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NATIONAL ACADEMY OF SCIENCES
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This report has been prepared by the Foreign Secretary of the National Academy of Sciences and Theresa Tellez, Professional Associate of his staff, for the Office of Science and Technology, Bureau for Technical Assistance, Agency for International Development, Washington, D.C., under Contract No. AID/csd-2584, T.O. #1.

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Foreword

The U.S. National Academy of Sciences has had a longstanding interest in the applications of science and technology to problems in the less developed countries. As the growing importance of such applications to the emergence and well-being of developing countries was recognized, the administrators of the U.S. foreign assistance programs turned with increasing frequency to the Academy to provide advice.

In 1969 the concurrent establishment of the Office of Science and Technology within AID and the Board on Science and Technology for International Development within the Academy, coupled with the allocation of funding on an annual basis, facilitated the establishment of a more systematic and sustained program. The National Academy of Sciences together with the National Academy of Engineering responded with a program of workshops, studies, and special projects which, during my tenure as Administrator of AID, has been the backbone of our efforts to strengthen national science and technology policies, priorities, and organizations in the developing countries. I am happy to say that working with the Academies during this period has been especially satisfying, productive, and pleasant.

We hope that this excellent report will be as valuable to other institutions and persons interested in technical assistance as it is to AID.

John A. Hannah
Administrator
Agency for International Development

October 1973

Preface

This review and analysis of joint programs between the National Academy of Sciences and counterpart groups in developing countries has provided an opportunity for introspection perhaps not engaged in often enough in connection with such efforts. Whether or not one pauses to contemplate the results of one's actions, those actions are nevertheless usually based on the more or less disorganized ingestion of information accumulated over time. Therefore, we believed that a more careful sorting out of the evolution of our projects and what we have learned in the process could contribute to the improvement of future undertakings of a similar kind. Reviews and evaluations of these programs by AID have also been useful. Although our method of operation may have been unique, we hope this report will help others who are working in technical assistance programs.

The close relationships established with colleagues overseas have been a source of much satisfaction to all of us. We know we have mutually profited from many exciting developments and achievements. Although this report is based on a straightforward, factual account of events and results, the significance of the roles played by countless dedicated individuals has not been overlooked. In the case of the Office of the Foreign Secretary, many U.S. scientists have selflessly contributed much of their time to our overseas programs. A special note of appreciation is also due to highly dedicated and imaginative staff members.

We are especially indebted to the following board members for their comments and critical reviews of this report, as well as the one submitted to AID: Carl Djerassi, John J. McKelvey, Jr., William A. W. Krebs, Robert N. Kreidler, and Joseph B. Platt.

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Foreign Secretary

Theresa Tellez
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October 1973

I Introduction

During the past decade, the Office of the Foreign Secretary (OFS) of the National Academy of Sciences (NAS) has drawn attention to science as a constructive element in foreign technical assistance and enlisted the support of increasing numbers of U.S. scientists and engineers for this effort. This review, covering the decade ending in 1972, focuses on science cooperation programs aimed at improving indigenous scientific and technological capabilities for socioeconomic progress and conducted by the Office of the Foreign Secretary with counterparts in Africa, Asia, and Latin America.

The principal function of the NAS is to advise on matters pertaining to science and technology. The Act of Incorporation passed by the U.S. Congress in 1863 provided an extraordinarily broad mandate which has enabled the NAS to engage in numerous activities to enhance science in the United States and abroad. Although it was created by Congress, the NAS is an independent, private institution dedicated to the furtherance of science and technology and to their application for the national well-being.

The founders of the NAS recognized the universality of scientific principles. For centuries, international communication in the scientific community has been essential to scientific progress, and from its founding, the NAS has fostered the flow of scientists and scientific information between the United States and other countries. In retrospect, it is clear that had U.S. scientists not been able to study and work in European universities during the nineteenth and early twentieth centuries and had European scientists not come to the United States to teach in our universities, U.S. scientific capabilities would not have reached their present growth so quickly. Technical assistance contributed substantially to our national development.

Maintaining relationships with colleagues in Africa, Asia, and Latin America has long been an NAS tradition,[1] but in the last 10 years the OFS has made a special effort to increase its communications with these regions.

[1] As early as 1870, NAS astronomer B. A. Gould responded to a request from the Argentine government and spent 15 years in Córdoba, where he helped organize and direct the National Observatory.

In the United States the sociopolitical momentum of the early sixties reflected a hearty sense of commitment to goals of human betterment, worldwide. Aware of problems in the underdeveloped countries, the scientific community contributed enormously to OFS efforts, in the belief that science and technology can contribute to international development. This belief is an essential part of the OFS philosophy developed over the years of experience in which it has been able to identify the role of science and technology more precisely. Although the relationships between socioeconomic change and technological change are by no means thoroughly understood, it is generally believed that through careful study and planning, science and technology can be better utilized to improve the human condition. Because the OFS has consistently drawn upon the expertise of scientists throughout the country and in many disciplines, it is reasonable to say that OFS experience reflects a larger, nationwide interest in technical assistance.

Initial financial support for OFS programs was derived largely from private foundations. Without their understanding support during several critical periods, many efforts would not have been possible. Some foundations, notably Rockefeller and Ford, have contributed substantially to the effectiveness of several programs by making available both funds and dedicated personnel. These foundations and others, such as the Asia Foundation, understand the contribution science can make to the general welfare of society and to international understanding.

In applying science and technology to problems of economic and social development, a primary objective of the OFS has been to combine its efforts with those of overseas colleagues and appropriate governmental authorities. During this first decade, a great deal of effort was devoted to increasing the interest and understanding of governments in supporting science and technology.

The assumptions underlying OFS international programs have been based on the beliefs that

- Scientific and technological growth is an essential element of national development;
- Indigenous scientific capability or local problem-solving competence is requisite for a country to lessen its dependence on others; and
- Science can be applied to human betterment in general, and specifically to the problems of poor nations suffering from hunger, disease, and inadequate resources.

This account of OFS cooperative programs describes an attempt to bring science and technology to bear on development policies here and abroad. Most of the results described are accomplishments of our counterparts abroad, the USAID missions, and the governments that have supported the concerted, collaborative endeavor. NAS counterparts and others, to be sure,

will have their own points of view. In this report, however, the OFS attempts to convey their sense of achievement by incorporating many of their expressions and views. Rather than a description of each program, this is a history of events and an analysis of the results. The data utilized included correspondence and spoken comments of participants and observers; proceedings and reports of workshops, study groups and panels; and communications from USAID missions and other overseas institutions.

II History

The OFS's current interest in underdeveloped countries began in the late 1950s. Earlier, its international endeavors were confined largely to maintaining cordial working relationships with science academies in other countries, particularly in Western Europe, and to participating in activities of the International Council of Scientific Unions and its constitutent unions. After World War II, as U.S. participation in international scientific endeavors increased, so did that of the National Academy. The Academy took part in the scholarly exchanges made possible by the Fulbright Act of 1946. It also created the Pacific Science Office in 1946 to sponsor and promote scientific research in the Pacific. A program of scientific exchanges with the Academy of Sciences of the USSR, inaugurated in 1959, eventually led to similar programs with other countries in Eastern Europe. The NAS also played a leading role in organizing multinational cooperative scientific endeavors, such as the International Geophysical Year (1957-59), noted especially for the gigantic cooperative research and exploration program in Antarctica; the International Biological Program (1964); and in the 1960s, the International Indian Ocean Expedition.

In 1958 the U.S. International Cooperation Administration (ICA), forerunner of the U.S. Agency for International Development (AID), asked the NAS to examine the scientific and technological components of U.S. technical assistance programs in Africa south of the Sahara and north of the Union of South Africa. In 1959 the agency requested advice on technical assistance programs in Latin America. After 1961, the NAS's involvement in assistance to underdeveloped countries became more substantial when the ICA was reorganized into AID and the Alliance for Progress was created.

In 1963 one of the first projects undertaken with AID support by the Office of the Foreign Secretary was a science book program, designed to make U.S. scientific and technical books available at low cost to institutions in underdeveloped countries. The NAS undertook the subsidized book-purchase program as an experiment in developing a viable mechanism to provide better access to technical books. From 1963 to 1968, technical books were sent to institutions in Brazil, the Central American republics, South Korea, Indonesia, Nigeria, Ethiopia, United Arab Republic, Ghana, Turkey, and Iran.

The NAS phased out its activities when Franklin Book Programs was preparing to undertake an expanded program. Unfortunately, the Franklin organization was unable to carry out the proposed program because of financial problems.

REGIONAL ACTIVITIES

In 1963 the Latin America Science Board (LASB) was created by the NAS to advise on programs under the Alliance for Progress, and in anticipation of similar activity in Africa, a regional advisory board (Africa Science Board, or ASB) was also established. With variation in emphasis and technique, the LASB, the ASB, and the long-established Pacific Science Board (PSB) concentrated on ways and means to strengthen scientific competence in their respective regions. Members of the boards were eminent U.S. scientists and other scholars with considerable knowledge of the particular geographic areas. The ASB was supported by the Ford Foundation; the LASB by AID; and PSB by the National Science Foundation, the Office of Naval Research, the Smithsonian Institution, and private sources. The Rockefeller Foundation also contributed substantially to all these efforts, especially those in Africa. Because of its sponsorship, the ASB was relatively independent, but funds were limited; the LASB was tied to the goals of the Alliance for Progress but had greater financial backing; and the PSB engaged in multifarious activities, most of which were oriented to increasing U.S. competence in the scientific exploration of the Pacific area rather than to development goals.

Although not ignoring individual country needs, the regional approaches, especially in Africa and Latin America, were aimed primarily at multinational efforts to solve common problems, particularly in agriculture, health, and higher education in the sciences. The NAS sought the participation of existing counterpart institutions, and encouraged their establishment where such institutions were lacking. In addition, the NAS established contacts with regional organizations such as the Scientific Council for Africa (CSA) and the Commission for Technical Cooperation in Africa South of the Sahara (CCTA).

In Latin America ties already existed between the NAS and the few existing national research councils (in Mexico, Brazil, and Argentina) and other scientific bodies, including the Department of Scientific Affairs within the Organization of American States (OAS). The LASB's charge was to identify opportunities for research in U.S. programs sponsored under the Alliance for Progress. In performing this task, the LASB made direct contacts with USAID missions in major aid-receiving countries. Although the LASB recommended some programs for specific countries, its main interest lay in developing regional research programs that would involve multinational efforts. The ill fate of an intensive study on research in tropical agriculture conducted by an LASB task force, however, made it evident that such programs were prema-

ture for national governments, and for USAID missions. Significant support of science in Latin America did not come about until the OAS Punta del Este Summit Meeting in 1967.

The Africa Science Board was not as successful as the LASB in obtaining AID support for its early activities. Nevertheless, in the early 1960s, ASB members visited African countries and established valuable contacts which led eventually to substantial programs. Subsequently, AID began to support several agricultural studies, including a major study on the cattle disease, rinderpest. Continued interest in tropical agriculture led to a pan-African conference in 1968, which in turn led to the creation of the Association for the Advancement of Agricultural Sciences in Africa (AAASA), the first pan-African scientific society. Other meetings and studies followed. Subsequently, AID requested a study on African agricultural priorities, which is now a collaborative task of the OFS and the NAS Agricultural Board, with the participation of African and European scientists. Other major studies sponsored by the ASB, funded by AID and Rockefeller Foundation funds, dealt with water resources and the biological-sociological problems engendered by the creation of large man-made lakes in Africa.

The early attempts of the LASB and ASB to garner support for regional programs provided valuable experience. All too often, the potential overseas participants regarded regional programs in Latin America as undertakings that would expend scarce human and capital resources with little return. Seldom did they view the programs as concerted attacks on common problems that would conserve resources and avoid duplication. In both Latin America and Africa, weak organizational structures and lack of trained personnel contributed to a general lack of enthusiasm from national governments, and from AID. As a result, the two NAS boards looked for constructive programs in specific countries that showed a potential for improving their scientific and technological capabilities. This move from a regional to a more focused approach on the national level paralleled the emerging bilateral activity in Taiwan under the auspices of the PSB.

BILATERAL PROGRAMS

In Asia the initiative for a Sino-American meeting on science and technology came in 1963 from the Academia Sinica of the Republic of China (Taiwan). The first meeting, a workshop in Taipei in 1964, led to a bilateral cooperative program between the NAS and the Academia Sinica in several areas of science and technology. As the program began, AID was phasing out its assistance because the country had reached a point of economic sufficiency; therefore, the bilateral program was privately funded, with major support from the Asia Foundation.

Bilateral programs in Africa and Latin America began with the more explicit goal of viewing national priorities in terms of applying science and technology to problems of economic and social development. At first these programs emphasized the role universities could play in training manpower for the development and management of natural resources and the organization of research. AID provided financial support. The countries selected were considered potentially able to generate support for science from both internal and external sources. Exploratory workshops held with Nigerians in 1965 and with Brazilians and Peruvians in 1966 led to further bilateral activity and encouraged the initiation of similar workshops in other countries.

As bilateral programs have evolved in several countries, some changes have occurred in the structure of relationships, program activity, and mode of operation. Within AID, the establishment of an Office of Science and Technology within the Technical Assistance Bureau centralized its interest in NAS science-cooperation programs. To be effective, bilateral programs also required closer relationships with AID missions abroad. Within the NAS, the regional boards were eventually superseded in 1969 by the Board on Science and Technology for International Development (BOSTID),[2] which has used increasing numbers of panels and ad hoc groups for various projects and studies. The OFS strengthened its links with foreign counterpart institutions, in the belief that national research councils, science ministries, and similar bodies could serve as focal points for marshalling internal and external resources. This bilateral approach made it possible to examine national priorities in a more systematic and comprehensive manner.

At first, bilateral workshop meetings were conceived as weathervanes to explore the feasibility of NAS cooperative programs in certain countries; however, workshops have developed into a continuing activity with a wide spectrum of functions, such as developing, overseeing, and evaluating programs in science and technology considered necessary to national development.

In countries where the NAS - counterpart relationship is particularly strong and constantly reinforced through personal contact between representatives of the two participating institutions, numerous constructive developments have taken place. This joining of forces has brought together matching and complementing expertise, and the collaborative, institutional arrangement has no doubt helped to convince some planning ministries of the good intentions of participating parties and of the potential benefits for the country.

Bilateral programs have not been uniformly successful, nor free of serious difficulties. Political conflicts between governments and domestic political upheavals have disrupted institutions, personnel, and finances. Military coups

[2]Preceded by the Science Organization Development Board, created in 1966.

or wars in Nigeria, Ghana, Argentina, Peru, and Bangladesh,[3] have affected bilateral activities, usually by delaying action. In Nigeria, two military coups in 1966 and prolonged civil strife thereafter prevented the development of a bilateral program, although the NAS stayed in touch with Nigerian scientists—partly through the participation of the universities of Ibadan and Ife in ecological studies of the Kainji Lake Basin, sponsored by the water resources subcommittee of the Africa Science Board.

