Annual Report of the Board on Science and Technology for International Development

Prepared for the Agency for International Development

Office of the Foreign Secretary
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ANNUAL REPORT OF THE

BOARD ON SCIENCE AND TECHNOLOGY

FOR INTERNATIONAL DEVELOPMENT

Prepared for the Agency for International Development

Contract No. AID/csd-2584, 1 April 1972 - 31 March, 1973

Office of the Foreign Secretary
National Academy of Sciences
Washington, D.C. 1973

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Annual Report, Contract No. AID/csd-2584
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INTRODUCTION

During 1 April 1972 through 31 March 1973 the Board on Science and Technology for International Development of the National Academy of Sciences (BOSTID, NAS) has continued its bilateral workshops and joint study groups in collaboration with counterpart institutions in Africa, Asia, and Latin America. Moreover during the year BOSTID has become interested in extending its bilateral programs to help more of the poorer countries to strengthen their scientific and technological capabilities for economic and social development. Exploratory discussions have been held with scientists and officials in Guatemala, Ethiopia, Sudan, Haiti and, Afghanistan, but no formal meetings have as yet taken place. These conversations are expected to continue and to lead to activities with at least some of these countries during the coming year.

In devising another approach to programs abroad, BOSTID held a bilateral workshop in Guyana on the management and control of aquatic weeds--the first workshop to focus on a technological problem instead of policy matters. It is expected that this approach will be duplicated in other countries to provide specific advice on a major problem in a specific country or group of countries.

During this period BOSTID completed a review and analysis of its experience over the past 10 years in science-and-technology development programs. A major comment in the report emphasizes the importance of continuity to our collaborative programs. Therefore, continuing or steering committees are being established to define and oversee workshop and study group activities of the Korea and Brazil programs. It seems likely that this arrangement will become more usual than exceptional, and it is already foreseen for the science cooperation programs with Ghana, India, Indonesia, Singapore, and Thailand.

BOSTID also continued work on special advisory studies requested by the U.S. Agency for International Development (AID).

The Advisory Committee on Technological Innovation (ACTI) continued its work and chose several specific projects for detailed investigation; two projects (on ferrocement and mosquito control) have led to the convening of special study panels and publications. A third project, to result in the forthcoming publication, Unsolved Problems in Food Science of Interest to Developing Countries, is expected to generate interest here and abroad in a number of aspects of this important field of applied research and to serve as a model for similar compendia to be compiled under the ACTI auspices bearing on other development-related research areas. ACTI intends to add to and revise each compendium periodically to include problem solutions that may have been found in the meantime.

The Board on Science and Technology for International Development, chaired by Dr. Carl Djerassi, has met twice during this reporting period. In addition, the ad hoc advisory panels established the previous year have periodically provided guidance to BOSTID staff. The full board will probably continue to meet twice a year to consider overall program direction and policy matters; the panels will meet as necessary to consider specific projects and programs.

The following report briefly summarizes all activities performed under contract AID/csd-2584 and attached task orders for the 1-year period ending 31 March 1973, as well as the remaining task order still in effect under the former contract, AID/csd-1122.

Reports describing completed individual programs were either forwarded to appropriate AID offices or missions, or are now in the final stages of preparation. A list of reports completed and in preparation is appended. Also attached are lists of NAS participants for each committee or panel.

The following task orders were issued, continued, or extended during this reporting period:

Task Order No. 1 provides for bilateral workshops and study groups with

developing countries and for creation of advisory panels and special studies dealing with science and technology related to specific problems of development. (Effective dates: 1 April 1972 - 30 September 1973)

Task Order No. 3 provided for the continuation of the Cooperative Science Program with the Argentine Council for Scientific and Technical Research. (Effective dates: 15 August 1970 - 31 December 1972)

Task Order No. 5 provided for the continuation of the NAS-COLCIENCIAS Cooperative Science Program with Colombia, involving study group assessments of the potential for graduate education and research in Colombian universities. (Effective dates: 15 November 1970 - 31 December 1972)

Task Order No. 7 provides for the continuation of a study concerned with the assessment and evaluation of African Agricultural Research Capabilities. (Effective dates: 10 February 1971 - 31 December 1973)

Task Order No. 9 provided for a joint study group on Demographic Training and Research in Zaire. (Effective dates: 15 January - 31 December 1972)

Task Order No. 10 provided for an NAS panel to examine the feasibility of a USAID/Brazil proposed loan program for the development and utilization of science and technology for specific social and development goals in the State of Sao Paulo, Brazil. (Effective dates: 1 April 1972 - 31 December 1973)

Task Order No. 11 provided for NAS participation in a workshop on natural resources planning and management, in cooperation with the Indonesian Institute of Sciences (LIPI). (Effective dates: 1 September 1972 - 1 February 1973)

The Brazil science-cooperation program was continued under task order No. 3 to contract AID/csd-1122, BOSTID's former contract with AID. This task order provides for continuation of joint study group activity with

the National Research Council of Brazil (CNPq). (Effective dates: 1 February 1968 - 30 June 1973). However, as of 30 June 1973, the expiration date of this task order, all activities under contract AID/csd-1122 will be completed.

PART I

BILATERAL PROGRAMS

1. AFRICA

Ethiopia

During staff visits to Addis Ababa discussions took place with Dr. Aklilu Lemma, Chairman of the National Science and Technology Advisory Committee and Director of the Ethiopian National Science Foundation. After these visits the Ethiopians expressed a general interest in U.S. assistance with a science and technology sector review. Following such a review, the Ethiopians would like to convene a joint workshop on science policy.

Ghana

In January 1971 a bilateral workshop on Research Priorities and Problems in the Execution of Research in Ghana, was held in Accra under the joint sponsorship of the National Academy of Sciences (U.S.A.), the Council for Scientific and Industrial Research (CSIR) in Ghana, and the universities of Ghana.

Two specific recommendations emerging from the workshop were (1) to establish a study group to consider the improvement and expansion of agricultural extension services in Ghana and (2) to organize a study group to consider how the CSIR should advise the Ghanaian government on science policy and research priorities.

The study on agricultural extension was held 27 September - 8 October 1971; it was planned that two members of the NAS group would visit Ghana again around May 1972 to assess the planning and implementation of work in agricultural research and extension that has taken place since completion of the study. However, these plans were temporarily shelved because of the January 1972 military coup. The idea of an assessment was raised again during the visit of the study group on science policy

(see next section) in March 1972 and it was decided to provisionally schedule such an exercise for late 1973, subject to availability of funding from the AID Mission.

Science Policy and Research Priorities

Planning for the study on science policy and research priorities began in October 1971 during the visit to Ghana of Dr. George Hammond, NAS co-chairman. Dr. Hammond held discussions with representatives of the CSIR; the Universities of Legon, Kumasi, and Cape Coast; and many individuals concerned with science policy and research priorities in Ghana. At the request of the chairman of the CSIR, the study originally scheduled for 7 - 23 March 1972 in Accra was postponed because of the political situation.

In September 1972 an NAS staff member visited Ghana at the request of the USAID Mission to Ghana to assess the possibility of reactivating the cooperative program. He held discussions with many local scientists as well as Ghanaian government administrators and military officials. The resulting recommendation, supported by the CSIR and the USAID Mission, was that the joint study on Science Policy and Research Priorities should be rescheduled for the spring of 1973, utilizing the terms of reference agreed upon earlier.

Accordingly, a joint NAS-CSIR Workshop on Science Policy and Research Priorities met in Accra, 20 - 30 March 1973 to consider how the CSIR could fulfill its mandate to advise the Ghanaian government on science policy and research priorities.

CSIR and NAS participants conferred with Ghanaian scientists, government officials, university administrators, and representatives from the private sector.

After examining alternative methods of developing advice on science policy and research priorities, the workshop produced the following recommendations and observations:

1. A new Science and Technology Planning and Analysis Group should

be established within the CSIR to assist it in performing the broad science advisory functions specified in Article I, Part 4 of the 1968 decree.

The functions, administrative relationships, and operating guidelines for the Planning and Analysis Group have been defined.

2. The workshop group has identified some principles that should influence development of science and technology in Ghana. These principles recognize a key economic priority--assuring an adequate scientific and technological infrastructure to support the aspects of industry and agriculture in Ghana that can compete in the world market, thereby generating foreign exchange, and supporting the areas essential to Ghana's general agricultural, industrial, health, and social development.

3. The CSIR should consider the following areas in relation to development objectives and needs in setting priorities for special studies:

(a) Agriculture

Sugar Production
Poultry Feed Industry
Agricultural Chemicals
Chemicals from Natural Products

(b) Industry

Industrial and Technical Extension
Development of Small-Scale Manufacturing Industries
Machine Tool Industry
Increasing the Export Potential
Local Studies of Scientific Equipment

(c) Education

Training for Science and Technology
Role of Classical Physical Sciences
Postgraduate Research and National Requirements

(d) Other Areas

Computer Utilization
Environmental Implications of Technological Development

While in Ghana the joint committee drafted a report, which the CSIR will publish in the near future.

NAS Panel

George S. Hammond, University of California, Chairman
Donald W. Barton, Cornell University
David Z. Beckler, Executive Office of the President
L. Edward Klein, Monsanto Company
John Henry Sununu, Tufts University

B.K. Wesley Copeland, NAS Staff Coordinator

Sudan

Sudanese National Council for Research Representatives have visited the NAS in Washington on two occasions to discuss the possibility of a collaborative program with the NAS. It has been tentatively agreed that a first workshop be planned for late 1973 to consider the development of Sudan's natural resources, with particular emphasis on soil and water management, livestock production, and stabilization of arid lands. A formal request to initiate the program is awaited; then NAS staff will visit Khartoum to discuss detailed arrangements.

Zaire (formerly Congo/Kinshasa)

Demographic Training and Research in Zaire

The report of the joint study group on Demographic Training and Research in Zaire, which met in December 1971, has been implemented during

the reporting period. A proposal submitted by the National University of Zaire to the Population Council, Inc., of New York for assistance in strengthening the demographic research and training capabilities of the university has resulted in a $75,000 grant for 1 year to permit the university to undertake a thorough planning effort for the long-term development of a department of demography. The initial grant provided for the services of two expatriate advisors and the award of two fellowships to qualified Zairois candidates for advanced training in demography at institutions abroad. The Board of the Population Council has approved in principle to a 5-year follow-on project to provide expatriate leaders, fellowships, and an expanded teaching and research program, budgeted at $300,000 - $500,000.

Earth Sciences

Following the visit of Dr. John C. Maxwell, then chairman of the NAS Division of Earth Sciences, to Zaire in December 1971 to discuss with ONRD counterparts the scope, timing, objective, and panel membership of the projected joint study, a meeting of U.S. scientists and Zairois scientists and government administrators took place in Kinshasa 20 July - 1 August 1972 to carry out the work program agreed upon by the two parties. The NAS panel of six specialists, accompanied by several Zairois counterparts, traveled in Zaire for 1 week to gain first-hand knowledge of the principal training and research facilities in the earth sciences and of the major mineral exploitation projects. The report of the joint study group considered the present state of the geological and mining professions in Zaire. It recommends increasing the numbers and quality of professionals and suggests mechanisms for increasing the effectiveness of geologic work, especially in the minerals industry. Their report emphasizes that to assure itself of a continued and increased income from its mineral and energy resources, Zaire must formulate long-range plans for their systematic discivery and development. Such plans should include a coordinated program of topographic, geologic, and hydrologic mapping. In conjunction with the mapping, research studies should be designed to accu-

mulate the basic scientific data needed by government and industry to find and exploit mineral, water, and energy resources and to collect the geologic and hydrologic data necessary for the construction and engineering groups engaged in developing the country.

To implement a comprehensive program of mineral prospection, evaluation, and exploitation, the joint study group also recommended the formation of a national company comprising the best qualified Zairois geologists, mining engineers, and metallurgists to plan and oversee a program for developing the country's mineral, water, and energy resources.

