centers, given their success in crop technology, to take on an ever expanding range of activity, some for which they have little capacity; for example, Ruttan is wary of the centers taking on much work on developing more productive cropping systems that can be extended to small farmers, arguing that that kind of fine tuning is best left to local stations of national systems.[10] Third, Ruttan views the international agricultural research system as a valuable, permanent part of global agricultural development, contributing not only immediate gains but serving also as a long-term knowledge and technology generator.

Among Ruttan's concerns about the international agricultural research network are the possibilities that: (1) the system, although currently somewhat informally funded and decentrally managed, will become overly bureaucratic; (2) it may become more difficult to focus on the most significant research projects, in part because there is not enough financial involvement by the developing countries, and; (3) national research systems in developing countries are not acquiring the capacity sufficiently rapidly to make effective use of the international agricultural research center developments. One might add to Ruttan's list the possibility that the international centers compete with national centers for scarce resources; they also compete with other AID program elements for U.S. foreign aid funds, such as Title XII program support.

The green revolution and the international agricultural research centers clearly represent a significant application of science and technology to an important development problem. One way of viewing what has happened is that science and technology have provided the means for producing higher grain yields which has made it possible for more food to be grown. This might be thought of as a first-order effect. However, with technological development there are always second and higher order effects. It is not enough to say that the new varieties are scale-independent, that is, that they grow as well on small or large farms. As J. S. Sarma has pointed out:

> Because the new technology works as well on small farms as large, provided the necessary inputs are available, it is possible to raise the income of small and marginal farmers by giving them access to credit, inputs, and marketing and extension services. For marginal farmers and landless laborers, subsidiary activities and rural industries need to be developed to supplement their incomes from crop production and wages. If these steps are taken, both growth and equity can be achieved simultaneously.[11]

Sarma has also indicated, however, that in India under the Fourth Plan, special equity programs to assist small and marginal farmers have not yet had significant impact due to inadequate coverage, ineffective implementation, etc.[12] This illustrates that technology does not function in a vacuum and that the policies and values which shape the context in which the technology is to be embedded are of major importance. Rapid advances in biotechnology and genetic engineering could be of great benefit to developing countries but they also could do harm. The impacts must be anticipated before the technology is developed and implemented, something that the U.N.'s Advance Technology Alert System (ATAS) is trying to do (see Chapter 4). Furthermore, efforts must be made to understand the impacts of programs that have already been implemented so that future programs may benefit from lessons learned. The equity issues which arise from the green revolution and the biotechnological revolutions to come do not appear to be fully resolved, nor may they ever be, given conflicting value systems and world views.

RENEWABLE ENERGY

Renewable energy technologies of a small-scale variety are generally perceived as being of an appropriate, capital-saving nature. Thus, with the passage of P.L. 93-189, the Foreign Assistance Act of 1973 with its "New Directions" policy, followed by legislation supporting new programs in "intermediate" or "appropriate" technology in 1975 foreign assistance legislation, AID became interested in renewable energy. The 1978 Nuclear Non-Proliferation Act authorized Department of Energy involvement in international small-scale, renewable energy activity to encourage developing countries to explore alternatives to nuclear power. Another driving force in all of this was the sharp increase in petroleum prices beginning in 1973.

With this legislative framework in place, a variety of renewable energy technologies began to receive attention. Prominent among these were wind energy, improved cookstoves, solar dryers and biogas units, to name only some. Among the applications of these technologies are water lifting for drinking, agriculture and watering animals, electricity for household and small industry use, cooking, water heating, and grain and timber drying. Many of these applications can directly benefit small farmers and families in rural areas -- primary target groups for new directions legislation. Thus, small-scale, renewable energy technologies became synonymous with technologies directed towards meeting basic human needs. Figure 5.2 summarizes eight technical areas which the World Bank-UNDP Energy Sector Assessment Programme has identified for pilot projects in the rural/renewable energy field.

Back in 1978, I had the opportunity to direct two studies as part of U.S. State Department preparations for UNCSTD. The second of these focused on renewable resources and their use in international development.[13] In this project, which was carried out in cooperation with Volunteers in Technical Assistance (VITA), we reviewed the state-of-the-art of a small number of technologies that we felt had potential for helping to

FIGURE 5.2 Areas Identified for Pilot Projects in the Rural/Renewable Energy Field

	Improved stoves and kilns	Wind pumps	Solar crop-driers	Solar water-heaters	Micro-hydro	Peat for domestic use	Biomass for power/heat	Biogas
Indonesia	x						x	
Kenya	x		x	x				
Morocco	x	x	x					
Burundi	x		x			x		
Rwanda	x		x			x		
Zambia	x	x	x		x			
Zimbabwe	x	x	x		x			x
Haiti	x						x	
Papua New Guinea				x	x		x	
Bolivia			x				x	
Sri Lanka	x	x	x	x	x			
Turkey	x							
Bangladesh	x		x				x	x
Malawi	x				x			
Fiji	x	x	x	x			x	
Nepal	x							
Senegal	x		x	x		x		
Niger	x		x	x			x	
Nigeria	x						x	
Peru	x				x		x	

Source: <u>A Progress Report: The Joint UNDP/World Bank Energy Sector Assessment Programme and Energy Sector Management Programme</u>, (November, 1982) p. 13.

meet basic human needs in developing countries, and then made recommendations as to what the U.S. government might do to foster these technologies. What technologies made sense? Our choices were based upon a series of meetings with VITA staff, many of whom had overseas experience. Furthermore, we were influenced by the kinds of requests for technical assistance and information that VITA was getting from overseas. We were looking for technologies that were reasonably affordable at either the individual or community level. We also excluded some areas such as biogas because we felt there was too much information for us to handle, given the time and resources we had available. Among the areas we selected were wind energy, improved cookstoves, solar grain and timber drying, and materials and products based on agricultural wastes and natural fibers. The first two of these will be considered here, with greater attention being given to improved cookstoves.

Wind Energy

Wind energy for low-income populations seems appropriate at the community or group level rather than for individuals, because a windmill will cost hundreds or even thousands of dollars, depending upon whether relatively simple water pumpers or more complicated electricity generators are being considered. There are many kinds of windmills and many projects and uses around the world -- so many that a comprehensive assessment would be very hard to make. One good example of an indigenous technology oriented towards meeting basic human needs is a windmill designed and developed for water pumping at low wind speeds by Las Gaviotas, a development project in the Savannah region of Colombia. The Gaviotas windmill is a medium-speed design with five metal airfoil-shaped blades mounted on a wooden tripod frame, with supporting guys. According to a July 1980 report, 25 windmills were being produced per day at Gaviotas to meet a contract with the Colombian Government to supply a total of 1,500 windmills for use in rural schools and public facilities. Ahrens reported a selling price of about 40,000 pesos per windmill, which was less than 25 percent of the cost of the nearest competitor.[14] The last word I had was that the 1,500 windmills had been produced.

Volunteers in Technical Assistance (VITA) has been involved in a variety of projects involving windmills. VITA representative Marcus Sherman helped to develop and begin to disseminate a water pumping windmill in Thailand which can be built locally. Tests indicate that the windmill can be used to irrigate up to 10 hectares of fields of rice for about one-quarter to

one-half of the cost of utilizing diesel pumps.[15] In Roatan Island off the coast of Honduras, Dempster windmills flown in from the U.S. by VITA and erected have improved the community water supply situation. Back in the United States, a team of engineers led by VITA volunteer and founder Dan Johnson has been working on developing a variable stroke windmill to increase water output.

In a survey of the potential for wind energy for water pumping in Somalia, VITA staff member Jonathan Hodgkin found that of the roughly 340 windmills that were estimated to be in place in Somalia in the 1960s, only about 100 were functioning by the early 1980s. Among the factors for this low utilization were lack of maintenance and unavailability of spare parts.[16] Other problems that can arise in implementing wind energy projects are a scarcity of the necessary technical knowledge and experience to install windmills locally. Existing windmill designs are often too costly and not properly adapted to rural village conditions. More efforts are needed to develop, implement, disseminate, modify and test windmill designs.

Improved Cookstoves

Wood is a major energy source for many developing countries. The utilization of wood as fuel for cooking accounts for the major share of the total energy consumption in rural areas. However, wood is becoming increasingly scarce and individuals spend more and more time gathering wood for essential household uses.[17]

There are two steps which have been receiving attention in efforts to combat growing problems of soil erosion and increasing energy scarcity due to deforestation. The first is obvious: grow more trees and replace those cut down. The second involves improving the efficiency with which wood is used in cooking.

It is traditional in many rural areas of developing countries to cook using an open flame with the pot supported by three stones. This process has been believed by some to be quite inefficient, that is, only a small percentage of the energy contained in the wood is transferred to the food. Furthermore, there are health and safety hazards associated with this method when used indoors. As a result, efforts have been underway to improve the design of cookstoves; one important design objective has been to increase the efficiency of cooking so that less fuel will be consumed for a given task. At least a doubling of the efficiency over traditional methods has been believed by some to be possible, which would result in a halving of the fuel requirement. However, to accomplish this increase in efficiency, the improved stoves must be technically feasible and affordable, and must prove culturally acceptable to the people who will use them.[18]

Although work on improved cookstoves has been going on for some time, particularly in India, cookstove efforts became more visible in the late 1970s with the development of the Lorena Stove for use in the highlands of Guatemala. Made from mud (lodo) and sand (arena), these "high-mass" stoves were designed to be built with locally available tools, materials and skills. Grass-roots training and demonstration efforts on stove construction and use at the Choqui Experimental Station in Guatemala resulted in roughly 500 to 1,000 stoves being built in that country by 1979.[19] Stoves were constructed either by the villagers themselves, or by entrepreneurs at a price of $15 to $35 (1979 prices) including materials, with profits of from $8 to $18 per stove. User acceptance surveys at that time indicated that a high percentage of the stoves were in daily use but in some cases, the stoves were not being used as designed, resulting in efficiencies lower than hoped for. Some of these high-mass stoves, which also can serve as space heaters, were also built in Honduras and Mexico.

In February of 1979, a Panel on Improved Cookstoves was held at VITA headquarters, convened by VITA and the Center for Development Technology (CDT), Washington University (St. Louis) as part of a larger study by the Center in connection with UNCSTD preparations. The panel indicated that the following areas needed attention (not necessarily in order of importance) in order to bring about an effective expansion of use of improved cookstove designs in developing countries: design improvements; evaluation of end-use needs; matching of designs with durability requirements; improved financing arrangements; social and cultural acceptability; effective training and extension programs.[20] More broadly, the CDT study concluded that improved cookstoves and other renewable resource technologies require some appropriate mix of the following activities to bring about increased utilization; (1) collection, evaluation and publication of data on village-level needs and local resources; (2) provision of information dissemination programs on appropriate technologies; (3) support for extension efforts; (4) performance of research to improve and adapt designs; (5) carrying out of testing and performance evaluation of designs; and (6) evaluation, assessment and publicity for efforts to utilize the technologies.[21]

Within the past three to five years, improved cookstove programs have received considerable emphasis, particularly in Africa and Asia.[22] Funding for these efforts has been provided by a variety of organizations

including U.S. AID, European aid organizations, and the World Bank. In December of 1982, experts from ten countries met at VITA headquarters to develop an international set of standards for testing the efficiency of wood burning cookstoves. Three basic tests were recommended; a water boiling test, a kitchen performance test, and an intermediate test.[23] At that meeting, informal discussions were held on the subject of the extent to which improved cookstoves were in place and being utilized. It is the author's impression, based upon those discussions, that something on the order of a few tens of thousands of improved stoves were in place as of 1982. Utilization rates for these stoves varied greatly from country to country or even from program to program within a country, from very high (80 percent or more of stoves in use) to not so high (50 percent or less).

Madon has described the principal results of the evaluation of the rate of utilization of improved high-mass cookstoves (clay and sand) with and without chimneys in the "Ban Ak Suuf" project in Senegal. Between March 1980 and July 1982, more than 5,000 stoves were built and disseminated in a project that had U.S. Peace Corps volunteer, AID and French government support. A survey of 985 rural stoves that were eight months old indicated that 65 percent were in regular use (although 18 percent of these were judged to be in poor condition), and 13 percent had been totally destroyed. 77 percent of the stoves without chimneys constructed by women were used regularly, indicating that superior results were obtained through the involvement and education of the women who actually used the stoves for cooking. Stoves without chimneys were used at a somewhat higher rate than those with chimneys. Stoves without chimneys were usable for one or two years; unusable stoves usually failed almost immediately after they were built due to faulty construction technique and other factors. Madon's evaluation found the overall utilization rates encouraging and concluded that with further effort, it should be possible to approach utilization rates of 100%. No stove efficiencies were given.[24]

A major program effort of which the "Ban Ak Suuf" project is a part, is underway in the Sahel region in Africa, sponsored by CILSS, a regional organization that coordinates activity concerned with combatting drought in the Sahel. Senegal and Upper Volta are two countries in which cookstove projects have been particularly active. VITA representative Dr. Sam Baldwin worked with CILSS in Ouagadougou, Upper Volta. Baldwin a Ph.D. physicist replaced Dr. Tim Wood, another scientist, who returned to head the environmental studies program at Wright State University in Ohio. Baldwin and Wood typify VITA's ability to involve young, well-qualified scientists and engineers in development work. In addition to heavy involvement in implementing field projects, Baldwin found time, with African colleagues, to carry out research and produce reports on both engineering and economic aspects of improved stoves.[25]

Baldwin's experiences in Africa have made him an advocate of low-mass stoves. For tropical regions of Africa, space heating isn't needed as it is in the highlands of Guatemala where the Lorena stove, a high-mass stove, was introduced. If made of mud, high-mass stoves will not be durable enough in tropical areas. If made with masonry, their $35 or more cost goes beyond the means of many people. In Africa there are many skilled village potters who make clay vessels at very low ($5 or less) cost. There are also skilled metal workers. Baldwin worked on improving the designs of low-mass stoves made of either clay or metal. Although there were problems (fragility of clay, etc.) to be overcome, when I talked to him he seemed both enthusiastic and optimistic.[26]

In a January 1984 article in VITA News summarizing his work, Baldwin draws conclusions about one facet of his experience as follows:

> Appropriate technology (AT) is not synonymous with low quality technology or engineering. On the contrary, AT embodies the highest principles of good engineering: AT must meet the severe constraints found in developing countries and yet work. AT must be locally producible with local materials to the extent possible, locally maintainable, of low cost, and meet real local needs. This requires elegant engineering.
>
> Such engineering, however, cannot be provided on an individual case basis. Western industry has achieved the highest standard of living in history through precision engineering of mass produced goods sold in mass markets. To reduce the engineering effort in bringing a product to market generally dooms the product to failure. There is no alternative. "Small is beautiful" cannot be applied to the engineering effort.[27]

Although this overall study focuses primarily on the U.S. role in science and technology for development, other industrialized countries are an important resource. An organization at the forefront of work on improved cookstoves is the Intermediate Technology Development Group (ITDG) in London, the organization formed originally by Ernst Schumacher. For example, ITDG is providing consultancy services to the Research Centre for Applied Science and Technology (RECAST) of Tribhuvan University, Nepal, on stove design as part of a Community Forestry Development Project sponsored by

UNDP, FAO and the British Government. Tests are being carried out on ceramic (pottery) stoves with and without chimneys, and on mud stoves with chimneys. These stoves cost around $2 to $6 each. Plans call for 15,000 stoves to be built and distributed over the period from 1980/81 through 1984/85. An efficiency increase of at least 30 percent is expected.[28] ITDG has also been active in stove programs in Sri Lanka, Indonesia, and Kenya with grass-roots organizations such as Sarvodaya Shramadana (Sri Lanka) and Dian Desa (Indonesia).[29,30] Concerning improved stoves, Stephen Joseph of ITDG urges recognition that "diffusion of such complex technology is slow and requires sufficient resources if the new technology is to remain embedded in the fabric of the society."[31]

Evaluation. Of all the clearly identifiable renewable energy technologies, it would appear that improved cookstoves would seem to have good prospects for having a significant direct positive impact on the lives of poor people, mainly rural people in the least developed countries and regions of Africa, Asia, Latin America and the Caribbean. The problems, (growing fuelwood scarcity), the level of need (food -- a basic), and the response (improved cookstoves) are clear-cut and understandable. Yet progress appears slow for several reasons. First, cooking is part of cultural traditions that change slowly. Second, solutions must be attractive, yet very low cost. Third, scientists and engineers have tended to avoid these problems because they are not at "the cutting edge" of science and technology and there is no market for their services in such activity. Yet the technical as well as the economic, social and cultural challenges are there and they are significant.