In all countries, the NAS has striven to maintain its relationships with scientific communities under even the most difficult circumstances. In some dire situations, such contacts have been of critical importance. For example, in the mid-1960s serious concern was aroused by the mistreatment of the academic communities in Argentina and Brazil, attributed to military and political heavyhandedness. Colleagues in both countries asked for moral support. In the case of Argentina, at the request of high-level Argentine scientists, several NAS members beseeched President Onganía to intervene on behalf of scientists. Some assistance was also lent to scientists who sought professional placement in other countries. This disruption in the Argentine universities caused a delay in the first bilateral workshop of at least 2 years.

The situation of the Argentine graduate science students who were left stranded by the precipitous departure of their professors was considered an emergency; the NAS helped to place some students in U.S. universities. Most, however, chose to complete their work in Latin America.

During this period, some scientists in Argentina, Brazil, and the United States said that the NAS should sever all relations in these countries, thereby denouncing the regimes. The NAS, however, has held to a policy of cooperation and support for scientific communities worldwide without endorsement or censureship of national political ideology.

By the end of 1971, 26 bilateral workshops had been held in 12 countries: 1 each in Ghana, Nigeria, Zaire (formerly Congo/Kinshasa), Argentina, Chile, and Colombia; 2 each in India, Indonesia, and Peru; 4 alternating between the Philippines and the United States; 4 between Brazil and the United States; and 6 between Taiwan and the United States.

Most workshops have dealt with the general theme of science and technology in economic and social development and have emphasized priorities for research. But several workshops dealing with more specific topics have also been held, particularly in Asia.

Workshop topics and the number of countries in which they have been discussed follow:

Science Policy and Organization	12
Natural Resources	11

[3]Disrupted the program in India.

Manpower and Education	10
Industrial R&D and Management	9
Agriculture	9
Medical Sciences, Public Health, and Demography	7
Scientific and Technical Information, Computers, and Communication	7
Marine Sciences and Fisheries	6
Food and Nutrition	5
Social Sciences and Humanities	3
Environmental Problems	1
Transportation	1
Urbanization and Unemployment	1

Workshop meetings have generated a total of 21 study groups composed of U.S. and host-country members. As shown in Table 1, most have examined education and research needs in basic science and in areas related to agriculture and industry. Two regional workshops—on water resources and the environment—are also shown in Table 1.

Workshops have stimulated several other cooperative bilateral endeavors: specialized seminars and conferences, short-course seminars, science-policy missions, provision of staff personnel for short-term assignments, a major project to develop graduate education and research in chemistry in Brazil, and a telex network for the exchange of scientific and technical information between Argentine and U.S. institutions. The two-way flow of persons attending meetings, conducting studies, or visiting institutions has resulted in the establishment of many institutional ties among universities, professional societies, research institutes, and technical assistance agencies. For example, contacts between BOSTID members and Thomas Odhiambo of the University College in Nairobi contributed to the creation in 1970 of the International Centre of Insect Physiology and Ecology in Nairobi, Kenya. BOSTID members and staff participated in the early planning and development organized by the American Academy of Arts and Sciences and Dr. Odhiambo.[4]

Parallel to the bilateral workshop activity, several studies have been conducted at AID's request on particular aspects of science and technology in development.

A 2-year study undertaken for AID by the Office of the Foreign Secretary, but not under BOSTID's auspices, examined the consequences and policy implications of rapid population growth. Under the chairmanship of Roger

[4]See "East African 'Center of Excellence': The International Centre of Insect Physiology and Ecology." *Bulletin of the American Academy of Arts and Sciences.* March 1972. 25 (6): 3 - 23.

TABLE 1. OFS Workshops and Study Groups: Topics by Country/Region, 1964 - 1971

Country/Region	Science Policy & Organization	Manpower & Education	Agriculture (Research, Training, Extension)	Food & Nutrition	Medical Sciences, Public Health, Demography
Ghana	W	W	S-Research		W
Nigeria	W		W		W
Zaire	W	S-Earth Sciences	W	S	S-Demography S-Primates
India	W				
Indonesia	W	W	W	W	
Philippines	W	W	W	W	W
Taiwan	W	W			W
Argentina	W	W	W	S-Food Technology	
Brazil	W	S-Earth Sciences S-Steroid Chemistry S-Chemistry	S-Research S-Economics		W
Chile	W	W		W	
Colombia	W	S-Chemistry S-Math S-Biology S-Engineering, Physics, Geology	W		
Peru	W	W	W		W
NO. COUNTRIES	12	10	9	5	7
Central America					
SE Asia (Singapore, 1972)					

S = Study Groups (21 total)
W = Workshops (26 bilateral, 2 regional)

Natural Resources (Forestry, Water, etc)	Marine Sciences, Fisheries	S&T Information, Computers, Communication	Industrial R&D Management	Social Sciences, Humanities	Environ-mental Problems	Trans-port	Urban-ization Unemploy-ment
w	w		w				
w	w						w
w							
w		w	w				
		w	w				
w	w	w	w	w			
w	w	w	w	ww			
S-Hydrology		S-Science Information	w				
w		S-Computers	S-Industry S-Norms, Standards, etc.				
w	w						
w			w				
w	w	w	w	w			
11	6	7	9	3		1	1
					w		
w							

Revelle of Harvard University, 11 committee members and 16 authors of research papers assessed the extent of knowledge on population questions.[5]

Many problems considered in the BOSTID studies have been identified at workshops; others reflect AID's interest in pursuing additional opportunities for study and action. Important examples are these current studies:

Research Management and Technical Entrepreneurship: A U.S. Role in Improving Skills in Developing Countries
U.S. International Firms and R, D & E in Developing Countries
Appropriate Technologies for Developing Countries

A related feasibility study on a proposed International Industrialization Institute reflects AID's interest in new approaches to technical assistance in aspects of industrialization. Another study completed in 1969, concerns post-AID technical assistance to Korea.

Other experimental approaches and techniques are under trial. In a joint project, the Brazilian National Research Council (CNPq) and the NAS are working to develop a program of graduate teaching and research in chemistry at two major universities in Brazil. Begun in 1969, the chemistry program has such innovative features as NAS Overseas Research Fellowships and the commitment of several U.S. universities to assist U.S. fellows and Brazilian faculty and students.

Another major project seeks to identify appropriate and innovative technologies for underdeveloped countries. It is guided by an advisory committee and a series of technical panels who examine such topics as solar energy, small power sources, ferrocement applications, roofing systems, food problems, and mosquito control.

In summary, the program pattern over the last decade reveals a regional and problem-oriented beginning followed first by a bilateral focus and then a present resurgence of interest in problem-oriented studies and regional endeavors. BOSTID's principal techniques have been bilateral workshops and joint study groups, coupled with special advisory missions requested by the host institutions. In addition, BOSTID has sponsored special studies, international conferences, and symposia. Some studies on problems common to underdeveloped countries are, or have been, conducted by technical panels, some of which are multinational in membership.

Approximately 38 publications of workshop proceedings and auxiliary reports, and 45 technical reports by joint groups and consultants, have resulted from the bilateral programs. In addition, 20 special studies have been

[5] *Rapid Population Growth: Consequences and Policy Implications.* Vol. 1. *Summary and Recommendations.* Vol. 2. *Research Papers.* (See appendix B, p. 67.)

undertaken, many in the last 2 years, including 5 now under way that deal with innovative technologies for underdeveloped countries.

Published reports and proceedings of studies and conferences held since 1963, including those conducted under bilateral auspices, are listed in appendix B.

III Analysis

Many questions arise from the experiences of the past decade. Has the National Academy contributed to the solution of some of the serious problems facing underdeveloped countries? Has it helped build indigenous scientific and technological capabilities? What has been accomplished in the short run? What are the likely accomplishments in the long run?

The question of effectiveness and ultimate success must be answered in relative terms because of the constantly changing situations within the countries involved. Overall, the programs are affected by variations in human, physical, and capital resources and the political and social environment in which they are found. The dynamic operating framework requires taking advantage of opportunities as they arise. In each country, therefore, the evolution of science-cooperation programs differs—in some cases, sharply—from programs in other countries.

In our analysis major actions taken in response to bilateral recommendations were considered paramount indicators of program effectiveness. In addition to quantifying the implementations of bilateral recommendations, several questions were posed to determine the effects of these actions within each country. In every country there is evidence of changes in policies affecting the support of science and the attainment of certain goals at which the bilateral programs were aimed.

The general characteristics of programs were examined to determine overall patterns. In addition, the results of each program have been measured by examining common issues:

- The institutional framework developed to effect planning, evaluation, and implementation;
- The accomplishment of stated goals, both short-term and long-term;
- The evidence of future capacity for scientific and technological growth and self-sufficiency; and
- The effects on U.S. technical assistance programs.

Because of the nature of the science cooperation programs and the institutional network required to conduct them, implementation of recommendations usually takes place at three stages along the way. These stages involve institutional relationships between:

1. NAS and AID (both the Washington offices and the USAID missions)
2. NAS and counterparts overseas; and
3. Any combination of the foregoing, plus others, that may be concerned with implementation. This third set of relationships, which may or may not involve the NAS directly, produces results at the implementation stage—considered the most important indicators of overall effectiveness because they generally reflect the attainment of major objectives by all parties concerned.

The patterns of implementation and the results have been analyzed from the point of view of the institutional relationships, the temporal aspects (short- and long-term), and the fulfillment of certain objectives posed by a set of questions applied to each bilateral program.

INSTITUTIONAL RELATIONSHIPS

1. NAS AND AID/WASHINGTON AND USAID MISSIONS

The recent significant increase in the number of bilateral programs and other projects requested of the NAS by AID could in itself be interpreted as evidence of success. Over the past decade, the NAS has advised AID's regional bureaus for Latin America, Africa, and the Far East; the Bureau for Technical Assistance; and the field missions. At first, when little attention was given to science and technology (S&T) as such, the scientific and technical components of AID programs were situated entirely within regional or country programs. Initial arrangements with the NAS for providing advice were with regional bureaus, although USAID overseas missions were primarily responsible for implementing programs. Thus, the NAS had to surmount two major problems: getting more S&T into AID programs and working simultaneously with several offices of AID because of jurisdictional problems within that agency.

At present, the NAS is under contract to the Office of Science and Technology, established in 1969 within the Bureau for Technical Assistance. In addition, many USAID missions contract with the NAS directly for specific aspects of the bilateral programs. Some confusion remains about responsibilities and jurisdictional boundaries among the AID entities and about whether some projects fall within the development framework. Nevertheless, AID itself has undoubtedly given more attention to S&T in foreign assistance programs, as manifested by the creation of the Office of Science and Technology within the Bureau for Technical Assistance. The bureau, of course,

uses and contracts the services of many institutions, but the NAS contract is the only one of its kind—with the objective of strengthening the general S&T capabilities of underdeveloped countries. No other U.S. institution, to our knowledge, has undertaken such extensive programs in science directed at economic and social development.

Recommendations from workshops and related activities have determined much of the emphasis of NAS programs, provided a framework for evaluating the state of science in several countries, and established priorities that reflect the views of the local scientific communities. Where AID representatives have been involved in the programs from an early stage, responses to recommendations have usually been positive, subject, of course, to the availability of funds. Interaction between the NAS and its counterparts, on the one hand, and between the NAS and AID on the other, has in most cases resulted in coordination of effort and better ordering of priorities.

Some USAID missions have increasingly relied on NAS advice for major programs in science and technology, as in Brazil, which was until recently the recipient of the second largest U.S. foreign assistance effort. AID has also sought NAS advice for countries such as Korea on ways to make continued U.S. technical expertise and assistance available after AID phases out. In this way, some adverse effects of sudden termination of programs, such as those Taiwan experienced, can be avoided.

Perhaps more than any other single mechanism, NAS sponsorship of bilateral programs has provided AID a wide opportunity for tapping high-caliber experts from an extensive pool of talent in the U.S. scientific and engineering community. A large part of the U.S. S&T community is deeply concerned about the problem of world poverty; the bilateral programs provide a way for many to become seriously involved in development problems.

Since the bilateral programs began in 1964, nearly 500 U.S. scientists and engineers have participated in workshops, conferences, and studies. Over half worked directly with programs abroad, and many made large commitments in time and effort to joint studies or other activities generated by the programs. Another 200 specialists have been involved in BOSTID studies, ranging from 1-day meetings to studies lasting longer than 2 years. In the NAS tradition, nearly all participants volunteer their time and are reimbursed only for per diem and travel expenses. A few paid consultants were used, however.

2. NAS AND COUNTERPART INSTITUTIONS

The choice of a counterpart institution and good working relationships with it are key elements of a successful bilateral program. Because the major responsibility for enhancing science and technology within a country, and for

applying them to the solution of development problems, rests with local institutions, as many as possible should be involved in a bilateral program from its earliest stages. The counterpart institution, usually a national research council or the equivalent, must have motivation, influence, and qualities of national leadership to mobilize local institutions for the achievement of common goals.

The single most significant characteristic of NAS relationships with counterpart institutions has been the concept of partnership. The importance of partnership cannot be overemphasized in dealings between countries labeled "underdeveloped" or "developed"—often interpreted as "inferior" or "superior." Joint decision making with counterparts has been beneficial to both sides at both personal and institutional levels.

Joint effort was deemed essential for other reasons, both philosophic and pragmatic. Too many experts have prescribed remedies for ills they knew little or nothing about. Because advisors are expected to advise ("to come up with solutions"), usually within a limited time, the listening-learning-solving process has too often lacked substance and sensitivity. To avoid this, the learning and solving process should be synergistic, combining the talents of experts from both countries. A more pragmatic consideration is that because any effective or lasting social or cultural change depends primarily on local institutions, local input at all levels of problem solving is indispensable.

Ideally, the total endeavor is shared, including planning, decision making, meetings, projects, selection of participants, hosting, financing, reviewing, and evaluating. Much of this ideal has been realized in NAS programs, more completely in some than in others.

One difficulty has been cost sharing in countries where S&T have had low priority in national budgets. For instance, it was not possible to secure local funding for workshops in two countries that had no viable NAS-NRC counterpart at the time of the workshops. Reciprocal meetings in the United States have also been difficult to arrange because of a lack of travel funds, which the counterpart must provide. Nevertheless, the idea of cost sharing has appealed to all colleagues overseas. Fortunately, some USAID missions have willingly provided funds for initial endeavors until individual projects or programs could be locally funded.

The mutual effort in program development has been highly satisfactory and rewarding, from initial planning of workshop agenda and selection of participants through joint studies and implementation of recommendations. Alternating meeting sites has proved useful in unforeseen ways for scientists of both countries. Exposure to each other's working environments and institutions has often given better insights into the nature of the problems faced and the facilities needed for their solutions. Seminar-type sessions at workshops held in the United States on research policies in various governmental

agencies and on R&D administration in industry have proven so useful that counterpart institutions have been prompted to hold similar seminars at workshops in their countries.

