TA/OST 73-18

POLICIES AND PROGRAMS IN SELECTED AREAS OF SCIENCE AND TECHNOLOGY

Office of Science and Technology
Agency for International Development
Washington, D.C.

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PREFACE

This Report describes the major components of an AID program to assist developing countries with selected aspects of the problem of technological transfer and adaptation. It focuses on: (a) helping developing countries develop national policies and institutions which permit them to make better technological choices, particularly in industry; (b) natural resources assessment and management; and (c) reducing public investment costs.

This program is designed as a supplement to AID's priority programs in fields such as Agriculture, Population and Health, and Education. The Report does not define AID's science and technology strategy in these priority areas. This will be addressed separately; but by focusing on the general problem of improving the abilities of developing countries to make technological choices, this program is relevant to AID efforts in Agriculture, Population, and other priority fields. Moreover, many of the technologies considered have multiple applications in these fields.

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THE DEVELOPMENT SETTING

"Income distribution is of interest only if there is income to distribute"

Shift from Rural to Urban/Industrial Life

The processes of urbanization, industrialization, and modernization move together as integrally related aspects of economic and social development. Urban/industrial life is expanding at a rapid rate in the developing countries, and exerts influences on national development and policy disproportionate to the size of this sector. Urban populations will grow by about 50 percent in the 1970's. At the start of the decade, they already were 54 percent of total population in Latin American, 38 percent in East Asia, 22 percent in Africa, and 14 percent in South Asia.

Thus, the quality of life is increasingly affected by the quality of urban/industrial development. This sector is the big user and provider of scarce capital and the potential source of higher income job opportunities. It provides markets, goods and services, and new skills and opportunities for rural people, as well as for the urban population. At the current urban growth rates, it is a source of the most troublesome unemployment. Rapid development of the right kinds of industry is the most promising source of a better livelihood for the peoples of the developing countries, not only through direct industrial employment but through the indirect stimulus throughout the economy.

Paradoxically, the quality of development of the urban/industrial sector has been given comparatively little attention by those concerned with economic and social development in developing countries and in assistance agencies. The development process suffers from this neglect: scarce capital is squandered, employment problems are intensified, and rural development and social progress are slowed. While this deficiency is gradually being addressed, imbalances remain between rural development efforts and concerted attention to urban/industrial problems.

Importance of Better Use of Natural Resources

Another source of neglected and wasted assets in the developing countries results from their lack of capabilities for identifying and assessing their natural resources, and for managing their use in their own best interests. Most of the world's timber is in the tropics (more than 70 percent),recent oil discoveries illustrate the unrealized energy potential of the developing countries, and geologically there is no reason why we should continue to find a disproportionate share of the world's major ore bodies in the temperate and arid regions of the world (currently 90 percent of identified reserves). Obviously, progress in this subsector can contribute fundamentally to expanding and improving the productive resource base that undergirds the whole economy of the developing countries; rural and non-rural: jobs, productivity, foreign exchange earnings and savings, capital accumulation, and national and individual incomes are all affected in major ways.

Most of the territories of the developing countries have not been covered by systematic mineral, forest, soil, or water resources surveys. Of the surveys that have been carried out by the developed countries and private firms, some have not been made available to the developing countries, others are presented in a form that cannot be readily used, and others lie gathering dust. The data collection by the developing countries themselves is often spotty and of questionable accuracy. Off-the-shelf survey techniques are often excessively expensive or not effective in the somewhat unique vegetative, soil, and geological conditions of the tropics. Frequently data cannot be handled by the developing countries due to requirements for sophisticated processing and analysis techniques. At the same time, with rather modest effort, data collection, processing, and presentation techniques developed for application in the temperate zones can be suitably adapted.

Wise development of natural resources also has been plagued by lack of adequate planning and management skills and techniques -- together with inadequate baseline information. Random development of these resources -- often in response to the interests of foreign investors -- has led to widespread erosion

of arable land, increasing denudation of forest areas, intensified desertification, and extensive leaching of soils. As pressures for competitive use of accessible land areas continue to increase, development that balances economic exploitation with sound conservation practices becomes even more critical.