In early 1983, some new concerns about improved cookstove efforts emerged.[32] Questions about the durability of high mass stoves arose, coupled with doubts about their suitability for tropical areas. Early hopes of large (50 percent) improvements in efficiency of wood use were not being borne out by pilot experiments and the efficiency of open fire cooking was beginning to look better to some. Foley and van Buren, and Hosier et al. have raised fundamental questions about the inability of the rural subsistence sector to accomodate energy initiatives which rely on noncommercial fuels.[33,34] Thought was being given to moving on from "first generation" mud and clay stoves to "second generation" stoves that are more durable and attractive and that people will want to use and maintain. Just what a "second generation" stove would look like is unclear but there is evidently some feeling at the World Bank and elsewhere that emphasis should be placed on commercially built and marketed stoves geared towards urban and semi-urban users, including small industries (e.g. beer production). Such a strategy would appear, however, to fail to address head on the vast problem of the needs of the rural poor majority.

From a technical point of view, it may be that stove pilot projects were implemented without adequate research and development. These is very little stove R&D work going on in U.S. universities to provide backup for field efforts.[35] Some work has been going on in the Netherlands and Belgium. From a policy point of view, it is important that the kind of resources and continuity that were put into the international agricultural research centers be expended on renewable energy projects if they are to succeed. The emphasis on renewable energy at AID can't be more than five years old and the cutback that took place in the Reagan administration in U.S. government support for domestic renewable energy activity could conceivably spill over into AID's program.

It is exceedingly important that cookstove efforts be carefully and objectively evaluated, that these evaluations be used to plan future activity, and that sweeping conclusions not be drawn from these evaluations which are not supported by the data simply to support ones point of view. In addition, work on renewable energy might be more closely coupled in the future to local private sector entrepreneurial activity within developing countries.

Sam Baldwin's work in Africa with VITA and CILSS stands out as an example of what can be done when well qualified technical skills are combined with a desire to contribute to development efforts. Baldwin and his African colleagues measured three-stone fire efficiencies of 15 to 19%, if the recuperable charcoal values in the wood are included, assuming reasonable protection from the wind. He summarizes the work he was involved in with others in Africa as having resulted in the development of low-mass, metal and pottery stoves that are "40% more efficient, 80% lower in cost, and 20 times faster to produce than previous forms, potentially saving -- at 30% intrusion globally -- 200 million barrels (of) oil equivalent per year of biomass."[36]

An editorial in the April 1984 issue of "Boiling Point," the ITDG cookstove newsletter, indicates that ITDG's cookstove efforts are moving from the pilot phase to wider dissemination. Their programs have shifted from mud stoves to artisan-made stoves of pottery and metal, a shift that has also been made by VITA. The importance of urban and peri-urban wood and charcoal purchasers on deforestation due to fuel collection has resulted in attention being focused more on stoves for these groups.[37] A 1984 report of an international workshop on woodstove dissemination came

to the following consensus concerning the present situation:

> ... mud stoves are still viable options in many rural areas of the world. They represent a 'people's technology' which is widely accepted and used with satisfaction in terms of time and fuelwood savings. However, the development of improved portable metal and fired clay stoves is expanding rapidly to broaden the range of choice offered to users.[38]

STUDENTS FROM DEVELOPING COUNTRIES IN U.S. ENGINEERING SCHOOLS

In this section,[39] we deviate from looking at a particular technology such as cookstoves or sector such as agriculture and consider another important element of U.S.-developing country interaction in science and technology. U.S. engineering schools and foreign students have had an important relationship ongoing for the last 20 or 30 years. Large numbers of international students have come to the U.S. seeking engineering education, supported by four sources: (1) U.S. government or U.S. government-supported programs; (2) home governments; (3) U.S. university research assistantships and other sources of university funds; (4) the students' own personal resources. The mix of those four sources tends to change with time and with country of origin. The trend in the last half of the 1970s was for funding by U.S. sources to decrease while foreign student enrollments increased.[40]

In 1979, I directed a study of the role of U.S. universities in science and technology for development as part of U.S. preparations for the U.N. Conference on Science and Technology for Development (UNCSTD).[41] After examining three fields -- engineering, agriculture and science -- it became evident that U.S. universities in the last three decades have been heavily involved in a variety of activities which serve to aid developing countries in building their own indigenous capacity to use science and technology for development, including institution building and cooperative research and development. From 1949 to 1979, more than two million students from developing countries had studied in U.S. universities, land-grant colleges and community colleges, including large numbers of engineers, agriculturalists and scientists who returned home to key positions on university faculties and in research institutes, government ministries, and public and private enterprises. At the time of our 1979 study, the major impact of foreign students on U.S. engineering schools was at the graduate level.

With the expansion of U.S. engineering education following the launching of Sputnik, graduate engineering programs developed at a rate which outstripped the demand for them by U.S. students. A major impact of foreign students has been to keep graduate engineering enrollments in the U.S. at reasonably high levels, thereby justifying retention of faculty members. Without foreign graduate students, U.S. engineering faculties probably would have had to be cut in size by a significant factor. Many research projects could not have been completed without foreign graduate students, nor could undergraduate classes have been taught without foreign teaching assistants. It was and is impossible to be an engineering faculty member at a U.S. university and not be involved with or affected by students from developing countries. With time, as had happened in the past, some of the students of today became the faculty members of tomorrow. In my opinion, the United States and U.S. engineering schools have benefited greatly from these developments and clearly, the foreign students have done well also -- both those who have stayed here and those who have gone back. In this latter regard, my impression is that students who have returned home have used the U.S. experience as stepping stones to careers in public or private administration. It appear to give some of them a comparative advantage over locally educated people.

Viewed from the developing country government's point of view, if the primary objective is to build up indigenous S&T capability, caution should be used in sending people to the U.S. Heavy emphasis should be placed on developing and using local educational capability. Individuals should be sent abroad who have strong attachments and incentives to return home.

K. N. Rao, in a 1978 article, has provided a useful framework for developing country planners to use in considering whether or not sending students abroad is consonant with their existing science and technology infrastructure and developmental objectives.[42] Countries are classified according to the extent to which local universities have established programs of higher education. A logical sequence would have a country pass through various stages of development in which first undergraduate and then graduate students would receive overseas training. However, it seems evident that such logic is not necessarily followed in all cases. Foreign student enrollments in the U.S. have continued to increase in recent years at all levels. Developmental objectives are just one factor in a very complicated situation. There clearly are perceived advantages associated with study in the United States. Furthermore, higher education in developing countries is just not expanding at a rate sufficient to keep up with the local demand.

Do U.S. engineering schools have incentives for focusing on special needs of foreign students and the developmental needs of their countries? Many engineering schools place a premium on obtaining sponsored research and other external support. In the 1960s, one modest source of such support was U.S. A.I.D., which provided funds for consortia of engineering schools to help build engineering colleges in India and Afghanistan. About 20 U.S. universities were involved in these two activities. Another source of support was AID's 211d program which provided a modest amount of support for cooperative research involving engineering schools.

In the U.S., engineering is based upon mathematics, physics and chemistry. Undergraduate engineering students all take at least one year of the engineering sciences (statics, dynamics, fluid mechanics, heat transfer, thermodynamics, electrical sciences, etc.) and one-half year of engineering design. Most engineering students can be found in the traditional disciplines: electrical, chemical, mechanical and civil engineering. Computer science and computer engineering have become important. Other specialties and more general programs can be found. Somewhat more practical "engineering technology" programs parallel the traditional engineering disciplines. All engineering students take some humanities and social sciences courses. At the graduate level, advanced work in the discipline is taken and theses or projects are often required.

Back in the 1960's, there were many discussions of whether or not U.S. engineering curricula were "relevant" to students from developing countries.[43] On one extreme were those who felt that everything done here was totally relevant to what the foreign student would need upon returning home. On the other were those who wanted to design entirely new curricula and degrees for foreign students. As with many things, the truth lies somewhere in between. Engineering has an applied, design or synthesis component. In the U.S., most applications studied in school are oriented towards the United States. Furthermore, given the broad range of technologies, from primitive to exotic, which may in fact be useful in a given region of a specific country at a particular point in time, it is not likely that the "totally relevant" hypothesis applies. On the other hand, certain principles and methods of analysis -- of looking at problems -- may be universal.

There are steps which can be taken to make the education of foreign students more relevant to home country needs. For example, it should be relatively easy to build into the design synthesis experience, work that has a developing country setting or relevance. At the undergraduate level, social science electives with an international dimension are appropriate. In engineering, the thesis or dissertation sometimes provides an opportunity to do work targeted towards a developing country environment. In particular, at the master's level, there is sometimes room, even in traditional disciplines, for some innovation. An example would be a chemical engineering thesis relevant to a natural resource found in the student's country.

An idea which has been around for awhile, but which has received little if any financial support, is that of special summer programs for foreign students geared specifically towards home country needs -- courses on technology and international development, on management of technology, perhaps on more practical laboratory skills than are taught in standard U.S. curricula. Such courses, held the summer after the student's first year in the U.S., should have a broad potential international student audience to draw upon from all over the United States. However, such courses need to be made attractive to students and relevant to their academic program and career goals.[44]

There are also the non-traditional degree programs like the masters degrees in Technology and Human Affairs offered at Washington University in St. Louis, that enable students from engineering, the natural and social sciences to broaden their perspectives, building on traditional disciplines but focusing on problem areas like technology and international development. A relatively small number of programs of this kind, well-supported, could make a difference, assuming foreign students could be persuaded to take them; the latter would depend on whether the students or their home governments or the U.S. government would be willing to provide support for enrolling in such a program as opposed to a traditional engineering discipline. To date, funding sources have tended to avoid the non-traditional. In addition, support for collaborative international engineering research projects between developed and developing country institutions is needed. Such projects could provide relevant training for foreign, as well as U.S. students, and appropriate incentives for research-intensive U.S. faculty.

The discussion in this section has focused primarily upon the positive contributions of students from developing countries to U.S. engineering education and upon the relevance of that education to the needs of their home countries. Within the past two or three years, other issues have become prominent. They include possible negative impacts of foreign students on the quality of U.S. engineering education, military and economic security concerns, and immigration issues. At present, the data base to help in resolving these issues is inadequate.[45]

FUELS AND CHEMICALS FROM OILSEEDS

There are a great variety of uncultivated plant species that grow around the world, representing an untapped source of fuel for uses such as lighting, cooking, and powering diesel engines. These species could also serve as well as feedstocks for a wide variety of industrial chemicals. Seeds from the Chinese tallow tree, the buffalo gourd, and many other unfamiliar species contain high oil content and can grow on marginal soils. Whether such plants can be utilized successfully in rural sectors and cultivated economically without conflicting with land and other requirements for food production remains to be determined.

E. B. Shultz, Jr. at Washington University, St. Louis, and co-workers have carried out several technical and economic feasibility studies of oilseed applications.[46,47,48] The Washington University work, although promising for both the U.S. as well as developing countries, is exploratory in nature. The portion of the research that focuses on chemical feedstocks is not easily matched with AID program interests; even the energy applications have been difficult to accomodate.[49] The Office of the Science Advisor's PSTC program supports laboratory and field studies in selected areas but does not support the kidns of techno-economic feasibility and planning studies that are crucial to the oilseed work at this stage. Washington University is not a land-grant, agricultural university so it is difficult to develop support from the Title XII framework. To date, the work has been supported almost entirely with university funds. The difficulties we have encountered in developing support for a somewhat high risk R&D activity in S&T for development may not be unique. There are undoubtedly other scientists and engineers outside of AID's traditional network who have experienced similar difficulties.

Although many opportunities can be conceived of for new processes and products from oilseeds, there are obstacles to be overcome if oilseeds not now grown commercially are ever to become significant sources of energy or to capture an increased share of the chemical feedstock market. For species which have not been cultivated, overall resource estimates are difficult to make confidently. Also, the economics of oilseed utilization is not well developed and differing viewpoints and opinions exist. Other obstacles to change include alternative land uses, existing cropping practices, entrenched interests and lack of public policy support. Nevertheless, potential chemical products are economically important and are increasing in demand, including specialty polymers, plasticizers, surfactants, synthetic lubricants and antimicrobial agents. Furthermore, in spite of recent decreases in petroleum prices in 1983-1984, fossil fuels remain a finite, limited resource for which renewable alternatives need to be vigorously pursued.[50]

HOUSING AND DISASTER ASSISTANCE

Contributions of science and technology to international housing and disaster assistance have received relatively little attention. However, in recent years, both AID and the National Science Foundation have begun to pay more attention to problems such as how to make relatively low-cost housing more earthquake resistant and how to create safer settlements in disaster prone areas.