One of the most useful functions of the NAS in its relationships with counterpart institutions has been its catalytic role. In many underdeveloped countries, before the NAS workshop, there was little interaction among scientific institutions and almost none between the counterpart institution and important parts of the governmental and private sectors. From the first Peruvian workshop to a more recent one in Ghana, the seemingly simple act of bringing scientists together with key planners to discuss an obvious need has brought repeated praise. For example, Modjaben Dowuona, Chairman of the Council for Scientific and Industrial Research (CSIR) in Ghana, stated,

> The Workshop . . . was, in many respects, a unique event in the history of scientific development in Ghana. Never before has there been such a gathering in Ghana of Ministers of State, Heads of University and Research Institutions, Deans of Faculties, Directors of Research Institutes, Professors, Lecturers and Research Officers, for the purpose of discussing in real earnestness how science may be developed and scientific research planned and organized so as to have the requisite impact on the economic and social development of the country. The importance of the occasion was enhanced by the participation of a strong team of scientists from the U.S.A., covering a wide range of disciplines, and having behind them considerable knowledge and experience of the status and role of science not only in their own country but in several countries of both the developed and the developing world. Their contribution helped on several occasions in guiding the discussion and in clarifying some fundamental issues involved in a number of controversial matters. Also where local efforts were halting because uncertain, they were able to bring their wider knowledge and experience to bear in reinforcing or in questioning wavering convictions equally, as seemed appropriate to them, they did not hesitate in criticising assumptions underlying on-going, full-fledged programmes.[6]

Interaction among diverse but select groups of participants has often resulted in recommendations of programs that are more workable and more politically feasible than they might otherwise have been. Moreover, on a number of occasions NAS representatives have been asked to accompany local scientists to meetings with planning ministries and fund-granting institutions. As a result of formal and informal interaction, increasing care has been given to the formulation of programs that require joint endorsement. The idea of joint endorsement by representatives of the NAS and the local scientific institution has likewise led to more careful planning and implementation.

NAS relationships with counterpart institutions have grown from initial curiosity and caution to the present attitude of, mainly, friendliness and

[6] "Foreword." In *Scientific Research in Ghana. Full Report.* Part 2 of *Research Priorities and Problems in the Execution of Research in Ghana* (See appendix B, p. 59.)

openness. Because any relationship is greatly influenced by the nature of the local institution, the NAS has striven to maintain the flexibility required to deal with both newly formed research councils and the more mature and sometimes rigid institutions. In avoiding overenthusiasm and the related danger of falling into a parent-child relationship, the NAS is often reminded of the friendly but frank advice of a colleague at an early workshop: "an NAS push will be necessary periodically—only don't push too hard." This advice has encouraged new, more flexible approaches at times when little appeared to be happening with recommended projects.

One of the best examples of NAS technical assistance at the counterpart level is reflected in the results of the study on developing industrial research in Brazil. This exercise involved breaking new ground for the Brazilian National Research Council (CNPq), which was reluctant to go beyond academic expertise to draw in private and governmental industrial experts for the study. Nevertheless, the leaders of the CNPq were eventually persuaded of the need, and appropriate representatives were chosen. The Brazilian component of the joint study group became so intensely interested in the problem that it met about 30 times in 18 months. Since the joint report was issued in 1968 (see appendix B, p. 63), several important recommendations have been implemented. NAS assistance to the CNPq at an early stage and at subsequent critical junctures contributed substantially to the success of this effort. In the years since the publication of the study, the CNPq has continued to exert influence by sponsoring national and regional meetings and forming specialized panels to consider various aspects of Brazil's industrial research needs. Other parallel, joint efforts of the NAS and the CNPq have been undertaken, for example—the study on norms, standards, and testing; and the chemistry program, which is concerned directly with university graduate research.

The NAS - counterpart relationship, best exemplified in Brazil, has also been established in other countries of Asia, Latin America, and Africa. The partnership relation is more often than not on firm ground, but effectiveness of implementation ranges from teetering to promising, for it depends also on the financial strength, political influence, leadership, and flexibility of the counterpart institution.

Bilateral programs, which always involve much personal interaction, have not been without strains. The strains in relationships that have occurred have been mainly at the study group level, where the interaction is more intense and both staff and experts labor to produce recommendations acceptable to all parties. These problems have generally been surmounted, except for a few groups that suffered from a mismatching of members and personnel; the programs were resurrected, however, by changing some of the persons on both sides.

Slightly different problems arose in the more recent Colombian study group activity. In Colombia, the NAS is collaborating with two counterpart institutions: the Colombian Fund for Scientific Research and Special Projects "Francisco José de Caldas" (COLCIENCIAS), a newly created institution, and the more established Colombian Institute for the Development of Higher Education (ICFES), whose main purview is university education. In addition, *Planeación,* the government agency charged with coordinating planning efforts, had a major voice in determining the magnitude and nature of technical assistance programs. Aside from the bureaucratic complications of dealing with three organizations, prolonged university strikes helped delay the studies. Colombian counterparts have had, on the one hand, to appease students by playing down foreign collaboration and, on the other hand, to satisfy requirements for higher standards of technical advice requested by international and other foreign fund-granting organizations. One measure of the effectiveness of this collaboration is the extent to which the groups have been able to function under difficult circumstances.

If the NAS - counterpart relationship is unique and the concept of joint effort has proven to be worthwhile, it is important to inquire further about the nature of the relationship. In a general sense, the NAS and counterpart roles can be easily distinguished. The NAS enjoys the image of an independent, nongovernmental, and nonprofit organization devoted to the advancement of knowledge and the welfare of mankind. In bilateral programs, the NAS has stimulated or initiated projects, acted as a catalyst or a mediator, and formed a partnership with its counterparts in many undertakings. As a purveyor of technical advice for well over a century, its advisory resources have long included government, academia, and industry; it recruits experts for studies ranging from the highly particularistic to the broad and multidisciplinary. It can offer high-quality technical advice, and traditional or avant-garde ideas. In its partnership role, it has used many approaches with counterparts for the first time, thereby making the experience one of reciprocal learning and teaching.

On the counterpart side, the foreign institution is also challenged to mobilize the best talent available and encourage the participation of government at the highest levels in efforts to upgrade the nation's science and technology. Although these two tasks have benefited from outside assistance, the results have been most successful where local counterpart institutions have pursued these objectives as a matter of policy. A major advantage of the local institution and one of the principal contributions it brings to the partnership are its intrinsic knowledge of the country's resources, problems, and cultural imperatives that must be taken into account in formulating research priorities and policies.

Most counterpart institutions are young, limited in resources, and dependent on some branch of government. Given the local limitations, the

institution often needs a great deal of skill to maintain standing in the community and to use foreign assistance in an optimal way. Most colleagues recognize the need for external assistance but must also respond to concerns about foreign influence, usually protested most sharply by students. The mutual head-scratching and problem-solving relationship has been accepted by counterparts as a learning-teaching experience—an acceptance made easier because of the relative independence of the NAS and its acceptability as a respected scientific institution.

Aside from their contributions to the partnership exercise itself, counterparts must be ultimately responsible for large outlays of time, effort, and resources if they are to succeed in strengthening local scientific and technological competence. Carrying out this major responsibility for follow-up is not incumbent on outside help, but counterparts can profit from external assistance. As with any scientific endeavor, intellectual interaction and joint generation of ideas can lead to productive results.

It is not easy to distinguish the roles the NAS and its counterpart must play every step of the way. It is clear, however, that combined intellectualizing, debating, and persuasion have proven fruitful and gratifying to both.

3. DURING IMPLEMENTATION

The implementation of a wide variety of recommendations generated by NAS bilateral programs requires the cooperation of many institutions of government, industry, or universities within the host country. Many proposed actions fall within the interest of regional organizations, the United Nations and its specialized agencies, and other international organizations. Nevertheless, to bring a program into being, the counterpart institution must take the necessary initial steps, such as bringing the appropriate persons together, finding the required funds, or formulating a policy that might necessitate legislation for the creation of a new governmental entity. NAS assistance is often sought in these efforts.

It is impossible to demonstrate in all cases a relationship between the bilateral programs and subsequent developments; nevertheless, the workshops help create a climate of trust between individuals and an appreciation of technology that permit things to happen that might not occur otherwise.

Many developments took place soon after a workshop, within a few weeks to 18 months; others happened later. Results of bilateral programs can be distinguished by short-term (within 18 months) and long-term (more than 18 months) developments. Because these developments appear later in "The Questions Asked," the following are only brief illustrations.

Short-Term Developments

In more than half the bilateral programs (Ghana, India, Indonesia, Philippines, Taiwan, Brazil, Chile, and Colombia) recommendations made at workshops were incorporated into national development plans or discussed as subjects of legislation to be drafted on specific topics, e.g.: Philippine bill introduced to allocate 1 percent of the gross national product for science and technology; in Indonesia, recommendations of a food and nutrition workshop were incorporated in a national nutrition policy.

Several institutions recommended at workshops have been created. In some countries plans were under discussion before the workshops, but the joint deliberations served to strengthen the case. In Taiwan, following the first workshop in 1964 and the subsequent visit by the NAS science policy mission, the Chinese created five graduate centers.[7] An outgrowth of the second joint meeting was a parallel Sino-American cooperation program in the humanities and social sciences.

In most countries, inventories and other similar studies recommended at workshops were undertaken soon thereafter by appropriate national institutions; for example, there were surveys in certain fields of higher education in Peru, Colombia, Brazil, the Philippines, and Taiwan. Joint study groups have conducted, or prompted the undertaking of, surveys of graduate education facilities and of training programs; made natural resources inventories; and initiated reviews and compilations of basic data deemed necessary for the attainment of national objectives.

Most joint study groups were organized and functioning soon after they were recommended at a workshop. Most study groups have functioned for 12 - 18 months and by the end of the period have recommended specific actions. Most of the 21 study groups have dealt with university education and research in the sciences.

Science policy missions, organized in response to counterpart requests, were undertaken in Colombia and Taiwan. Several committees have also been established for a short period after the workshops, most of them for follow-up on recommendations or policy formulation in areas given priority.

Long-Term Developments

Several countries have made successful attempts at improving program inputs and increasing appropriations for S&T projects in national development plans. Major institutional changes have continued to take place, especially in Taiwan, Peru, and Brazil. The graduate research centers in Taiwan,

[7] One each for chemistry, physics, biology, mathematics, and engineering was created within a year; subsequently, institutes for marine sciences and agriculture were created.

established shortly after the bilateral program began, have awarded their first doctor's degrees. This program and the chemistry project in Brazil have promoted curriculum revision in science education and increased the exchange of information. Support for graduate fellowships in the sciences has increased in many areas of study covered by the bilateral programs. While graduate teaching and research facilities in Taiwan and Brazil are improving, other changes—such as increased faculty salaries and establishment of university chairs for visiting professors—are improving the academic environment. In the first 2 years of the exchange-of-scientists program with the National Science Council of Taiwan, the U.S. National Science Foundation supported 30 short-term visits to Taiwan for consultation, teaching, and research. The Asia Foundation has supported a Special Visitor Program, which by mid-1971 covered visits of 14 U.S. specialists in science and engineering education, oceanographic and marine resources, patent laws and practices, and systems analysis.

Another example of cooperation involving other institutions concerns the oceanographic program in Taiwan. Two U.S. members of the Sino-American Cooperation Committee spent 3 months in Taiwan in early 1966. After the establishment of the Oceanographic Institute in 1968, the U.S. naval vessel *Geronimo* was leased to the Chinese, who converted the ship for training and research. The ship's captain was trained in the United States, and a U.S. scientist was assigned to the ship. Other agencies, especially the U.S. Department of the Interior and the U.S. Navy, took major responsibility for this aspect of the programs.

Visits to U.S. institutions by individuals or teams of colleagues have been an integral part of bilateral programs. Other activities playing a part in successful implementations of programs include lectures, seminars, and consultations by U.S. scientists and engineers when they are abroad, and by counterpart scientists visiting the United States.

THE QUESTIONS ASKED

In assessing the effectiveness of workshop programs country by country the following questions were asked, with no order of priority implied.

Has the program affected the policymaking structure for science and technology? Has it stimulated the development of executive-level machinery for planning, coordinating, and financing scientific and technological research oriented to the country's economic and social needs and objectives?

Has the program affected the research infrastructure? Has it stimulated the development of research infrastructure, supporting services, and a related policy framework in broad sectoral and multidisciplinary areas—such as agriculture, food and nutrition, industry, marine resources, the environment—and their effective orientation to the needs of the user communities?

Has the program affected advanced training and research? Has it stimulated the development of particular scientific or technical disciplinary capabilities—in both teaching and research—in fields pertinent to the country's resource base and development potential, such as earth sciences, agricultural economics, and polymer chemistry?

Has the program resulted in an overall improvement in the attitude of the government toward science and technology? Has it resulted in increased financing of advanced training and research—or actions by government leaders at the ministerial level aimed at the better utilization of research for the solution of sectoral problems?

Has the program led to a genuine strengthening of the local S&T community? Has it increased the cohesiveness of the community and improved relationships and communications between its disparate parts?

Has the program given rise to important inputs to national planning efforts and programs? Have recommendations been incorporated into national plans? Have one or more ministries made use of workshop recommendations? Has the program led to other projects, locally funded, without any NAS involvement?

In only a few cases could one expect the answers to all these questions to be an unqualified yes, for the objectives of most programs have been relevant to only one or two indicators. A strong positive response to any one of the six questions indicates an effective program.

When the results of the bilateral programs in 12 countries are studied, the degrees of effectiveness are found to vary considerably, ranging at present from very effective to indeterminate effectiveness.

POLICYMAKING STRUCTURE FOR S&T

Although the Brazilian Research Council (CNPq) is a well-conceived organization which has operated effectively for many years, the bilateral program resulted in its increased influence in policy matters involving science and technology. The budget of the CNPq has grown several-fold since the bilateral program was conceived.

As a result of bilateral discussions, the Government of the Republic of China (Taiwan) restructured its scientific establishment by creating a National Science Council and a Committee for Science Development within the National Security Council. As a result of a workshop held to consider the problems of building up an industrial-research complex in Taiwan, a committee was established under the cabinet to oversee implementation of the recommendations. Since the bilateral program was initiated, allocations for R&D have increased to 2 percent of GNP.

Following the first Colombian workshop, priority was given to the establishment of a top-level Council for Science and Technology to deal with

policy questions, together with the Colombian Fund for Scientific Research and Special Projects "Francisco José de Caldas" (COLCIENCIAS), a funding agency within the government to promote science and technology. President Lleras Restrepo decreed the establishment of both organizations.

The Peruvian participants in the first bilateral workshop (1966) gave priority to the creation of a national research council, which was established by presidential decree in 1968. Earlier, in 1967, the same leadership had founded the Peruvian Association for the Advancement of Science (APAC) at the second bilateral workshop. Although both organizations have undertaken effective programs, they have not had sufficient funding.

The U.S. - Nigerian workshop stimulated the Nigerian group to plan concrete steps for developing a policymaking structure for science and technology. After the civil war the Nigerian Government created the National Council on Science and Technology.

Initial workshops in Ghana, Indonesia, and Zaire have increased the visibility of existing research councils in these countries.