The developing countries are increasingly recognizing the economic penalties associated with degradation of their environment -- health hazards, cleanup costs, disruption of normal activities, and discouragement of tourism. As a minimum almost every country wants to keep abreast of the levels and the changes in the levels of air, water, and soil pollution. In some cases, these countries are taking steps to avoid the pollution problems accompanying growth and prosperity in the developed countries.

Technology Transfer Problems

While technology is but one of the determinants of the rate and direction of industrialization, it is frequently a key determinant as to the competitiveness of products, the commercial viability of processes, and the efficient utilization of capital and manpower resources. In changing their traditional methods, the developing countries often have to use the immediately available technologies, even when they are unsuited to their economic and social conditions. They might otherwise forego important development opportunities since they lack the capability for devising an indigenous technology or for appropriately adapting one from foreign sources. At the same time, the transfer of technologies from the advanced countries often has built-in mechanisms and time elements which hinder modification or adaptation. Domestic policies in the developing countries and the conditions attached to foreign aid frequently make capital available on subsidized terms and thus encourage excessive use of scarce resources of capital and underutilization of abundant manpower resources. Among the consequences of adoption of inappropriate technologies have been the growing lack of capital, particularly foreign exchange, the rapidly increasing rate of unemployment, and the inability to develop industrial skills at the rate required.

With regard to technology transfer through the private sector, it is tempting to argue that the best hope for the developing countries lies in their acquisition of technologies that are already applied in more advanced countries, and that it is a mistake and waste of their resources for them to go for research and technical development on their own. There are several reasons, however, why the developing countries clearly should not rely entirely on foreign sources of technology, although they can continue to gain great advantages by using private investment and licensing and the many other means of acquiring foreign know-how.

It is difficult for a country that does not itself possess a certain number of trained scientific and technical personnel to know what usable technology exists elsewhere, to understand it, to adapt it to the country's special needs or peculiar conditions, to repair and maintain the necessary equipment, or indeed to operate it. If a country builds up its own scientific and technical capacity, it is in a much better position to utilize what exists elsewhere. Lack of appropriately trained persons is often an obstacle to the wider application of technology that is already known and to some extent used in a country. In addition, each country is more able to hold its place in international competition if it has the capacity to introduce innovations (new products or less costly methods of production) based on existing technology.

Finally, the foreign technology is often adapted to very different basic conditions, such as a relative shortage of labor, abundant supplies of capital, and a large market. Developing countries, facing almost diametrically different conditions, will often find that a variant of the technology of the developed countries, or perhaps an altogether different technology, is more suited to their conditions. But the choice of an appropriate technology is not readily achieved by a country that lacks indigenous research and development facilities. This research and development structure needs to be heavily weighted towards the problems of production. In many cases, existing institutions need to be brought into closer relation with the country's actual agriculture and industry, and new institutions should, from the beginning, be strongly oriented towards local practical problems and the needs of local users.

Not the least of the reasons for developing countries to develop their own scientific and technological base for adapting, disseminating, and as necessary inventing technologies is that it provides them with a more secure technical and psychological base for expanding productive private trade and investment relations with the more developed countries. The developed countries have the strongest and stablest economic relations with countries in this situation.

Heavy Investments in Physical Infrastructure

Every developing country devotes a major portion of its limited budgetary resources to the construction of physical infrastructure. In Africa some countries are devoting more than 50 percent of their budgets to transportation, and throughout the world structures are a principal consumer of public investments.

Given the heavy investments in public works, housing, transportation, communications, and energy development, even a modest technological contribution to reducing short and long-term costs can have a significant impact on the current drain on national budgets of these activities. Particular attention should be directed to opportunities for reducing foreign exchange costs by greater use of indigenous materials -- and for increasing job opportunities in the manufacturing of the materials required, in the construction activities, and in the operation and maintenance of the systems.

Traditional engineering approaches will be essential to meet immediate requirements. In the longer term, and in many short-term situations, however, innovative approaches both to broad systems problems and to accomplishing specific tasks may pay high dividends.