With respect to local training of specialized manpower, the joint study group notes the need for (1) better coordination of the curricula of the various institutes, (2) greater flexibility for the student in choosing his courses within his individual academic program, (3) better use of existing teaching personnel, (4) closer coordination of the present academic time schedules to permit students to avail themselves of existing programs of instruction, and (5) opportunities for on-the-job training in government service and in private mining and petroleum industries. The report also discusses the need for better use of available teaching equipment and identifies critical deficiencies in equipment, library facilities, and other material essential to an effective program for instruction and training.

U.S. Panel

John C. Maxwell, University of Texas, Chairman
Randolph W. Bromery, University of Massachusetts
Frank C. Canney, U.S. Geological Survey
Mark Gipson, Jr., Virginia State College
Lincoln R. Page, U.S. Geological Survey

James G. Zavistoski, NAS Staff Coordinator

2. ASIA

Afghanistan

In February 1973 Dr. Victor Rabinowitch visited Kabul to discuss BOSTID's programs in developing countries with officials of USAID and the Royal Government of Afghanistan. As a result of these discussions, it was agreed to hold a joint workshop on agricultural research priorities with particular reference to research on crop diversification, marketing, and food processing. The workshop is tentatively scheduled for late summer of 1973, pending a formal request from the RGA and the USAID Mission.

India

The NAS's collaborative program with the Indian National Science Academy remained in abeyance during the reporting period because of the continued political estrangement between the two countries and the projected termination of the AID program in India. No information is available regarding specific follow-up measures by the Government of India to the recommendations of the workshop on Water and Man's Life in India, in New Delhi, September 1971. Indications are, however, that the workshop, and the informal discussions and consultations between U.S. and Indian scientists during the NAS panel's 2-week visit to India, had a sizeable impact on Indian thinking about problems of the environment; for example, the constructive formal positions of the Indian delegation at the 1972 U.N. Conference on Problems of the Human Environment at Stockholm.

Indochina

In light of the political and military developments in Indochina during 1972, the NAS has begun to consider possible constructive roles in the

postwar period there. BOSTID staff members have gathered background material and held discussions with a considerable number of people who either have expertise on Indochina or are connected with organizations involved with possible postwar development efforts in the region.

Under a special grant from the NAS President's program initiation fund, and not as a part of contractual arrangements with AID, NAS Foreign Secretary Harrison Brown convened an ad hoc meeting on 9 April 1973 to consider the role of the NAS in the reconstruction and development of Indochina. Participants in the meeting were a group of National Academy of Sciences and National Academy of Engineering members, chairmen of relevant National Research Council committees, and several other individuals with specialized knowledge of social, political, and economic conditions in Indochina. The group recommended the kinds of scientific contacts the NAS should explore in Indochina, along with mechanisms for carrying out the exploration. The ad hoc meeting and related deliberations on Indochina are now financed through private resources of the NAS.

The ad hoc group considering possible NAS roles in the reconstruction and development of Indochina suggested that it might be useful and appropriate to investigate the possibilities of a bilateral workshop with South Vietnam. When the President of South Vietnam's Scientific Research Council, Professor Le Van Thoi, visited the NAS in April 1973, it was agreed that it would be useful for a BOSTID staff member to visit Saigon on a future Southeast Asian trip.

With regard to other program possibilities in the Indochina area, Staff Director Victor Rabinowitch and staff member John Hurley met with an official of AID/Laos on two separate occasions in Bangkok. Discussions were held on the possibility of conducting an NAS study of specific development strategies appropriate to the abundance of hydroelectric power in Laos. It was agreed that the subject could usefully be explored further and that AID/Laos should contact the NAS with a further definition of the problem if they wished to pursue the possibility of a study or workshop.

Ad Hoc Meeting on the Role of the NAS in the Reconstruction and Development of Indochina

Gilbert F. White, University of Colorado, Chairman
Harrison Brown, Foreign Secretary, National Academy of Sciences
David Challinor, Smithsonian Institution
James Grant, Overseas Development Council
Anton Lang, Michigan State University
Matthew Meselson, Harvard University
Bruce Old, Foreign Secretary, National Academy of Engineering
Roger Revelle, Deputy Foreign Secretary, National Academy of Sciences
Wallace Waterfall, Institute of Medicine

John Hurley, NAS Staff Coordinator

Indonesia

The NAS, through BOSTID and its predecessors, has had a long-term relationship with the scientific community in Indonesia. A major activity of this relationship has been a series of workshops jointly sponsored by the NAS and the Indonesia Institute of Sciences (LIPI). A workshop on food, in Jakarta in May 1968 produced several key recommendations on food production, which were incorporated into Indonesia's first 5-year plan. In January 1971 a workshop on Industrial and Technical Research, held in Jakarta, produced recommendations dealing with research organizations and management, technical information, standardization, fiscal incentives, patents, and small-industry extension services, as well as recommendations dealing with major industrial sectors.

The third joint activity, a workshop on Natural Resources, was held in Jakarta 11 - 16 September 1972 with the following major objectives:

1. To suggest policies and procedures for strengthening the integrated planning and utilization of natural resources;

2. To suggest scientific and technological inputs relevant and useful to the planning and utilization of natural resources; and

3. To provide a forum for a coordinated and constructive exchange of views by key scientists, policymakers, and adminstrators concerned with natural resources in Indonesia.

Seven NAS panelists participated in the workshop with about ninety Indonesian panelists and twelve observers from various Southeast Asian and European countries. Five working groups--land and soil resources, forest resources, water resources, ocean resources, and mineral resources--addressed detailed sectoral problems. Participants also met in plenary sessions to consider overall, cross-sectional issues.

The recommendations of the workshop were submitted to the National Development Planning Board (BAPPENAS) for consideration and use in preparation of the Second Five-Year Development Plan (1974 - 1979). A summary of the conclusions and recommendations was presented to President Suharto and his cabinet ministers responsible for economic and natural resources programs.

U.S. Panel

Joseph L. Fisher, Resources for the Future, Inc., Chairman
Leonard Berry, Clark University
Charles S. Dennison (retired), International Minerals and Chemicals Corporation
John M. Kelly, Petroleum Consultant
Joseph Lintz, Jr., University of Nevada
Harry Perry, U.S. Atomic Energy Commission
Roger Revelle, Harvard University
William E. Towell, American Forestry Association

John Hurley, NAS Staff Coordinator

A number of interesting follow-up activities have occurred since the workshop. In October 1972 President Suharto established a National Committee on the environment, thereby implementing one of the ten overall recommendations of the workshop. As a direct result of the workshop, in

late 1972 the Indonesian Armed Forces held a meeting on the security aspects of natural resources and presented a report to the Security Council of the Government of Indonesia. With regard to problems of data acquisition and dissemination and the integrated planning of water resources, both important workshop topics, UNESCO advisors will go to Indonesia during 1973 to work with BAKOSURTANAL (the survey and mapping agency), the Indonesian National Commission on Water Resources, and the Ministry of Public Works.

In February 1973 BOSTID staff members visited Indonesia to discuss further follow-up activities related to the natural resources workshop and to explore new project ideas. In meetings with LIPI and AID, several possibilities were identified and are currently undergoing further consideration and development.

Korea

The NAS has maintained a program of scientific cooperation with Korea since 1969. The anticipated termination by 1972 of the U.S. aid program in Korea prompted AID to obtain the advice of the NAS on actions that should be taken before that year to ensure continued Korean access to U.S. technical resources in support of development objectives. A BOSTID panel of five visited Korea in July 1969 and subsequently submitted a Study on the Future of U.S. Technical Cooperation with Korea.

In January 1972 at the request of AID and Korean officials, the NAS provided a three-man advisory panel to consult with officials of the Korean Ministry of Science and Technology (MOST). The panel's purposes were (1) to advise informally on the development of long-range policy for science and technology, (2) to suggest ways to strengthen and improve the governmental structure for science and technology, and (3) to review the organization and functions of research and development institutions and suggest modifications where appropriate. The recommendations of the panel resulted in a number of significant initiatives and changes in the policy and organizational structure of MOST and other scientific and technical

institutions; the implementation of these recommendations was reported in detail by Mr. Glenn Schweitzer, former head of AID's Office of Science and Technology, after his visit to Korea in November 1972.

Korea's Minister of Science and Technology, Dr. Choi Hyung Sup, has expressed a strong interest in putting NAS-MOST cooperation on a regular basis. Following visits by BOSTID Director, Dr. Victor Rabinowitch, to Seoul in February 1973 and by Minister Choi to Washington in the same month, agreement was reached on the outlines of a NAS-MOST program of scientific cooperation. A joint continuing committee on scientific cooperation will meet at least annually; four to six NAS members will serve on the committee for terms of several years. The continuing committee will address broad issues of the application of science and technology to Korean development, and will recommend possible ways to strengthen problem areas. Specific follow-up activities--such as workshops, study groups, or seminars--are likely to result from the committee's deliberations.

The detailed mechanisms and financial support for the program of cooperation are currently being actively explored. The first meeting of the continuing committee is tentatively scheduled for late 1973.

Philippines

The NAS has maintained a program of collaboration with the scientific community in the Philippines since 1965, working with the Philippines National Science Development Board (NSDB). The first Philippines - U.S. Workshop on Scientific and Technological Cooperation and Development, held in Manila in November 1965 was deliberately broad and exploratory, focusing on the challenges and potential for science and technology in the Philippines, scientific manpower needs, requirements for applied and basic science facilities, and mechanisms for increasing scientific cooperation between the Philippines and other countries.

In November 1966 a second joint workshop, at Asilomar, California, recommended that four specific problem areas--industrial research, oceano-

graphy, food and nutrition, and demography--be the subjects of further cooperative activity. Subsequently, a third workshop, on fisheries and oceanography, was held in Manila in December 1967. A fourth workshop in Bagio in January 1969 addressed problems of industrial research. A workshop on food technology was planned for 1970, but it was cancelled near the scheduled time because of student disturbances in the Philippines.

Although no joint projects have been carried out by the NAS and NSDB since 1969, the two organizations have maintained close contacts. BOSTID director Victor Rabinowitch and staff member John Hurley visited Manila in February 1973 and during discussions with the NSDB agreed in principle that a joint workshop on manpower needs for environmental planning and programs would be held in late 1973. Detailed workshop plans and arrangements for financial support are now being worked out.

Southeast Asia Regional Workshop in Singapore

A regional workshop on Water Resources, Environment, and National Development was held in Singapore in March 1972. The workshop, jointly sponsored by the Science Council of Singapore and the NAS, was attended by delegates from six Southeast Asian countries--Singapore, Malaysia, Indonesia, Thailand, South Vietnam, and the Philippines--and ten NAS participants. The first regional effort undertaken in the BOSTID workshop program, it was described in detail in last year's anniversary report.

No commitments have been made for further regional activities during the coming program year, although several ideas have been discussed. In February 1973, for example, BOSTID staff members visited the Asian Institute of Technology (AIT) in Bangkok. Dr. Harold Hoelscher, President of AIT, expressed interest in the possibility of developing a series of AIT-NAS seminars on specific environmental problems of the region. In a different context, several BOSTID advisors have suggested that there would be considerable value in undertaking a regional study--which might include a seminar or workshop on systems of response to natural hazards such as tropical cyclones and earthquakes.

With respect to continuing cooperation with Singapore, the Science Council of Singapore has invited the NAS to sponsor jointly a workshop on problems of tropical corrosion. The concept seems sound and useful, but NAS participation will depend on finding the necessary financial support.