RESEARCH INFRASTRUCTURE

As a result of bilateral workshops and working groups, the Brazilian CNPq sponsored seminars on R&D organization and administration in industry and agriculture and created internal working groups in food technology, ceramics, steel, cellulose and paper. Recommendations concerning the organization of research have been adopted by several major research institutes. The Brazilian pharmaceutical industry has established a foundation on the model outlined by the joint working group on industrial research. The CNPq has provided increased support for research on national technological problems. It has sponsored two symposia on the administration of agriculture research, which have contributed to the coordination of research-training programs.

One of the first priorities in the bilateral program with Taiwan concerned manpower needs and the brain-drain, which siphoned off about 95 percent of the 2,000 college graduates who were sent abroad each year for postgraduate technical training. Recognizing that one important approach to this problem is first-class postgraduate education at home, the Chinese established seven major centers for graduate research and education in the sciences and engineering and took steps to attract scholars back to Taiwan. This has now proved to be a successful effort. They also took steps to implement recommendations of a joint workshop dealing with the R&D aspects of food technology, textiles, chemicals and plastics, electronics, metals, and energy.

After the bilateral workshop dealing with problems of Indonesian food and nutrition, a team of U.S. agricultural research specialists worked with their Indonesian counterparts on the formulation of a plan for a national

agricultural research system. As a result of the Workshop on Industrial and Technological Research, a program has been initiated to improve the management and organization of Indonesian industrial R&D institutes.

A direct effect of the workshop in Ghana was the establishment of a joint study group on agricultural research and extension, which made several recommendations on the establishment of a closer relationship between the two and on the development of a more coordinated system of agricultural-extension training.

The workshop in Zaire led to the formation of study groups on research and training in demography and earth sciences. Four months after the workshop, a center for research on food and nutrition was established.

In India the Workshop on The Management and Organization of Industrial Research recommended the creation of an Indian planning committee to form a society to promote better management of applied research laboratories. Subsequently, such a committee was formed, although it is now inactive.

As a result of the workshop in Argentina, a telex network is being developed for scientific laboratories and documentation centers. It has been linked to the John Crerar Library in Chicago. The Argentines also planned to develop a computer-based literature-information service, initially in the chemical sciences.

The first two workshops in the Philippines emphasized the inadequacy of support for science and technology and the disproportion between resources allocated for basic and applied research related to the country's needs. As a result, new revenue-producing legislation was passed, and a special science fund was established. Also in the Philippines, the Workshop on Industrial Research led to the establishment of a National Advisory Commission on Industrial Research.

As a result of the workshop in Chile, a national nutrition office was established, and a plan for institutional coordination in the marine sciences was accepted by the government.

ADVANCED TRAINING AND RESEARCH

One of the most significant developments with respect to advanced training and research has been the experimental chemistry project in Brazil. Its objectives are to develop graduate education and research in chemistry in the Universities of Rio de Janeiro and São Paulo. Eight U.S. chemists, selected by the Brazilians, agreed to establish cooperative research programs with designated counterparts. Each agreed further to sponsor one or more postdoctoral students from the United States who would undertake research, conduct

seminars, and teach at a Brazilian institution. The postdoctoral fellows were given the title National Academy of Sciences Overseas Research Fellow.

Under the program the U.S. chemistry professors visit Brazilian laboratories and the Brazilians spend time, when appropriate, at their colleagues' laboratories in the United States. Brazilian students who require, to participate in the research, special courses that are not available in Brazil are allowed up to 1 year of study in the United States.

The program is jointly funded: Brazil pays for all equipment and supplies and international travel of Brazilians; the United States pays for the stipends of the fellows and international travel of the U.S. participants. The host country pays for internal travel.

From 1969, when the program was begun, through 1971 the number of graduate students rose from 25 to 116. In the same period, 5 master's degrees were granted and 29 others, as well as 3 doctorates, were in progress. Eleven technical papers had been published, and ten more had been submitted for publication.

In terms of developing graduate research and education in chemistry, the Brazilian chemistry project promises to be one of the more successful undertakings. A far more important aspect of the program's success is the potential application of the principles and procedures embodied in the program to other disciplines and to other nations. The chemistry project is a pioneer approach to technical assistance with broad applicability.

In addition to chemistry, the Brazilians have shown a keen interest in developing graduate research and training in the earth sciences. A more recent joint study group has outlined a cooperative training program which would include five Brazilian universities. Once there are enough trained Brazilian earth scientists, the intention is to start a cooperative program of graduate research and training similar to the present CNPq-NAS chemistry project.

A joint study group in agricultural economics has formulated a proposal designed to strengthen research in agricultural economics in Brazilian agricultural research stations. Another joint study group in computer sciences has made recommendations for strengthening graduate programs at three Brazilian universities and for improving computer-science teaching in the universities that have computers and computer-service departments.

In Taiwan some excellent research and teaching facilities have been established. As a result of the bilateral discussions, five graduate research centers were created under a consortium of five Chinese universities—one each for chemistry, physics, biology, mathematics, and engineering. Later, institutes were created for marine sciences and agriculture. Many graduate-center faculty members have been recruited from abroad. Thus far, several hundred master's degrees and several doctorates have been awarded in physics, chemistry, and engineering.

In Colombia a series of jointly sponsored studies was conducted on graduate education and research potential in chemistry, biology, mathematics, physics, earth sciences, and engineering. Several joint panels have submitted recommendations on the development of graduate research and education in those fields.

In the Philippines the National Science Development Board reexamined its allocations for research in terms of obtaining a ratio of basic to applied research more in conformity with the experience of most industrial countries. Other developments include the creation of an institute for coconut research, an institute for textile research, and the expansion of documentation services.

ATTITUDES OF LOCAL GOVERNMENT

In Brazil the bilateral program has definitely contributed to an overall improvement in the attitudes of the government toward science and technology. Heads of the Ministry of Planning, the National Bank of Economic Development, the National Department of Mineral Production, and the Ministry of Agriculture have indicated strong support for the development of an effective Brazilian establishment for R&D. President Médici expressed personal interest and concern. In part as a result of these attitudes, investments in science and technology have increased at a rate far in excess of the rate of inflation.

In Taiwan, from the beginning of the bilateral relationships, the highest level of government has shown interest in the program. The President pledged strong support for science and technology. Within 2 years after the first meeting in Taiwan, two members of the Chinese committee were appointed, respectively, Minister of Education and Minister of Economic Affairs. Other members of the Chinese committee have subsequently been appointed to cabinet rank.

That the Government of India has traditionally been a strong supporter of science is evidenced by the country's total scientific production and the number of laboratories, such as those under the Council for Scientific and Industrial Research, which receive substantial government support. Viewed solely from the point of view of science, as distinct from its applications, India leads all the developing countries, and many industrialized ones. Unfortunately, India has not been particularly successful in applying science to the solution of many of its problems of development, particularly those of industry. Somehow, in spite of the strong support given to applied science, the research establishment has had little impact on industry.

Some industrial leaders, as well as leaders of the governmental scientific establishment, recognize this problem; indeed, this was a topic discussed at the Workshop on the Management and Organization of Industrial Research.

In Colombia the attitudes of government leaders toward the development of a strong scientific and technological base were initially enthusiastic. The Minister of Education personally participated in the first workshop, and President Lleras Restrepo invited the participants to the Presidential Palace to report their finding to his cabinet. Since that time, several changes in the Ministry of Education, *Planeación*, and other key posts have resulted in less interest in science and technology.

In 1966 President Belaúnde Terry of Peru showed no particular interest in the development of a strong scientific-technological base. The administration of President Juan Velasco showed more interest by decreeing the National Research Council, but, unfortunately, its funding has been inadequate. The Peruvian Government is now taking steps to improve support for R&D; it recently decreed that industry provide a share of its profits for the support of research.

In the Philippines various individuals in both the executive and legislative branches of government have stressed the importance of science and technology to Philippine development, and the workshop program appears to have accelerated this trend. The program received unusual recognition in 1966 when Presidents Johnson and Marcos issued a joint communiqué at the conclusion of Marcos's official visit to the United States commending the program and expressing hope for its continuation and expansion.

In Indonesia, Ghana, and Zaire the workshops appear to have stimulated recognition at high levels of government that science and technology are important elements in the development process.

LOCAL S&T COMMUNITY

The Brazilian Research Council (CNPq) has made a deliberate effort to involve in its activities scientists and engineers from a variety of institutions, geographical regions, and specializations. The result is cohesiveness and strengthened dedication to the task of applying science and technology to the solution of Brazil's development problems.

In Taiwan the bilateral program has helped to bridge a communications gap between the older scientific community in the Academia Sinica (Taipei) and the younger, more pragmatic community more interested in the application of science to the economic and social development of the country than in the pursuit of science for science's sake.

Ghanaian scientists and government officials have stressed that the workshop was of decisive importance insofar as it brought together for the first time many disparate elements of the local scientific-technological community. The workshop stimulated the emergence of a sense of common purpose, not only within the scientific-technological community but between that

community and officials of the universities and government ministries. Its catalytic effect is evidenced by such developments as the calling of the All-Ghanaian Conference on the Role of Agricultural Research and Its Relationship to the Development of Agriculture.

In India the two workshops included diverse elements of the scientific-technological community that might not otherwise have been brought together. The Workshop on Management and Organization of Industrial Research brought together one of the largest groups of Indian research administrators ever assembled to consider this topic.

In Peru the most important single effect of the bilateral program thus far has been the evolution of a cohesiveness within the scientific community. While the first workshop was being planned, a number of the scientists involved either did not know each other at all or did not know each other well. The first workshop created communication channels that have persisted over the years.

In Indonesia, Zaire, and Argentina bilateral programs have brought local S&T communities together to consider several critical aspects of national development. In the process, relationships and communications between disparate elements among the communities appear to have improved.

INPUTS TO NATIONAL PLANNING

In Brazil at present, scientific and technological research, primarily in health, agriculture, and industry, holds top priority in the Ministry of Planning's Program for Aims and Bases of Government Activities. The CNPq's initiatives in industrial research have influenced programs in the Ministry of Planning and the National Bank for Economic Development.

In Taiwan, with a Minister of Education and a Minister of Economic Affairs initially on the Chinese committee, the workshops' inputs to national planning efforts and programs have clearly been substantial. Undoubtedly, the ministers' efforts were a major stimulus to the greatly increased allocations for science research and development.

After the first workshop in Indonesia several key recommendations were incorporated in the First Five-Year Development Plan. Also, the targets recommended by the workshop for minimum calorie and protein requirements were incorporated in a national nutrition policy.

In Ghana some of the ideas generated by the participants in the study on agricultural research and extension were incorporated in the Medium-Term Plan for Economic Development.

The Workshop on Water and Man's Life in India brought together some 90 specialists and government officials, including the Minister for Power and Irrigation and the Minister for Planning. The workshop appears to have con-

tributed to the Indian input at the U.N. Conference on the Human Environment at Stockholm, 1972.

FACTORS INFLUENCING PROGRAM EFFECTIVENESS

The results of bilateral programs in the 12 countries in which workshops have been held show a broad spectrum of relative accomplishment. At one end, the counterpart organizations in Brazil and Taiwan have made substantial efforts to analyze their research and development needs and have made numerous important recommendations to their governments, many of which have been translated into action. At the opposite end, programs in Chile, Nigeria, the Philippines, and Peru have resulted in fewer actions.

The obvious factors that combine to affect the success of a program are discussed in the following sections.

U.S. - HOST COUNTRY RELATIONSHIPS

If political relations are good-to-excellent, as they have been with Brazil and Taiwan throughout the bilateral programs, the chances of success are obviously increased. If relationships are strained, as they have been with Peru since 1969, with Chile since 1971, or with India since late 1971, the chances for success are considerably lessened.

POLITICAL STABILITY IN HOST COUNTRY

Almost every internal political upheaval postpones workshop program activities or in other ways lessens their effectiveness. In Nigeria two military coups and a civil war halted the beginning program. In Ghana the recent coup has slowed the program there. In Argentina, Chile, Colombia, and the Philippines political uncertainties have had adverse effects on virtually all bilateral efforts in those countries.

ATTITUDES OF AID

From AID, enthusiastic support, or at least a neutral attitude, is essential to the success of an AID-funded workshop program. This includes AID offices in Washington, as well as the missions, since the concurrence of both is required. A large part of the success of the program in Brazil is due to the enthusiastic sponsorship from an early stage of program development of the

USAID mission in Rio de Janeiro. The failure of the USAID mission in Manila to become actively interested at an early stage in the development of the Philippine program undoubtedly contributed to the lack of progress in bilateral efforts.

QUALITY OF LOCAL LEADERSHIP

A bilateral program is doomed to failure from the start in the absence of highly qualified and motivated local leaders and staff who appreciate the importance of S&T to national development and are determined to take the actions necessary to strengthen and apply it. The leadership in the scientific communities of Brazil and Taiwan has been exceptional.

INFLUENCE OF LOCAL LEADERSHIP

If recommendations emerging from workshops are to be meaningful, they must be implemented. More often than not, implementation requires governmental action. Therefore, local workshop leaders must be close enough to their government to influence its actions. Leaders of the program in Taiwan were able to exert considerable influence on their government; indeed, four of them subsequently became ministers. Program leaders in Brazil and Ghana[8] also have been able to secure active government support for implementation of recommendations.

FUNDING FOR WORKSHOPS AND STUDY GROUPS

Ideally, workshops and study groups are jointly funded, and in certain programs—such as those in Brazil and Taiwan—this has been accomplished from the beginning. In other cases—for example, in the Nigerian and Peruvian workshops—only U.S. funding was made available. Sometimes U.S. funding has been available for workshops but not for continuing activities. AID/Washington has often financed the initiation of a workshop program, but turned the responsibility for continuing availability of U.S. funds over to the local USAID mission. If the mission is not interested in the program, funding must be sought elsewhere.

[8]Until the coup of Col. I. K. Acheampong, January 1972.

FUNDING FOR IMPLEMENTATION

The greater share of the financial responsibility for implementing recommendations from workshops and study groups must be borne by the host country. Often, however, U.S. support has contributed substantially to initial program development until funds were made available by the host country. In Taiwan the host government has paid virtually all costs of implementation. In Brazil it has paid the greater part of implementation costs, although U.S. contributions have also been important. In the Philippines, sufficient implementation funds have not been available from either local or U.S. sources.

QUALITY OF U.S. INPUT

Understandably, the quality of NAS inputs to workshop programs has varied. U.S. participants, who are appointed by the President of the NAS on the recommendation of the Foreign Secretary, have not been of uniformly high professional competence, or of equal cultural and political sensitivity. Nevertheless, considering the large numbers of scientists and engineers involved, the average overall quality has been high, and the deviation from the average has been low. Of all those who have been involved, only a small proportion would not be invited to participate again because of their inadequacies.

The high quality of the U.S. participation is attributable only in part to screening procedures. In substantial measure, the quality stems from the motivation of the U.S. scientific-technological community to become involved in such activities. A large reservoir of highly motivated, highly qualified candidates is available. Refusals to serve are few, and volunteers are numerous.