Improved Coupling of Science to Development

Recognizing the value of a science and technology capability that is more responsive to their needs, capabilities, and factor endowments, many developing countries now have or are developing embryonic national science and technology policies. They are increasing their financial support for research and development efforts and this support now exceeds 0.2 percent of their GNP. In almost

every Latin American country and in more than half the developing countries of Africa and Asia, there are either national science planning bodies or formalized scientific research coordinating bodies. Many of them are directly linked to economic planning agencies. But they lack experience in how to develop policies that will expand their science and technology capabilities efficiently, and also make good use of their existing capabilities in the service of their national development goals. Even when science and technology resources are relatively plentiful, there are invariably major problems in bringing them to bear on priority development concerns.

There are still considerable disparities between higher educational output and manpower requirements. Most science and engineering faculties have long been handicapped by inadequate spaces for qualified applicants, deficient teaching staffs, and equipment shortages. While these deficiencies are gradually being overcome, the orientation of the graduates to development needs is a serious deficiency. As the universities increase their science and engineering activities, particularly at the graduate level, they are beginning to invest more heavily in associated research facilities with the question of relevance of research on center stage. Traditionally university researchers have not interacted effectively with industry and governmental agencies even though such researchers frequently represent the greatest concentration of technical talent in the country.

Inadequate coupling of science and technology to the user organizations is not confined to universities. The research and service organizations of Government agencies have similar difficulties. Isolation from industrial activities is particularly acute, for example, among the majority of the more than 200 publicly supported industrial research institutes in the developing countries.

AREAS OF CONCENTRATION

"Science can only give us the tools in a box ... but of what use to us are miraculous tools until we have mastered the human, cultural use of them?" -FRANK LLOYD WRIGHT

The first emphasis of this science and technology program is on policy and institutional development -- helping developing countries build their capabilities for using science and technology more effectively in support of development. There will also be smaller programs in natural resource assessment and management and in reducing public investment costs. AID will support developing country initiatives where they are strongly supported locally.

Science and Technology Institutional Development: AID will focus on helping in three areas:

-- Developing institutions for formulating national science and technology policies, priorities, and organizational responsibilities and for implementing decisions in this field.

-- Encouraging more effective orientation of university science and engineering programs of developing countries to development needs.

-- Strengthening the capabilities of developing country industrial service institutions to assist local industries in selecting, adapting, and using technologies suited to their circumstances, with special attention to support of small-scale industry.

This program reflects a need for national institutions that are effective in pursuing two related purposes. One purpose is to stimulate the efficient development of scientific and technological capabilities which meet national development requirements. The other purpose is to stimulate more effective use of existing scientific and technological capabilities in support of economic and social development.

While selection of technologies is largely a matter for private entrepreneurs, developing country technological institutions can play an important role through their influence on macro-economic policies of the Government, advice to entrepreneurs on availability of alternative technologies, and supporting services to industry. Included in these services is the network of industrial research, extension, and standards institutes throughout the developing countries. Generally, AID will sponsor collaboration between U.S. and developing country technological institutes that work with private industry. Particular attention will be paid to stimulating commercially viable small scale industry, which tends to use more labor and less capital per unit of output.

Other Programs: In addition to science and technology infrastructure, AID will also undertake two smaller activities under this program.

-- Natural Resource Assessment and Management: Improved developing country capabilities for assessing the location and nature of their natural resources and for determining how these resources can best be developed is of great importance for development. This includes extractive resources such as minerals and clays and the renewable resources of water, soil, and forests. Attention will be given to faster, cheaper, and more effective techniques for identifying and appraising natural resources, as well as to improved techniques for managing natural resource development such as integrated land use planning, conservation of renewable resources, and pollution abatement and control. Particular attention will be paid to opportunities to advance knowledge of means for environmental protection.

AID's role in this field will be one of an agent or broker between the developing countries and U.S. experts, such as the organizations involved in the Earth Resources Technology Satellite (ERTS) program, and will avoid politically sensitive areas of commercial contracting to develop these resources.

-- Reducing Public Investment Costs: AID will also explore, on a selective basis, technological innovations that can greatly reduce the costs of economic infrastructure activities that are heavy users of public funds of the developing countries such as public works, housing, transportation, communications, and energy development. Success here could release public revenues that could be applied to other development needs. Priority will be given to those activities which relate directly to the quality of life for the mass of the population such as water and sewage for low-income areas, low-income housing, and rural development.