In 1978, a joint India-U.S. Workshop on Natural Disaster (Earthquake and Wind-Effects Mitigation) Research was held in New Delhi, sponsored by the Indian Department of Science and Technology and the U.S. National Science Foundation.[51] It was agreed at the meeting that both countries would benefit from cooperative research on techniques for strengthening the earthquake resistance of prevailing masonry construction, as well as increased communication and exchanges. In May 7, 1981, an International Workshop on Earthen Buildings in Seismic Areas was held in Albuquerque, New Mexico, sponsored by the National Science Foundation, AID's Office of Foreign Disaster Assistance and A.T. International.[52] The meeting was hosted by the University of New Mexico and Intertect, a small, private organization with both technical capability and experience in disaster assistance.

The Albuquerque workshop is of interest for several reasons. First, the papers represent an effort to consider the application of science and technology to a major problem facing poor people, namely the need for more secure, yet affordable housing. Second, the hosts for the workshop represented an interesting coupling of university and private sector capabilities which nicely complemented each other. Third, although U.S. government collaboration among agencies was evident, there was a visible lack of developing country sponsorhip. Related conferences have been held, however, in Roorkee, India in 1982 and in Lima, Peru in 1983.

Some support for these conferences and the research agenda defined there has been forthcoming from NSF's engineering directorate and from AID. Whether this support is sufficient to permit a sustained research effort to be made in applying science and technology to housing and disaster assistance remains

to be determined. It does not seem to be a priority within AID's Science and Technology Bureau.

HEALTH

Although neglected in this study, the field of international health and the associated role of science and technology is a fertile one for future investigation. The results of efforts in health are very visible and the humanitarian basis for cooperation and assistance is very strong. In this section, a very small number of items will be touched upon.

James Grant, Executive Director of the United Nations Children's Fund (UNICEF), has articulated a program that, if implemented, could save the lives of some seven million children annually who die from diarrhea, according to UNICEF estimates.[53] Grant calls the program GOBI, each letter of which stands for the four main program elements: (1) growth monitoring, using simple ten cent charts that can be used by mothers to measure their children in order to spot malnutrition early; (2) oral rehydration therapy (ORT) consisting of administering by mouth an inexpensive a mixture of salt, sugar and water to prevent or correct dehydration induced by diarrhea; (3) promotion of breast feeding as opposed to bottle feeding; and (4) immunization against childhood diseases.[54] These procedures, taken together, can be implemented at relatively modest cost. Oral rehydration therapy and immunizations are also part of AID's health sector efforts.[55]

The World Health Organization (WHO) is taking part in a Tropical Diseases Research Program aimed at six diseases which are widespread in tropical areas, namely, (1) malaria; (2) schistosomiasis; (3) filariasis; (4) trypanosomiasis; (5) leishmaniasis and (6) leprosy. The effort is being coordinated under U.N. auspices in a manner similar to the CGIAR work in agricultural research. These diseases threaten hundreds of millions of people; yet the budget for research from all sources to conquer them is only about $60 million per year (1983 estimate).[56] The U.S. contributes to the WHO effort; it also supports bilateral activity in this area.

The Research Grants Program of the National Research Council funds investigators in developing countries in three areas of health. They are: (1) mosquito vector control; (2) acute respiratory infection; and (3) developing methods for doing rapid epidemiological assessments of the health status of populations.

The eradication of smallpox is often cited as a leading success in the international health field; the full story is in the process of being written. Health projects are highlighted by AID in its FY 1984 Congressional Presentation;[57] projects such as the Volta River Basin Oncholerciasis (river blindness) Control Program and the Endemic Disease Control Program in Zaire appear to have contributed significantly to improving health in developing countries.

CONCLUDING REMARKS

The preceding cases illustrate some aspects of the role of science and technology in development. The two cases presented in most detail, namely international agricultural research and improved cookstoves, indicated that science and technology can not be considered in a vacuum; they are inexorably intertwined with the fabric of the societies in which they are to be applied. There is a continuing need to perform in-depth evaluations of programs and projects so that both opportunities for using science and technology in the development process and limitations to their use can be better understood.

NOTES

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3. Richard Critchfield, "Science and the Villager: The Last Sleeper Awakes", Foreign Affairs 61 (1982) pp. 14-41.

4. For a detailed description of the development of the International Rice Research Institute, see Robert F. Chandler, Jr., An Adventure in Applied Science: A History of the International Rice Research Institute, International Rice Research Institute, Los Baños, Laguna, Philippines (1982).

5. Based upon material in Nyle Brady, "The Unstoppable Agricultural Revolution," pp. 2-7.

6. See Paul Harrison, The Third World Tomorrow, 2nd Ed., (New York: The Pilgram Press, 1983) p. 94.

7. Consultative Group on International Agricultural Research, informational brochure published by CGIAR Secretariat, World Bank, 1818 H Street, N.W., Washington, D.C. 20433 (October, 1981).

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9. Vernon W. Ruttan, Agricultural Research Policy, (Minneapolis: University of MInnesota Press, 1982), pp. 142-144.

10. Ibid., pp. 135-136.

11. J. S. Sarma, Growth and Equity: Policies and Implementation in Indian Agriculture, Research Report No. 28, International Food Policy Research Institute, Washington, D.C., (November 1981), p. 8.

12. Ibid., p. 7.

13. Robert P. Morgan and Larry J. Icerman, Renewable Resource Utilization for Development, (New York: Pergamon Press, 1981). (With Elizabeth S. Andrews, et al.).

14. Cited in Morgan and Icerman, Renewable Resource Utilization for Development, p. 27. Elizabeth S. Andrews was a major contributor to the wind energy chapter.

15. David Jarmul, "Windmills Enter the Computer Age," Horizons 2, No. 9 (Washington, D.C.: U.S. AID, Oct., 1983) p. 34.

16. Jonathan Hodgkin, Potential for Wind Energy for Water Pumping in Somalia, Volunteers in Technical Assistance (Arlington, Va., undated), p. 1.

17. See, for example, Erik Eckholm, "Planting for the Future: Forestry for Human Needs," Worldwatch Paper 26, (Washington, D.C.: Worldwatch Institute, February 1979).

18. For a detailed state-of-the-art review of biomass utilization for cooking through 1979, see Robert P. Morgan and Larry J. Icerman, Renewable Resource Utilization for Development, Chapter 2 (with Holly G. Winger).

19. Ibid., pp. 99-102. Holly G. Winger was a major contributor to the improved cookstoves chapter.

20. Ibid., Appendix A, p. 293-309.

21. Ibid., p. 264.

22. Improved cookstoves also figured prominently in the 1981 United Nations Conference on New and Renewable Sources of Energy held in Nairobi, Kenya.

23. "Experts Agree on Stove Tests," in VITA News, (January 1983), pp. 8-12.

24. G. Madon, Principaux Resultats de L'Evaluation du Taux D'Utilisation des Cuisinieres Ameliorees "Ban Ak Suuf" Construites en Zone Rurale, C.E.R.E.R., July 1982.

25. See, for example, Georges Yameogo, Issoufou Ouedraogo and Sam Baldwin, Lab Tests of Fired Clay Stoves, The Economics of Improved Stoves, and Steady

State Heat Loss from Massive Stoves, CILSS/VITA, (November 1982).

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27. Sam Baldwin, "New Directions in Woodstove Development," *VITA News*, (January, 1984), pp. 22-23.

28. Kumud Shrestha, *Introduction of Improved Stoves for Domestic Cooking in Nepal*," Stove Improvement Unit, Community Forestry and Afforestation Division, Department of Forests, Nepal, (undated).

29. Stephen Joseph, Yvonne Shanahan and Bill Stewart, *An Outline of The Sarvodaya Stove Programme*, prepared for the 7th Woodstove Seminar, Leuven, Belgium, (March 4-5, 1982), ITDG, London, U.K.

30. Stephen Joseph, *A Resume of The Intermediate Technology Development Group Stove Programme*, prepared for the CILSS meeting held in Bamako, Mali, December 1982.

31. Ibid., p. 4.

32. At about the same time, the World Bank was giving some thought to a greatly increased effort in cookstoves, of the order of millions of stoves, but evidentally the decision to move ahead with such a program was not made.

33. Gerald Foley and Ariane van Buren, "Realities in Rural Energy Planning," *Revue de l'Energie* for World Energy Conference, Delhi, 1983. See also, Gerald Foley and Patricia Moss, *Improved Cooking Stoves in Developing Countries*, Earthscan Technical Report No. 2, (London, 1983).

34. R. Hosier, P. O'Keefe, B. Wisner, D. Weiner and D. Shakow, "Energy Planning in Developing Countries: Blunt Axe in a Forest of Problems?," *Ambio*, 11, No. 4 (1982) pp. 180-187.

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36. Sam Baldwin, personal communication, March 26, 1984.

37. Editorial in *Boiling Point*, ITDG Stoves Project, Applied Research Section, Shinfield Rd., Reading, U.K., RG2 9BE, (April, 1984) p. 1.

38. "Report of International Workshop in Woodstove Dissemination, in *Boiling Point*, (April, 1984) p. 3.

39. Portions of this section are excerpted or adapted from Robert P. Morgan, *Technology and the Foreign Student in U.S. Universities*, remarks at NAFSA Conference on "The Foreign Student in the United States and the Technology Transfer Process," Snomass, Colorado, June 10-12, 1982.

40. See "A profile of Foreign Students in U.S. Higher Education -- Present and Future Trends" by Mary Ann Hood, summarized in the March 1982 *Newsletter of the Council of Graduate Schools in the United States*.

41. Robert P. Morgan, *Science and Technology for Development: The Role of U.S. Universities*, (New York: Pergamon Press, 1979), (with E. E. Irons, E. A. Perez, T. N. Soule and A. K. Fried).

42. K. N. Rao, "University Based Science and Technology for Development," *Impact of Science on Society* 28, No. 2 (1978) pp. 117-125.

43. See, for example, G. S. Brown and H. E. Hoelscher, "Open Forum: Are We Mistraining our Foreign Graduate Students?," *Engineering Education*, 61, No. 3 (December 1970), pp. 272-275.

44. Moravscik reports that a workshop was run in the summer of 1983 to teach Asian graduate physics students and post-doctoral physicists in U.S. and Canadian universities how to function as scientists in a developing country environment. Personal communication from Michael J. Moravscik (Jan. 26, 1984).

45. For a review of current policy issues and concerns surrounding foreign students in U.S. universities, see Elinor G. Barber and Robert P. Morgan, "Engineering Education and the International Student: Policy Issues," *Engineering Education* 74, No. 7(April, 1984) pp. 655-659.

46. Robert P. Morgan and Eugene B. Shultz, Jr., "Fuels and Chemicals from Novel Seed Oils," *Chemical and Engineering News*, 59, No. 36 (September 7, 1981) pp. 69-76.

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6
Policy Issues and Options

For more than thirty years, the United States has been involved in programs of development assistance and cooperation with the developing countries of the world. In parallel with these programs, a series of private efforts has brought U.S. scientists, engineers, businessmen and academicians in contact with counterparts in other countries. These three decades have seen tremendous changes, not only in military, economic and political spheres, but in the perceptions with which people in the United States view the world.

When President Truman articulated the Point Four program in 1949, the United States, triumphant from World War II, was unrivaled militarily. For the most part, the U.S. post-war economy was expansive and optimistic. Following on the successful reconstruction of Western Europe through the Marshall Plan, it seemed logical to launch a war against poverty, hunger and disease in underdeveloped parts of the world. It was our obligation as human beings. Further, it was necessary to contain and combat communist expansion. We could afford to do it, though perhaps not on a scale that some developing countries would have liked.

Today, things have changed. Many countries have made progress in improving the standard of living and quality of life for their people although much deprivation and hardship remain. Groups of developing countries such as the OPEC nations and the "newly industrializing countries" (NICs) have risen to prominence because of their oil wealth or because of their recent prosperity and competitiveness in certain manufacturing sectors or business areas. The countries the U.S. defeated in World War II, Germany and Japan, have become major industrial powers. In recent days, one sees and hears in the United States relatively little about international poverty, except perhaps in the World Bank Annual Report or in an occasional church or missionary sponsored TV program. The country that conceived of the Point Four program, after inconclusively fighting a war on poverty at home in the 1960s and 1970s, found itself entering the 1980s with double-digit unemployment, heavily underutilized manufacturing capacity, and increasingly worried about being out-competed by a growing number of countries. The revival of a cold war mentality in the U.S., greatly accelerated by the advent of the Reagan administration, pumped temporary new life into the idea of foreign aid as a bulwark against communism. Furthermore, economic factors have risen to the fore. Concern about the impact of the growing indebtedness of countries such as Mexico, Argentina and Brazil on U.S. banking institutions has resulted in U.S. support for increasing the capital it makes available to the International Monetary Fund (IMF).[1] At this writing, third world debt issues continue to trouble the international financial community. However, increases in IMF quotas have not been matched by increases in support for development assistance via loans on concessional terms through the International Development Association (IDA).

The policy issues facing the United States today in the international development sphere are similar in many respects to those of previous years but because of changing conditions and perceptions, the U.S. response required may very well be different. How much development assistance and cooperation is desirable? What financial level and what kinds of aid are needed? What criteria should govern who gets U.S. assistance? What should be the mix of bilateral and multilateral assistance? How can science and technology best be organized and utilized within development assistance and cooperation efforts? How can S&T for development programs be made more effective? In this chapter, these and related issues will be organized and discussed in two broad categories: (1) those concerned with development assistance and cooperation as a whole; and (2) those concerned more specifically with science and technology within the context of development.

DEVELOPMENT ASSISTANCE AND COOPERATION

Why Foreign Aid?