Thailand

The NAS - National Research Council of Thailand (NRC) Workshop on Science Planning and Policy in Thailand, in Bangkok, 3 - 6 July 1972 was the first activity to be jointly sponsored by the two institutions, though not the first scientific meeting in Thailand in which the NAS has participated. The NAS selected a panel of nutritionists and food technologists to participate in the Seminar on Protein-Food Promotion in Bangkok 22 November - 1 December 1970. The seminar, organized and sponsored by the Institute of Food Research and Product Development at Kasetsart University, the Department of Health of the Ministry of Public Health, and USAID/Thailand, prepared recommendations on national nutrition policy and programs, which were approved by the Thai Cabinet and given to appropriate government agencies for implementation.

During the course of several contacts in 1971 and early 1972, the Secretary-General of the NRC, Dr. Pradisth Cheosakul, discussed with BOSTID the Thai interest in holding a bilateral workshop to help identify key problems and issues relating to science policy and to suggest possible means of strengthening problem areas.

Participation in the workshop consisted of 8 NAS panel members led by Foreign Secretary Harrison Brown, 50 official Thai participants from government ministries, universities, research institutes, and economic and planning organizations, and 15 - 20 observers from organizations such as UNESCO, AID, and SEAMES (Southeast Asia Ministers of Education Secretariat). The deliberations of the meeting were conducted in both plenary sessions and five working groups: industry and engineering; natural resource utilization; agricultural production; medicine, public health, and environmental quality; academic sciences.

Sectoral recommendations were made in the five working groups, and three overall recommendations were made by the workshop. The overall recommendations highlighted the following needs:

1. A high-level government committee to develop proposals for an effective governmental administrative structure for planning and implementing national policy in science and technology;

2. Detailed analyses of the problems related to science, technology, and national development and integration of the analyses into the third 5-year plan; and

3. Improvement of existing personnel policies relating to careers in science and technology.

Two important developments have occurred in relation to the implementation of the major workshop recommendations. Late in 1972, the Thai National Executive Committee (Cabinet) appointed a Subcommittee on Science Organization of its National Committee on Government Reorganization. This subcommittee has moved quickly to develop proposals for a new, streamlined government organization to relate economic and social development needs to science policy and plans. At the same time, and complementary to the reorganization subcommittee work, the National Economic Development Board is forming a Science and Technology Policy Subcommittee, which can play a strong role in the day-to-day integration of economic and scientific planning.

As a follow-up to the workshop, the NAS sponsored a visit to Thailand by Dr. Brewster Denny, Dean of the Graduate School of Public Administration at the University of Washington and a member of the earlier NAS workshop panel. Dr. Denny visited Bangkok 11 - 17 February 1973 to provide further encouragement and advice related to implementation of the workshop recommendations and to explore ways for the NAS to engage in continuing helpful collaboration with the Thais.

U.S. Participation

Harrison Brown, Foreign Secretary, National Academy of Sciences
Brewster C. Denny, University of Washington
Arnold B. Grobman, University of Illinois
William A.W. Krebs, Arthur D. Little, Inc.
John Milton, Washington, D.C.
Howard A. Minners, National Institutes of Health
A.H. Moseman, Malaysian Agricultural Research & Development Institute
Sidney Passman, National Science Foundation

John Hurley, NAS Staff Coordinator

3. LATIN AMERICA

Argentina

As part of the continuing U.S. - Argentine Cooperative Science Program, a task order under the NAS contract with AID was issued in August 1970 to support the implementation of recommendations adopted at the 1969 workshop with the Consejo Nacional de Investigaciones Cientificas y Tecnicas (CONICET). Activities were undertaken in science-information exchange, groundwater hydrology, and food technology.

Science Information Programs

Computer-Based Information Services. As originally envisaged, the project was directed toward the development within Argentina of computer-based information services, initially in the field of chemistry, and had the following components: (1) an intership program in the United States for the Argentine manager of the proposed service; (2) a U.S. consultant to help initiate the service in Argentina; and (3) commitment by CONICET of short- and long-term funding to establish the service. Following several unsuccessful attempts to initiate the project during 1971, the Board on Science and Technology for International Development was finally informed in May 1972 of CONICET's decision that for financial and organizational reasons, a major effort in the establishment of a computer-based chemical information service was not feasible at that time. CONICET and BOSTID agreed, therefore, that the best alternative strategy for continuing joint activities in science information would be to expand and strengthen the Telex Network during the following 6 months and to undertake a joint evaluation of the network to provide a case study for other groups contemplating similar activities.

Argentine Telex Network. During the period April 1972 - January 1973, the Telex Network was expanded and strengthened by

1. Supporting existing, and establishing new, linkages between U.S. libraries and the Argentine network. By 1 September 1973 the network was cooperating with five U.S. libraries: (John Crerar Library, Chicago; National Agricultural Library, Washington; MIT Libraries, Cambridge; Georgia Institute of Technology Libraries, Atlanta; and Linda Hall Library, Kansas City). All U.S. libraries agreed to use the abbreviated Telex communications format developed in the project and based on the international code of the International Federation of Library Associations. (This marks the first time, to our knowledge, that U.S. Libraries have been willing to use this abbreviated code extensively; this lays the groundwork for further "relatively" inexpensive, rapid communications between these libraries and other developing countries).

2. Investigation of possible cooperative agreements with other countries. In cooperation with the NAS, the Telex Network contacted libraries and information centers in a number of countries (Australia, Belgium, Canada, Great Britain, Ireland, Spain, Denmark, Hungary, Sweden, India, Mexico, Brazil, Chile, and Colombia) concerning the possibility of cooperative agreements with the Telex Network. Many have agreed in principle to cooperate, some on a quid pro quo basis; currency exchange problems have delayed the initiation of other cooperative agreements.

The network has taken particular steps to begin cooperation with other Latin American countires. A report on the network was presented to Latin American information scientists and documentalists at the August 1972 meeting of the Latin American Commission of the International Federation for Documentation in Mexico. Subsequently, the Mexican National Council for Science and Technology (CONACYT) invited Monica Allmand, Chief of the Argentina Telex Network, to Mexico for 2 weeks in December 1972 to discuss with its staff the establishment of a national telex network for scientific and technical information in Mexico and to give a training course on the topic to Mexican participants.

3. Acquiring necessary bibliographic tools for the network. Several publications to assist it in assessing the collections of U.S. and

other libraries acquired for the network included Chemical Abstracts Serivce Source Index, and Quarterlies; Irregular Serials and Annuals, an International Directory (Bowker); New Serial Titles, 1950 - 1970 (Bowker); Library Telecommunications Directory: Canada, and United States, and numerous serial holding lists of U.S. libraries.

The current cooperative science program between the NAS and CONICET terminated 31 December 1972. During December and January 1973 responsibility for the deposit accounts with the cooperating U.S. libraries was transferred to CONICET, and review and evaluation of the Telex Network was begun. The review, to be completed shortly, covered the following major topics: protocols for the establishment of the network; network operation and management; influence of the network on information services and use patterns in Argentina; costs and financing the Telex Network; and general evaluation, conclusions and recommendations. Interest in the Argentine Telex Network and its implications for pilot projects in other developing countries and regions has been expressed by a number of organizations, including the Organizations of American States, the Asian Institute of Technology, and the World Science Information System (UNISIST) program in UNESCO.

NAS Panel

Melvin S. Day, National Aeronautics and Space Administration, Chairman
Vern M. Pings, Wayne State Medical Library
Fred A. Tate, Chemical Abstracts Service

Judith Werdel, NAS Staff Coordinator

Groundwater Hydrology

In June 1972 Argentine authorities invited Dr. Stanley N. Davis, Department of Geology, University of Missouri, Columbia, to visit Buenos Aires to discuss a proposed groundwater hydrology research project in the dry pampas region. Dr. Davis had participated in the 1969 workshop and in 1970 had served on a NAS-CONICET study group to determine the feasibility

of a groundwater management study of the region. Largely because of local financing problems, the proposed study outlined by the NAS-CONICET group could not be undertaken in 1970. Upon returning to Argentina during 27 August - 3 September 1972, Dr. Davis reviewed the research design with officials of CONICET and the Subsecretariat of Hydraulic Resources; traveled to the interior of Argentina to inspect proposed sites for the research project; and, with Argentine associates, recommended modifications in the 1970 groundwater research proposal. Because international funds (AID or UNDP) have not been available for the project and because of very limited funding from Argentine sources, the study was not implemented during the year.

Food Technology

No significant activities developed after the July 1971 meeting in Buenos Aires of an NAS-CONICET Panel on Food Technology. The Argentine National Research Council was invited to send a small group of food scientists to the United States to discuss specific projects for joint research collaboration but did not do so. Again, the Consejo seemed to be principally interested in receiving direct grants in aid for research in Argentine food science rather than participating in bilateral programs in which CONICET would fund Argentine activities and U.S. sources would fund U.S. research.

Bolivia

In March 1972 during a visit to La Paz, Bolivia, a NAS staff member met with the President of the Bolivian Academy of Sciences to explore possibilities for a joint project. This meeting responded to an inquiry and invitation from Bolivia sent in November 1971. After the initial conversations in La Paz, the BOSTID office anticipated a letter from the Bolivian Academy on natural resource development; however, the communication was limited to research interests on Lake Titicaca. Because of the restricted focus of the Bolivian Academy's inquiry, the proposed project did not fit into BOSTID's development-oriented criteria. Although corre-

spondence continues with the President of the Bolivian Academy of Sciences and the USAID Mission, no plans have been made for a joint workshop or similar activity in the near future.

Brazil

During 1972-73 no major NAS - Conselho Nacional de Pesquisas (CNPq) workshop was scheduled but several continuing activities arising from recommendations of the Fourth Workshop (November 1971) were implemented.

Agricultural Research

A NAS-CNPq agricultural engineering education study was recommended by the Joint Agricultural Research Study Group at the Fourth Workshop. CNPq suggested that three U.S. agricultural engineers, two under NAS auspices and one under FAO sponsorship, collaborate with Brazilian experts in conducting the study. The NAS panel members were

Carl W. Hall, Dean, Washington State University
W.G. Matlock, University of Arizona

Jay Davenport, NAS Staff Coordinator

The Joint Study Group met 24 July - 12 August 1972 in Brazil. Members visited 16 teaching and research institutions as well as experimental farms, a major agricultural colonization project in the Northeast, and government agencies to assess the need for agricultural engineers, study current training methods, observe present research projects, and evaluate alternatives for future development of agricultural engineering as a new discipline and profession in Brazil. A separate report, Study for Agricultural Engineering Development in Brazil, was issued. The major recommendations of the study group were that (1) recognition under Brazilian law be given to agricultural engineering (engenheiro agricola) as a profession, (2) CNPq appoint an Agricultural Engineering Commission to guide

the development of the new profession, and (3) emphasis be given immediately to the preparation abroad of a cadre of Brazilian agricultural engineers who would return to carefully selected institutions for teaching and research.

A second project under the category of agricultural research is a proposed study of the utilization of the cerrado areas for more intensive agricultural production. A study group is to be formed in 1973 to examine present research in the cerrado, evaluate alternative strategies for developing sustained agricultural production, and make recommendations to the CNPq.

Agricultural Economics

A proposed program for strengthening agricultural economics research in state and federal agricultural stations was adopted by CNPq. Financing for U.S. visiting professors following the pattern of the chemistry program is under discussion under the terms of a new AID - Government of Brazil agricultural education loan, but actual implementation is probably at least one year off. In the meantime, the CNPq has provided funds for two Brazilian agricultural economists to work on research programs at the federal experiment station (IPEACO) in Sete Lagoas, Minas Gerais State.

Computer Science

The Joint NAS-CNPq Computer Science Study Group held its third and final meeting in Brazil, 6 - 12 August 1972, immediately after the Rio Symposium on Computer Education for Developing Countries. A specific plan, in the form of a project proposal, to strengthen graduate computer-science education at the Catholic University of Rio de Janeiro, the Graduate School of Engineering of the Federal University of Rio de Janeiro, and the University of Sao Paulo was submitted to CNPq and to the USAID Mission in Brazil.