PROGRAM ACTIVITIES

"We must sail sometimes with the wind and sometimes against it ... but we must sail, and not drift, nor lie at anchor."
-OLIVER WENDELL HOLMES

In collaborating with developing countries in science and technology, three considerations are particularly important:

-- The quality of the U.S. participants is crucial to the success of individual projects.

-- U.S. inputs must be truly responsive to developing country interests and designed to reinforce local efforts.

-- Institutional development, and not short-term spectaculars, is the key to real progress.

During the past several years AID has supported a number of projects in the areas previously described and in closely related areas. Many of these projects have been of a short-term nature undertaken explicitly for assessing the feasibility of relatively new developmental approaches and their potential impact. Others have been a continuation of long standing AID interests. The following criteria seem particularly appropriate in selecting program areas for specific project activities:

-- pervasiveness of the problems in the developing countries and their importance to development;

-- availability of internationally recognized U.S. expertise of relevance to developing country problems, and reasonable expectation that U.S. inputs can have an impact with high benefit/cost ratios;

-- actionability on a bilateral basis, and particularly suitability and interest of appropriate counterpart institutions and individuals that can provide effective channels for U.S. inputs, recognizing that in some cases the U.S. role might be to stimulate development of such counterparts;

-- division of labor with other assistance agencies, with emphasis on how bilateral and multilateral efforts can be mutually reinforcing.

Office of Science and Technology

Within AID the Office of Science and Technology, in collaboration with the Office of Engineering and other central offices as appropriate, is responsible for Agency policy guidance and technical leadership in areas identified previously. It will:

-- coordinate and focus the use of Agency resources in research, institutional grants, and pilot programs to identify and establish innovative approaches to major problems impeding developing country progress in these sub-sectors, manage the interregional components of such composite efforts, and provide technical advisory services to Regions and Missions on desirable linkages and content for related activities in their programs;

-- identify and help mobilize the technical inputs needed for appropriate analysis, design, and implementation of Regional and Mission projects in these sub-sectors and for closely related types of science and technology activity;

-- mobilize, in collaboration with the Regional Bureaus, sufficient consultants and contractors from the most qualified elements of the U.S. science and technology community, to provide the services needed by the Agency in this sphere of activity; and

-- provide technical liaison with interested international organizations and assist Regional Bureaus in providing such liaison for regional organizations, seeking more effective use of U.S. talent and experience by these organizations.

Identified in Table III-1 are the Office's principal projects, which are categorized as: research-development of new knowledge for solving specific problems; institutional development-strengthening the capability of U.S. universities to participate in specific aspects of development; pilot (demonstration)-testing the feasibility and impact of innovative approaches; pilot (specialized training)-demonstrating the effectiveness of new training programs; and pilot (network building)-support for deliberately structured international networks of technical institutions. Also identified are the key U.S. institutions providing technical inputs and the collaborating developing countries.