The situation with respect to the inputs of the NAS staff is similar. Although the staff has varied in quality, overall competence has been high. Some programs have undoubtedly been accelerated by imaginative staff inputs, and some have undoubtedly suffered from lack of adequate staff effort. Sometimes these differences have resulted from variations in the qualities of individuals; more often they have resulted from inadequate staffing necessitated by budgetary constraints. Again, the range in quality separating the best from the worst is small compared with the range in the preceding factors.

COMMUNICATIONS

One of the most difficult problems in the development, operation, and implementation of a workshop program is communication. Experience has

shown that it is not possible to develop a program with colleagues in developing countries by mail. A great deal of personal contact is essential; in its absence programs tend either to stagnate or to disintegrate.

Communication with the numerous facets of the AID bureaucracy is often even more difficult than communicating with colleagues in developing countries. Not infrequently, a program will need simultaneous approval by the Technical Assistance Bureau, the Regional Bureau, and the country USAID mission. Rapid personnel turnover is a constant problem. Inadequate communication with AID, particularly when coupled with bureau provincialism, jealousies, and personality problems, has often placed tremendous strains on the NAS staff. In the process, programs have been delayed, weakened, or even cancelled.

If an AID-sponsored program in Country X is to be successful, one or more members of BOSTID and staff must travel there frequently to develop close working relationships with appropriate individuals in the scientific-technological-governmental community, as well as with appropriate individuals in the local USAID mission. It is also essential for the same staff members to develop adequate working relationships with key persons in the AID Regional and Technical Assistance Bureaus in Washington.

These communication demands consume a large part of staff time, and communication failures have not been infrequent. More often than not, lack of progress in a workshop program can be traced directly or indirectly to inadequate personal contact either in Washington or in the field.

IV Conclusions

Over the past decade a variety of activities has characterized OFS technical assistance efforts; about midway, however, the predominant mode became the more systematized bilateral programs conducted with counterpart, or near-equivalent, institutions. The chief media of the bilateral programs are workshops and study groups, often supplemented by advisory missions, international conferences, symposia, and short-term visits by specialists, all of which involve intensive staff effort and travel.

Successful in all regions, bilateral programs have varied from one continent to another. The most workshops and study groups were undertaken in Latin America, although Taiwan sponsored more workshops and perhaps undertook more follow-up activity than any single country. In Asia workshops have generally served the purpose of setting up large conferences with no bilateral study groups but some internal follow-up. In Africa major pan-African developments were stimulated by such impressive gatherings as the Abidjan Conference on Agricultural Research Priorities for Economic Development in Africa in 1968. Except for the 1965 Nigerian workshop, workshops and bilateral study groups did not take place until recently in African countries.

Complementing the bilateral programs, BOSTID panels and committees undertook several studies on problems common to underdeveloped countries, including the identification of appropriate and innovative technologies.

In spite of the systematic operation of bilateral programs that has evolved, no airtight model has been devised for planning successful bilateral programs a priori, principally because of the diversity of conditions within each country, and in part because of gaps in knowledge. NAS experience thus far provides empirical evidence, however, that given a critical mass of highly motivated scientists and policymakers within a country, both internal and external assistance can be mobilized for programs to improve indigenous competence in science and technology.

Even though some accomplishments by certain countries might have been inevitable, given the broad premises and goals to utilize S&T for bettering human welfare, the record of achievement is still impressive beyond expectation. When the programs began, S&T was hardly popular in foreign technical assistance—it did not fit in as a "line item," and it is still subject to vague

interpretations. The current stance on foreign assistance in Congress notwithstanding, changes favoring S&T have been apparent within AID and USAID missions, as well as within foreign governments and other institutions. Many channels of communication have been opened. If foreign institutions have profited from a transfer of science and technology and the methods of transfer, the NAS and its many cooperating institutions have profited no less. The intangible results include a better understanding of the transfer of S&T; improved personal and institutional relationships and linkages; and a generally improved climate for continuing these efforts.

The more tangible accomplishments include the incorporation of S&T programs in national development plans in several countries; the creation of science-policy bodies, research institutions, and professional scientific societies and associations; the development of local and international cooperative research and exchange programs; and the initiation of scientific journals and other means for disseminating S&T information, such as the telex system in Argentina.

It has been rewarding to see a significant number of these results occur within a short period, and, moreover, to see the multiplier effects of many accomplishments.

Key concepts and principles have involved mutual partnership, flexibility, continuity, and the aim toward building indigenous capability in S&T. These guiding principles have allowed integrated, multidisciplinary approaches to the joint problem-solving experience. An outcome of several studies designed to strengthen higher education and research in the sciences has been the identification of national priorities and resources. Therefore, a great deal of attention has been given to science organization and policy in several areas. As a result, cooperation and assistance covers the spectrum from highly specific projects to broader national planning and policy issues. Future cooperative endeavors would increasingly benefit U.S. science wherever scientific capabilities improve as they have in Taiwan and Brazil.

Many questions regarding the technical and social aspects of the development process remain for further study: determination of numbers of scientists and engineers needed per country; better cost analyses of R&D and S&T products; labor-intensive versus capital-intensive technologies; rural-urban migration and the unemployment-underemployment syndrome; population growth and pressures; environmental pollution and congestion; and so on. In the brief span of a decade, many of these problems have barely been touched upon, although some now loom large and grim. Experience over the next decade will, it is hoped, provide more answers.

V Guidelines and Recommendations

The following comments and recommendations embody the general principles that have guided the OFS in the conduct of international programs and some lessons learned from a decade of involvement with overseas colleagues. The material is organized under these topics:

Conduct of Programs
Importance of Continuity
Follow-up and Implementation
Selection of Countries
AID and USAID Missions
Evaluation and Program Development
NAS Role

CONDUCT OF PROGRAMS

The most effective programs so far have demonstrated that workshop techniques developed by the OFS enable goals to be reached bilaterally if certain basic operating conditions are fulfilled:

1. A viable counterpart institution is selected, preferably a national research council, an academy of science, or an executive-level office or ministry dealing with science and technology.
2. Open, joint discussion of objectives takes place.
3. Following the discussion, participants from the host country decide what tasks will be undertaken, taking into account limitations on both sides of money, manpower, and time. The form, content, and emphasis of the program is fitted to the local situation, utilizing where necessary such techniques as a series of workshops, standing policy committees (as in Taiwan and Brazil), study groups (as in Colombia), or specific project assistance (as in Argentina).
4. From this point until the implementation stage, the program is completely cooperative:

- All major recommendations on steps to be taken are joint ones, reached only after adequate discussion.
- The bilateral programs are financed by contributions, ideally about equal, from both sides. Whenever feasible, private funds are available to supplement governmental support to permit adequate flexibility.
- To maximize the spirit of cooperative problem solving, in contrast to one-sided giving of advice, each joint group—workshop, study group, or mission charged with an assignment—includes equitable efforts from each country.

5. Recommendations are implemented as indicated—unilaterally by the host country, bilaterally, or by the host country in collaboration with international agencies. In bilateral implementation, the basic decisions remain the sole responsibility of the host country, but they should be made after adequate discussion by joint groups of experts.

6. Great care is taken by both sides in selecting members of joint groups. Personalities, including the ways that individuals interact with their counterparts, as well as with their colleagues, can be crucial. U.S. participants should be sensitive to the local political climate, and it is important that at least some speak the local language. Showing respect for an individual's knowledge or influence can also be important. Candidates for bilateral programs should be acceptable to counterparts.

7. Workshop recommendations are based primarily on their importance to the development of the host country and on the feasibility of proposed solutions in terms of available technology and resources.

8. All reasonable efforts are made to minimize politics in bilateral group deliberations. Indeed, this consideration makes it desirable, where possible, for the study of problems and the formulation of recommendations to be undertaken by nongovernmental organizations.

9. Bilateral professional staff of high quality helps each joint group. Effective programs enjoy daily conduct by staff with initiative, diplomacy, creativity, continuity, and, often, language ability. Furthermore, a substantial amount of advance staff preparation is required for workshops and study groups. Essential to success, also, is selection by counterpart organizations of a staff that can work well together, particularly because they should frequently be in personal touch with one another.

10. When the not infrequent difficulties arise from the anti-U.S. expressions of student groups, newspapers, or individual government officials, a deliberate effort is made to broaden the program participation to include representatives from academies or equivalent institutions in other technologically advanced countries. It is attempted on a scale large enough to dilute the visibility of the U.S. presence, but not large enough to raise serious organizational and administrative problems. Ideally, the other participating organizations are willing to share program costs.

11. When host country and U.S. participants agree it might be useful, scientists from other developing countries are asked to participate in workshop programs.

IMPORTANCE OF CONTINUITY

Most conspicuous in less successful programs is a lack of continuity, which has stemmed from several sources:

Changes of government have delayed programs in Argentina, Chile, Peru, Colombia, Ghana, and Nigeria. Because changes of government are inevitable, and governmental coups often unforeseen, it is essential that to the extent possible, the political situation of a country be known before a program is planned.

Changes of administration in counterpart organizations have delayed programs in Argentina, Chile, Brazil, Peru, Colombia, Zaire, and the Philippines. Nevertheless, proper provision for travel by staff and appropriate committee members could minimize many of these delays.

A sudden change or break in political relations between the United States and the host country can delay programs, sometimes indefinitely, as in Chile, Peru, and India. Although it is not easy to predict such difficulties, they can be ameliorated to some extent by U.S. staff support adequate to maintain communications during the troubled period.

Failure of the local government to support a bilateral program adequately is one of the more frequent reasons for lack of success. This difficulty could be partly eased by finding temporary financing from other sources.

The extremely thin spread of highly trained scientific manpower in most developing countries often burdens the individuals responsible for science and technology programs with so many other responsibilities they cannot operate effectively. The possibility of asking carefully selected individuals from more technologically advanced countries to assume, temporarily, some local administrative responsibilities merits serious consideration.

Indifference of local USAID missions to science and technology has been an important reason behind minimal success of some NAS programs. This situation would be greatly improved if all workshops and directly related activities were financed by AID/Washington with the consent, of course, of USAID missions. Concrete program implementation would still be financed by local missions collaborating with local governments.

Rapid turnover of AID personnel and consequent inadequacy of memory within the organization has been a handicap. One way of coping with this difficulty is to ensure adequate continuity and memory within the NAS staff and to develop and maintain good communications between NAS staff and USAID missions.

Lack of adequate follow-up by NAS staff, an important element in the lack of program continuity, has stemmed in part from inadequate numbers of staff, which is related to inadequate funding.

FOLLOW-UP AND IMPLEMENTATION

If a program is to be successful, it must have substantial follow-up: plans are made to implement recommendations, which necessitates close communication between the NAS and its counterpart organizations. The following are some guidelines for appropriate follow-up:

1. Formation of study groups or similar bilateral activities should take place soon after they are recommended because of the amount of preparation necessary for their work.
2. It is essential to make arrangements for continuing discussions between NAS staff and committee members and their counterparts in developing countries.
3. Beyond the joint evaluative stage, implementing programs within countries is the responsibility of the counterpart or other institutions within the country. Even at this stage, however, the NAS should continue to lend scientific and technical expertise to help countries identify the necessary technical and human resources, particularly if they must be obtained from sources outside the countries.
4. Preferably, local implementation of recommendations should be financed either with local funds alone or local funds supplemented by international or U.S. funds, but not solely with U.S. funds.
5. In jointly financed programs arising from workshop programs, such as the chemistry project in Brazil, joint staffing and joint direction are essential.
6. In countries with workshop programs in progress, general workshops should be held at least every 2 years to review progress and develop future plans.
7. The constraints placed on the expenditure of government funds make limited but definite private funds highly desirable for the development and implementation of programs.

SELECTION OF COUNTRIES

The criteria for selecting a country and a program should include factors that indicate a reasonable promise of success. Several questions should be asked:

1. How stable is the government? How likely is a change in government policy that would make it impossible to implement workshop recommendations?

2. Does the climate of local government promise support of programs? Given all goodwill, what are the chances that a set of recommendations will be implemented by the government?

3. Is there an institution, such as a research council, with which the NAS can work effectively? If not, what is the likelihood that a suitable and viable organization can be created?

4. Is there a critical mass of trained technical personnel in the country to generate the necessary action?

5. Is the local scientific community eager to develop indigenous capabilities for their country's development of science and technology?

AID/WASHINGTON AND USAID MISSIONS

Dedicated staff members of AID and the Department of State in Washington and the USAID missions and U.S. embassies in host countries have often provided vital support and help with the science-cooperation programs. Overall working arrangements between the NAS and AID would be greatly improved, however, if certain procedures could be modified, for example:

1. It would be extremely useful if the greater part of U.S. expenses in connection with workshops, working groups, and study groups were provided by AID/Washington, with local mission funds reserved for selected cost-shared implementation programs. Naturally, the local mission would still be consulted from the beginning of program planning, and it would, it is hoped, provide a reasonable level of logistic support.

2. Where the local mission pays for a proportion of implementation costs, it should also pay for NAS efforts involved with the implementation. Should implementation be financed primarily by the host country, NAS inputs should wherever possible be funded by AID/Washington.

3. Present contractual arrangements between the NAS and AID, along with the established operating procedure, do not provide for enough flexibility to permit more effective follow-up and to enable the Board on Science and Technology for International Development and staff to take advantage of new opportunities at appropriate times.

EVALUATION AND PROGRAM DEVELOPMENT

Systematic efforts should be made to measure the results of all projects and programs. Accurate records and accounts of program results should be

obtained from the counterpart institution, AID, and other participating parties. Other suggestions for program evaluation and development follow:

1. A major comparative study might be undertaken of the largest bilateral programs, in Brazil and Taiwan, to determine the full impact of the programs and to explore new directions and opportunities.
2. Major projects, such as the chemistry project in Brazil, should be evaluated at the end of NAS involvement and within 10 years from their inception.
3. The content of bilateral programs has been determined largely by colleagues in the host country; this practice should continue. In most countries periodic workshops have served to take stock of results and to point to new directions as programs evolved. In countries where periodic workshops have not taken place, bilateral groups should determine whether follow-through or project termination is indicated.
4. Reviews and evaluations of special studies conducted for AID in the last 5 years should be undertaken.
5. In examining program potential, evaluators should investigate major areas of interest that were discussed at workshops but had little or no follow-up, for example, natural resources development.
6. Case studies should be made of the development and application of science and technology in selected countries, such as Mexico, in which NAS has not been active. Comparing developments in these countries with those in countries in which workshop programs have been successful would be useful.

NAS ROLE

As an institution engaged in furthering science and its applications for human welfare, the NAS has traditionally shared its intellectual resources and partaken from its colleagues abroad. In an age of increased technological and societal complexities and interdependence among nations, the need to engage in intellectual discourse with other societies is even more apparent. In the last 10 years, the NAS has been engaged with counterparts in underdeveloped countries in efforts to develop their scientific and technological capabilities and in promoting cooperative research. More recently, its new associate, the National Academy of Engineering, has joined in these efforts, and it is expected that the Institute of Medicine will also participate. Some guidelines for the NAS role in foreign assistance programs follow:

1. The NAS should continue to cooperate with its colleagues in underdeveloped countries in applying science and technology to the solutions of major national problems, such as eliminating hunger, controlling disease, and making use of undeveloped resources.