The proposal was accepted by both organizations for grant funding at a level of U.S.$730,000 over a 4-year period. In March 1972 the proposed

grant was under review in the Latin America Bureau, AID/Washington, and was expected to be approved for funding beginning in FY 1974. However, with the impending reduction of effort of the USAID Mission, the future of the funding for this project is uncertain.

Two documents completed in 1972 were Recommendations for Improving Computer-Science Education in Brazil, First Report, December 1971; Second Report, August 1972.

U.S. Panel

Harry D. Huskey, University of California
Barry Boehm, Rand Corporation
Bruce Gilchrist, American Federation of Data Processing Societies
Michel A. Melkanoff, University of California

Jay Davenport, NAS Staff Coordinator

Other Activities

Because a new contract between the NAS and the USAID Brazil Mission was not completed in 1972, a study group in earth sciences education was not reactivated. Planning for the study group and for an NAS-CNPq continuing committee to oversee all joint projects was continued in anticipation of the new contract.

For a summary of the NAS ad hoc committee report, Science and Technology in Sao Paulo's Development, see Part II, Chapter 6.

Brazil Chemistry Program

As the chemistry program enters its fourth year, several major objectives have been accomplished: the enhancement of advanced research capability at "centers of excellence" in Brazil; the expansion of institutional capacities to produce high-level scientists; and the creation of close and it is hoped long-term, scientific ties between the United States and Brazil, at the usual level of senior scientists and also at the working level of young postdoctoral chemists.

Currently, eight NAS Overseas Research Fellows are actively working in Brazil, three at Rio de Janeiro and five at Sao Paulo. Of the total, three in Sao Paulo and two in Rio de Janeiro are in their third year; three of five Fellows who have completed their tours have been replaced.

Since the program's inception, the proposed ten major research projects have been initiated.

The program has resulted in completion of 7 MS degrees; 34 MS's and 10 PhD's are in progress. Fifteen technical papers have been published in international journals and fourteen others submitted for publication.

It is now evident that a smaller number of Brazilian PhD's will have been produced by the end of the original 5-year experimental period than was originally anticipated, and those produced will have had little postdoctoral experience. This situation results from initial difficulties and delays in recruiting and in enrolling appropriately qualified MS and PhD candidates when the program began in 1969.

The operational activities of the program were reviewed in detail by the joint study group in November 1972 with the objective of solving problems related to the need for rapid importation of equipment and chemicals, and other administrative and programmatic matters. A decision was reached not to expand the chemistry program by including additional Brazilian universities at this time; however, the field of catalysis research is to be added. The chemistry program will continue at least through 1974. Although this program resulted from a study group under the general cooperative program, AID financing of NAS participation is now accomplished through a host-country contract. Supplementary funding has been provided from both public and private sources.

Central America

Late in February 1973, a meeting of an NAS - Central American Research Institute for Industry (ICIATI) continuing committee was held at

ICAITI headquarters in Guatemala City. This was the first opportunity to review recommendations of the 1971 workshop and to consider follow-up activities. U.S. panelists were Dr. Edward Ackerman, Executive Officer of the Carnegie Institution of Washington, who had been chairman of the U.S. workshop participants in 1971; and Dr. David Pimentel, Professor of Insect Ecology, Cornell University. Agreement was reached to form a joint NAS-ICAITI study group on Central American Pesticides Use in Cotton Production.

Cotton is third in importance as an export crop for Guatemala, El Salvador, and Nicaragua, ranking just below coffee and bananas. High levels of insecticide use in cotton production have led to significant economic and environmental side effects: destruction of beneficial insect species; contamination of fish, commercial shrimp, livestock, wild animals and birds; and increasing incidence of human poisonings. The proposed ICAITI study will monitor and measure these effects and provide specific recommendations for better management of pesticide use. The role of the joint study group is to design and project and, if appropriate, to evaluate the results, but ICAITI will be responsible for gathering the data and publishing the final report.

Colombia

Since 1967, the Office of the Foreign Secretary, NAS, has been cooperating with Colombian scientists, engineers, economists, and other leaders on problems of science and technology in development. In 1968, a Colombia - U.S. Workshop on Science Policy Planning led to the creation of the Colombian Fund for Scientific Research and Special Projects (COLCIENCIAS) within the Ministry of Education. The first joint project of COLCIENCIAS and NAS was an examination of graduate education and research potential in Colombian universities in biology, chemistry, engineering, geology, mathematics, and physics. COLCIENCIAS requested the cooperation and assistance in the studies of the Colombian Institute for the Development of Higher Education (ICFES) of the Ministry of Education and the human resources section of the National Department of Planning (DNP).

Individual studies were completed in chemistry (February 1971), mathematics (March 1971), and engineering and applied sciences (February 1972). The final study, in the biological sciences, was made in June 1972.

U.S. Participants

Karl M. Wilbur, Duke University
Edward S. Deevey, Jr., Florida State Museum
Clinton Nathan Woolsey, University of Wisconsin

Jay Davenport, NAS Staff Coordinator

A multidisciplinary review panel met in Bogota on 30 - 31 October 1972 to examine each of the four studies and discuss summary conclusions. The review panel recognized that implementation of the studies on graduate education and research in Colombian universities is the responsibility of Colombian authorities. Furthermore, limited resources of highly trained manpower and of funds and considerations of Colombian economic development plans make setting priorities and a strategy for implementation very important. COLCIANCIAS and ICFES are cooperating in this task of implementing recommendations. The following reports on the NAS - Colombia projects are available.

1. Staff Summary Report of the Colombia - U.S. Study Panel for Graduate Education and Research in the Biological Sciences, May 29 - June 13, 1972.

2. Staff Summary Report on the Program for the Improvement of Graduate Education and Research in Colombian Universities in the Sciences and Engineering, February 1971 - October 1972.

In June 1973, COLCIENCIAS and ICFES plan to sponsor a meeting of Colombian university rectors to set priorities and a strategy for development of graduate education programs. Discussions have been held with BOSTID to plan a joint workshop with appropriate Colombian authorities

on coordination of university - industry - government institute research strategies related to Colombian development priorities.

Guatemala

In August 1972 OFS staff held discussions concerning a bilateral program with representatives of the USAID Mission in Guatemala; the Guatemalan Academy of Natural, Physical, and Medical Sciences; the Ministry of Agriculture; and the National Economic Planning Council. The proposed bilateral program between the NAS and the Guatemalan Academy would provide technical advice on a plan for the development and management of natural resources in Guatemala. Guatemalan-government support for the Guatemalan participation through their academy has not yet been forthcoming; however, Guatemalans still hope that funding for the program will be found in the near future.

Guyana

In 1972 Dr. Ptolemy Reid, Deputy Prime Minister of Agriculture of Guyana, indicated to the USAID Mission in Georgetown his interest and that of his government in applying the latest scientific and technical knowledge to converting into useful products the vegetation clogging Guyana's waterways. The National Science Research Council (NSRC) of Guyana and USAID in turn requested NAS support for a workshop on the management and utilization of aquatic plants.

The joint NSRC-NAS workshop, held in Georgetown 15 - 17 March 1973, was charged with making recommendations, for implementation by local authorities, on

1. dealing with the aquatic-weed problem, particularly by utilizing the vegetation for products, such as animal feeds and soil additives, needed by Guyana; and

2. developing outlines of integrated systems of aquatic-weed management in Guyana using biological, physical, and chemical methods.

Dr. Dennis Irvine, President of the NSRC, served as chairman of the Guyanan panel; Dr. Gerald Rohlich chaired the NAS group. Approximately 25 Guyanese participants took part in discussions with the seven member NAS panel.

The workshop was opened by the Prime Minister of Guyana, the Honorable L.F.S. Burnham. At the conclusion of the workshop, practical demonstrations were arranged at the Bel Air Dairies on the outskirts of Georgetown. A press designed by one of the NAS panelists was used to remove moisture from water hyacinth--the first step in producing animal feed and soil additives--and the pressed cake was fed to cattle and made into hay.

A final report on the proceedings and recommendations of the workshop is being published by the NSRC in Guyana.

Dr. Irvine indicated NSRC interest in future collaborations with the NAS, especially in the field of natural resources (rice technology, coconut, cassava, bagasse). Dr. Irvine is now inventorying all research under way in Guyana, to place the Council in a better position to choose priority areas for future NAS-NSRC collaboration. This will be discussed during Dr. Irvine's scheduled visit to Washington in early June 1973.

U.S. Participation in the Workshop

Gerard A. Rohlich, University of Texas, Chairman
Lawrence O. Bagnal, University of Florida
Fred D. Bennett, Commonwealth Institute of Biological Control (W. Indies)
Daniel S. Hartman, Crystal River, Florida
James Hentges, University of Florida
D.F. Livermore, University of Wisconsin
Richard R. Yeo, University of California

Noel Vietmeyer, NAS Staff Coordinator

Peru

The proposed workshop on national nutrition planning in Peru, scheduled for mid-May 1972, was postponed indefinitely at the request of Peruvian authorities. During a visit to Lima in November 1972, Dr. Rabinowitch discussed with Peruvians their interest in a renewal of bilateral activity, particularly in establishing criteria for assessing priorities for industrial research. Because governmental reorganizations have taken place since these discussions, it was felt that a delay was in order.

Haiti

During a brief visit to Port-au-Prince in March 1973, made at the request of AID Washington, NAS staff called on an official of the Haitian National Research Council and the USAID office to determine the interest in and desirability of establishing a cooperative program. Since USAID has only recently been reestablished in Haiti after an 8-year hiatus, no specific project ideas were developed. AID officials will inform the NAS if any program areas of possible mutual interest develop.

Caribbean (General)

Recent discussions with Hector Wynter, Project Director for the Association of Universities and Research Institutes of the Caribbean (UNICA), we stimulated interest in a possible workshop program, development of marine resources (including pollution aspects) being suggested as an appropriate topic. A staff visit is planned to follow up alternative sources of funding.

PART II

SPECIAL STUDIES AND ADVISORY PANELS

4. ROLE OF MULTINATIONAL CORPORATIONS IN STRENGTHENING R, D & E IN DEVELOPING COUNTRIES

NAS workshops and other studies related to industrial research in developing countries have suggested that U.S. firms operating in the developing world could contribute significantly to the strengthening of indigenous research, engineering, and development capabilities. To clarify these possibilities and provide guidance for its own policies, AID requested the NAS to undertake a study in collaboration with the National Academy of Engineering to

1. Examine the past role of U.S. private investment in strengthening R, D & E capabilities of developing countries;

2. Examine the potential role of the U.S. corporation in assisting the development of local R, D & E capabilities by

a. conducting local, in-house R, D & E programs,

b. identifying and designing R, D & E projects or processes of specific relevance to the host country,

c. adapting existing advanced technology to local conditions,

d. utilizing local R, D & E facilities and personnel, and

e. training research workers in both local facilities and U.S. laboratories;

3. Identify major factors that either strengthen or inhibit the initiation and expansion of these activities--the analysis to include such factors as

a. management attitudes toward local development efforts and U.S. corporate responsibilities therein,

b. management policy on the decentralization of corporate R, D & E activities,

c. host-country policies toward technological development by foreign enterprises,

d. host-country import policies on scientific and technological equipment and materials,

e. U.S. and host-country fiscal incentives for undertaking R, D & E activities, and

f. U.S. and host-country patent policies and related measures to protect industrial property rights.

The 15-member panel was composed of 10 from industry, 2 each from five sectors: automotive-farm implements, chemicals, electronics and communications, food, and pharmaceuticals. In addition, 5 academic members were selected for their professional interest in the subject.

The panel also met with ad hoc subpanel groups of experts from industry, the universities, foundations, government and international agencies in Washington, Boston, and New York. These subpanel sessions provided a framework for the study.

The report is now in press and will be ready for distribution in July 1973.