TABLE III-1
PROJECTS OF THE OFFICE OF SCIENCE AND TECHNOLOGY

Project Category & Title	U.S. Institution	Collaborating Countries
Developing Institutions for National Science & Technology Policies		
PD-*Bilateral Workshops on Priorities, Coupling of Science with Development, and Manpower*	Nat'l Academy of Sciences Nat'l Academy of Eng.	12 Countries
PD-*Science and Technology in a Small Country*	Cornell University	Costa Rica
ID-*National Science & Technology Policies*	Cornell University	Korea
Encouraging More Effective Orientation of University Science & Engineering		
PD-*Developmentally Relevant Bilateral Linkages between University Scientists & Engineers*	National Science Foundation	20 Countries
PD-*Support for Developmentally Relevant Research of Developing Country Scientists*	FORGE	Being Selected
Strengthening Industrial Service Institutions		
PN-*Advice, Training, and Information Services for Industrial Research Institutes*	Denver Research Institute	Being Selected
PN-*Advice, Training, and Information Services for Industrial Standards Institutions*	National Bureau of Standards	Korea, Thailand, Turkey, Ecuador, Ethiopia
PT-*Management of Industrial Research Institutes*	Denver Research Institute	Being Selected
PD-*Techniques for Improving the Contribution of Research to Industrial Development*	Univs. of Wash, Mich St., Wisc, R.I., and Calif	Central America (Regional)
PD-*Transfer of Industrial Technologies Developed by NASA to Developing Countries*	Illinois Institute of Tech. Research Institute	Korea
PD-*Increasing Ready Availability of U.S. Technical Publications*	National Technical Information Service	40 Countries
ID-*Employment Generation through Small Industry*	Georgia Tech	Being Selected
Improving Natural Resource Assessment and Management		
R-*Ecological Aspects of Genetic Control of Aedes Aegypti Mosquitoes*	University of Notre Dame	Kenya
R-*Geobotanical Reflectance Indicators of Mineral Deposits in Tropical Areas*	U.S. Geological Survey	Philippines
PD-*Remote Sensing Techniques from Satellites and Low Cost Aircraft*	U.S. Geological Survey	Mali, Indonesia, and 20 Countries
PD-*Case Studies of Environmental Impact of Selected Development Projects*	Smithsonian Institution	Korea, Indonesia, Ghana
PT-*Pollution Control Techniques for Industry*	Univ. of North Carolina	15 Countries
PT-*Management and Use of Scientific Data on Marine Resources*	Nat'l Oceanic & Atmospheric Administration	12 Countries
Reducing Public Investment Costs		
R-*Binders for Low Cost Roofing*	Monsanto Research Corp.	Being Selected
R-*Low Cost Housing Design and Construction Techniques in Typhoon Areas*	National Bureau of Standards	Philippines
PD-*Reducing Costs and Improving Performance in Construction of Public Works*	Arthur D. Little	Colombia, Philippines
PD-*Techno-Economic Aspects of Alternative Approaches to Communications Technology*	Massachusetts Institute of Technology	Brazil, India
ID-*Adaptation of Industrial and Public Works Technologies*	Massachusetts Institute of Technology	Kenya, Colombia

KEY: PD-Pilot (Demonstration); PT-Pilot (Specialized Training); PN-Pilot (Network Building); ID-Institutional Development; R-Research.

Although the capabilities of other assistance organizations in science and technology are relatively limited, and they are unlikely to develop early access to much of the top U.S. talent, their interests and capabilities are growing. The needs for assistance are rapidly outpacing the assistance community's technical resources for response, and there are growing opportunities for collaboration between organizations. In this regard the Office has participated in the international meetings identified in Table III-2.

TABLE III-2
STAFF ATTENDANCE AT INTERNATIONAL MEETINGS

1970	
Caracas	OAS-*Science and Technology Priorities*
Addis Ababa	ECA-*Science and Technology Priorities*
Manila	Association of Ministers of Science in Asia-*Science Policy*
1971	
Malta	UNESCO-*Marine Sciences*
Paris	OECD-*Research Priorities*
Vienna	UNIDO-*Industrial Development*
Copenhagen	UNIDO-*Industrial Research Institutes*
Addis Ababa	ECA-*Environment and Development*
Mexico City	ECLA-*Environment and Development*
New York	UN Preparatory Commission for Environment-*Environmental Policies*
Paris	OECD-*Research Priorities*
Sao Jose dos Campos	UN Outer Space Committee-*Remote Sensing*
1972	
Bangkok	ECAFE-*Industry and Natural Resources*
Nairobi	UN Committee on Natural Resources-*Resource Development*
Rio de Janeiro	OAS-*Technology Transfer*
Bogota	OAS-*Science Policy*
Brasilia	OAS-*Technology Transfer*
Paris	OECD-*Research Priorities*
Vienna	UNIDO-*Industrial Development*
Paris	OECD-*Appropriate Technology*
Paris	OECD-*Environmental Policies*
Paris	UNIDO-*Technology Transfer through Licensing*
Mar del Plata	OAS-*Science and Technology Priorities*
1973	
Bangkok	ECAFE-*Industry and Natural Resources*
New Delhi	UN Committee on Natural Resources-*Resource Development*
Paris	UNESCO-*Marine Sciences*
New York	UN Committee on Science and Technology-*Policy Framework*

Other AID Units

Over the years AID Missions and other AID/Washington offices have supported many projects within the areas of science and technology described in this Report and within closely related areas. Table III-3 identifies most of the current AID projects in these areas. Some of the activities are components of larger programs directed to somewhat broader areas of concern.