2. The NAS's principal role should still be to advise, and in this process to provide technical advice to AID and NAS counterparts and to combine talents with colleagues abroad. Although this role allows the NAS to stimulate and initiate action, it should be primarily catalytic; the implementation of programs is largely the responsibility of its counterparts abroad. Exceptions to this policy should be taken only infrequently, and then primarily on an experimental basis.

3. The NAS should encourage other U.S. entities and regional and international organizations to support development projects arising from NAS bilateral programs.

4. To ensure optimal effectiveness and flexibility, private funds should be sought to supplement the central funding provided by AID.

5. NAS efforts should not be spread too thin. Programs would be more effective were they concentrated in a few countries in which there is vigorous follow-up, rather than in many countries on a sporadic basis. Again, this emphasizes the importance of carefully selecting countries and programs.

6. An advisory board, such as BOSTID, should continue to guide the overall program. Board members should be well informed and, without exception, should participate actively in BOSTID programs.

7. The selection of highly qualified U.S. scientists and engineers is a key factor in all programs; therefore, the criteria for "highly qualified" and "appropriate" must in each case be based on the requirements of the task at hand and not on a preconceived, prescriptive notion of expertise.

8. Although maximum participation of outstanding individuals should be encouraged, care should be exercised not to rely too heavily on a few individuals. The pool of talent should be expanded to include new individuals, particularly younger scientists, women, and members of minorities.

9. A concerted effort should be made to enlist more social scientists on advisory panels, particularly those advising on major developmental programs that affect the social as well as the physical environment. The health of peoples must be taken into full account, including the requisite social and cultural integration that sustains it.

10. The use of consultants, lecturers, and short-term training programs should be explored more fully to see how bilateral programs can use these services to the fullest extent possible as either innovative or supplementary features.

11. Wherever possible, BOSTID panels should seek the involvement of representatives from underdeveloped countries and aid-lending agencies. (Some panels already have multinational membership and representation from multilateral organizations.) In the selection of panel members, the experience already gained by individuals through NAS bilateral programs should, wherever possible, be taken into account.

12. A staff adequate in both quantity and quality is vital to NAS programs, particularly because the daily conduct of programs must rely on staff initiative, diplomacy, creativity, and memory.

Appendix A
Staff and Program Participants, 1963–1972

CONTENTS

Tables

It has long been recognized and often emphasized that a major strength of the National Academy of Sciences is its ability to mobilize almost any part of the scientific and technical community for its activities. This capability has been amply demonstrated in the NAS international development activities where, through membership on regional science boards, workshops, study groups, conferences, and studies, hundreds of specialists have voluntarily devoted their time and energies to consideration of science and technology for international development programs.

Since 1963 nearly 800 U.S. scientists and engineers took part in studies or other program activities of the Office of the Foreign Secretary, with approximately 1,200 scientists and engineers from Africa, Asia, Latin America, and Europe. The lists that follow contain names of selected committee members and staff. Tables A-1 - A-4 show the numbers and distribution of all participants from 1963 to 1972. These tables also show that almost two-thirds of the participants were engaged in bilateral workshops and study groups.

STAFF OF AFRICAN, ASIAN, AND LATIN AMERICAN PROGRAMS

HARRISON BROWN, Foreign Secretary, National Academy of Sciences, 1962 - ; Professor of Geochemistry, 1951 - ; Professor of Science and Government, 1967 - , California Institute of Technology

W. MURRAY TODD, Executive Secretary, Office of the Foreign Secretary, 1962 -

AFRICA SCIENCE BOARD (1962 - 1968)

THERESA TELLEZ, Professional Assistant, 1962 - 63
WILTON DILLON, Head, African Affairs, 1963 - 66
MARYANNE DULANSEY, Professional Associate, 1966 - 67
M. G. C. McDONALD DOW, Head, African Affairs, 1967 - 68

PACIFIC SCIENCE BOARD (1963 - 1970)

HAROLD J. COOLIDGE, Head, Pacific - Far Eastern Affairs, 1963 - 1970*
ROBERT E. SHEEKS, Associate Director, 1963 - 68
MARYANNE DULANSEY, Professional Associate, 1967 - 68
JOHN TAYLOR, Professional Associate, 1966 - 67
WILLIAM L. EILERS, Associate Director, 1968 - 1970

LATIN AMERICA SCIENCE BOARD (1963 - 1968)

WILLIAM C. PADDOCK, Executive Secretary, 1963 - 65
HERBERT J. PULSIFER, Professional Associate, 1963 - 65
DIANA RIEHL, Research Assistant, 1963 - 68
THERESA TELLEZ, Professional Associate, 1963 - 67; Head, Latin American Affairs, 1967 - 1970
VICTOR RABINOWITCH, Professional Associate, 1965 - 67

SCIENCE ORGANIZATION DEVELOPMENT BOARD (1966 - 68)

WILTON DILLON, Director, 1966 - 68
M. G. C. McDONALD DOW, Professional Associate, 1966 - 67
MARYANNE DULANSEY, Professional Associate, 1966 - 68
WILLIAM EILERS, Professional Associate, 1968
JULIEN ENGEL, Professional Associate, 1966 - 68

*Head, from creation of PSB in 1946 until 1970.

CLEARTHOS LOGOTHETIS, Head, Middle East/South Asian Affairs,* 1964 - 67
VICTOR RABINOWITCH, Professional Associate, 1965 - 67, Deputy Director, 1967 - 68; Director, 1968 - 69
ROBERT E. SHEEKS, Professional Associate, 1963 - 68
ROBERT SOLO, Professional Associate, 1965
THERESA TELLEZ, Professional Associate, 1966 - 68

BOARD ON SCIENCE AND TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT (1969 -)

WILLIAM L. EILERS, Staff Director, 1969 - 1970; Head of Bilateral Programs, 1970 - 71
VICTOR RABINOWITCH (February 1969 - March 1970, State University of New York); Staff Director, 1970 -
ROSE AMESER, Professional Assistant, 1969 - 70; (November 1970 - July 1971, overseas travel); Assistant to the Director, 1971 -
ROBERT BRAINARD, Professional Associate, 1970 - 71
NORMAN L. BROWN, Professional Associate, 1970 -
B. K. WESLEY COPELAND, Professional Associate, 1969 -
JAY J. DAVENPORT, Professional Associate, 1969 -
DIOSDADA DeLEVA, Librarian, 1971 -
M. G. C. McDONALD DOW, (December 1968 - September 1972, Haile Sellassie I University) Deputy Director, September 1972 -
JULIEN ENGEL, Deputy Director, 1969 - ; Head of Special Studies, 1970 -
JOHN G. HURLEY, Professional Associate, 1970 -
JANE LECHT, Editor, 1971 -
LORETTA POTTS, Librarian, 1970 - 71
THERESA TELLEZ, Head, Latin American Affairs, 1967 - 1970; Professional Associate, 1970 -
NOEL VIETMEYER, Professional Associate, 1970 -
JUDY WERDEL, Professional Assistant, 1970 -
ADOLPH WILBURN, Professional Associate, 1970 - 71
EARL YOUNG, Professional Associate, 1970 - 71
JAMES ZAVISTOSKI, Professional Associate, 1970 - 72

Temporary Appointments

RICHARD MORSE, Professional Associate, 1972 - (Study on International Industrialization Institute)
RUSSELL SCARATO, Professional Associate, 1972 (Study on International Industrialization Institute)

*The Middle East/South Asia Science Board, which was created in 1964 and met only once, is omitted from this list.

MEMBERS OF REGIONAL BOARDS AND SUBCOMMITTEES

AFRICA SCIENCE BOARD, 1962 - 1968

C. W. De KIEWIET, American Council on Education,* *Chairman*
JOHN J. McKELVEY, JR., Rockefeller Foundation, *Vice Chairman*
HARRISON BROWN, Foreign Secretary, National Academy of Sciences, *ex officio member*
PAUL J. BOHANAN, Anthropology, Northwestern University (1962 - 64)
RICHARD BRADFIELD, Agricultural Sciences, Rockefeller Foundation (1962 - 65)
W. M. CHAPMAN, President, Van Camp Sea Food (1965 - 68)
JAMES S. COLEMAN, Political Science, University of California (1962 - 64)
WILLIAM O. JONES, Food Research Institute, Stanford University
FREDERICK C. LINDVALL, Chairman, Division of Engineering and Applied Sciences, California Institute of Technology
ROBERT A. LYSTAD, African Studies, Johns Hopkins School of Advanced International Studies (1964 - 68)
EDWIN S. MUNGER, Geography, California Institute of Technology (1964 - 68)
W. M. MYERS, Agricultural Sciences, Rockefeller Foundation (1965 - 68)
LINCOLN R. PAGE, U.S. Geological Survey
FREDERICK D. PATTERSON, Phelps-Stokes Fund
HAROLD E. THOMAS, U.S. Geological Survey
JOHN M. WEIR, Director, Medical and Natural Sciences, Rockefeller Foundation (1964 - 68)
THOMAS H. WELLER, Tropical Public Health, Harvard University

Committee on the Development of Water Resources in Africa, 1966 - 1968

GILBERT F. WHITE, Geography, University of Colorado, *Chairman*
H. FRANCIS HENDERSON, Zoology, University of Wisconsin
WILLIAM O. JONES, Food Research Institute, Stanford University
THAYER SCUDDER, Anthropology, California Institute of Technology
HAROLD E. THOMAS, U.S. Geological Survey, Menlo Park, California
THOMAS H. WELLER, Tropical Public Health, Harvard University

Subcommittee on Animal Disease in Africa, 1964 - 1965

CARL BRANDLY, Dean, Veterinary College, University of Illinois
M. R. CLARKSON, President, American Veterinary Medical Association
WILLIAM O. JONES, Food Research Institute, Stanford University
JOHN J. McKELVEY, JR., Agricultural Sciences, Rockefeller Foundation
J. G. MATTHYSE, College of Agriculture, State University of New York
GEORGE P. MURDOCK, Anthropology, University of Pittsburgh
FREDERICK D. PATTERSON, President, Phelps-Stokes Fund
GEORGE C. POPPENSEIK, Dean, Veterinary Medicine, Cornell University

*All affiliations or professional fields refer to the time the individual served on a board or panel.

Study Group on Animal Disease in Africa, 1964 - 1965

NELS M. KONNERUP, Department of Health Data, Walter Reed Army Institute of Research, *Chairman*
HARRY E. FERGUSON, President, Mt. Haggin Livestock Company
PETER HAMMOND, Anthropology, Indiana University
D. E. HOWELL, Entomology, Oklahoma State University
JAMES R. PICK, Institute of Laboratory Animal Resources, National Academy of Sciences
ROBERT C. REISINGER, Microbiology, Agricultural Research Service, U.S. Department of Agriculture

PACIFIC SCIENCE BOARD, 1963 - 1970*

RALPH E. CLELAND, Genetics, Indiana University, *Chairman*, 1964 - 67
H. BURR STEINBACK, Woods Hole Oceanographic Institution, *Chairman*, 1967 - 1970
HARRISON BROWN, Foreign Secretary, National Academy of Sciences, *ex officio member*
JOHN E. BARDACH, School of Natural Resources, University of Michigan (1968 - 1970)
PRESTON E. CLOUD, JR., Paleontology, University of Minnesota (1963 - 66)
HAROLD C. CONKLIN, Anthropology, Yale University (1963 - 66)
FRED R. EGGAN, Anthropology, University of Chicago (1968 - 1970)
ROLAND W. FORCE, Bernice P. Bishop Museum (1966 - 68)
H. BENTLEY GLASS, Biology Science Education, State University of New York at Stony Brook (1968 - 1970)
FRANK H. GOLAY, Southeast Asia Program, Cornell University (1968 - 1970)
WARD H. GOODENOUGH, Anthropology, University of Pennsylvania (1963 - 66)
Y. BARON GOTO, Center for Cultural and Technical Interchange between East and West (1966 - 69)
STERLING B. HENDRICKS, Plant Physiology, U.S. Department of Agriculture (1963 - 67)
ROBERT W. HIATT, Zoology, University of Hawaii (1963 - 65)
CARL L. HUBBS, Scripps Institution of Oceanography (1963 - 66)
HARRY C. KELLY, Physics, North Carolina State College (1963 - 68)
WILLIAM A. KREBS, Vice President, Arthur D. Little, Inc. (1968 - 70)
JOHN M. H. LINDBECK, Columbia University (1968 - 1970)
ARTHUR P. LONG, Preventive Medicine, University of California (1963 - 66)
C. E. PEMBERTON, Entomology, Hawaiian Sugar Planters Association (1963 - 65)
JOSEPH B. PLATT, President, Harvey Mudd College (1965 - 1970)
WALTER ORR ROBERTS, National Center for Atmospheric Research (1963 - 68)
A. C. SMITH, Botany, University of Hawaii (1963 - 65)
ATHELSTAN F. SPILHAUS, Dean, Instiute of Technology, University of Minnesota (1968 - 1970)
M. H. TRYTTEN, Office of Scientific Personnel, National Academy of Sciences (1968 - 1970)
I. E. WALLEN, Director, Harbor Branch Foundation Laboratory (1966 - 1970)

*The PSB was created in 1946.