I take it as given that some form of U.S. international development assistance and cooperation is desirable, a position espoused by every U.S. administration since that of President Truman. In this section, some of the reasons for holding this point of view are reviewed.[2]

In an appearance before the House Foreign Affairs Committee in February of 1983, Secretary of State George Shultz stressed the military and economic security aspects of development programs. According to Shultz, in 1980, developing countries purchased roughly 40 percent of all U.S. exports, exceeding that purchased by Western and Eastern Europe, China and the Soviet Union combined. One out of every five acres of U.S. farmland and one out of every twenty workers in U.S. manufacturing plants produce for markets in developing countries. These countries provide more than half the cobalt, tin and bauxite used by U.S. industries and significant amounts of other strategic minerals and metals. Shultz indicates how the negative effects of worldwide recession on developing countries in the early 1980s also hurt the U.S. The fall off in developing country growth rates from about 5 percent to about 2 percent per year are cited as being partly responsible for the tapering off of U.S. exports to these countries, which had been climbing at more than 30 percent per year in the late 1970s. In addition, each billion dollar decline in U.S. exports has cost the United States an estimated 60,000 to 70,000 U.S. jobs.[3]

Shultz then moves from economics and jobs to arguments based on international peace and military security:

> ... the Third World is fundamental to our aspirations for security and peace. Since 1950, most of the major threats to international stability, and the chief opportunities for expansion of the Soviet Union's political reach, have come in the Third World.... The least desirable method for preserving our strategic interests and ensuring stability in the Third World is by sending U.S. forces. If we are to avoid incidents in the future, we need a modest commitment of resources -- exercised consistently over time -- to secure peace and economic well-being in the developing countries.[4]

In the introduction to the Overseas Development Council's annual (1983) assessment of the state of U.S. foreign policy vis-a-vis the Third World, Robert MacNamara, after emphasizing the importance to the U.S. economy of Third World growth and well-being, stresses another aspect of development which received little emphasis in the Shultz presentation, namely, the humanitarian imperative.[5] McNamara finds agreement by most observers that growth rates in about forty low-income countries that contain a majority of the world's poorest people will be considerably lower than in the past, resulting in average annual per capita growth rates of less than one percent; in Sub-Saharan Africa, per capita growth rates will decrease, not increase. At the same time, per capita GNP in the industrialized countries will grow substantially; $2,750 higher in 1990 than in 1980, compared with only $10 higher in low-income countries. According to McNamara, "A peaceful world cannot be built on such inequities. Growing numbers of poor people living in misery and devoid of hope are at least as great a threat to world order as superpower military rivalry."[6]

McNamara goes on to consider the impact of adverse development prospects in LDCs on people. There were at least 750 million people in 1980 living in absolute poverty; that number is likely to increase. He indicates a direct relationship between human well-being as measured by rates of life expectancy and infant mortality on one hand, and rates of economic growth on the other as follows: "A drop of one percentage point in future GNP growth rates is likely to mean a loss of as much as one-fifth of the reduction in infant mortality that could otherwise be expected."[7] According to McNamara:

> These figures alone cannot communicate the reality of the conditions faced by individual men, women and children--conditions too often accepted because of an entrenched assumption that 'the poor will always be with us.' Remarkable progress has been made in the past three decades... But much more can, indeed must, be done to deal with the very real human tragedy that continues on a massive scale. There is no substitute for the social and economic development that will enable all countries to participate fully in the international system and all people to have access to decent, secure lives. In the meantime,however, it is possible to take some immediate specific steps to improve human well-being and to do so at a relatively low cost.[8]

The statements by George Shultz and Robert McNamara emphasize two different aspects of the rationale for development assistance and cooperation. The Shultz statement reflects the priority the Reagan administration gives to justifying foreign aid on the grounds of being essential to U.S. economic and military security. In the FY 1984 foreign aid budget request, 63 percent of the funds were for "security assistance: military aid and economic support funds (ESF) to assist in building the economic and military capabilities of countries in regions of strategic importance."[9] McNamara, on the other hand, stresses the plight of people in low-income countries. The latter approach, which appeals to humanitarian instincts, appears to play less of a role in Reagan administration thinking. It was this approach that led John Sewell, at the May 1983 Overseas Development

Conference, to call for two steps to deal with deteriorating conditions in Third World countries: (1) to allow the Third World more of a say in the working of the international monetary system; and (2) for the U.S. to take the lead in mounting an attack on the worst forms of absolute poverty throughout the world, involving increases in concessional aid to the least-developed countries.[10]

It is beyond the scope of this book to explore in detail the justification for U.S. involvement in international development assistance and cooperation. But it is important at this point in history to review the reasons for such involvement to determine if the old rationales are still valid and if changes are needed. One such review by the Commission on Security and Economic Assistance, the Carlucci Commission report, attempted such an assessment in 1983, calling for increased foreign aid and closer integration of economic and military assistance.[11] My own preference is for a policy that gives higher priority to the humanitarian basis for aid programs, particularly programs that can benefit those most in need; one that recognizes that the U.S. has legitimate economic and security interests but one that also views the U.S. as part of an interdependent family of nations striving to maintain a peaceful, international order. Financial support for international development efforts could be much more readily available if less resources were spent on military and defense preparations; improvement of relations between the U.S. and the Soviet Union is a key element in freeing up such resources.

Level of Aid

Table 6.1 shows official development assistance from Development Assistance Committee (DAC) countries of the Organization for Economic Cooperation and Development (OECD) in 1970 and 1981. The United States contribution, while the largest in absolute terms, fell to next to last, 0.27 percent, in terms of share of gross national product (GNP). The DAC total contribution, 0.35 percent of GNP, is one-half of the target of 0.7 percent of GNP set by the United Nations for official development assistance.

Table 6.2 shows the distribution of DAC and U.S. bilateral assistance by income group in developing countries for the year 1980. Low-income countries, mostly in Africa, appear to receive a disproportionately small share of aid as measured by official development assistance on a per capita basis.

Table 6.3 indicates those countries that were major recipients of U.S. economic aid in FY 1981. Two categories of funds, both administered by the Agency

TABLE 6.1
Official development assistance from DAC countries, net flow, 1970 and 1981

	Total Contribution ($ millions)		Per Capita Contribution ($)		Contribution as Share of GNP (%)	
	1970	1981	1970	1981	1970	1981
Netherlands	196	1,510	15.04	105.99	.61	1.08
Sweden	117	916	14.54	110.04	.38	.83
Norway	37	467	9.54	113.90	.32	.82
Denmark	59	403	11.97	78.68	.38	.73
France	971	4,177	19.13	77.41	.66	.73
Belgium	120	575	12.45	58.26	.46	.59
Austria	11	313	1.48	41.43	.07	.48
Germany	599	3,181	9.88	51.57	.32	.47
United Kingdom	447	2,195	8.05	39.15	.36	.44
Canada	346	1,189	16.23	49.11	.42	.43
Australia	202	649	16.18	43.48	.59	.41
New Zealand	14	68	4.96	21.64	.23	.29
Finland	7	135	1.52	28.14	.07	.28
Japan	458	3,171	4.43	26.97	.23	.28
Switzerland	30	237	4.79	37.03	.15	.24
United States	3,046	5,783	14.87	25.16	.31	.20
Italy	147	666	2.74	11.63	.16	.19
DAC Total	6,807	25,635	10.92	37.75	.34	.35

Sources: U.S. Foreign Policy and the Third World: Agenda 1983, John P. Lewis and Valeriana Kallab, Eds., Published for the Overseas Development Council (New York: Praeger, 1983), p. 276. Reprinted by permission.

Note: Countries are ranked according to 1981 Official Development Assistance (ODA) as a percentage of 1981 GNP.

TABLE 6.2
Recipients of U.S. and DAC bilateral Official Development Assistance (ODA), by income group and region, 1980

	United States			DAC[1]		
	Number of Countries Receiving ODA	Total ODA ($ millions)	ODA Per Capita ($)	Number of Countries Receiving ODA	Total ODA ($ millions)	ODA Per Capita ($)
Low-Income Countries	28	684	0.64	39	5,218	2.42[2]
Middle-Income Countries	47	2,050	2.12[3]	75	7,784	7.32
High-Income Countries	6	799	11.18[4]	22	2,653	29.22
Total	81	3,533	1.68[5]	136	15,633	4.73

[1]Data for all DAC member countries, including the United States.
[2]If China is excluded, Asia receives $2.77 per capita, and low-income countries receive $4.41 per capita, from DAC.
[3]Egypt alone receives $19.81 per capita. If Egypt is excluded, Africa receives $1.57 and middle-income countries receive $1.31 per capita.
[4]Israel is the only high-income country in Asia receiving U.S. bilateral ODA. If Israel is excluded, U.S. ODA to high-income countries is $.28 per capita.
[5]If Israel and Egypt are excluded, U.S. bilateral ODA to all recipient countries is $.93 per capita.

Source: Adapted from U.S. Foreign Policy and the Third World: Agenda 1983, p. 279. Reprinted by permission.

TABLE 6.3
Major recipients of U.S. economic assistance, FY 1981 commitments ($ millions)

15 Major Recipients	Agency for International Development: Economic Support Fund	Development	Total	P.L. 480	Other	Total Economic Assistance[1]
Egypt	829.0	—	829.0	301.4	—	1,130.4
Israel	764.0	—	764.0	—	—	764.0
India	—	104.5	104.5	170.6	—	275.1
Turkey	200.0	—	200.0	—	1.0	201.0
Bangladesh	—	80.0	80.0	72.1	—	152.1
Indonesia	—	68.8	68.8	61.2	—	130.0
El Salvador	44.9	33.4	78.3	35.3	0.4	114.0
Sudan	50.0	24.5	74.5	34.9	—	109.4
Philippines	30.0	38.5	68.5	24.1	5.0	97.6
Peru	—	34.5	34.5	42.5	3.2	80.2
Pakistan	—	—	—	76.3	0.5	76.8
Jamaica	41.0	12.9	53.9	17.1	2.5	73.5
Sri Lanka	—	46.1	46.1	24.7	—	70.8
Nicaragua	56.6	1.8	58.4	1.2	0.3	59.9
Somalia	—	12.1	12.1	44.9	—	57.0
Total, 15 Recipients	2,015.5	457.1	2,472.6	906.3	12.9	3,391.8
Total, All Recipients	2,199.0	2,010.0	4,209.0	1,542.0	1,554.0	7,305.0

[1] "Economic Assistance" figures represent gross commitments in fiscal years, while ODA figures are net disbursements or net flows in calendar years.

Source: U.S. Foreign Policy and the Third World: Agenda 1983, p. 289. Reprinted by permission.

for International Development (AID), are included. Economic support funds (ESF) are used to provide support for a limited number of countries deemed to be of key political and strategic importance to the U.S. Three-quarters of ESF funds went to Egypt and Israel; Development assistance funds are distributed over a larger number of AID-eligible countries than economic support funds.

During the period from FY 1980 to FY 1983, the level of functional development assistance grew very slowly from $1.16 billion to $1.35 billion whereas the Economic Support Fund grew from $2.16 billion to $2.97 billion,[12] indicating the Reagan administration's preference for the ESF instrument. In Secretary Shultz's February 16, 1983 testimony before the House Foreign Affairs Committee, the words "development assistance" appeared infrequently, being subsumed under the category of economic assistance.[13]

A variety of opinions exist about the nature of the Economic Support Fund. In analyzing military versus economic aid spending, a Congressional Quarterly article concluded that: "Although considered an 'economic' program by some observers, the $2 billion-plus Economic Support Fund was included under military aid because its primary purpose is to enable economically hard-pressed allies to increase their military spending."[14] Secretary Shultz's testimony defines the Economic Support Fund as "economic stabilization and development funds for security assistance countries."[15]

Regardless of views on the nature of the Economic Support Fund, it is clear that the Reagan administration has placed considerable emphasis on military as opposed to development assistance. According to an analysis by the Federation of American Scientists, the Administration's 1983 foreign aid request involved more than a doubling of the percentage of aid going to military assistance, from 8.5 percent in 1981 to 19.5 percent in 1983. Authority for arms sales credits would more than double while development assistance's share of the total would fall significantly.[16] More recently, the FY 1985 Budget Request shows an estimated $10.0 billion in international security assistance, including $5.92 billion for military aid financing, $3.07 billion for the Economic Support Fund and $750 million for assistance to Central America; this compares with a total of $5.20 billion in foreign economic and financial assistance, both bilateral and multilateral.[17]

The trends discussed above reflect a policy which supports relatively low per capita spending by the U.S. on development assistance compared with other industrialized countries and compared with U.N. targets, a policy which has persisted for some 20 years. Within the last three or four years, there has been increased emphasis on U.S. military security aspects and economic benefits to the U.S. of aid programs, as opposed to emphasizing broader humanitarian and developmental objectives. These policies reflect a somewhat narrow, self-centered view of the world by the U.S. leadership as the United States adjusts to increased economic and political competition. As necessary as they may appear to some at the moment, in the long run these policies, if not tempered by a broader international vision, may prove to be both poor economics and politics.

Bilateral vs. Multilateral Aid

This issue has been debated over the years, with the Reagan administration tilting towards the bilateral approach. As indicated in Table 6.4, the trend towards multilateral assistance in both the U.S. and the DAC countries in the 1970s has been reversed. (See Chapter 4). The governing policy now seems to be to hold down multilateral aid expenditures, particularly those involving voluntary as opposed to obligatory contributions to international organizations, to avoid new commitments such as contributing to the U.N. Financing System for Science and Technology for Development, to challenge existing commitments such as that to UNESCO, and to hold down commitments of concessional funds to the International Development Association. According to an analysis by the Federation of American Scientists, the Reagan Administration strongly prefers a policy of bilateral over multilateral aid because with the latter, there is less direct U.S. control over where and how capital is allocated, thus making it harder for the U.S. to influence the policies of Third World countries.[18] Arguments are also made that bilateral aid is more efficient than multilateral aid although I am not aware of solid documented support for such statements. Multilateral aid, on the other hand allows the U.S. to support worthwhile, sometimes sensitive projects that might not succeed if one country played a dominant role as provider of assistance. It also is more consonant with a world in which international cooperation is a valued policy goal in itself.

"New Directions" vs. Other Directions

The congressional mandate for AID programs requires that aid be targeted directly to the poorest of the poor to help meet basic needs. Current AID policy has interpreted this mandate very broadly, arguing that basic needs will not be met unless indigenous institutions and infrastructure are in place. The

TABLE 6.4
Bilateral-multilateral mix of ODA from DAC countries and the United States

	1970	1975	1977	1980	1981
All DAC Countries[1]					
Official Development Assistance ($ billions)	6.8	13.6	15.7	27.3	25.6
Bilateral Assistance as % of ODA	83.5	72.2	64.1	66.4	71.3
Contributions to Multilateral Institutions as % of ODA	16.5	27.8	35.9	33.6	28.7
United States					
Official Development Assistance ($ billions)	3.0	4.0	4.7	7.1	5.8
Bilateral Assistance as % of ODA	87.1	73.4	61.9	61.2	74.7
Contributions to Multilateral Institutions as % of ODA	12.9	26.6	38.1	38.8	25.3

Source: U.S. Foreign Policy and the Third World: Agenda 1983, p. 280. Reprinted by permission.

[1]Includes the United States. For complete listing of Development Assistance Committee (DAC) countries, see Table 6.1.

emphasis on technology transfer and technical development at AID would appear to require some such interpretation.