TABLE III-3
SELECTED PROJECTS SUPPORTED BY OTHER AID UNITS

Project Title	U.S. Institution	Collaborating Countries
National Science & Technology Policies		
Bilateral Workshops on Priorities, Coupling of Science with Development, and Manpower	Nat'l Academy of Sciences Nat'l Academy of Eng.	Korea, Indonesia, India, Brazil, Colombia
University Science and Engineering Capabilities		
Chemistry Faculties at Selected Universities	Nat'l Academy of Sciences	Brazil
Support of Selected University Science Faculties through OAS Programs	Various	Latin America
Korea Advanced Institute of Science (L)	Stanford University	Korea
Asian Institute of Technology	Colorado State University	Thailand (Regional)
Science and Math Teacher Training Center		Malaysia (Regional)
National Technical Center	University of Missouri	Vietnam
Support of Individual Scholars including University Scientists	Asia Foundation	Asia
Asia Research Program--Support of Individual Scholars including Scientists	Various	Asia
Secondary and College Science and Math	Nat'l Science Foundation	India
Kabul University Faculty of Engineering	Education Development Ctr.	Afghanistan
Haile Selassie University including the Science Faculty	Various	Ethiopia
Access to Industrial Technology		
Industrial Standards Capability	Hughes Aircraft Company Nat'l Bureau of Standards	Vietnam Ecuador
Technical Advisory Services to Selected Industrial Institutions	International Executive Service Corps	Worldwide
Industrial Feasibility Studies (L)	Arthur D. Little	Bolivia
Development of African Enterprise (L)		Entente States
Small Enterprise Development	Technoserve	Honduras, Ghana Kenya
Agricultural Equipment Development	Int'l Rice Research Inst.	Philippines
Field Research and Testing of a Water Hand Pump	Battelle Memorial Institute	Nigeria, Thailand, Bangladesh
Strengthening Information Capabilities through Regional Technical Aids Center		Mexico (Regional)
Technical Inquiry Service	Volunteers in Technical Assistance (VITA)	Worldwide
Development of Natural Resources		
Geological Survey and Appraisal	U.S. Geological Survey	Liberia, Indonesia
Geological Survey and Appraisal (L)	U.S. Geological Survey	Brazil, Colombia
Geothermal Energy Development (L)	U.S. Geological Survey	Indonesia
Remote Sensing Advisory Services and Training	U.S. Geological Survey	Thailand, CENTO, Philippines
Natural Resources Development Program of the OAS	Various	Latin America
Hydrology Data Center		Upper Volta (Reg)
Development of Wood Products	U.S. Forest Service	Vietnam
Mekong Basin Ecology Studies	Various	Asia
Tropical Biological Research Center		Indonesia (Regional)
Public Works Technology		
Engineering Properties of Laterite Soils	Lyon Associates	Thailand, Ghana
Earthquake Resistant Adobe Houses	Fresno State College	Peru
Electric Power Training and Technical Assistance (L)	Rensselaer Polytechnic Institute	Brazil

NOTE: (L) indicates loan financing

Most of the activities supported by other AID units are carried out through traditional technical assistance methods, usually involving U.S. technical advisers, participant training, and limited provision of equipment. Generally, these activities are grant-financed although during the past several years greater attention has been directed to opportunities for loan financing of assistance efforts in science and technology.

The largest programs in this field currently being supported by AID are the science and technology activities of the Organization of American States and several science education institutions designed to serve regional needs in Southeast Asia. The largest past AID investment in a single science and technology project has been support for the establishment of the Korea Institute of Science and Technology. Another particularly significant recent AID project has been support for the Indian Institute of Technology at Kanpur, India.