Panel Members

Charles S. Dennison, Former Vice President, International Minerals and Chemicals Corporation, Chairman

Jack N. Behrman, University of North Carolina

Ray H. Boundy (retired), Dow Chemical Company

Henri C. Busignies, International Telephone and Telegraph Company

Thomas Carney, G.D. Searle and Company

Paul F. Chenea, General Motors Corporation

Theodore Geiger, National Planning Association

Charles E. Geise, Del Monte Corporation

Humboldt W. Leverenz, RCA Corporation

Frederic, C. Lindvall, Deere and Company

Glenn A. Nesty, International Paper Company

Stefan H. Robock, Columbia University

Lewis H. Sarrett, Merck, Sharp and Dohme Research Laboratories

Wickham Skinner, Harvard University

John R. Stockton, CPC International

5. SUMMARY AND ANALYSIS OF PROGRAMS UNDERTAKEN BY THE OFFICE OF THE FOREIGN SECRETARY

The summary and analysis includes science cooperation programs undertaken from 1961 to 1971 in African, Asian, and Latin American countries. Primarily a self-evaluation, the study bases many program results, favorable and unfavorable, on reports by counterpart organizations, AID missions, and other appropriate sources. The main appendices contain descriptive summaries of programs and projects, project reports and publications, and an extensive list of U.S. and foreign participants who have engaged in the activities covered by the report.

The summary and analysis covers workshop activities of the Office of the Foreign Secretary since 1961 - 1971 in 12 countries and attempts to identify the factors influencing the success of projects. Generally speaking, factors influencing success were attitudes of AID, leadership of host institutions, availability of funding for workshop development and follow-up, quality of staff and panelists--especially in regard to sensitivity, knowledge, and communication ability; frequency and quality of communications between the NAS and host institution. Posing questions on the effectiveness of programs points up the difficulty of obtaining accurate program information; since not only AID has a poor institutional memory, but perhaps more surprisingly, the NAS does, too.

Critical factors for workshop programming evolving from the analysis are

1. The importance of working with a viable counterpart organization;
2. The need for open, joint discussion of objectives;
3. Agreement among the participants on the limitations of the exercise, so that the form and content of the program fit the local situation; and
4. Avoidance of a pedagogic or a patronizing attitude.

Continuity is extremely important to the success of the bilateral programs and is influenced by several factors, including changes of government, changes in the administration of the host organization, and changes in the political relations between the two countries. Other factors influencing program success include the too thin spread of local manpower in science and technology, the local AID mission's indifference toward the program, the short AID institutional memory, and lack of follow-up by NAS staff due to lack of funds.

The analysis makes clear that the optimal arrangement for AID-funded efforts is to have AID/Washington provide the basic funding, and AID country missions the local program costs.

The summary and analysis include the following recommendations:

1. An in-depth study of the Brazil and Taiwan programs, which represent two of the most successful BOSTID activities, to obtain more insight into factors that influence program quality and success;

2. A built-in evaluation of all major projects;

3. More follow-up activity to workshops and studies arranged with counterpart institutions;

4. Evaluation of special studies by an ad hoc committee; and

5. A study of factors influencing scientific and technological development in countries where the NAS has not been involved (such as Mexico) in contrast to countries in which NAS science cooperation programs have taken place--to see whether any differences are discernable.

The analysis concludes that the role of the NAS should be to work jointly with developing countries in applying science and technology to their development needs, serving in an advisory capacity and realizing that the implementation of recommendations must be carried out by the host country. The bilateral programs could be improved by finding more private funding (to permit greater flexibility and more follow-up), by careful program selection (so that BOSTID resources would not be spread too thinly), and by improved identification and selection of panelists, and inclusion of more social scientists.

6. SCIENCE AND TECHNOLOGY IN SAO PAULO'S DEVELOPMENT

In November 1971 officials of the USAID Mission to Brazil met with staff members of the Office of the Foreign Secretary to discuss a new approach for utilizing science and technology for the economic development of the State of Sao Paulo. Before proceeding further with the project, which was expected to be partially funded by a $25 million soft loan from USAID, AID officials sought a critical and objective outside review of the project concepts and the possible mechanisms for implementation. The NAS was requested to establish an ad hoc committee to perform this function.

The main objectives of the Brazilian project were

1. To improve the scientific and technological resources in the State of Sao Paulo, particularly as they relate to key areas in the industrial development of the state;

2. To encourage industry to utilize indigenous manpower capabilities and to develop new, or adopt imported, technologies that would accelerate development of new domestic products and processes or reduce production costs; and

3. To increase the state's capacity to train scientists and engineers and technicians for pure and applied research.

To reach these objectives, the Brazilian project proposed

1. To develop an advisory group to plan and evaluate programs in science and technology within the state's Ministry of Planning;

2. To enhance the resources to train scientists, engineers, and technicians in the universities and centers of technology through provision of scholarships, research grants and the institution of exchange programs; and

3. To provide risk capital for funding research and development projects for industry.

The AID Mission in Brazil believes the Sao Paulo project to be the first of its kind in that it utilizes a systems approach to harness science and technology for economic development. The project intends to concentrate on increasing the capacity of centers of reserach, i.e., universities, institutes of technology, and industrial reserach organizations, to train competent individuals and to conduct in-house research. These centers will be coupled to industry through the provision of risk loans to support research based on industrial needs. Significant emphasis will be placed on the development and improvement of services such as science information, standards, patent banks and protection laws, and financing institutions to support the research program.

The panel met in Washington in April 1972 to take part in a briefing on the project and to develop a plan of work for the project review scheduled for May 21 - 31 in Brazil.

Six major recommendations as quoted below from the Sao Paulo report, resulted from the panel's deliberation:

First: The Council of Science and Technology/Banco de Desenvolvimento de Estado de Sao Paulo Fund loans should be promoted for, and directed to, research projects that have a demonstrable commercial importance. Accordingly, most of the loans should go to the projects of firms susceptible to breaking into the EDR (engineering, development, and research) cycle. Correspondingly, we recommend that projects proposed and initiated by government institutes and universities should be financed from the Fund only if 20 - 30 percent of the total cost will be borne by one or more industrial or agricultural enterprises that would ultimately benefit from the work.

Second: The initial projects selected for financing from the Fund for Science and Technology should be used for a relatively few, generally large-scale, demonstration projects, which will have high visibility and thus lend credibility and impetus to the effort to promote the utilization of research and applied technology in Sao Paulo industry. To ensure

this result, extraordinary support--technological, managerial, and financial--for the design and execution of these demonstration projects should be mobilized in Brazil and abroad.

Third: The Council of Science and Technology and Banco de Desenvolvimento de Estado de Sao Paulo should be supported with highly competent staff to perform the key coordinating and policy and program decision making functions in the use of the Fund and in mobilizing resources to

- Encourage projects in export areas of economic and technological significance;

- Assist in policy formulation, and in the review and monitoring of projects from the perspective of the adequacy of the scientific-technological preparations for the projects as well as the possibilities of successful execution;

- Bring to bear on the selection of project proposals--and in the design of project proposals--judgments of a substantial marketing and research competence; and

- Assure that projects have as their objective tangible product and process development, the key purpose of the entire program.

The Council of Science and Technology and Banco de Desenvolvimento de Estado de Sao Paulo also should undertake to assure the establishment in such institutions as the Instituto de Tecnologia de Alimentos (ITAL) and the Instituto de Pesquisas Tecnologicas (IPT), of a strong capability for market research and project evaluation so that these institutions can make a strong contribution to the purposes of the project.

Fourth: Since the proposed Project is only one part of the State's program in science and technology, it is essential that the state give concomitant and substantial budgetary support to the research institutes and universities. More specifically, the State should strengthen the capacities of these institutions to contribute to the Project by correcting such fundamental problems as low salaries at the institutes and the prohibition on consultation with industry by university faculty and staff.

Technical assistance, to support the roles in the Project envisaged for the research institutes and the universities, should take the following forms:

- For the research institutes: Resources should be provided for sending technical specialists from the United States to work with staff in the Sao Paulo research institutes to help these institutes develop and strengthen their capabilities in such fields as project evaluation and market research, product and process development, standardization and quality assurance, and information systems. In certain circumstances, it may be advantageous to send institute staff to the United States for training in these fields.

- For the universities: Resources should be provided for sending young educators from U.S. universities to the universities in Sao Paulo to initiate or strengthen educational programs in, for example, research and engineering fields related to the project, research management, and marketing. U.S. postdoctoral students could be most usefully engaged in this task. Correspondingly, support should be provided for Brazilian students to enroll in U.S. universities for doctoral training in similar fields so they will be able to assume these educational responsibilities in the Sao Paulo universities in due course.

Fifth: Technical assistance provided by USAID should be deployed so as to have a significant impact on the project in two ways: first in the use of funds; and, second, in the administration of the use of resources by USAID itself.

Concerning the proposed use of funds, the proposal at present suggested that $10 million be allocated for hardware, and $15 million for other forms of technical assistance. The Panel believed there was insufficient justification for the hardware and that most of the equipment required by the Project can be made available from other existing sources, such as state and federal agencies.

Moreover, some of the other forms of technical assistance described in the Project are not fully responsive to certain major needs of industry.

Technical assistance should support the marketing, evaluation, and technical-service efforts that are summarized in the third and fourth recommendations, as well as the projects approved by the Council of Science and Technology. This would suggest a major emphasis on technical assistance of a practical type, except in such specialized areas as certain research and engineering fields related to the Project, information systems, standardization, and development of new university education programs. In any case, U.S. advisors in Sao Paulo should have ready access to institutional support in the United States.

The other major contribution of USAID will be through the activities of the staff it enlists to administer the technical assistance support for the Project. The quality of this administrative effort, especially in mobilizing other high-quality resources for the Project, will be a key factor in the entire process. Since this is an extraordinary role, it requires extraordinary talent.

To offer less than excellence in the management of USAID's contributory role could seriously handicap this promising initiative in economic development; to provide outstanding advice, counsel, and technical help through this Project could tangibly demonstrate the will and ability of the United States to mobilize its best resources to help Brazil achieve its major national objective.

Sixth: The entire Project, as revised, should have an implementation plan and program. Such a plan and program should be the principal responsibility of the Council of Science and Technology Project director and staff; it should be coordinated with the Government of Brazil and USAID as the other major participants in the program; and it should encompass activities outside Sao Paulo, in the United States, and possibly, Europe and Japan, which could aid in mobilizing EDR resources, facilitating access to appropriate technologies, and in creating a network of institutional relationships that would backstop the Sao Paulo engineering, R & D, and information-systems efforts. A deliberate, well-coordinated, and performance-oriented implementation program, possibly involving further assistance from the National Academy of Sciences and the National

Academy of Engineering, could be vital in moving the Project from an original, exciting concept to the realization of a model effort by Brazil to become an "outwardly oriented" industrial country in the shortest possible time.

The opportunity exists; the means are at hand; and Brazil and Sao Paulo have already demonstrated the national will and regional dynamism that can make this effort succeed.

In submitting its report, the panel chairman emphasized the following points: "first, the importance of having the Sao Paulo project focus on those efforts in science and technology that can improve the capacities of Brazilian industries to compete successfully in world markets; second, the potential importance of the Sao Paulo project as a model for demonstrating some of the significant ways by which science and technology can contribute to economic development; and third, the need for a plan and program of implementation that can better assure the successful operation of the Sao Paulo Project as a viable model for Brazil and other developing countries."