AID's current development assistance program, if not totally directed at the poorest of the poor, does focus on those areas which do represent basic needs: food, health, education, etc. It does not focus heavily on industrial development. Such an approach attempts to avoid charges within the U.S. of aiding others who will out-compete us or use our technology against us, or of government interference in what should be the business of the commercial, private sector. It also accords with humanitarian impulses. Other mechanisms, such as the Economic Support Fund have a security rationale for going beyond this approach and seem less consistent with New Directions legislation. The ESF supports some countries that are excluded from AID's development assistance activity because their income levels are too high.

Congress continues to maintain an active interest in the AID mandate. In December of 1982, it amended the Foreign Assistance Act of 1961 to require that at least 40 percent of AID funds be targeted directly for assisting those living in absolute poverty.[19] How this requirement will be interpreted and whether it will have any effect at all on the current direction of AID programs remains to be seen.

The impact of politics on aid programs is well illustrated by three developments which were of concern at the time of this writing: (1) the decision by the Reagan administration to withdraw from UNESCO, (2) the review of population policies within the administration, which could lead to withdrawal of U.S. aid funds from programs that support abortion, even though U.S. funds are not used for that purpose, and (3) the large increases in military and economic aid funds requested for Central America. While the outcome of these developments is not known at this time, it is clear that international development assistance and cooperation in general as well as science and technology programs in particular can be strongly influenced by political developments and policy shifts.

SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

Science and technology have received increased emphasis in the AID program of the Reagan administration. According to AID estimates, in the FY 1985 request for development assistance funds, $446,000,000 or 28% of the total are for science and technology activities. Of this amount, $264,000,000 is for research, representing more than a doubling of AID's

research budget since FY 1980.[20] "Technology transfer, development and adaption" is one of four major policy priorities, supported by a central AID Science and Technology Bureau established in 1981 that is headed by a senior agricultural scientist. The science and technology thrust in the agency, with increased emphasis on R&D, and on training, is one that is compatible with a movement away from capital assistance and resource transfers, towards technical assistance. It also provides a new, visible focus at a time when development assistance budgets are constrained. In 1983, Peter McPherson summarized the new focus at AID as helping the developing countries to produce trained people, strong institutions, and appropriate technology.[21]

The emphasis on science and technology at AID represents a policy that scientists and engineers in general are likely to find desirable. However, science and technology can not be divorced from the overall policy objectives of the agency or the nation. They are tools for achieving certain goals or ends.

One issue which arises is whether the science and technology thrust is consistent with AID's congressional mandate. A previous review of U.S. foreign aid legislation indicates that there is no explicit mandate for helping to build indigenous science and technology capability in other countries.[22] The current mandate is still heavily oriented towards helping the poorest of the poor meet basic needs. It can be argued that without strong local S&T capability and institutions, long-term prospects for some countries will not be good. This approach, however, may not yield immediate benefits to those living in absolute poverty. Developing improved food crop varieties or even growing more food is not necessarily synonymous with giving poor people access to food. The Reagan administration's AID strategy is only compatible with the congressional mandate if one is willing to accept a philosophy of long-term, indirect as well as direct benefits to the poor. Jean Wilkowski, the U.S. ambassador to UNCSTD in the Carter administration, has stated the case for such a philosophy as follows:

> UNCSTD has taught us that the overriding objective in the application of science and technology is to further the modernization of developing economies and *simultaneously* to meet the basic human needs of developing country populations. It cannot be either or; it has to be both simultaneously. From the outset the U.S. rejected any implication that meeting basic human needs and modernization were mutually exclusive or incompatible development strategies. The two can and should proceed simultaneously in a mutually enforcing relationship.[23]

What Kind of Science and Technology for Development?

It appears to this observer that AID programs are a peculiar mix of individual preferences by agency personnel, and of congressional and administrative priority setting. At present, development assistance activity within AID is heavily oriented towards agriculture, with some activity in health, population, education and energy. In the FY 1985 AID budget request, 64 percent of science and technology activity and 72 percent of research activity falls under the heading agriculture, rural development and nutrition.[24] One can speculate on why this emphasis on agriculture, which is not unique to the Reagan administration, exists. First, food and agriculture are basic to any society. Second, the agricultural business and academic communities have taken a strong interest in aid programs through the years and have been successful in obtaining congressional support. Third, science and technology assistance in agriculture and other basic needs areas may be perceived of as less threatening to the interests of the United States than other kinds; for example helping a country to develop an electronics capability. Although there has evidently been some concern that if countries learn to grow more food they will import less from the United States, counter-arguments seem to have prevailed, namely that: (1) one must help the truly needy on humanitarian grounds, and, (2) agricultural aid works to strengthen the markets for U.S. food exports as well as for fertilizer, pesticides and other elements needed in modern agriculture.

In addition to the heavy emphasis on agriculture, AID's science and technology activity is limited in other ways. For one thing, the focus seems to be on applied research, with very little basic scientific research being supported. For another, research with industrial applications outside of agriculture does not receive much emphasis. A 1983 statement of future AID research priorities includes four elements: agriculture, biomedical research on major diseases, family planning methods, and fuelwood production and conversion technology.[25]

The phrase "technology transfer" has been used in connection with one of AID's four main policy thrusts. However, AID does not seem to emphasize strongly the transfer of industrial technology within its science and technology activities. There may be two reasons for this. First, such transfer may not be deemed in the U.S. economic interest. Second, it may be an inherently difficult thing to do through the mechanism of a government aid program. Jack Baranson has made

the point that technology derives from a spectrum of research, development and engineering activities that are often linked closely to ongoing production and marketing efforts; therefore, technology and science can not be neatly packaged and dispersed like other foreign aid commodities. Baranson is skeptical about the efficacy of universities and research laboratories, both foreign and indigenous to developing countries, to contribute to the creation of operational technology, other than to develop human resources through education and training. He sees operational technology continuing to be "the products of enterprise units linked to technology generating units."[26]

Baranson's analysis calls into question the relevance of AID efforts relating to industrial technology transfer; it also tends to support the programmatic areas (agriculture, health, etc.) to which AID has given priority. It remains to be seen whether the new Bureau of Private Enterprise within AID will be able to facilitate some of the coupling between the generators and users of technology which Baranson calls for. Industrial technology transfer would appear to take place primarily through commercial channels and to be somewhat divorced from AID.

Another issue is the extent to which the United States is prepared to assist or cooperate with developing countries in science and technology areas which can be characterized as high technology. Clearly, some such activity goes on when students from other countries come to study science and engineering in the U.S. Furthermore, high technology is not necessarily excluded from traditional AID areas such as agriculture and health. There is probably no simple way to resolve this issue; political and security considerations are likely to play an important role, with decisions being made in some cases on a country by country basis through bilateral agreements.

Concerns about leakage or hemorrhage of technology to the Soviet Union became more prevalent in the Reagan administration, leading to withdrawal of U.S. government support for the International Institute of Applied Systems Analysis, (IIASA) a joint U.S.-U.S.S.R. activity located in Austria, and to attempts to increase restrictions both on exports and on scientific communication.[27] While these concerns generally do not get aired in connection with programs involving developing countries, they might possibly have some relevance because developing countries could conceivably serve as conduits for technology from one nation to another. However, appropriate development assistance to the least developed countries is least likely to be of military value.

Appropriate Technology

Schumacher's concept of an "intermediate technology" more modest than the large-scale capital-intensive technology favored by the West yet an advance above traditional subsistence technique formed the basis for one of the major developments in technical assistance in the 1970s. Through the efforts of U.S. Congressional supporters and staffers, a small band of dedicated individuals in AID, and individuals from the private sector, legislation was passed requiring AID to emphasize appropriate, "capital-saving" technology in its programs.[28] This effort, which in many ways fit well with AID's "New Directions," "basic human needs," "poorest of the poor" policy, resulted not only in the establishment of an aid supported private organization, AT International, but also in an effort to infuse the whole AID agency with sensitivity to appropriate technology concerns.

The question of what technology is appropriate is inevitably linked to the stage of development of a country and its needs; it also raises issues for which policy choices must be made. One illustration of the issues that can arise is provided by the energy program at AID. There have been two main program elements, one on renewable energy and the other on conventional energy. Renewable energy advocates stress the relevance of this activity to the congressional basic needs mandate. Yet they are hard pressed to demonstrate major successes in the relatively short time the activity has been emphasized at AID. Conventional energy development, such as enhanced oil and gas exploration, can address pressing needs of countries faced with rising oil imports and high kerosene prices. Yet some fear that if developing countries are assisted in finding new sources of fossil fuel, it will hurt U.S. business, although just the opposite argument could be made.

In the energy area, it would seem desirable to have a flexible program that could accommodate both approaches. Although U.S. government support for renewable energy activity within the U.S. has been greatly reduced in response to the policies of the Reagan administration, renewable energy seems to be continuing to receive attention within AID, at least as of this writing. Efforts to expand energy activity within the World Bank by establishing a separate energy affiliate with the bank have met with U.S. resistance.

The question of what to do with appropriate technology was an issue that the Reagan administration dealt with in 1983. As a creation of previous administrations, appropriate technology arose as part of a larger set of concerns that included AID's New Directions policy. Congressional support and a mandate for appropriate technology still appear to exist. Two

options for dealing with appropriate technology were: (1) to declare it a success and integrate it into a wide variety of activities at AID and; (2) to continue to give appropriate technology programs a distinct identity within the agency. The issue appears to have been resolved by tilting somewhat towards the first option. The phrase "capital-saving technology" rather than "appropriate technology" appears in the FY 1984 AID congressional budget presentation.[29]

The AID Administrator, Peter McPherson, has stated his support for elements of appropriate technology. He appears to have taken a personal interest in refocusing the work of A.T. International, the primary private sector vehicle created in the 1970s for implementing U.S. appropriate technology efforts. Nevertheless, some continuing concerns expressed by appropriate technology adherents are that target populations be involved in the definition as well as the execution of projects, and that support for appropriate technology efforts not suffer as AID Bureau of Private Enterprise activity expands.

S&T at AID: Further Issues

Bureaucracy vs. Innovativeness. The large bulk of funding in science and technology for development goes for programs defined by government agency personnel with scientists and engineers in a reactive mode. There needs to be more opportunity and support for unsolicited proposals and inputs from creative scientists and engineers from both the U.S. and developing countries. Collaborative research and development makes a great deal of sense as countries develop and increase their indigenous capability. It also lessens the need for a large U.S. overseas presence. Yet collaborative research and development, outside of agriculture, has never received much emphasis in U.S. science and technology for development programs.

Manpower Issues. There is some feeling, although not by any means unanimous, that it is becoming increasingly difficult to attract new participants to the development field in general and the science and technology for development field in particular. Major obstacles have been lack of increased funding for science and technology for development activity, coupled with a feeling that it is not a high U.S. priority. Even in agriculture, where funds are more readily available, AID has evidently experienced some difficulty in attracting new people.

AID's "joint career corps" will require faculty to make commitments to spend 2/3 time at the university and 1/3 overseas, averaged over several years. Whether this proves to be attractive to faculty remains to be seen. Some universities or individuals could view it as an encroachment by AID on the prerogatives of the university, although this may prove less likely in the land-grant universities with their history of service and extension. As of this writing, the corps does seem to be attracting recruits.

Some concern has been expressed about the extent to which the AID overseas missions have personnel that are knowledgeable about science and technology matters. The missions play a key role in program definition. A central Science and Technology Bureau needs the knowledgeable, sympathetic support of the missions if it is to succeed in developing expanded programs of S&T activity within the agency.

There are indications that the Reagan AID administration has devoted considerable attention to better coordination, planning and definition of programs. Sector councils in program areas such as agriculture and health have brought together individuals from the regional AID offices and the S&T Bureau, resulting in sector papers which define program priorities and objectives. The 1985 AID congressional budget presentation outlines plans for developing agency-wide research priorities in agriculture, contraceptive development, biomedical health research and fuelwood production, and for encouraging field missions and regional bureaus to adopt a "common-theme network approach." The latter concept seeks to focus on important problems common to countries within similar ecological zones, such as "humid tropics" or arid lands."30 Better planning, and coordination don't guarantee better results but hopefully they will help.

<u>On the Economic Support Fund</u>. In reading through the AID Congressional budget presentations, there is a striking contrast between the detailed breakdown of development assistance activity and the lack of detail concerning how Economic Support Funds are spent. The Economic Support Fund is considerably larger than the Development Assistance Account. Some ESF activity is science and technology related; the large ESF program in Egypt has science and technology components. It would be desirable to have more information available on science and technology activity within the ESF programs; such activity could conceivably be quite substantial and place major demands on AID for trained personnel and other S&T support.

Need for Continuity

The success of some of the international agricultural research centers can be attributed in part to

their having had continuous support for an extended period of time. Ways need to be found to provide such continuity for other science and technology activity, such as institution-building. Nyle Brady has stressed this point. According to Brady, much of the progress in the Third World today is due to successful research efforts, some of which were partly funded by the U.S. and/or other donors, primarily in agriculture and health. Research is a long-term endeavor with success for any one effort being uncertain. Patience is required, therefore, in supporting an activity, namely development assistance, which may not yield short-term results; hence, the difficulty in maintaining a foreign aid constituency. Brady also acknowledges the need for an occasional big success, one with dramatic results.[31]

One can question definitions of success in aid programs and whether in fact Third World progress is due primarily to research efforts. But Brady's argument for sustained research activity seems valid.

Need for Evaluation

It has been evident to this author for some time that an important missing link in development assistance activity has been the lack of careful, independent evaluation of such activity; this holds for S&T activity as well. In the late 1970s, AID initiated a series of impact evaluations of its programs which was an important step in the right direction. As of mid-1984, about 100 AID impact evaluations, special studies, discussion papers and evaluation reports had been released on a wide range of subjects; they range from evaluation of individual projects such as the Sine Saloum Rural Health Care Project in Senegal, to evaluation of an entire sector, e.g. "Policy Directions for Rural Water Supply in Developing Countries."32 These reports deserve careful scrutiny and evaluation; they contain a great deal of information and some of them are quite frank about shortcomings in AID programs.

The need persists however, for additional evaluations that are independent of AID. It is always difficult for an organization which is charged with carrying out activity to evaluate and report on its own activity with total objectivity. Furthermore, it is all too easy to use such reports to reinforce policies of current interest; for example, it appears that an increasing number of recent AID evaluation reports deal with aspects of private enterprise and the private sector. An independent commission, funded perhaps by private foundations, might provide valuable information and insights. Evaluations need to focus on the effectiveness of AID programs -- on what works and what doesn't. And in dealing with programs with science and technology content, what constitutes success may very well go beyond the purely technical and involve value judgments.

INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL COOPERATION

Unlike development assistance, with its implication of the U.S. contributing resources to bring about improvements in developing countries, I use the term cooperation to emphasize activities in which two or more parties join together to pursue related goals and objectives. Countries involved in bilateral S&T cooperative activities with the U.S. include Japan, Brazil and the People's Republic of China, to name only a few. Table 6.5 provides an inventory of bilateral scientific and technical agreements listed by U.S. lead agency.

My subjective judgment is that the climate for international science and technology cooperation at the present time is not all that it could be. Concern about technological leakage or hemorrhage to the Russians and loss of economic competitiveness to Japan and other countries appear to have had a negative effect on U.S. S&T cooperation, although in the case of Japan it may be that the U.S. has a great deal to learn from such endeavors. Furthermore, because funds for the Institute for Scientific and Technological Cooperation were never appropriated by the Congress, there is no clear, strong focal point for such activity within the U.S. government.

Title V of the Foreign Relations Authorization Act for fiscal year 1979 (Public Law 95-426) requires the president to report annually to the Congress on U.S. international activities in science and technology. In the 1983 report, President Reagan asserts that a principal foreign policy goal is "to give science and technology a more prominent position in our relations with other countries."33 According to the president, international science cooperation was, for the first time, discussed by the leaders of the main industrial democracies at the summit meeting in Versailles, leading to the establishment of 18 new U.S. cooperative projects. He also emphasizes new cooperative agreements and understandings with India, Brazil, Pakistan and China.34

One of the main purposes of the Title V legislation was to strengthen the ability of the U.S. diplomatic apparatus to incorporate knowledge of science and technology into its functioning, in keeping with a philosophy that science and technology are of major importance to U.S. foreign policy. The four annual Title V reports submitted to date by the president to the Congress have consistently run into congressional

TABLE 6.5
Inventory of U.S. bilateral scientific and technical agreements listed by country and lead agency

Countries	Agencies[1] USDA	AID[2]	DOC[3]	DOE[4]	EPA	DHHS[5]	HUD	DOI[6]	NASA[7]	NRC[8]	NSF	DOT	Bilateral S&T agreements
Algeria	...	...	...	...	...	...	...	1	...	...	...	...	...
Argentina	X	...	...	...	...	1	...	1	X	...	X	...	X
Australia	X	...	...	...	...	2	...	1	X	...	X	X	X
Belize	X	...	...	...	...	...	...	...	...	...	...	...	...
Belgium	...	...	...	X	...	2	...	...	...	X	...	...	X
Bolivia	...	...	...	...	...	...	...	1	...	...	...	...	...
Brazil	...	X	...	...	...	...	...	2	X	X	X	...	X
Bulgaria	X	...	...	...	...	...	...	...	...	...	X	...	X
Canada	X	...	...	X	X	2	X	3	X	...	...	X	X
Chile	...	...	...	...	...	...	...	1	...	...	...	...	...
Columbia	X	...	...	...	...	...	...	1	X	...	...	...	X
Costa Rica	...	...	...	...	...	...	...	...	...	...	...	X	...
Denmark	...	...	...	...	...	2	...	...	...	X	X	...	...
Egypt	X	X	1	...	X	3	...	1,2	...	X	...	...	X
El Salvador	X	...	...	...	...	...	...	...	...	...	...	...	...
Finland	...	...	...	X	...	3,4	...	...	...	X	...	X	X
France	X	...	1,2	...	...	1,2	X	3	...	X	X	X	X
FRG	X	...	...	X	X	3	X	1,3	X	X	X	X	...
Ghana	...	X	...	...	...	...	...	...	...	...	...	...	...
Greece	...	...	...	...	...	...	...	...	...	X	...	...	X
Guatemala	X	...	...	...	...	...	...	...	...	...	...	...	...
Honduras	X	...	...	...	...	...	...	...	...	...	...	...	...
Hungary	X	...	...	...	...	1	...	...	...	...	X	X	X

TABLE 6.5 (continued)
Inventory of U.S. bilateral scientific and technical agreements listed by country and lead agency

Countries	Agencies[1]												Bilateral S&T agreements
	USDA	AID[2]	DOC[3]	DOE[4]	EPA	DHHS[5]	HUD	DOI[6]	NASA[7]	NRC[8]	NSF	DOT	
Iceland........	....	....	.....	....	...	2....	...	.....	.....	....	...	...	....
India..........	X...	....	.....	....	X..	3....	...	2....	X....	....	X..	...	X........
Indonesia......	X...	X...	.....	....	...	.....	...	1....	X....	....	...	...	X........
Iran...........	....	....	.....	....	...	.....	...	.....	.....	....	...	...	....
Iraq...........	....	....	.....	....	...	.....	...	.....	.....	....	...	...	....
Israel.........	X...	....	1....	....	...	3....	...	1....	.....	X...	...	X..	X........
Italy..........	X...	....	.....	....	...	3....	...	.....	X....	X...	X..	X..	X........
Japan..........	X...	....	1,2..	X...	X..	1,2,5	X..	3....	X....	X...	X..	X..	X........
Jordan.........	....	....	.....	....	...	.....	...	1....	.....	....	...	...	....
Kenya..........	....	....	.....	....	...	.....	...	1....	.....	....	...	...	X........
Korea..........	....	X...	1....	....	...	2....	...	1....	.....	X...	X..	...	X........
Kuwait.........	....	....	.....	....	...	3....	...	.....	.....	....	...	X..	....
Malaysia.......	....	....	.....	....	...	.....	...	1,3..	.....	....	...	...	....
Mexico.........	X...	....	1,2..	X...	X..	2,3,5	X..	1,2,3	.....	X...	X..	X..	X........
Morocco........	....	....	.....	....	...	.....	...	1....	.....	....	...	...	....
Netherlands....	X...	....	.....	....	...	.....	...	.....	X....	X...	...	X..	....
New Zealand....	X...	....	.....	....	...	2....	...	1....	.....	....	X..	...	X........
Nicaragua......	X...	....	.....	....	...	.....	...	3....	.....	....	...	...	....
Nigeria........	X...	....	1....	X...	X..	3....	...	1....	.....	....	...	...	X........
Oman...........	....	....	.....	....	...	.....	...	.....	.....	....	...	X..	....
Pakistan.......	X...	....	.....	....	...	3....	...	2....	.....	....	...	...	X........
Panama.........	X...	....	.....	....	...	.....	...	1....	.....	....	...	...	X........
Peru...........	....	....	.....	....	...	.....	...	.....	.....	....	...	...	....
Philippines....	....	....	.....	....	...	.....	...	.....	.....	X...	...	...	....
Poland.........	X...	....	.....	....	X..	3,4..	...	1,3..	.....	....	X..	X..	X........
Portugal.......	....	....	.....	....	...	6....	...	.....	.....	....	...	...	....
PRC (China)....	X...	....	1,2,3	X...	...	X....	X..	1....	X....	X...	X..	X..	X........
Romania........	X...	....	.....	....	...	3....	...	.....	X....	....	X..	X..	X........
Saudi Arabia...	X...	....	X....	X...	...	2....	...	1,2,3	.....	....	X..	X..	...(9)...
Senegal........	....	....	.....	....	...	.....	...	.....	.....	....	...	...	X........
South Africa...	....	....	.....	....	...	.....	...	.....	X....	....	...	...	....
Spain..........	X...	....	.....	....	...	.....	...	3....	.....	X...	...	X..	X........
Sri Lanka......	....	....	.....	....	...	.....	...	1....	.....	....	...	...	....
Sweden.........	....	....	.....	X...	...	2....	X..	3....	.....	X...	...	...	....
Switzerland....	....	....	.....	X...	...	1,2..	...	.....	.....	X...	...	...	....
Thailand.......	....	....	.....	....	...	.....	...	1....	X....	....	...	...	....
Tunisia........	....	X...	.....	....	...	X....	...	.....	.....	....	...	...	X........
Turkey.........	X...	....	.....	....	...	.....	...	.....	.....	....	...	...	....
UAR............	....	....	.....	....	...	.....	...	3....	.....	....	...	...	....
United Kingdom.	....	....	.....	X...	...	2....	X..	3....	.....	X...	...	X..	X........
U.S.S.R........	X...	....	1,2,3	....	X..	1,3..	X..	1,2,3	.....	....	...	X..	X........
Venezuela......	X...	....	.....	X...	...	3....	...	2....	.....	....	...	X..	X........
Yemen..........	....	....	.....	....	...	.....	...	1....	.....	....	...	...	....
Yugoslavia.....	X...	....	.....	....	X..	3,4..	...	1....	.....	....	...	X..	X........
Zaire..........	....	....	.....	....	...	.....	...	3....	.....	....	...	...	....
Zimbabwe.......	X...	....	.....	....	...	3....	...	.....	.....	....	...	...	X........

[1]Agencies:
USDA — Department of Agriculture.
AID — Agency for International Development.
DOC — Department of Commerce.
DOE — Department of Energy.
EPA — Environmental Protection Agency.
DHHS — Department of Health and Human Services.
HUD — Department of Housing and Urban Development
DOI — Department of Interior

TABLE 6.5 (continued)
Inventory of U.S. bilateral scientific and technical agreements listed by country and lead agency

[1]Agencies: (continued)
NASA — National Aeronautics and Space Administration.
NRC — Nuclear Regulatory Commission.
NSF — National Science Foundation.
DOT — Department of Transportation.
Bilateral S&T agreements: List of science and technology-related treaties and other international agreements of the United States in force on Jan. 1, 1982.
[2]AID: Only specifically S&T programs are indicated. In addition, there is significant S&T content in most other AID country programs.
[3]DOC: 1. National Bureau of Standards
2. National Oceanographic and Atmospheric Administration (NOAA).
3. Maritime Administration (MARAD).
[4]DOE: Also has agreement with the European Community (EEC).
[5]DHHS: 1. National Institutes of Health (NIH).
2. Food and Drug Administration (FDA).
3. Public Health Service (PHS).
4. Office of Human Development Services (OHDS).
5. Alcohol, Drug Abuse and Mental Health Administration (ADAMHA).
6. Health Resources and Services Administration (HRSA).
[6]DOI: 1. U.S. Geographical Survey (USGS). 2. Fish and Wildlife Service (F&WS).
3. Other (Bureau of Land Management, Water and Power Resource Service, Bureau of Mines, National Park Service).
[7]NASA: Also has agreement with European Space Agency (ESA).
[8]NRC: Also has agreements with Nordic Group, EEC, and Holden Reactor Project.
[9]Saudi Arabia: Additional cooperation under technical cooperation agreement establishing Joint Commission on Economic Cooperation (coordinated by Treasury Department).

Source: Science, Technology and American Diplomacy, 1983, Fourth Annual Report Submitted by the President Pursuant to Section 503 (b) of Title V of Public Law 95-426 (1983). Appendix 2.

criticism on a variety of grounds. For example, the 1983 report is characterized by a Congressional Research Service critique as being little more than a compilation of existing programs by agencies with very little discussion of how these activities relate to U.S. foreign policy, what priorities the government attaches to its international S&T programs, or how it evaluates them. Also missing are specific recommendations on S&T personnel, training, policies and programs as required by law; in addition the report was five months late. These shortcomings prompted a call for the Congress to consider further oversight mechanisms to strengthen U.S. management of international S&T issues.[35]

It may be that international scientific and technical cooperation were not given very high priority, especially in the early years of the Reagan administration, by relevant policy-making groups, such as the Office of Science and Technology Policy and the Department of State. My impression is that the global, international outlook of the Carter years was replaced by an overriding concern with military and defense matters, and by a bipolar (U.S. vs. U.S.S.R.) view of the world by some officials. However, pressures for various cooperative arrangements involving science and technology are likely to continue.

As was pointed out in Chapter 3, the National Science Foundation is prominent in U.S. international scientific and technical cooperative activity, both through management of certain bilateral S&T agreements and through support of certain scientific activities which are international in scope. Recent National Science Foundation and National Science Board policy statements appears to justify international S&T cooperation primarily for the benefits that they can bring to U.S. science as well as for the economies inherent in the sharing of resources for large projects by having some international division of labor with our industrial allies. Mutual benefit is also an important criteria for cooperative projects. Yet for some poorer countries, benefits of equal magnitude in cooperative arrangements may not be possible. The new management scheme at NSF (see Chapter 3) which removes some budget and other authority from the STIA-Directorate would appear to work against developing country programs. AID has managed to build some collaborative research into its programs through its Office of the Science Advisor; however, it is not a very large effort. If, in fact, international S&T cooperation is to be an important element of our foreign policy, its support, management, and execution would appear to greatly need strengthening.

FOREIGN ENGINEERING STUDENTS

Foreign students in U.S. universities are a significant element of science and technology for development activity (see Chapter 5). By their sheer numbers, even allowing for a sizeable brain drain, many have gone or will go back to key positions in their own countries. Throughout the years, there have been calls for modest support for activity which would enable foreign students in the U.S. to obtain an experience more focused on the application of science and technology to the development of their home countries, through targeted summer courses, relevant dissertation support, etc. These calls have generally gone unheeded.

Within recent years, developments in the U.S. engineering job market, in engineering education, and in the U.S. and world economies, have brought several new issues to the fore, including:

1. Should foreign nationals increasingly be relied upon to fill vacancies on U.S. engineering faculties in various engineering fields?

2. Do foreign nationals take engineering jobs away from U.S. citizens?

3. Are there areas of research to which foreign students should not have access due to security considerations?

4. Do the costs associated with the large percentages of foreign students in engineering outweigh the benefits? Costs would include non-economic factors such as decline in the quality of engineering education as perceived by some individuals.[36] Benefits include the important role of foreign students in keeping graduate engineering programs at reasonable levels in meeting research commitments.

5. To what extent does educating foreign engineering students in the U.S. contribute to or work against U.S. foreign policy objectives?[37]

These issues are not academic; policy decisions are in the process of being made, in some cases, with a very limited data. At the federal level, as of July, 1984, differing versions of comprehensive immigration legislation (the Simpson-Mazzoli bill) had been passed by the House and Senate. Both versions require that all

foreign students return home for at least two years before seeking employment in the United States, with certain exceptions. According to the House version, the U.S. Attorney General can waive this rule for individuals with advanced degrees who have been offered faculty positions; it can also be waived if the Department of Labor certifies that there is a shortage of workers in certain science, technology and other professional fields of employment at the place where the graduate is to work. No waivers will be allowed after 1989. The amended Senate version of the bill is very similar.[38]

If this immigration legislation becomes law, it is likely that it will slow down the loss of trained scientific and engineering personnel from the developing countries to the United States, the so-called "brain-drain." Such a policy could very well prove to be an asset to the U.S. in its dealing with developing countries. However, such a policy could also reduce the flow of highly trained immigrants to the U.S., a flow that has produced substantial benefits to the U.S. over the years. It might also make U.S. universities less attractive places for study to foreign students. The situation bears careful examination; at present, the data base on the career trajectories of foreign students who study in the U.S. is far from adequate.