This Report does not attempt to describe the many capital assistance projects for development of physical infrastructure currently being financed by AID. A number of U.S. engineering firms are currently participating in these activities, and they will continue to play an important role in our assistance efforts.

STRENGTHENING THE ANALYTICAL BASE

"Ideas circulate throughout the Union ... The Government invites the aid of all who have talents or knowledge to serve it."
-ALFXIS DE TOQUEVILLE

Improving Aid Policies and Programs

There is a continuing need for improved understanding of the development process, and particularly refinement of the conceptual framework for AID project activities in science and technology. Clearly, the principal work in relating specific projects to development objectives must be carried out within AID. However, experience has repeatedly demonstrated that outside expertise can be very helpful in this regard. During the past several years, a number of important workshops have been held to provide general policy guidance for AID's activities, as shown in Table IV-1.

TABLE IV-1 POLICY SEMINARS

	Convenor	Topic
1969	President's Science Advisory Committee	*Science and Technology Priorities*
1970	National Academy of Sciences	*Environmental Policies*
1971	A.I.D.	*Science and Technology Priorities*
	National Academy of Sciences	*Science and Technology Priorities*
	A.I.D.	*Science and Technology Priorities*
1972	A.I.D.	*Natural Resources*
1973	Cornell University (planned)	*Science and Technology Priorities*

State-of-the Art Assessments

A number of state-of-the-art assessments have been conducted in concert with other development agencies. Recently, most of these analyses have been carried out within the framework of the activities of the Organization for Economic Cooperation and Development (See Appendix A). The techniques that have been used include the convening of technical panels and the carrying out of studies by the Office staff and consultants, as indicated in Tables IV-2 and IV-3.

TABLE IV-2 TECHNICAL PANELS TO ASSESS STATE-OF-THE-ART

	Convenor	Topic
1970	Smithsonian Institution	*Remote Sensing*
1971	National Bureau of Standards	*Industrial Standards and Technology*
	American University	*Computers*
	A.I.D.	*Geothermal Exploration Techniques*
	National Academy of Sciences	*Solar Energy*
1972	A.I.D.	*Information Sources*
	National Academy of Engineering	*Low Cost Roofing*
	National Academy of Sciences	*Ferro-Cement*
	Colorado State University	*Hydrology Research Priorities*
	National Academy of Sciences	*Low Power Energy Sources*

TABLE IV-3 STAFF STUDIES TO ASSESS STATE-OF-THE-ART

1971	*Role of Remote Sensing in Developing Countries*
	Economic Damage Caused by Aquatic Weeds
1972	*Desert Encroachment on Arable Lands*
	Appropriate Technologies for International Development
	Forestry in Developing Countries
	The Application of Geochemical, Botanical, Geophysical, and Remote Sensing Mineral Prospecting Techniques to Tropical Areas
1973	*Techniques for Assessing Hydrological Potentials in Developing Countries*
	Remote Sensing: A Developmental Framework and Case Studies

New Approaches to Development

During the past decade the international environment for development assistance activities has changed significantly. Now, for the first time, many developing countries have the capacity and the experience needed to establish their own development priorities and a strong and understandable determination to do so. Even the poorest countries have cadres of trained technical specialists and embryonic scientific institutions.

At the same time there is widespread concern among the developing countries that traditional approaches to development are inadequate. The secondary and the delayed effects of modern technologies are beginning to cause a variety of unforeseen problems, and new departures are needed to respond to these problems. Tables IV-4 and IV-5 describe recent efforts to analyze past development activities and to explore improved techniques for addressing these concerns.