NAS Panel

Robert N. Kreidler, Alfred P. Sloan Foundation, Chairman
William E. Andrus, Jr., National Bureau of Standards
Kenneth R. Hansen, Doxiadis Associates, Inc.
George R. Herbert, Research Triangle Institute
Bernard Kupferschmid, Technology Transfer International
Richard O. Mason, University of California at Los Angeles
Kenneth K. Mabuchi, Greater Washington Interventure
Robert D. Stillman, Consultant
Jack Baranson, Resource Person

Wesley Copeland, NAS Staff Coordinator
Paul Irick, NAS Staff Coordinator

7. DEVELOPMENT OF RESEARCH ADMINISTRATORS AND TECHNICAL MANAGERS IN NEWLY INDUSTRIALIZING COUNTRIES

In the last reporting period, an ad hoc panel was constituted to advise AID on potential forms of U.S. technical assistance that would offer management training to administrators and senior researchers of industrial research institutes and other applied scientific establishments in developing countries. The objectives of the study were to (1) identify needs for, and features of, various training programs for research managers and senior researchers that U.S. organizations are best equipped to undertake in either the host country or the United States; (2) assess the interest in such programs, and potential contributions to them, of U.S. universities, government laboratories, private corporations, and independent research institutes; and (3) assess various alternative means of setting up training programs.

As a consequence of staff changes and the illness of the panel chairman, the completion of the report has been significantly delayed. It is now complete and will be sent to the printer in the summer of 1973.

Panel Membership

K. Nagarajo Rao, The Ford Foundation, Chairman
Lawrence W. Bass (retired), Arthur D. Little, Inc.
James Blackledge, Denver Research Institute
Donald W. Collier, Borg-Warner Corporation
Frank Croxton, Battelle Memorial Institute
D.H. Fisher, Roanoke College
Herbert O. Fleischer, U.S. Department of Agriculture
Lawton Hartman (retired), National Science Foundation
George R. Herbert, Research Triangle Institute
John Hoffman, National Brueau of Standards
Carl Rampacek, U.S. Bureau of Mines
N. Allen Riley, Chevron Oil Field Research Company

Daniel David Roman, George Washington University
George L. Royer, American Cyanamid Company
Merrit Williamson, Vanderbilt University

Julien Engel, NAS Staff Coordinator

8. ROLE OF U.S. ENGINEERING SCHOOLS IN TECHNICAL ASSISTANCE OVERSEAS

During the reporting period, the ad hoc advisory panel submitted a preliminary draft report addressed to its terms of reference:

1. To identify in U.S. engineering schools the interests and capabilities that are related to needs of developing countries such as curriculum reform, training and orientation of teachers, and development of indigenous institutions;

2. To recommend needed changes in the curricula of U.S. engineering schools to train engineers more directly to work with problems of developing countries;

3. To examine ways to relate research interests of U.S. schools to specific problems of developing countries and recommend ways for AID to mobilize U.S. schools for this task; and

4. To assess the interest of U.S. engineering schools, and their capabilities, in acting as intermediate contract organization in implementing development projects.

The panel gave particular attention to 1 and 3, but because of insufficient time and resources was unable to address itself adequately to 2 and 4. Moreover, other important questions on the potential role of engineering schools had emerged in the meantime, and the NAS proposed to AID that the study be extended into a second phase that would permit, with a change in the composition of the panel, a more extensive consideration of the subject. It is anticipated that AID will be agreeable to such an extension with modification of the new panel's terms of reference.

Initial Panel Membership

H. E. Hoelscher, University of Pittsburgh, Chairman
Merton R. Barry, University of Wisconsin
William Bollay, Private Consultant
George Bugliarello, University of Illinois
Robert M. Drake, University of Kentucky
Lucius P. Gregg, Alfred P. Sloan Foundation
John S. McNown, University of Kansas
Percy A. Pierre, Howard University

Julien Engel, NAS Staff Coordinator

9. APPROPRIATE TECHNOLOGIES FOR DEVELOPING COUNTRIES

Begun in 1971 under the title "Labor-Intensive Technologies for Developing Countries," the study was broadened in 1972 to include a wider range of topics on the industrialization process. The study continues to deal with labor-intensive versus capital-intensive techniques; strategies on import substitution, tariffs and capital; managerial factors in production and marketing; and noneconomic factors in the technology transfer process.

During the year a number of case studies were commissioned for the overall study:

1. Technologies in housing and building industries in developing countries, by Professor W. Paul Strassman, Michigan State University.

2. Appropriate chemical technologies and processes, by Ing. Jose Giral B., National University of Mexico.

3. Appropriate technological choices in metalworking industries, by Dr. Gerard K. Boon, El Colegio de Mexico.

4. Alternate technologies in iron and steel making, by Charles L. Kusik, A.D. Little, Inc.

5. A general study of the parameters and rationale for technological choices in product development in developing countries, by Dr. Simon Teitel, Inter-American Development Bank.

A special panel is being formed to review the case studies and, from the perspective of the individual member's experience, prepare a report that will

1. Appraise the relationship between technology and other factors affecting industrialization in LDCs;

2. Suggest mechanisms whereby indigenous capabilities in LDCs may be enhanced for selecting, adapting, and developing technologies more appropriate to local needs;

3. Identify research needs relevant to the development of more appropriate technologies;

4. Suggest U.S. and third-country capabilities that exist to help in the process of "discovery" of appropriate technologies; and

5. Recommend specific follow-up actions suitable for U.S. and multilateral donor organizations.

Panel Membership to Date

Bruce S. Old, Arthur D. Little, Inc., Chairman
Christian Kristoff, General Motors Corporation
Francisco Sagasti, OAS Advisor, Lima, Peru
Joseph E. Stepanek, UNIDO (Austria)
Simon Teitel, Inter-American Development Bank
Michael Todaro, Rockefeller Foundation

Jay Davenport, NAS Staff Coordinator

10. THE NEED FOR FEASIBILITY AND FUNCTIONS OF AN INTERNATIONAL INDUSTRIALIZATION INSTITUTE

Acting on a recommendation of an Airlie House seminar convened by AID/OST in December 1971, AID requested NAS-NAE to assess the feasibility, need, and demand for an international industrialization institute to aid the developing countries in the industrialization process.

The NAS-NAE study was conducted in two phases. Phase one, designed to furnish a preliminary assessment, was based on interviews with knowledgable persons in organizations located in the United States, such as the United Nations, foundations, the World Bank and its affiliated units, and other assistance agencies. This phase culminated in a 2-day meeting in April 1972 of a specially appointed NAS-NAE panel composed of U.S. and LDC specialists. The panel recommended an in-depth study with extensive canvassing of informed opinion in developing countries and appropriate development-oriented organizations and institutions in other parts of the world. These inquiries were conducted in the summer of 1972, and the results--as well as a draft report--were submitted to the original panel, which reconvened in November. Additional interviews were held; drafts of the report were prepared in the following months; and a preliminary draft of the final report circulated on a limited basis to AID in March 1973. The final report is expected to be published in 1973.

The panel recommended that the International Industrialization Institute be organized as a research body devoted to enhancing knowledge of the industrialization process, with the aim of helping both developing and developed countries to maximize the contribution of industrialization to their economic and social development, and to share equitably in its benefits.

The institute will be constituted to ensure autonomy and perceptive awareness of critical industrialization issues. It will be governed by an independent, self-perpetuating board of trustees drawn equally from developing and developed countries. The institute will have a core staff

of about 40 professionals from various nations, expert in a variety of disciplines, including industrial economics, physical and social sciences, engineering, international economics and trade, and in industry location, marketing, and manpower development.

The institute's interdisciplinary work program will not duplicate that of any existing agency. Program activities will be carried out in close collaboration with other research groups at national, local and international levels and with industrial and financial institutions. Location of the institute for maximum use of human and information resources will be determined by the board of trustees in consultation with prospective host countries.

The program of the institute will emphasize applied research to create new linkages among policy, the market mechanism, and technology, thereby helping to guide industrial decisions more effectively toward development goals. The initial program focus would be directed toward selection of industries and technologies by countries of varied circumstances; identification of policies to promote the growth of the selected industries, and increasing adjustability in advanced economies to accelerate desirable shifts of industries to new locales.

Panel Membership

Ojetunji Aboyade, University of Ibadan

I.A. Akinrele, Federal Industrial Research Institute (Nigeria)

Jack Baranson, Harvard Business School

Jack Behrman, University of North Carolina

James Blackledge, Denver Research Institute

William Bredo, Stanford Research Institute

Bernardo de Azevedo, Brazilian Mission to the U.N.

Gordon S. Brown, Massachusetts Institute of Technology

Charles S. Dennison, Former Vice President, International Minerals and Chemicals Corporation

Ignatio Deschamps. Instituto Mexicana de Investigaciones Technologicas (Mexico)

Kenneth Hansen, Doxiadis Associates, Inc.
Seymour W. Herwald, Westinghouse Electric Corporation
William A.W. Krebs, Arthur D. Little, Inc.
Lee Kum Tatt, Singapore Institute of Standards and Industrial Research
Kenneth K. Mabuchi, Greater Washington Interventure
P.C. Nayak, Bangalore, India
Oliverio Phillips-Michelsen, Bogota, Colombia, S.A.
Moeen A. Qureshi, International Finance Corporation
Saadia Schorr, General Electric Corporation
Joseph E. Stepanek, UNIDO (Austria)
Simon Teitel, Inter-American Development Bank
Lang Wong, International Development Research Center (Singapore)

Richard Morse, NAS Staff, Study Director
Hugh Miller, Principal Staff Officer for Study

11. AFRICAN AGRICULTURAL RESEARCH CAPABILITIES

African agricultural development is of increasing concern to African nations, as well as to the United States, other donor countries, and international agencies. Promising results obtained through research in Africa and other parts of the world, suggest the potential that exists for improving animal and crop production in Africa.

To explore this potential in depth, the Office of Technical Assistance Coordination in AID's Africa Bureau asked the NAS to undertake a study

1. To review, analyze, and establish, if necessary, the priorities in research and education that will enable agriculture to make its maximum contribution to the development goals of Africa;

2. To specify the institutions and systems of agricultural research and research-related education--international, regional, and national--needed to achieve the goals identified in 1.;

3. To determine the most appropriate roles, modes of operation, subject areas, and locations for non-African agencies to provide coordinated support for agricultural research and education in Africa;

4. To suggest appropriate channels of communication and cooperation among nations, agencies, and institutions;

5. To outline the means by which research and education can be applied most effectively to agricultural development; and

6. To make a broad assessment of the needs for scientific manpower implicit in the research system(s) and institutions recommended by the NAS committee.

To carry out this study, an international committee was created, consisting of 17 agricultural experts from the United States, Canada, Africa, and Western Europe. Several are affiliated with the leading institutions and agencies concerned with the development of African Agri-

culture, such as the World Bank; FAO; the U.N. Economic Commission for Africa; the French, British, and Canadian aid programs; the Rockefeller Foundation; and others.

The first meeting was held in Washington, D.C., in April 1971. A topical outline was drawn up to specify the subject areas to be addressed. Consultants were selected to provide resource papers on subjects such as commodities, livestock, farming systems, infrastructure of rural services and institutions, regional and international agriculture development, institutions and manpower training and others.

The second meeting was convened in Addis Ababa, Ethiopia, to afford study members the opportunity to converse with the 129 agricultural scientists representing 20 African counrtries and 8 European and North American nations at the Conference of the Association for Advancement of Agricultural Sciences in Africa (AAASA).

Subsequently, a meeting was held in December 1971 in Washington, D.C. and another in Bellagio, Italy, in March 1972 to review and discuss the general topics and content of the draft report.

A draft report was completed in November 1972 and circulated to the committee for review and comments. Suggestions, comments, and other inputs received from the membership and some review readers were used to prepare a revision of the November 1972 draft. It has been circulated to the membership in preparation for the last meeting of the study group on 24 - 26 April 1973 in Dakar, Senegal. This 2-day executive session is to be devoted to a review of the final chapter dealing with conclusions, recommendations,and priorities.

Following the April meeting, the final draft will be prepared and submitted to the NAS for its review and edutorial procedures. As soon as the published document is ready, it will be forwarded to USAID.

This project is carried out under the joint auspices of the NAS Agricultural Board and the Board on Science and Technology for International Development.