SCIENCE, TECHNOLOGY AND MULTILATERAL INSTITUTIONS

Earlier in this chapter, the Reagan administration's tilt away from multilateral aid towards bilateral aid was examined. That tilt carries over to science and technology for development activity. In addition, within the multilateral sphere, the effort to establish a U.N. Financing System for Science and Technology for Development (UNFSSTD) has raised the issue of what is the best mechanism by which multilateral S&T activity should be conducted.

There are some who feel that programs in which scientists and other technically-competent administrators make decisions about program priorities and operations are more efficient and likely to be more successful than programs which require extensive political consensus building. Nyle Brady is an articulate spokesman for this position, citing the CGIAR as an example of the kind of mechanism that has succeeded in providing important applied research breakthroughs with a minimum of overhead and formal organization.[39] By contrast, according to Brady:

> By its nature, a multilateral, intergovernmental mechanism requires consensus building, a process

which is slow, cumbersome, and expensive in staff and administrative resource costs. When donors contribute to a common pool, they may give up a large measure of control over the choice of projects. The results of a consensus may not necessarily fit the priorities of those parties that would expect to contribute the bulk of the resources. Moreover, an intergovernmental mechanism with worldwide membership necessarily must consider geographical distribution in its funding decisions. However, what is equitable politically may not be sound scientifically or economically. With limited control over specific approvals, U.S. funds could be used for projects that may not always be the most effective or efficient choices.[40]

Based in part upon this philosophy, Brady goes on to oppose U.S. financing for UNFSSTD on the grounds that "it would be more efficient to let existing agencies that have already proven their technical competence, design and administer projects that have been expressly approved by donors."[41]

Brady provides a powerful argument for a certain kind of development assistance. However, there are counterarguments. First, statements about the relatively efficiency of one mode of aid versus another tend to be anecdotal and not supported by hard data or independent evaluation; this goes for bilateral vs. multilateral aid as well. Second, multilateral programs involving government consensus building and state participation can be important in ensuring that countries are committed to utilizing the results of science and technology efforts. Third, efficiency considerations and definitions of success can not be divorced from political considerations; unless developing countries feel that they have a part in the multilateral process, technical advances can remain isolated from the mainstream where they are needed. As Rustam Lalkaka of UNFSSTD notes:

> .... international cooperation under multilateral aegis has an essential role in providing objective professional experience. It is complementary and not competitive to bilateral programmes, which will continue to play a major role. At the same time, it must be noted that a developing country without proper technical capacity finds it very difficult to create a working relationship with an advanced country having enormous technological power. A mouse playing games with an elephant, however friendly, is likely to be stepped upon.[42]

There is still a great deal we do not know about S&T for development; it seems prudent therefore to utilize a variety of approaches and mechanisms, both bilateral and multilateral.

UNFSSTD

The failure of the United States to support the U.N. S&T financing system agreed to at UNCSTD appears to rest on several premises. First, UNFSSTD will be politicized; that is, political actions presumably beyond U.S. control will dictate who gets support for what. Second, countries unfriendly to the U.S., e.g. Cuba, will get money from UNFSSTD. Third, monies will be distributed according to some geopolitical formula rather than on scientific merits. Fourth, it is necessary to hold the line on spending for development assistance. Fifth, multilateral institutions are generally less effective than bilateral institutions -- in fact some are downright ineffective.

A response to these points is as follows. First, all U.S. foreign assistance programs are political. The question is will they be politically favorable to the U.S. I would argue that giving up some control of one program, particularly one we helped to create and which would require a relatively modest contribution on our part, could be greatly to our political and diplomatic advantage. Second, if we primarily make "non-core" contributions to UNFSSTD, that money will go only to countries we designate. Third, some formula spending as opposed to scientific peer review is not necessarily bad , particularly for very applied projects. The Hatch Act in the U.S. which allocated agricultural research money to the states did a great deal of good in supporting the development of U.S. agriculture. Peer review is a mixed blessing. Fourth, because we really do not know enough about the effectiveness of either multilateral or bilateral programs of S&T for development to come to sweeping conclusions, it might be desirable to experiment with still another mechanism. Fifth, UNFSSTD is supporting some projects which are not supported by other aid mechanisms (see Table 4.4) They could afford opportunities for the U.S. to develop new business activity.

IFAST.

A proposal was put forth by individuals in the Reagan administration and explored with other countries in 1982 and 1983 for an "International Foundation for The Advancement of Science and Technology in Developing Countries (IFAST). The objectives of IFAST were:

(1) To strengthen the institutional and human capacities of the developing countries in science and technology for development.

(2) To promote collaboration among international and national science and technology organizations from the developing and developed countries.

(3) To identify and define the critical science and technology requirements of the developing countries and to promote the concentration of human and financial resources to meet these requirements.

(4) To increase the availability of scientific, technical and financial resources from the world-wide donor and scientific communities and to enhance the capabilities of the developing countries.

(5) To provide high-quality international scientific expertise to advise on S&T requirements in the developing countries and to evaluate scientific and technological project proposals.[43]

What was envisaged here was a private international organization which could serve as a broker between developed and developing countries, and match projects with prospective donors. A non-governmental board of individuals from both groups would bring their individual technical expertise to bear in setting priorities and recommending proposals for funding by donor groups. The IFAST concept appears to have been developed as a possible alternative to U.S. participation in UNFSSTD. IFAST would have retained more donor control than UNFSSTD and projects could be targeted as the donor wishes.

The IFAST idea appears to be lying dormant as of this writing.[44] It did not respond to the developing countries desire for an S&T vehicle which affords them more of a say in its operation, as does UNFSSTD which is their concept. Furthermore, it is not clear that a new entity could have won congressional approval, if such approval were needed. And then there were the ever present financial constraints. The IFAST idea has a good deal of merit. However, I see it as a complement to UNFSSTD and other S&T for development activity, rather than as an alternative to it.

CONCLUDING REMARKS

This survey of policy issues arising in the field of science and technology for development is not all inclusive. There are several other issues that are current at this point in time that have become very visible. However, they are not primarily perceived of as science and technology issues, although in one way or another, science and technology play a role in certain programmatic elements.

UNESCO

Should the U.S. stand by its determination to withdraw from UNESCO? If so, can U.S. participation in the science programs currently administered by UNESCO be continued in other forms? Will reforms in UNESCO persuade the U.S. to continue to participate?

According to Robert Cowen; "Many knowledgeable U.S. scientists see no credible alternatives in fields such as oceanography and environmental science, where UNESCO is now the preeminent medium for cooperation. Those scientists think the United States would simply find itself frozen out of some important fields of international scientific endeavor."[45] I find the arguments of Roger Revelle [46] and other international scientists to be compelling. My opinion is that U.S. interests would best be served by continuing to participate in UNESCO and to work for reform from within.

Population Assistance

In a departure from previous policies, the Reagan administration has decided to adopt a policy at the August 1984 United Nations population conference in Mexico City in which support will no longer be provided for nongovernmental organizations that "perform or actively promote" abortions. According to Constance Holden in *Science*, such a policy could reduce U.S. annual contributions to the International Planned Parenthood Federation and the U.N. Fund for Population Activities (UNFPA) by $50 million; UNFPA would get no U.S. money unless it certifies that none of its funds are used for abortions.[47]

AID requested $250,000,000 for population assistance programs in FY 1985, including $38,000,000 for the U.N. Fund for Population Activities. AID's support for family planning service programs rests on the principles of voluntarism and informed choice.[48] It gives preference to "programs which provide a wide range of choices in family planning methods, excluding abortion."[49]

The population program in AID has not been without controversy in the past, with concern expressed previously about AID funds being used to support involuntary sterilization of women. By its very nature, a population program is an extremely sensitive one, in which AID runs the risk of upsetting someone. Yet some foreign aid supporters see the population program as being crucial to AID's efforts.

This is not an easy matter to resolve. The current controversy comes at a time when an analysis of world population trends by the World Bank has resulted in a call by the bank for more foreign aid for population programs.[50] The present U.S. position seems to rely heavily on the free market and private enterprise as the forces which will bring about economic development and population stabilization. However, it is not clear to me that development will occur without a substantial expansion in resources available to poor countries -- an expansion which does not seem to be forthcoming at the moment through foreign aid. My hope is that the U.S. position in Mexico City and as it evolves subsequently will listen to and take into account the opinions of those countries with low incomes and burgeoning populations that are most in need of assistance.

Women in Development

The 1973 Percy Amendment to the Foreign Assistance Act of 1961 requires that AID give particular attention to programs, projects and activities which tend to integrate women into economies of developing countries. A Women in Development program at AID is in the process of shifting from advocacy of women-specific projects funded and managed by that program to inclusion of women into projects throughout the agency. A variety of activities are underway to incorporate women into various AID science and technology activities.[51] It is likely and desirable that this emphasis continue in the coming years.

African Famine and Drought

One continent where the green revolution to increase food yields has not taken place, where population increases outstrip food production gains and where drought conditions have brought extreme hardship is Africa. Since 1983, U.N. and U.S. officials have been warning of a food crisis in about 20 countries in Africa by 1984 unless extraordinary measures are taken.[52] As of this writing, even Kenya, which has been held up as a model of development efforts, is

suffering from food shortages.[53] Philip Johnson, Executive Director of CARE indicates that as a result of the worst drought in this century, some 20 million people are on the brink of starvation.[54]

The pressing need now is for emergency relief aid through either government or private chanels. However, in the long run, much more attention needs to be devoted to African development, with emphasis on agriculture so that famine can be averted. Sustained efforts to provide technical assistance and increased resources through a variety of organizations, including the International Development Association (IDA) of the World Bank are essential. Economic policy reforms of the kind espoused by the Reagan administration which favor free market incentives could conceivably help in some instances. However, the scale, the duration, and the severity of the situation are such that it will take a variety of approaches and a major commitment by many parties to bring relief and build for a better future.

NOTES

1. See "Reagan Ends Feud by Signing IMF Aid Bill," St. Louis Post-Dispatch December 1, 1983), and "Too Many Debts, Too Many Crises," editorial in New York Times (October 12, 1983).
2. For opposing views, see P. T. Bauer, Equality, the Third World and Economic Delusion, (Cambridge: Harvard, 1981), and Frances Moore Lappé, et al., AID as Obstacle, (San Francisco: Institute for Food and Development Policy, 1981).
3. Statement by The Honorable George P. Shultz before the Foreign Affairs Committee, U.S. House of Representatives, (February 16, 1983).
4. Ibid., pp. 7, 9.
5. Robert S. MacNamara, in U.S. Foreign Policy and the Third World: Agenda, 1983, John P. Lewis and Valeriana Kallab, Eds., Published for the Overseas Development Council by Praeger, (New York, 1983) pp. 2-3.
6. Ibid., p. 2.
7. Ibid.
8. Ibid., pp. 2, 3.
9. George P. Shultz, Statement before the House Foreign Affairs Committee, p. 10.
10. John Sewell, Remarks at the International Development Conference, Washington, D.C., May 19, 1983.
11. The Commission on Security and Economic Assistance, A Report to the Secretary of State, Department of State, 220 21st Street, N.W., Room B-648, Washington, D.C. 20520 (November, 1983). The chairman of the commission was Frank C. Carlucci, President of

Sears World Trade, Inc. and a former Deputy Secretary of Defense.

12. These are actual expenditures, compiled from the AID FY 1983 and FY 1985 congressional budget presentations. Functional development assistance does not include AID operating expenses. Of the $1.35 billion in development assistance for FY 1983, $921 million was grants and $428 million was loans.

13. George P. Shultz, Statement before the House Foreign Affairs Committee, p. 20.

14. Congressional Quarterly (January 15, 1983) p. 92.

15. George P. Shultz, Statement before the House Foreign Affairs Committee, p. 20.

16. F.A.S. Public Interest Report, 35, No. 10, Federation of American Scientists, (Washington: December, 1982), p. 4.

17. From The Budget For Fiscal Year 1985, International Affairs, p. 5-22. The 1985 budget for the first time includes foreign military sales credit loans from the Federal Financing Bank.

18. FAS Public Interest Report, p. 3.

19. The relevant amendment appears in the Further Continuing Appropriations Act of 1983, P.L. 97-377 and reads as follows:

> .... chapter 1 of part I of the Foreign Assistance Act of 1961 is amended by adding at the end thereof the following new section:
>
> Sec.128. TARGETING ASSISTANCE FOR THOSE LIVING IN ABSOLUTE POVERTY. -- In carrying out this chapter, the President in fiscal year 1983, shall attempt to use not less than 40 per centum of the funds made available to carry out this chapter to finance productive facilities, goods, and services which will expeditiously and directly benefit those living in absolute poverty (as determined under the standards for absolute poverty adopted by the International Bank for Reconstruction and Development and the International Development Association). Such facilities, goods, and services may include, for example, irrigation facilities, extension services, credit for small farmers, roads, safe drinking water supplies, and health services. Such facilities, goods, and services may not include studies, reports, technical advice, consulting services, or any other items unless (A) they are used primarily by those living in absolute poverty themselves, or (b) they constitute research which produces or aims to produce techniques, seeds, or other items to be primarily used by those living in absolute poverty. Research shall not constitute the major part of such facilities, goods, and services: provided further, That within six months after the date of approval of this joint resolution, the Administrator of the Agency for International Development shall report to Congress on the implementation of this provision, the types of projects determined to meet these requirements, and the effect on the overall United States foreign assistance program.

(Laws of 97th Congress -- 2nd Session, December 21, 1982. 96 STAT 1832, 1833.)

20. U.S. Agency for International Development, Congressional Presentation for Fiscal Year 1985, Main Volume, pp. 260, 262.

21. M. Peter McPherson, Remarks at the International Development Conference, Washington, D.C., May 19, 1983.

22. Robert P. Morgan, Science and Technology for Development: The Role of U.S. Universities, (New York: Pergamon Press, 1979) p. 23 (with Ellen E. Irons, et al.).

23. Jean M. Wilkowski, "Science and Technology for Development: Myth or Reality", paper presented at International Development Conference, Washington, D.C., May 19, 1983, p. 4.

24. U.S. Agency for International Development, Congressional Presentation, FY 1985, Main Volume, p. 261.

25. John R. Eriksson, "Science and Technology for Development: Perspectives at AID", paper prepared for International Development Conference, Washington, D.C., May 19, 1984, p. 6.