JOHN C. WARNER, President, Carnegie Institute of Technology (1965 - 67)
ALAN T. WATERMAN, Director, National Science Foundation (1965 - 68)
JOHN S. WELLINGTON, University of California (1966 - 68)
GEORGE P. WOLLARD, Geophysics, University of Hawaii (1963 - 66)

LATIN AMERICA SCIENCE BOARD, 1963 - 1968

WILL M. MYERS, Agronomy, University of Minnesota, *Chairman* (1963 - 65)
HARRISON BROWN, NAS Foreign Secretary, *Acting Chairman* (1965 - 66)
CARL DJERASSI, Chemistry, Stanford University, *Chairman* (1966 - 68)
T. J. CUNHA, Animal Sciences, University of Florida (1966 - 68)
ALLAN R. HOLMBERG, Anthropology, Cornell University (1963 - 67)
JAMES G. HORSFALL, Director, Connecticut Agricultural Experiment Station (1963 - 67)
W. D. JOHNSTON, JR., U.S. Geological Survey (1963 - 68)
DAVID B. KING, U.S. Forest Service, U.S. Department of Agriculture (1967 - 68)
RALPH A. KRAUSE, Consultant, International Science and Technology (1963 - 64)
ROY L. LOVVORN, Agriculture and Life Sciences, North Carolina State University (1967 - 68)
STACY MAY, Rockefeller Brothers Fund (Retired) (1965 - 67)
CHARLES L. MILLER, Civil Engineering, Massachusetts Institute of Technology (1965 - 68)
NORMAN MOORE, Consulting Scientist (1967 - 68)
FRANKLIN A. NEVA, Tropical Public Health, Harvard University (1963 - 68)
JOHN S. NIEDERHAUSER, Agriculture, Rockefeller Foundation (Mexico) (1963 - 64)
RICHARD W. PATCH, Anthropology, State University of New York at Buffalo (1967 - 68)
A. J. RIKER, Plant Pathology, University of Wisconsin (1963 - 64)
STEFAN H. ROBOCK, Graduate School of Business, Columbia University (1967 - 68)
MILNER B. SCHAEFER, Science Adviser, Department of the Interior (1963 - 68)
THEODORE W. SCHULTZ, Economics, University of Chicago (1963 - 64)
J. MAYONE STYCOS, Sociology, Cornell University (1963 - 65)
FRANK M. TILLER, Dean, Engineering, University of Houston, (1963 - 65)
KENNETH L. TURK, Animal Husbandry, Cornell University (1963 - 65)
MERLE A. TUVE, Terrestrial Magnetism, Carnegie Institution of Washington (1963 - 65)

Task Force on Tropical Agriculture, 1964 - 1965

ELMER A. BEAVENS, Food Technologist, U.S. Department of Agriculture
T. J. CUNHA, Animal Sciences, University of Florida
NATHAN A. HAVERSTOCK, Writer, Washington, D.C.
WALTER HOFMANN, U.S. Geological Survey, Menlo Park, California
ERNEST P. IMLE, American Cocoa Research Institute
NORTON C. IVES, Consulting Engineer, Rolfe, Iowa
HENRY KERNAN, Forestry, State University of New York
DAVID B. KING, U.S. Forest Service, U.S. Department of Agriculture
ROY L. LOVVORN, Agriculture and Life Sciences, North Carolina State University

EILIF MILLER, Rural Development, Agency for International Development
RICHARD W. PATCH, American Universities Field Staff, Lima, Peru
VIRGIL PETERSON, Rural Development, Agency for International Development
CLARENCE E. PIKE, Agricultural Economist, U.S. Department of Agriculture
LEONARD ROSENFELD, Metropolitan Hospital, Detroit, Michigan
HUBERT J. SLOAN, Animal Scientist (retired), St. Paul, Minnesota
DAVID TIMOTHY, Crops, North Carolina State University
JOSÉ VICENTE-CHANDLER, Soils, U.S. Department of Agriculture

DEVELOPMENT BOARDS AND PANELS

SCIENCE ORGANIZATION DEVELOPMENT BOARD, 1966 - 1968

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STANISLAW ULAM, Mathematics, University of Colorado
LEWIS PERINBAM, International Organizations, Canadian International Development Agency, *Advisor*

TABLE A-1. Number of Participants, Boards and Subcommittees, 1963 - 1972

Boards, Subcommittees	Number of Members	Totals
Africa Science Board	17	37
Water Resources Committee	6	
Animal Disease Subcommittee	8	
Animal Disease Study Group	6	
Pacific Science Board	30	30
Latin America Science Board	24	41
Tropical Agriculture Task Force	17	
Science Organization Development Board	16	16
Board on Science & Technology for International Development	26	31
Technology Innovation Advisory Committee	5	
Grand Total		155

TABLE A-2. Number of Participants, Bilateral Programs, 1963 - 1972

Region/Country	U.S.		Foreign	
	Workshops	Study Groups	Workshops	Study Groups
AFRICA	36	13	110	27
Ghana	15	5	67	6
Nigeria	11	-	10	-
Zaire	10	8	33	21
ASIA	165	-	540	-
India	22	-	134	-
Indonesia	43	-	192	-
Philippines	43	-	58	-
Taiwan	48	-	105	-
Thailand	9	-	51	-
LATIN AMERICA	87	94	130	100
Argentina	9	9	10	9
Brazil	42	59[a]	46	53
Chile	10	-	35	-
Colombia	9	24	10	34
Peru	17	2	29	4
TOTAL	288	107	780	127

[a]Includes São Paulo study (see appendix B, p.63).

TABLE A-3. Number of Participants, Special Studies and Projects, 1963 - 1972

Area & General Science Panels	Conferences U.S.	Conferences Foreign	Study Panels U.S.	Study Panels Foreign
Africa	29	148	8	9
Korea, panel 1	-	-	5	-
Korea, panel 2	-	-	3	-
Thailand	6	5		
East Pakistan	-	-	8	-
Singapore	13	64	-	-
Central America	7	19	-	-
General S&T panels	-	-	167	34
Total	55	236	191	43
GRAND TOTALS	U.S. 246	Foreign 279	Both 525	

TABLE A-4. Total Numbers of Participants, 1963 - 1972

	U.S.	Foreign	Totals
Boards and subcommittees	155	-	155
Bilateral workshops & study groups	395	907	1,302
Conferences & special studies	246	279	525
GRAND TOTALS	796	1,186	1,982

Appendix B
Publications: Reports and Studies

CONTENTS

Representative of BOSTID's activities, and its predecessors', this list of publications includes bilateral science cooperation programs and special studies undertaken for AID. It does not include some reports by NAS counterparts or their consultants, which were produced for their own purposes and local use.

Part I consists primarily of workshop and joint-study-group reports produced under bilateral programs from 1965 to the present. A few studies by individual consultants are also included. Entries for workshop reports include theme, place, date, and the NAS's co-sponsors of the meeting.

Part II consists of studies conducted since 1963 under the sponsorship of regional science boards and, more recently, the Board on Science and Technology for International Development. Reports of regional workshops are also included in this section.

Entries are arranged chronologically under each heading.

A dictionary of acronyms follows the list.

The availability of each item is indicated as follows:

Available from BOSTID

Request free copy from Board on Science and Technology
for International Development
Office of the Foreign Secretary
National Academy of Sciences
2101 Constitution Avenue
Washington, D.C. 20418 USA

NTIS (National Technical Information Service) accession number

Out-of-print reports (and others) with NTIS numbers can be purchased from the NTIS. To order, send report title, NTIS Accession Number (beginning with PB), and $3.00 per volume (unless otherwise noted). Pay by NTIS Deposit Account, check, or money order. U.S. orders without prepayment are billed within 15 days, and a $0.50 charge is added. Foreign buyers must enclose payment plus $2.50 handling charge per volume.

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5285 Port Royal Road
Springfield, Virginia 22151 USA

No copies available

No distribution; however, most reports can be examined in the BOSTID library, 2100 Pennsylvania Avenue, N.W., Washington, D.C.

PART I. BILATERAL PROGRAMS

AFRICA

Ghana

Research Priorities and Problems in the Execution of Research in Ghana.

Part 1. **Summary.** Proceedings of joint NAS-CSIR workshop with Universities of Ghana, held in Accra, Ghana, January 1971. Accra: CSIR, n.d. 60 p. PB 203-329.

Part 2. **Scientific Research in Ghana: Full Report.** Ammishaddai Adu, ed. Accra, Ghana: CSIR, 1971. 299 p. PB 203-330. $6.00.

[NAS Staff] Report of a Workshop on Research Priorities and Problems in the Execution of Research in Ghana. Sponsored by NAS and Ghanaian CSIR with cooperation of Ghanaian Universities, held in Accra, Ghana, January 18-22, 1971. Washington, D.C.: NAS, n.d. 40 p. (photocopy). No copies available.

Report of the Joint U.S.A./Ghana Committee on Agricultural Extension and Research. Sponsored jointly by NAS, CSIR, Universities of Ghana, 27 September - 8 October 1971. Accra, Ghana: CSIR, 1971. 45 p. PB 208-605.

Workshop on the Role of the Council for Scientific and Industrial Research in Determining Science Policy and Research Priorities. Organized jointly by CSIR, Universities of Ghana, and NAS. Accra: CSIR, 1973. 54 p. PB 223-310. $3.50.

Nigeria

Science and Nigerian Development. Report of a workshop, August 19 - 25, 1965, Bellagio, Italy, sponsored by ASB of NAS/NRC in cooperation with Rockefeller Fdtn. and AID. Washington, D.C.: NAS, n.d. 100 p. (photocopy). PB 203-390-U.

Zaire (Formerly Democratic Republic of the Congo)

[NAS Staff] Summary Report of Workshop on the Role of Science and Technology in the Economic Development of the Democratic Republic of the Congo during the 1970's. Held in Kinshasa, 7 - 11 June 1971. Sponsored by ONRD, Congo-Kinshasa, and NAS, U.S.A. Washington, D.C.: NAS, n.d. (photocopy). 25 p. No copies available.

U.S. - Zaire Science Cooperation Program: Report of the Joint Study Group on Demographic Training and Research in the Republic of Zaire. Held in Kinshasa, Zaire, 24 - 28 January 1972. Jointly sponsored by ONRD (Zaire) and NAS (U.S.A.). Washington, D.C.: NAS, n.d. (photocopy). 32 p. (French translation, 32 p.). No copies available.

NAS-ONRD Science Cooperation Program: Report of the Joint Study Group on Geological Training and Research in the Republic of Zaire. Held in Kinshasa, Zaire, 20 July - 1 August 1972. Washington, D.C.: NAS, n.d. 29 p. (photocopy). No copies available.

ASIA

China, Republic of (Taiwan)

Report on Progress of Sino-American Science Cooperation. Taipei: China Committee on Sino-American Science Cooperation [Academia Sinica], January 1965. 24 p. No copies available.

Oceanography Report. By I.E. Wallen [for China Committee]. n.p.: n.p., March 1966. 17 p. (mimeographed). No copies available.

Report on Progress of Sino-American Science Cooperation. Taipei: China Committee on Sino-American Science Cooperation [Academia Sinica], March 1967. 14 p. No copies available.

Third Joint Conference for Sino-American Science Cooperation. Held at Washington, D.C., 5 - 7 April 1967, sponsored by Academia Sinica and NAS. n.p.: n.p., n.d. 108 p. Available from BOSTID.

Progress Report, China Committee on Sino-American Science Cooperation. Taipei: Academia Sinica, February 1968. 9 p. No copies available.

Fourth Conference on Sino-American Science Cooperation. Held at Hsinchu and Taipei, 26 - 30 August 1968. Taipei (?): n.p., n.d. No copies available.

Part 1. **Recommendations.** 13 p.

Part 2. **Industrial Development of Taiwan.** (Agenda and Participants only). 12 p.

Progress Report, China Committee on Sino-American Science Cooperation. Taipei: Academia Sinica, September 1969. 9+2 p. No copies available.

Report on the Sino-American Colloquium on Ocean Resources. Sponsored by Sino-American Science Cooperation Committee (Academia Sinica and NAS), held at Taipei, Republic of China, 28 April - 6 May 1971. n.p.: n.p., n.d. 44 p. Available from BOSTID.

Report on Graduate Centers in Engineering and Science. Joseph B. Platt [for China Committee]. n.p.: n.p., May 1971. 34 p. No copies available.

Report of the Sino-U.S. Workshop on Scientific and Technical Information Needs and Resources in the Republic of China (Taiwan). Held in Washington, D.C., April 25 - 27, 1973. Washington, D.C.: NAS (in preparation 1973). To be available through BOSTID.

India

Report of the Indo-U.S. Workshop on the Management & Organization of Industrial Research. Held at Baroda, India, March 2 - 6, 1970. New Delhi, India: NISI, n.d. 57 p. (photocopy). PB 203-311.

[NAS Staff] Summary Report of Workshop on Water in Man's Life in India. Held in New Delhi, India, 13 - 17 September 1971. Sponsored by INSA (India) and NAS (U.S.A.). Washington, D.C.: NAS, n.d. 28 p. (photocopy). No copies available. Full proceedings to be published by INSA.

Indonesia

Report on the LIPI-NAS Workshop on Food. Held at Djakarta, Indonesia, May 1968. Jakarta: LIPI, 1968. (photocopy).

Vol. 1. **Overall Findings & Recommendations.** 34 p. PB 203-370-U.

Vol. 2. **Reports of the Working Groups.** 154 p. PB 203-371-U.

Vol. 3. **Keynote Address, List of Participants, Background Papers.** 166 p. PB 203-372-U.

Report of the LIPI-NAS Workshop on Industrial and Technological Research. Held in Djakarta, Indonesia, January [25 - 30] 1971. Jakarta (?): LIPI, n.d. (photocopy).
Vol. 1. **Overall Findings and Recommendations.** 31 p. PB 217-118.
Vol. 2. **Plenary Sessions and Working Groups Reports.** 60 p. PB 218-724.
Vol. 3. **Program Design.** 104 p. PB 222-457. $4.25.

[NAS Staff] Summary Report of an Indonesia - U.S. Workshop on Industrial and Technological Research. Held at Djakarta, Indonesia, January 25 - 30, 1971, sponsored by NAS (U.S.A.) and LIPI (Indonesia). Washington, D.C.: NAS, n.d. 29 p. (photocopy). No copies available.

Report on the LIPI-NAS Workshop on Natural Resources. Held in Jakarta, Indonesia, September 11 - 16, 1972. Jakarta (?): LIPI (?), n.d. **Vol. 1. Overall Findings & Recommendations, Working Group Reports.** Available in two forms:
(1) 91 p. PB 217-293.
(2) Same as above + panelist list. 106 p. (photocopy). Available from BOSTID.

[NAS Staff] Summary Report of the NAS-LIPI Workshop on Natural Resources in Indonesia. Held in Jakarta, Indonesia, 11 - 16 September 1972. Sponsored by LIPI (Indonesia) and NAS (U.S.A.). Washington, D.C.: NAS, n.d. 37 p. (photocopy). No copies available.

Philippines

Philippines - U.S. Workshop on Scientific and Technological Cooperation and Development. Held at Manila, November 22 - 26, 1965, conducted by NAS-NRC (U.S.A.), NSDB-NRC (Phil.). Manila: NSDB-NRC, n.d. 166 p. No copies available.

[NAS Staff] Report: Philippines - U.S. Workshop on Scientific and Technological Cooperation and Development. Held at Manila, 22 - 26 November 1965. Washington, D.C.: NAS, n.d. (photocopy).
Part 1. **Report of Workshop.** 10 p. PB 203-394-U.
Part 2. **Appendices.** unpaged. PB 203-395-U.

Report of the Second U.S. - Philippines Workshop on Cooperation in Science and Technology. Held at Pacific Grove, California, 6 - 10 November 1966, by OFS, NAS, and NSDB in cooperation with Office of Technical Cooperation and Research, AID. Washington, D.C.: NAS, n.d. 104 p. PB 204-407.

Report on Recommendation V: Cooperation in Oceanography and Fisheries Research. Second Philippine-U.S. Workshop, Asilomar [California] and Washington, D.C., 6 - 10, 14 - 17 November 1966. Manila (?): Nat'l Committee on Marine Sciences, NSDB, April, 1967. 70 p. (photocopy). No copies available.

Philippines - U.S. Workshop on Fisheries and Oceanography. Held at Manila, 4 - 9 December 1967. Manila: NSDB, n.d. 150 p. PB 203-365-U.

Philippines - U.S. Workshop on Industrial Research. Held at Baguio City, [Philippines] 26 January - 1 February 1969. Manila (?): NSDB, n.d. Pts. 1&2 available from NTIS; also, limited copies from BOSTID.
Part 1. **Summary Report.** 30 p. PB 203-376-U.
Part 2. **Working Papers.** 155 p. PB 203-377-U.