Committee Membership

John J. McKelvey, Jr., Rockefeller Foundation, Chairman

H.R. Albrecht, International Institute of Tropical Agriculture

G.H. Beck, Kansas State University

A.H. Bunting, University of Reading

G.C. Camus, Office de la Recherche Scientifique et Technique Outre-Mer

R.W. Cummings, International Crops Research Institute for the Semi-arid Tropics (India)

Matthew Dagg, Ahmadu Bello University

R.F.E. Devred, FAO

J.C. deWilde, International Bank for Reconstruction and Development

R.K.A. Gardiner, U.N. Economic Commission for Africa

W.D. Hopper, International Development Research Center (Canada)

G.L. Johnson, Michigan State University

F.D. Maurer, Texas A & M University

T. Odhiambo, National University of Nairobi (Kenya)

G.F. Sprague, U.S. Department of Agriculture

Montague Yudelman, Organization of Economic Cooperation and Development

Joyce Torio, NAS Staff Coordinator

12. ROLE OF SCIENCE AND TECHNOLOGY IN INTERNATIONAL DEVELOPMENT IN THE 1970s

During the last reporting period, at the request of AID, the NAS undertook a study aimed at providing a clearer perspective on the uses of science and technology as development tools and suggesting guidelines for more effective use of these tools in the future. As a first step, the NAS held a week-long conference at Woods Hole, Massachusetts, in August 1971 to consider The Role of Science and Technology in International Development in the 1970s. The meeting involved about forty participants from private business and industry, development-assistance agencies, government, universities, and both developed and developing countries.

The conference worked on three major themes: (1) the capacity of developing countries to generate science and to generate, adapt, or transfer technologies; (2) the capacity of developing countries to utilize science and technology effectively; and (3) the role of developed countries and assistance agencies in helping developing countries strengthen their technology-generating and- utilizing capacities. Interesting ideas and important issues were raised; the participants concluded that it would be valuable to explore these matters more systematically and in greater depth, and to treat the relevant issues in a holistic framework, examining case studies of the uses of science and technology in developing countries, in order to make recommendations in the light of real-life patterns of success and failure.

The current reporting period has been spent organizing and initiating the case studies portion of the report. About a dozen authors have been identified and are in various stages of their work. Other study topics have been identified, and authors are being considered. Selection of the official study committee has been under way and is nearly completed.

The coming months will be devoted primarily to interaction between commissioned authors and the study committee, and the revision of draft papers.

It is anticipated that this process will be completed early in 1974 and that the final summary and conclusions portion of the study will be drafted then.

Membership of the Ad Hoc Advisory Committee

Roger Revelle, Harvard University, Chairman
William L. Eilers, Smithsonian Institution
Everett E. Hagen, Massachusetts Institute of Technology
Maximo Halty-Carrere, Organization of American States
W. David Hopper, International Development Research Center (Canada)
Bruce S. Old, Arthur D. Little, Inc.
James B. Quinn, Dartmouth College
Vernon W. Ruttan, University of Minnesota
Saadia M. Schorr, General Electric Corporation
Theodore W. Schultz, University of Chicago

John Hurley, NAS Staff Coordinator

13. ARID LANDS OF SUB-SAHARAN AFRICA

Discussions have been held periodically between BOSTID staff and personnel of AID's Africa Bureau and OST on a study or workshop on arresting the deterioration of the arid lands, and on their economic and social development. Although the indigenous scientific competence in these countries (Nigeria and Sudan, parts of which fall in this region, are referred to elsewhere) is still limited and it is premature to consider holding a science-development workshop with any of them, their "least-developed" status in the international technical assistance scheme and particularly the severe drought they have suffered in recent years, with appalling consequences for humans and livestock alike, have made the response to their problems a matter of some priority. It seems likely the NAS may be requested to participate in an effort to bring U.S. and international scientific competence together to bear on problems of soil and water management, livestock production, and stabilization of the fragile ecosystem.

14. ADVISORY COMMITTEE ON TECHNOLOGY INNOVATION (Formerly Technological Innovation and Monitoring Program)

Although a developing country is generally well aware of the problems it faces in the process of development, it frequently is not in a position to avail itself of all the benefits advanced technologies can offer to solve these problems. Furthermore, these technologies may often be inappropriate to the particular circumstances in developing countries. What often is more to the point is the identification of technologies--dormant, latent, or utilized in a different fashion in the United States or other developed countries because of their different economic or social conditions--that could be usefully applied in developing countries. This problem of how to identify and transfer innovative uses of technology--and how to foster the related research and development activities--that may contribute to developing countries is a serious gap in the spectrum of assistance provided by developed countries.

To respond to this need, an Advisory Committee on Technology Innovation (ACTI) was established at the end of July 1971 by the Board on Science and Technology for International Development, at the request of the Agency for International Development. This committee has met every other month since its inception.

The program supervised by this committee has two specific objectives:

1. The generation of ideas for innovative applications of present-day technological developments to immediate problems of developing countries; and

2. The identification of concerted research efforts that could drastically shorten the time lag characteristic of the normal progression of scientific advance to potential application.

The approach evolved by ACTI is, in principle, a progression from (1) initial idea exploration by the committee to (2) ad hoc advisory group studies to (3) in-depth study by expert panels to (4) project

recommendation. The progression is altered, however, to suit particular cases, and the value of flexibility has been amply justified by experience thus far. A significant characteristic in the operation of the committee is the breadth of the background of its members, which ranges from international organizations to engineering to mathematics to food technology. Equally important to the operation of the committee as its activities unfold, is the participation of members from developing countries. A presentation at the Fourth Brazil - U.S. Workshop in November 1971 of the goals and mode of the committee's operation elicited considerable interest from the Brazilian participants and led to a request that the committee meet in Brazil in the near future. This meeting is now being negotiated under a task order with the Brazil USAID Mission.

During this reporting period the committee and its staff have completed some studies and begun others, all of which are briefly described, as follows.

Terrestial and Marine Applications of Ferrocement Construction

The initial stimulus for this study on ferrocement was the hope of remedying the shortage of suitable fishing vessels which frequently prevents developing countries from realizing the potential of their fishery resources, but early in the study, other, equally important applications of ferrocement engaged the panelists' attention. The panel has issued a report Ferrocement: Application in Developing Countries (February 1973) intended for use by AID and for distribution to appropriate organizations and individuals in developing countries. The report includes a review of the state of the art and recommendations for applications in LDCs, including

1. Substitution of ferrocement for wood in the construction of hulls for indigenous boats;

2. Utilization of ferrocement for pest-proof storage facilities;

3. Investigation of the use of ferrocement in construction of food-processing equipment;

4. Investigation of the use of ferrocement for low-cost roofing;

5. Establishment of a continuing international coordinating committee to encourage transfer of information;

6. Establishment of international training facilities.

NAS Panel

James Romualdi, Carnegie-Mellon University, Chairman
Gordon W. Bigg, Carleton University
Thomas E. Colvin, Colvin Manufacturing Corporation
Martin E. Iorns, Fibersteel Company
Smith Kampempool, Applied Scientific Research Corporation of Thailand
Pelayo Llarena (Guatemala)
John E. Pinto, Naval Ship Engineering Center
W. Morley Sutherland (New Zealand)
R. Brady Williamson, University of California (Berkeley) (Consultant)

Noel Vietmeyer, NAS Staff Coordinator

Development and Use of Inexpensive Roofing Materials and Techniques

In response to AID's concern with construction of low-cost housing in less developed countries, the committee agreed to commission a study of upcoming technologies relevant to roofing, a major problem in the low-cost construction field. The study by a special panel of the NAS Building Research Advisory Board (BRAB) reviews available materials and technologies, suggests applications, and recommends critically needed research and development. Soon to be issued, the report is intended for use by AID and other development agencies, as well as building research institutes concerned with construction of low-cost housing in tropical countries.

NAS Panel

Albert G.H. Dietz, Massachusetts Institute of Technology, Chairman
C.E. Bushnell, Jr., Armstrong Cork Company
Thomas Callaway, U.S. Dept. of Housing and Urban Development
Eric Carlson, United Nations
J.P.R. Falconer, Washington University
Richard L. Fricklas, Johns-Manville Research and Engineering Center
Alberto Gonzalez-Gandolfi, United Nations
Philip Huber, Organization of American States
J.W.S. deGraft Johnson, University of Ghana (Africa)
Robert G. Lindner, H.H. Robertson Company
Bruce McCartney, Peace Corps--ACTION
Dinesh Mohan, Central Building Research Institute (India)
Trayon Onett, Koppers Company, Inc.
Arnold Rosenberg, W.R. Grace Company
Henri Scioville Samper, Inter-American Development Bank
William R. Tyler, Aluminum Company of America

Warren Nellis and Noel Vietmeyer, NAS Staff Coordinators

Low-Power Sources of Electricity for Rural Areas

In fall 1971, ACTI became interested in the problem of providing power for electrical devices in rural areas not served by electrical power transmission lines or by local generators. Although the interest was sparked by the problems faced by Indian planners in connection with the Satellite Instructional Television Experiment (i.e., how to power the television receivers to be used in villages with no power lines), the committee knew that the problem extended throughout the developing world in the need to operate fixed and portable devices for communications, emergency lighting, refrigeration, and medical equipment.

A special ad hoc panel of experts in mechanical and electrical engineering, solid-state physics, and field use of small devices in developing

countries met in April 1972 to consider the status of materials and devices that might be applicable. As a result of this discussion, ACTI commissioned the National Bureau of Standards to conduct an engineering survey of the devices now available in the range up to about 100 watts, on which would be based formal recommendations to AID for further activity.

Now that the engineering survey is complete, ACTI can identify the people, disciplines, and industries to be represented on a second expert panel to be organized soon. This panel, using the survey as a base document, will report on the status of low-power electrical generators that will include recommendations for immediate and midterm solutions to rural power requirements.

Unsolved Technological Problems in Developing Countries

ACTI, having noted the enthusiasm with which the two publications 100 Problems in Environmental Health* and 101 Problems in Food Science and Technology** were received by the U.S. scientific community, felt strongly that a series of publications describing specific technological problems of immediate concern to developing countries would be useful and valuable from many points of view:

1. It would provide a series of compendia, in specific fields, of real problems of practical concern to developing nations, which, as a source of research topics, could stimulate the interest and involvement of researchers and graduate students, at home and abroad, in research activity leading to their solution.

2. It would serve as a rational filter for screening the ever increasing numbers of problems that are being brought to the attention of ACTI and its staff and provide a needed data base for ACTI's activities.

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* 100 Problems in Environmental Health. Jack E. McKee et al. ed., HEW (1961)

** 101 Problems in Food Science and Technology. C.O. Chichester et al. ed., HEW (1969)

3. It would provide a mechanism for diffusion of technological information to the scientific community and the public.

4. It would serve as a mechanism to enable the NAS to become a catalyst in applying the technological abilities of the United States to problems of development.

5. By incorporating solutions and the names of their developers in subsequent issues, it would increase communication within the developing world, facilitate wider application of results, and discourage duplication of effort.

For the pilot study in food technology, over 300 solicitations for problem contributions were sent, primarily to developing countries. From approximately 100 responses, about 65 were selected for further consideration by an editorial committee of eminent scientists in food technology and nutrition. This committee with a member of ACTI serving as editor, has examined each contribution to ensure the validity of the information and the importance of the problem. The following format is used.

Title
Problem Description
Background Information
Possible Approaches to Solution
Special Requirements
Bibliography
Key Contact Person

Following are a few examples of the problems submitted for this volume:

Low-Cost, Safe Food Packaging for Processed Foods

Indigenous Sources of Enzymes for Accelerated Fish Fermentation

Changes in the Carbohydrate Fraction of Corn during Tortilla Preparation

Plant-Protein Mixtures as Food Supplements

Development of Ready-to-Eat Weaning Food Suitable for the Middle East

Low-Cost Grain Storage for Family Unit
Design for a Portable Rice Dryer
Microbiological Monitoring Kit for Small Food Plants
Separation of Coconut Oil and Protein by Fermentation
Production of Low-Lactose Milk Foods in Developing Countries
Preservation of Raw Fish

As mentioned previously ACTI intends to up-date the volume periodically to include not only important new problems, but also solutions that have been found.