26. Jack Baranson, North-South Technology Transfer, (Mt. Airy, Md.: Lomand, 1981) pp. 3-5.

27. See Mitchel B. Wallerstein, "Scientific Communication and National Security in 1984," Science 224 (May 4, 198[illegible]) pp. 460-466.

28. Proposal for a Program in Appropriate Technology" Revised Edition, printed for the use of the Committee on International Relations, 95th Congress, 1st Session, (Washington, D.C.: U.S. Government Printing Office, Feb. 7, 1977).

29. U.S. Agency for International Development, Congressional Presentation: Fiscal Year 1984, Main Volume, p. 193.

30. U.S. Agency for International Development, Congressional Presentation: Fiscal 1985, Main Volume, p. 260.

31. Nyle Brady, Remarks at the Annual Meeting of the American Association for the Advancement of Science, New York City, May 26, 1984.

32. Abby L. Bloom, Prospects for Primary Health Care in Africa: Another Look at the Sine Saloum Rural Project in Senegal, AID Evaluation Special Study No.

20, AID, Washington (April 1984). See also Policy Directions for Rural Water Supply in Developing Countries, AID Discussion Paper No. 4 (April, 1979). A complete list of AID evaluation reports is available from the AID Bureau of Science and Technology.

33. Science, Technology and American Diplomacy, 1983, Fourth Annual Report Submitted to the Congress by the President Pursuant to Section 503(b) of Title V of Public Law 95-426, (Washington: U.S. Government Printing Office, 1983) p. v.

34. Ibid., pp. v, vi.

35. Genevieve Knezo and Allen Greenberg, "Congressional Research Service Critique of the 1983 Title V Report on Science, Technology and American Diplomacy," in Science, Technology and American Diplomacy, 1983, Appendix 3, pp. 124-136. See also Overview of International Science and Technology Policy, Hearings before subcommittees of the House Committee on Foreign Affairs, (August 2, 3 and September 21, 1983).

36. See Crauford D. Goodwin and Michael Nacht, Absence of Decision: Foreign Students in American Colleges and Universities, (New York: Institute of International Education, 1983) p. 18.

37. See Elinor G. Barber and Robert P. Morgan, "Engineering Education and the International Student: Policy Issues," Engineering Education, 74, No. 7 (April, 1984) pp. 655-659.

38. Janice Long, "Immigration Bill Affects Foreign Students in U.S. Colleges," Chemical & Engineering News, 62, No. 27, (July 2, 1984) pp. 16-17.

39. Nyle C. Brady, Personal Communication, Washington, D.C., (Nov. 17, 1982).

40. Nyle C. Brady, Remarks at Annual Meeting of the American Association for the Advancement of Science, (New York: May 26, 1984).

41. Ibid.

42. Rustam Lalkaka, paper prepared for Annual Meeting of the American Association for the Advancement of Science (New York, May 26, 1984) pp. 14-15.

43. "International Foundation for the Advancement of Science and Technology in Developing Countries: A Proposal" (Undated).

44. IFAST is mentioned briefly in Science, Technology and American Diplomacy, 1983, p. 20. At the AAAS Meeting in May, 1984, Nyle Brady indicated that the idea was not being pursued.

45. Robert C. Cowen, "The Price of Leaving UNESCO," Technology Review 87, No. 5, (August/September 1984) p. 4.

46. Roger Revelle, Remarks at Annual Meeting of the American Association for the Advancement of Science (New York: May 27, 1984).

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48. U.S. AID, Congressional Presentation for FY 1985, Main Volume, p. 41.

49. Ibid., p. 42.

50. Constance Holden, "World Bank, U.S. at Odds on Population," Science 225, (July 27, 1984) p. 396.

51. U.S. AID, Congressional Presentation for Fiscal Year 1985, Main Volume, pp. 225-230.

52. See Bernard Weinraub, "Famine in Africa is Called Worst in a Decade," New York Times (June 7, 1983). See also John Walsh "Sahel Will Suffer Even if Rains Come," Science 224 (May 4, 1984) pp. 467-471.

53. Alan Cowell, "Drought in Kenya Exposes Poor Nations' Vulnerability," St. Louis Post Dispatch (July 12, 1984).

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7 Summing Up

In this volume, an attempt has been made to define the shape of U.S. policies and programs in science and technology for development as they have evolved since the 1979 United Nations Conference on Science and Technology for Development (UNCSTD). The bulk of the analysis is concerned with the policies and programs of the Reagan administration and the U.S. Congress in the first part of the 1980s. Although there is much continuity with the policies of the past, there are at least three respects in which the policies of the Reagan administration seem to depart from those that have gone before. First, science and technology have emerged as a key element of development assistance programs. Second, multilateral development assistance programs are receiving lower priority. Third, foreign aid activities seem to be justified more and more by military and economic security considerations -- including competition with the Soviet Union, economic benefits to the U.S., and strengthening the private sector and free enterprise -- and less as a response to humanitarian concerns for alleviating world hunger and poverty. The latter concerns remain a part of U.S. motives but appear to receive less attention.

SCIENCE AND TECHNOLOGY AT AID

The environment for science and technology (S&T) for development in the United States today has several contrasting features. There is a much more focused effort on the part of AID to emphasize science and technology in its programs than has been the case in the past, due to the efforts of Nyle Brady and Peter McPherson. There are other significant pieces of activity going on, some of it funded by AID, at the

National Academy of Sciences, the National Science Foundation and Volunteers in Technical Assistance (VITA) -- to name just three organizations. These efforts include:

(1) provision of technical assistance for specific projects in agriculture, health and other selected fields;

(2) helping to build science and technology capability in developing country institutions;

(3) cooperative research projects between U.S. and developing country scientists and engineers;

(4) education and training of developing country nationals in technical fields in the United States;

(5) dissemination of technical information of a non-proprietary nature to help solve problems at the grassroots or village level.

None of these things are new but some of them appear to be getting more attention than in the past.

This activity, at AID and elsewhere, laudable though it is, operates under some constraints. First, overall budgets for development assistance activity and cooperative international science and technology efforts have not grown significantly. Second, although one segment of the U.S. science and technology community, namely the land-grant agricultural universities has been tapped, the contributions that other parts of this community can make are not being seized upon. Third, the case for development assistance is not being made in a way which is compelling to the U.S. public. Congressional interest in science and technology for development activity appears to be minimal. Recent concerns in the U.S. about the state of the U.S. economy and the world economy have tended to overshadow concerns about drought and famine in Africa. The view evidentially held and occasionally articulated by some in the Reagan administration, including President Reagan himself, of the Soviet Union as the personification of evil, helps to nurture a climate in which it becomes exceedingly difficult, if not impossible, to free up sufficient non-military resources to mount an effective program of international development assistance and cooperation.[1]

ON ISTC, UNFSSTD, IDA AND TECHNOLOGY TRANSFER

Interest in science and technology for development probably peaked in the United States around 1979, at the time of the United Nations Conference on Science and Technology for Development (UNCSTD). There was a certain optimism on the part of some of us in the science and engineering community that we were entering a period in which S&T for development activity would be taken seriously. A major U.S. initiative defined in preparation for UNCSTD, namely the Institute for Scientific and Technological Cooperation (ISTC), promised a new mechanism for getting more science and technology input and more research and development into U.S. international development activities. A new financing system for science and technology at the United Nations, UNFSSTD, insisted upon by developing nations and supported by the United States at UNCSTD, was to serve as a focal point for expanded multilateral activity.

ISTC is on the books but funds were never appropriated for it by the U.S. Congress. It is to the Reagan administration's credit that some pieces of the ISTC idea have been implemented, albeit in an ad hoc manner, through such vehicles as the Research Grants Program of the National Academy of Sciences and the AID Office of the Science Advisor. Perhaps more significantly, AID as a whole has espoused and expanded its program in science and technology and in research and development.

The story of U.S. participation in the United Nation's Financing System for Science and Technology for Development, UNFSSTD, is less encouraging. The United States has contributed nothing as yet to UNFSSTD when even a small "non-core" contribution targeted to projects and countries of our choosing would appear to me to be good diplomacy and good foreign policy. Furthermore, U.S. reduction of support for multilateral assistance through the International Development Association (IDA), the concessional loan arm of the World Bank, represents in dollar terms a much more significant cutback in resources for development projects than failure to support UNFSSTD or withdrawal from UNESCO, a withdrawal I do not favor. IDA support is of particular importance for parts of Africa that are now stricken by severe drought. The overall trend concerning multilateral assistance is in the wrong direction and needs to be reversed.

The phrase "technology transfer" is still used a great deal these days. It is not clear to me that it is the right phrase to use for our AID programs, except maybe in agriculture. Industrial technology transfer is likely to involve private U.S. companies and multinational corporations. What they do and how they operate are important to understand; that should be the subject of another study. In my opinion, a major emphasis of our development assistance programs should be on helping to build indigenous capacity for technological innovation and adaptation within developing countries, and especially within those countries which are the least developed by criteria of income and other quality of life indicators.

ON INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION, FOREIGN ENGINEERING STUDENTS, AND APPROPRIATE TECHNOLOGY

International scientific and technological cooperation is not necessarily synonymous with development assistance. As countries develop, cooperation should increase and assistance decrease. Yet, we have not rationalized our cooperative science and technology activities very well, even though we have over thirty bilateral agreements in this area, including some with AID-graduate and/or newly industrializing countries.

The National Science Foundation (NSF) could play a more significant role in international scientific and technical cooperation with developing countries than it does. Although NSF and the National Science Board recognize the importance of international cooperative science and technology activity, their recent policy statements give heavy emphasis to the benefits of such cooperation to U.S. science and relatively little emphasis to the benefits to developing countries. A management scheme adopted in 1983 at the National Science Foundation shifted decision making and control of resources for some international program activity from a central international programs division to the disciplinary research directorates. In my opinion, this was a step in the wrong direction; it is likely to hurt developing country activity at NSF and hurt efforts to carry out interdisciplinary and/or applied research at the technology and international development interface.

Not that the previous level of S&T for development effort at NSF was satisfactory. In my opinion, we still need an ISTC or something like it to beef up our efforts in international scientific and technological cooperation; current efforts are fragmented and inadequate. Such cooperation represents a valuable means of improving relations among nations; the U.S. also

acquires a great deal of useful scientific and technical information in the process.

The Department of State continues to draw criticism from Congress for its failure to provide an analytical framework for rationalizing U.S. science and technology activity within U.S. foreign policy, as well as for its failure to provide detailed information on steps it has (or has not) taken to strengthen its capability for dealing with science and technology matters. That such a framework is needed seems evident, although ad hoc responses to crises and situations will no doubt always be with us.

An important link in the science and technology for development chain is the large numbers of engineering and science students who come to the U.S. to study. Although some stay in the U.S., many go back home to assume important positions in industry, government and universities. We need to somehow see to it that these individuals get a professional education in their discipline with a plus -- one that gets them up to speed on the role of science and technology in their country's development, just as we urgently need to do a parallel kind of international broadening for our own students. Also, we need to proceed very slowly and carefully with immigration restrictions, lest the imported "seed corn" we have been using to keep up our own stocks of engineering manpower in certain fields be eaten up. If restrictions are desired by some countries to stem a "brain drain," they might best be imposed by the country from which the students come, or by creating conditions within those countries so that a U.S. education doesn't look so much better. U.S. development assistance programs have a role to play here.

You hear less about "appropriate technology" these days. Yet if we are really serious about helping to meet basic needs, particularly in rural areas of populous poor countries, we need to think in terms of capital-saving, employment generating activity. It is perhaps a sign of maturity and progress that programs which contain many of the elements that were desired by early appropriate technology enthusiasts are now being carried out quietly, without the appropriate technology label.

ON SCIENCE, TECHNOLOGY AND THE NEED FOR EVALUATION

We need to spend more time finding out what works and what doesn't work in the science and technology for development field. And the answer usually isn't a simple yes or no. Successful results often take time, resources and continuity. The international agricultural research centers have a lot going for them as a model for science and technology for development activity, but they are not the only model one can conceive of. In an area like renewable energy, you can't expect instant success, nor can you declare that overall efforts have failed after only three or four or five years of trying. Renewable energy -- improved cookstoves, solar dryers, windmills -- needs more, not less commitment and attention.

AID has been doing more within recent years to evaluate its programs; AID impact evaluation reports are available and deserve careful scrutiny. An expanded technology assessment capability should be created within AID to enable the agency to step back and take a broad look at how its science and technology programs are doing.[2] We also need independent evaluations. An independent commission funded in part by private foundations should be established to initiate much needed evaluative activity.

WHAT NEEDS TO BE DONE

First and foremost, there is a need to support efforts to bring about arms control and to reverse the escalation of military spending the Soviet Union and the United States have embarked upon.[3] A parallel reduction in military spending by developing countries themselves is also required. Improved relations between the U.S. and U.S.S.R. can help to free up resources for development projects as well as to establish a climate which fosters international science and technology cooperation.

Second, there is a need to develop and gain support for effective programs of development assistance and of international scientific and technological cooperation, both bilateral and multilateral. More rather than less financial and human resources should be devoted to these activities. At the same time, independent efforts are urgently needed to determine what really works and what doesn't in the S&T for development field.

Third, although they are tough to come by these days, there is a need for government, private industry, educational institutions and the public interest sector to create and sustain meaningful career opportunities that can attract individuals who wish to devote themselves to international scientific and technological cooperation and to the cause of international development. Private voluntary organizations such as Volunteers in Technical Assistance (VITA) have a significant role to play here.

Finally, there is a need to develop and articulate an understanding of the role of science and technology for development among the scientific and technological professional community, the politicians, and among the public at large. Educational institutions can be important participants in this process. Hopefully, this volume will contribute towards such understanding and towards illuminating policy issues for the United States that need further debate and resolution.

NOTES

1. About 15 years ago, the Soviet physicist, Andrei Sakharov stated the case for U.S.-Soviet cooperation in international development activity as follows:

> What is needed most of all is economic and technical assistance to these (developing) countries. This assistance must be of such scale and generosity that it is absolutely impossible before the estrangement in the world and the egotistical, narrow-minded approach to relations between nations and races is eliminated. It is impossible as long as the United States and the Soviet Union, the world's great superpowers, look upon each other as rivals and opponents. (Andrei D. Sakharov, in _Progress, Coexistence and Intellectual Freedom_, New York : Norton, 1970, pp. 45-46.)

2. By technology assessment, I mean examining the impacts of past, present and proposed S&T programs, both positive and negative.

3. The points made in this section first appeared in Robert P. Morgan, "Sharing Science and Technology," _Bulletin of the Atomic Scientists_ 39, No. 5, May, 1983, p. 27. Copyright by the Educational Foundation for Nuclear Science, Chicago, IL 60637. Used with permission.

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