Thailand

Workshop on Science Planning and Policy in Thailand, 3 - 6 July 1972: Final Report. [Bangkok: Thai NRC], n.d. Various p. (photocopy). PB 222-441.

[NAS Staff] Summary Report of the NAS-NRC Workshop on Science Planning and Policy in Thailand. Held in Bangkok, Thailand, 3 - 6 July 1972, sponsored by NRC, Thailand, and NAS, U.S.A. Washington, D.C.: NAS, n.d. 17 p. + Appendix B (reprint of Final Report). (photocopy). No copies available.

LATIN AMERICA

Argentina

Report of the Argentine - U.S. Workshop on Science & Technology in Economic Development. Held in Mar del Plata, Argentina, July 28 - August 1, 1969, sponsored by NAS and CNICT. Washington, D.C.: NAS, n.d. 79 p. Available from BOSTID or NTIS.

Argentine - U.S. Panel on Scientific Information: Report of the First Meeting. Held in Washington, D.C., August 24 - 25, 1970, sponsored by NAS and CNICT. Washington, D.C.: NAS, 1970. 16 p. + attachments. (photocopy). No copies available.

Preliminary Assessment of Some Problems of the Hydrogeology of the Dry Pampas in Buenos Aires Province, Argentina. Trip Report prepared by Stanley Davis and John Winslow under auspices of NAS and CONICET. n.p.: n.p., 1970. 13 p. (photocopy). No copies available.

Report of the Argentine - U.S. Study Group on Food Technology: Interim Report. (For final, see next entry.) Washington, D.C.: NAS, 1971. 30 p. No copies available.

NAS-CONICET Science Cooperation Program: Staff Summary Report of Activities. Program sponsored by BOSTID and CONICET in cooperation with AID. Washington, D.C.: NAS, 1973. 61 p. (photocopy). No copies available.

NAS-CONICET Science Cooperation Program: Staff Summary Report of Science Information Program, August 15, 1970 - December 31, 1972. Washington, D.C.: NAS, (in preparation 1973). To be available through BOSTID.

Brazil

Background Information for Brazil - U.S. Workshop on Science, Technology, and Development. Washington, D.C.: NAS, 1966. 179 p. PB 203-939-U.

Science and Brazilian Development: A Workshop on the Contribution of Science and Technology to Development. [First workshop] held in Itatiaia, Brazil, April 11 - 16, 1966, by NAS and CNPq. Washington, D.C.: NAS, 1966.
Part 1. **Report.** 39 p. PB 203-413-U.
Part 2. **Contributed Papers.** 132 p. PB 203-938-U.

Report of the Joint Group To Study Standards, Tests, and Weights and Measures in Brazil. Restricted edition. Rio de Janeiro: CNPq, 1968. 39 p. In Portuguese and English. No copies available.

Science and Brazilian Development: Report of the Second Workshop on Contributions of Science and Technology to Development. Held in Washington, D.C., February 5 - 9, 1968, by NAS and CNPq. Washington, D.C.: NAS, 1968. 102 p. PB 203-366-U.

Industrial Research as a Factor in Economic Development: Report of the Joint Study Group on Industrial Research, U.S. - Brazil Science Cooperation Program. Washington, D.C.: NAS, September 1968. 34 p. PB 203-373-U.

Report of a Trip To Evaluate Possibilities for a Joint NAS-CNPq Program in Computer Sciences. Washington, D.C.: NAS, September 1968. 6 p. No copies available.

Science and Brazilian Development: Report of the Third Workshop on Contribution of Science and Technology to Development. Held in Rio de Janeiro, Brazil, April 7 - 11, 1969, by NAS and CNPq. Washington, D.C.: NAS, 1969. 71 p. PB 203-391-U.

Science and Brazilian Development: Report of the Fourth Workshop on Contributions of Science and Technology to Development. Held in Washington, D.C., November 1 - 5, 1971, by NAS and CNPq. Washington, D.C.: NAS, 1971. 87 p. Available from BOSTID or NTIS. PB 210-345.

Recommendations for Improving Computer-Science Education in Brazil: Summary Report of the NAS-CNPq Study Group on Computer-Science Education in Brazil. [First Report]. Meeting held in Rio de Janeiro, December 10 - 15, 1971. Washington, D.C.: NAS, 1971. 19 p. + 3 appendices. No copies available.

Science and Technology in São Paulo's Development: A Review and Critique of a Proposed Program To Utilize Science and Technology for the Economic Development of the State of São Paulo, Brazil. By an ad hoc panel of BOSTID in cooperation with Council of Science and Technology for the State of São Paulo. Washington, D.C.: NAS for the AID Brazil Mission, July 1972. 100 p. No copies available.

Improving Computer-Science Education in Brazil: Second Report of NAS-CNPq Study Group. Washington, D.C.: NAS, August, 1972. 69 p. No copies available.

Study for Agricultural Engineering Development in Brazil: Report of the Joint Study Group on Agricultural Engineering in Brazil, U.S. - Brazil Science Cooperation Program. Held in Rio de Janeiro, July 24 - August 12, 1972. Washington, D.C.: NAS, 1972. 34 p. PB 214-534.

NAS-CNPq Science Cooperation Program. Staff Summary Report of Activities, February 1968 - December 1972. Washington, D.C.: NAS, 1973. 54 p. Available from BOSTID.

Chile

[NAS Staff] Summary Report of the Workshop on the Contribution of Science and Technology to Development. Held in Santiago, Chile, January 11 - 15, 1971, sponsored by NAS and CONICYT. Washington, D.C.: 1971. 28 p. No copies available.

Colombia

Institutions of Higher Education, Research, and Planning in Colombia: Background Information for Colombia - U.S. Workshop on Science and Technology in Development. Washington, D.C.: NAS, 1968. 65 p. No copies available.

Report of the Colombia - U.S. Workshop on Science and Technology in Development. Held in Fusagasugá, Colombia, February 26 - March 1, 1968, sponsored by Colombian Ministry of Education and NAS. Washington, D.C.: NAS, 1968.
Vol. 1. **Report and Recommendations.** 55 p. PB 203-374-U.
Vol. 2. **Contributed Papers.** 98 p. PB 203-375-U.

Seminario Sobre Ciencia y Tecnología para el Desarrollo. Held in Fusagasugá, Colombia, February 26 - 29, 1968. Bogatá: Ministry of Education, 1968. In Spanish and English. No copies available.
Vol. 1. **Final Report** 134 p.
Vol. 2. **Papers Presented** 209 p.

Report to the AID Mission in Colombia. Prepared by Jay Davenport. Washington, D.C.: NAS, 1969. 17 p. + appendices. (photocopy). No copies available.

Seminario Sobre Administración de la Investigación Científica. Sede: Universidad de Atioquia, Medellín, 4 al 14 de agosto de 1969. Medellín: Instituto de Integración Cultural & COLCIENCIAS, 1970. 286 p. Spanish only. No copies available.

Programa de Impulso a la Investigación y a los Estudio de Posgrado en las Universidades Colombianas–Informe de la Misión de Quimica. Held in Bogotá, Colombia, Febrero 22 - 27 de 1971. Bogotá: COLCIENCIAS, 1972. Spanish only. 40 p. No copies available.

Report of a COLCIENCIAS - NAS Panel Study of Graduate Education and Research in Chemistry in Colombia: [NAS] Staff Summary Report. Held in Bogotá, Colombia, February 22 - 27, 1971. Washington, D.C.: NAS, 1971. 17 p. No copies available.

Programa de Impulso a la Investigación y a los Estudios de Posgrado en las Universidades Colombianas–Informe de la Misión de Matemáticas. Bogotá, Colombia, Marzo 15 - 20 de 1971. Bogotá: COLCIENCIAS, 1972. 47 p. Spanish only. No copies available.

Report of a COLCIENCIAS-NAS Panel Study of Graduate Education and Research in Mathematics in Colombia: [NAS] Staff Summary. Held in Bogotá, Colombia, March 15 - 20, 1971. Washington, D.C.: NAS, 1972. 20 p. No copies available.

Programa de Impulso a la Investigación y a los Estudios de Posgrado en las Universidades Colombianas–Informe a la Misión de Ingeniería. Bogotá, Colombia, 14 - 25 de Febrero de 1972. Bogotá: COLCIENCIAS, 1972. 185 p. Spanish only. No copies available.

[NAS] Staff Summary Report of the Colombia - U.S. Study Panel on the Potential for Graduate Education and Research in Engineering, Physics, and Applied Geology in Colombia. Held in Bogotá, Colombia, February 14 - 25, 1972. Washington, D.C.: NAS, 1972. 26 p. No copies available.

Programa de Impulso a la Investigación y a los Estudios de Posgrado en las Universidades Colombianas–Informe de la Misión de Biología. Bogotá, Colombia, Mayo 30 al 13 de Junio de 1972. Bogotá: COLCIENCIAS, 1972. 47 p. Spanish only. No copies available.

General Report of the Colombia - U.S. Study Group on the Potential for Graduate Education and Research in the Biological Sciences in Colombian Universities. Held in Bogotá, Colombia, May 29 - June 13, 1972. Washington, D.C.: NAS, 1972. 23 p. No copies available.

Program for the Improvement of Graduate Education and Research in Colombian Universities in the Sciences and Engineering, February 1971 - October 1972: Final [NAS] Staff Summary Report. Washington, D.C.: NAS, 1972. 85 p. No copies available.

Peru

Basic Data and Background Information for the Workshop on the Role of Science and Technology in Peruvian Economic Development. Washington, D.C.: NAS, 1966. 125 p. No copies available.

Report of a Workshop on the Role of Sciences and Technology in Peruvian Economic Development. Held in Paracas, Peru, April 17 - 22, 1966, by NAS and ad hoc Peruvian group. Washington, D.C.: NAS, 1966. 85 p. PB 203-362-U.

Organización de la Investigación Científica. Lima: Comité del Grupo de Paracas, September, 1966. 34 p. (English translation, 29 p.). No copies available.

Second Peru - U.S. Workshop on Science and Technology in Economic Development. Held in El Bosque, Peru, November 20 - 24, 1967, by NAS and ad hoc Peruvian group. Washington, D.C.: NAS, 1967.
Vol. 1. **Report.** 62 p. PB 203-363-U.
Vol. 2. **Contributed Papers,** 308 p. PB 203-364-U. $6.00.

La Ciencia y la Tecnología en el Desarrollo. Reunión de Ancón, 28 Noviembre-Diciembre 1968. Lima: Consejo Nacional de Investigación, 1968. 256 p. Spanish only. No copies available.

PART II. SPECIAL STUDIES AND PROJECTS

BY AREA

Africa

Agricultural Development Schemes in Sub-Saharan Africa: A Bibliography. Compiled by Ruth S. Freitag for ASB, NAS. Washington, D.C.: Library of Congress, 1963. 189 p. Limited copies available from BOSTID.

Traditional Agricultural Methods in the Congo Basin. Compiled by Marvin P. Miracle for the ASB, NAS. California: Stanford University, Food Research Institute, 1964. Approx. 300 p. unpaged. Limited copies available from BOSTID.

Man-Made Lakes: A Selected Guide to the Literature. Compiled by Gabrielle Edgcomb for the ASB, NAS. Washington, D.C.: NAS, 1965. 98 p. Limited copies available from BOSTID.

Report by the Study Group on Animal Diseases in Africa. Washington, D.C.: NAS, 1965. 60 p. PB 203-361-U.

Research Services in East Africa. Compiled for the East African Academy (financed by NSF grant through NAS). Nairobi: East African Publishing House, 1966. 239 p. No copies available.

Conference on Agricultural Research Priorities for Economic Development in Africa. Held in Abidjan, Ivory Coast, April 5 - 12, 1968. Washington, D.C.: NAS, 1968. French & English eds. French eds. not available.
Vol. 1. **Report of the Conference.** 139 p. PB 203-367-U. French ed. 144 p. $3.00.
Vol. 2. **Contributed Papers.** 473 p. PB 203-368-U. French ed. 513 p. $6.00.
Vol. 3. **Contributed Papers (Animal Production, etc.)** 437 p. PB 203-369-U. French ed. 487 p. $6.00.

Report of the Africa Science Board Committee on Agriculture to AID on Recommendations from the April 5 - 12, 1968, Conference on Agricultural Research Priorities for Economic Development in Africa, Abidjan, Ivory Coast. Washington, D.C.: NAS, 1968. 9 p. No copies available.

Asia

The Future of U.S. Technical Cooperation with Korea: A Report to AID by a Panel of BOSTID. Washington, D.C.: NAS, 1969. 50 p. PB 203-325-U.

Report on Protein Food Promotion Seminar. Held in Thailand, November 22 - December 1, 1970. Bangkok: Kasetsart University, Institute of Food Research and Product Development, 1970. In Thai and English. No copies available.
Part 1. **Contributed Papers.** unpaged.
Part 2. **Report.** unpaged.

[NAS Staff Summary] Report on Seminar on Protein Food Promotion. Held in Bangkók, Thailand, 22 November - 1 December 1970. Sponsored by AID/Thailand and Thai Institute of Food Research and Product Development and Thai Dept. of Health. Washington, D.C.: NAS, n.d. 12 p. (photocopy). No copies available.

East Pakistan Land and Water Development as Related to Agriculture. Report of ad hoc panel of BOSTID. Washington, D.C.: NAS, 1971. 67 p. PB 203-328.

Staff Summary Report of Activities of the National Academy of Sciences Advisory Panel to the Ministry of Science and Technology, Republic of Korea, January 10 - 21, 1972. Washington, D.C.: NAS, 1972. 12 p. No copies available.

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ACRONYMS

ACTI	Advisory Committee on Technology Innovation, BOSTID (USA)
AID	U.S. Agency for International Development

ASB	Africa Science Board, NAS (USA)
BOSTID	Board on Science and Technology for International Development, OFS, NAS (USA)
CNICT	National Council for Scientific and Technical Research (Argentina, superseded by CONICET)
CNPq	Conselho Nacional de Pesquisas (Brazilian NRC)
COLCIENCIAS	Colombian Fund for Scientific Research and Special Projects "Francisco José de Caldas"
CONICET	National Council of Scientific and Technical Research (Argentina)
CONICYT	National Commission for Scientific and Technical Research (Chile)
CSIR	Council for Scientific and Industrial Research (Ghana)
ICAITI	Central American Research Institute for Industrial Technology (Guatemala City, Guatemala)
INSA	Indian National Science Academy
LASB	Latin America Science Board, NAS (USA)
LIPI	Indonesian Institute of Sciences
NAS	National Academy of Sciences (USA)
NISI	National Institute of Sciences of India
NRC	National Research Council
NSDB	National Science Development Board (Philippines)
NSF	National Science Foundation (USA)
NTIS	National Technical Information Service (USA)
OFS	Office of the Foreign Secretary, NAS (USA)
ONRD	Office Nationale de la Recherche et du Developpement (Zaire)