Editorial Panel on Unsolved Problems in Food Sciences for Developing Countries:

E.R. Pariser, Massachusetts Institute of Technology, Chairman
C.O. Chichester, University of Rhode Island
Samuel A. Goldblith, Massachusetts Institute of Technology
Marcus Karel, Massachusetts Institute of Technology
Peter Pellett, University of Massachusetts

Norman Brown, Staff Coordinator

Mosquito-Control Techniques

Preliminary investigation by the committee's staff indicated that many entomologists felt that the time was ripe for a new look at mosquito control in terms of innovative techniques that were not being explored by agencies concerned with public health in developing countries. An expert panel was established to examine such innovative techniques. Mosquito Control: Some Perspectives for Developing Countries (March 1973) reviews current knowledge in mosquito control and identifies several specific areas in which further research might produce results of great benefit to developing countries.

NAS Panel

David Pimentel, Cornell University, Chairman
Ernest C. Bay, University of Maryland
John Briggs, Ohio State University
Harold Chapman, U.S. Department of Agriculture
George B. Craig, University of Notre Dame
Marshall Laird, Memorial University of Newfoundland
Eldon L. Reeves, University of California
Claude H. Schmidt, U.S. Department of Agriculture

Noel Vietmeyer, NAS Staff Coordinator

Special Panels on Innovative Research Opportunities

ACTI is also experimenting with special panels whose aim is the identification of areas of research or development in which concerted effort can be instrumental in hastening the application of new laboratory developments. The panels are vehicles for generation and exchange of innovative ideas on an informal basis by groups of carefully diversified membership, each organized on a deliberately restricted geographical (U.S.) basis. Each group can meet frequently and informally, with a minimum of expense and inconvenience. The first such group, organized in the Palo Alto area, has identified developments in two fields that are the subject of continuing discussion: (1) field identification of intestinal parasites without the use of expensive equipment or highly trained personnel; (2) manufacture and fitting of cheap eyeglasses, to prescription, in urban centers and rural areas. ACTI expects to forward the results of these discussions to AID in the near future.

Encouraged by its experience with the first special panel innovative research opportunities, ACTI is now organizing a second group in the Boston-Cambridge area.

ACTI and its staff have also served as a resource base for information on specific technologies to AID, in Washington and various missions abroad. For example, one of the ACTI staff spent 2 months visiting the USAID missions in Bangladesh, Nepal, and Laos at their specific request.

Advisory Committee on Technology Innovation

George Bugliarello, University of Illinois, Chairman
E.R. Pariser, Massachusetts Institute of Technology
Lewis Perinbam, Canadian International Development Agency
Charles A. Rosen, Stanford Research Institute
Stanislaw Ulam, University of Colorado

III

REPORTS INFORMATION

Reports completed under AID/csd-2584 during

period April 1, 1972 - March 31, 1973

Task Order #1

1. Scientific and Technical Information for Developing Countries, April 1972.

2. Summary Report of a Regional Workshop on Water Resources, Environment and National Development, Singapore, March 13 - 17, 1972. (staff summary)

3. Regional Workshop on Water Resources, Environment, and National Development, March 13 - 17, 1972. Volume 1: Summary of Workshop Proceedings. Published by Science Council of Singapore.

4. Summary Report of the Workshop on the Contribution of Science and Technology to Development, Santiago, Chile, January 11 - 15, 1971. (staff summary)

5. Summary Report of the NAS - NRC Workshop on Science Planning and Policy in Thailand, Bangkok, Thailand, July 3 - 6, 1972. (staff summary)

6. Workshop on Science Planning and Policy in Thailand, Bangkok, Thailand, July 3 - 6, 1972. Final Report. Printed by National Research Council of Thailand.

7. Report of the Joint Study Group on Geological Training and Research in the Republic of Zaire, Kinshasa, Republic of Zaire, July 20 - August 1, 1972.

Task Order #3 (Argentina)

none submitted

Task Order #5 (Colombia)

1. Staff Summary Report on the Colombia - U.S. Study Panel on the Potential for Graduate Education and Research in Engineering, Physics, and Applied Geology in Colombia, Bogota, Colombia, February 14 - 25, 1972. (staff summary)

2. General Report of the Colombia - U.S. Study Group on The Potential for Graduate Education and Research in the Biological Sciences in Colombian Universities, Bogota, Colombia, May 29 - June 13, 1972. (staff summary)

3. Staff Summary Report--Program for the Improvement of Graduate Education and Research in Colombian Universities in the Sciences and Engineering. (staff summary of activities under Task Order #5)

Task Order #6 (Indonesia)

1. Report on the LIPI-NAS Workshop on Industrial and Technologcial Research, Jakarta, Indonesia, January 25 - 30, 1971. Volume I: Overall Findings and Recommendations. Vol. II: Plenary Sessions and Working Groups Report. Published by Lembaga Ilmu Pengetahuan Indonesia.

Task Order #7

none submitted

Task Order #8 (Korea)

1. Summary Report of Activities of the NAS Advisory Panel to the Mininstry of Science and Technology, Republic of Korea, January 10 - 21 1972. (staff summary)

Task Order #9 (Zaire)

1. Report of the Joint Study Group on Demographic Training and Research in the Republic of Zaire, Kinshasa, Republic of Zaire, January 24 - 28 1972.

2. Rapport et Recommandations du Colloque entre la NAS et l'ONRD sur les Problemes de Recherches et de Formation Demographiques, Kinshasa, 25 - 28 janvier 1972. (French)

Task Order #10 (Sao Paulo)

1. Science and Technology in Sao Paulo's Development, July 1972.

Task Order #11 (Indonesia)

1. Summary Report of the NAS-LIPI Workshop on Natural Resources in Indonesia, Jakarta, Indonesia, September 11 - 16 1972. (staff summary)

2. A Report on the LIPI-NAS Workshop on Natural Resources, Jakarta, Indonesia, September 11 - 16, 1972. Volume I: Overall Findings and Recommendations, Working Group Reports. Published by Lembaga Ilmu Pengetahuan Indonesia.

AID/csd-1122, Task Order #3 (Brazil)

1. Recommendations for Improving Computer-Science Education in Brazil: Summary Report of the NAS-CNPq Study Group on Computer-Science Education in Brazil, Rio de Janeiro, Brazil, December 10 - 15 1971.

2. Improving Computer Science Education in Brazil: Second Report of the NAS-CNPq Study Group on Computer-Science Education in Brazil, Rio de Janeiro, Brazil, August 1972.

3. Study for Agricultural Engineering Development in Brazil: Report of the Joint Study Group on Agricultural Engineering in Brazil, July 24 - August 12 1972.

4. Science and Brazilian Development: Report of the Fourth Workshop on Contributions of Science and Technology to Development, Washington, D.C., November 1 - 5, 1971.

Reports in preparation on activities held during period April 1, 1972 - March 31, 1973.

AID/csd-2584, Task Order #1

1. *Summary minutes of Meeting of Board on Science and Technology for International Development (October 1 - 2 1972).

2. *National Academy of Sciences International Development Programs: Summary and Analysis of Programs Undertaken by the Office of the Foreign Secretary.

3. Involvement of U.S. Engineering Schools in Foreign Assistance Activities (Initial report to serve as background document for new panel being convened.)

4. Development of Research Administrators and Technical Managers in Newly Industrializing Countries.

5. R, D & E in LDCs and the U.S. International Firm.

6. Report of Ghana-U.S. Study Group on Science Policy and Research Priorities.

*Reports completed and transmitted since 31 March 1972.

7. Innovative Potentials in Inexpensive Roofing Systems for Developing Countries.

8. *Mosquito Control: Some Perspectives for Developing Countries.

9. *Ferrocement: Applications for Developing Countries.

10. Unsolved Food Science Problems in Developing Countries.

11. Aquatic Plant Management: Some Perspectives for Guyana.

12. Meeting the Challenge of Industrialization: Proposal for an International Industrialization Institute.

Task Order #3 (Argentina)

1. Report of the Argentine-U.S. Study Groups on Food Technology and Groundwater Hydrology.

2. Report of the Argentine-U.S. Panel on Scientific Information.

Task Order #7 (Africa)

1. African Agricultural Research Capabilities Report.

AID/csd-1122, Task Order #3 (Brazil)

1. *NAS-CNPq Science Cooperation Program: Staff Summary Report of Activities, February 1968 - December 1972

*Reports completed and transmitted since 31 March 1972.

IV

MEMBERSHIP

BOARD ON SCIENCE AND TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT

Board on Science and Technology for International Development (BOSTID)

(Members, 1972 - 1973)

*Carl Djerassi, Department of Chemistry, Stanford University, Chairman 1972 - ; Member 1968 -

*Roger Revelle, Director, Center for Population Studies, Harvard University, Chairman 1968 - 1972; Member 1968 -

C. Arnold Anderson, Comparative Education Center, University of Chicago, Member 1971 - 1972

*Ivan L. Bennett, Jr., Dean, School of Medicine, New York University Medical Center, Member 1971 -

*George Bugliarello, Dean of Engineering, University of Illinois, Member 1972 -

*Charles S. Dennison, Former Vice President, International Minerals and Chemicals Corporation, Member 1972 -

D. Mark Hegsted, Department of Nutrition, Harvard University School of Public Health, Member 1970 - 1972

Lady Barbara Ward Jackson, Albert S. Schweitzer Professor of International Economic Development, Columbia University, Member 1971 - 1972

*William A. W. Krebs, Vice President, Arthur D. Little, Inc., Member 1968 -

*Robert N. Kreidler, Executive Vice President, Alfred P. Sloan Foundation, Member 1968 -

Roy L. Lovvorn, Cooperative State Research Service, U.S. Department of Agriculture, Member 1968 - 1972

John J. McKelvey, Jr., Associate Director, Agricultural Sciences, The Rockefeller Foundation, Member 1968 - 1972

*Joseph Pettit, President, Georgia Institute of Technology, Member 1972 -

*Joseph B. Platt, President, Harvey Mudd College, Member 1968 -

H. F. Robinson, Provost, Purdue University, Member 1968 - 1972

Stefan H. Robock, Graduate School of Business, Columbia University, Member 1968 - 1972

H. Burr Steinbach, Dean of Graduate Studies, Woods Hole Oceanographic Institution, Member 1968 - 1972

*Gilbert White, Institute of Behavioral Science, University of Colorado, Member 1972 -

Carroll L. Wilson, Alfred P. Sloan School of Management, Massachusetts Institute of Technology, Member 1968 - 1972

*Sterling Wortman, Vice President, Rockefeller Foundation, Member 1972 -

Members Ex-Officio

*Harrison Brown, Foreign Secretary, National Academy of Sciences

*Walsh McDermott, Institute of Medicine, National Academy of Sciences

*Thomas F. Malone, Deputy Foreign Secretary, National Academy of Sciences

*Bruce S. Old, Foreign Secretary, National Academy of Engineering

*Current Members

AD HOC ADVISORY PANELS

Panel on Biomedicine and Public Health
Chairman, Ivan L. Bennett, Jr.

Panel on Technological Innovation and Monitoring
Chairman, George Bugliarello; Ernst R. Pariser, Charles A. Rosen, Stanislaw Ulam

Panel on Industrialization
Chairman, William A. W. Krebs

Panel on Science and Economic Policy
Chairman, Robert N. Kreidler

Panel on Scientific and Technological Education
Chairman, Joseph Pettit

Panel on International Population Problems
Chairman, Roger Revelle

Panel on Environment
Chairman, Gilbert White