TABLE IV-4 SEMINARS ON NEW APPROACHES TO DEVELOPMENT

	Convenor	Topic
1970	National Academy of Sciences	*Labor Intensive Technologies*
1971	National Academy of Sciences	*International Development Institute*
	A.I.D.	*Role of Individual U.S. Scientists*
	National Academy of Sciences	*Technical Information*
	National Academy of Engineering	*Role of U.S. Engineering Schools*
	National Academy of Engineering	*Role of Multinational Corporations*
	National Academy of Sciences	*Training of Research Managers*
1972	National Academy of Sciences	*Technological Innovation*
	National Academy of Engineering	*International Industrialization Institute*
	A.I.D.	*Economics and Technology*
1973	A.I.D.	*Marine Sciences*
	A.I.D. (planned)	*Science, Technology, and Development Planning*

TABLE IV-5 STAFF STUDIES ON NEW APPROACHES TO DEVELOPMENT

1971	*Environmental Considerations for Construction Projects*
	Water Quality Standards and International Development
1972	*Impact on the United States of Transfers of Technology*
1973	*RANN Program: Potential Benefits to Developing Countries*

Surveys of Developing Country Institutions and Activities

Careful on-site analyses of activities in the developing countries, as identified in Table IV-6, have proved quite useful in shaping project activities.

TABLE IV-6 SURVEYS IN DEVELOPING COUNTRIES

	Organization Conducting Survey	Topic
1971	A.I.D.	*Environmental Problems*
1972	Denver Research Institute	*Industrial Research Institutes*
	University of California (Irvine)	*Nuclear Research Reactors*
	Department of Commerce	*Computers*
	National Bureau of Standards	*Construction in Earthquake and Typhoon Zones*
1973	U.S. Forest Service	*Secondary Forest Species*
	University of Oklahoma	*Low Cost Water and Sewage Treatment*
	National Technical Information Service	*Technical Information*

Areas for Further Analytical Research

During the past several years the international scene has been inundated with studies and reports generated throughout the world on the relationship of science and technology to the problems of development. The UN agencies in particular have stirred up a paper blizzard which has covered in some fashion almost every conceivable aspect of science and technology. As can be seen from the previous sections, AID has contributed its share of reports. This interest is long overdue and is welcomed by all concerned with development problems. However, now the problem is to separate the chaff from the wheat and to identify those priority areas which have been treated in an inadequate fashion. For example:

Developing Criteria for Evaluating the Strength and Effectiveness of the Science and Technology Infrastructure

At present there is only rudimentary understanding of those characteristics of the science and technology infrastructure which are appropriate for developing countries at different levels of development. As a result, neither developing countries nor development agencies have an adequate analytical basis for determining the types and size of programs that should be undertaken to enhance the contribution of science and technology to national development. In addition, it is extremely difficult to evaluate the effectiveness of such programs, or the progress in contributing to national development through development of a viable infrastructure, since there are no baseline criteria for measuring such progress. Conceptual work is needed to clarify the characteristics of an optimal science and technological infrastructure and to develop easily understood, but credible, indicators of such characteristics.

Transfer of Technology

The transfer of technology from developed to developing countries is being carried out through a variety of channels. Some of these avenues are deliberately structured by development agencies and multinational firms. Others are not. Critical analyses of the contributions to development -- both in the short and long term -- of existing

and innovative approaches to technology transfer, and particularly the impact of such activities on the technological infrastructure, can provide guidance for multinational firms as well as development agencies and recipient countries.

Technology Assessment

Much attention is being directed in the United States to techniques for assessing the impact of the introduction of a specific technology on society, with particular emphasis on unintended, indirect, and delayed effects. The analytical problem is no less difficult in the developing country scene where jobs, foreign exchange, and diversion of skilled manpower are crucial issues. Whether a standardized methodology beyond a refinement of the checklist/case study approach can be developed which will be of broad applicability to a multiplicity of technologies is questionable although exploratory steps in this direction appear warranted. Some work has been initiated in the United States to design multipurpose matrices which can serve as the basis for examining trade-offs, but these efforts have been largely confined to rather narrow fields. If such matrices can lay out realistic technological alternatives, on the one hand, and types of impacts -- both positive and negative -- on the other, they might be quite useful.

The Industrialization Process

The role of technology in the industrialization process -- and particularly the key problems that impede more effective use of technologies -- is ill-defined at best. For example, supply and demand patterns for export commodities of critical importance to the developing countries are changing, and these countries are not well prepared to identify realistic technological opportunities to respond to such changes. Analysis of trade patterns and export potential and of the role of an appropriate technological infrastructure to realize this potential represents a formidable task.

CONCLUSIONS

"It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."

ROBERT H. GODDARD

During the next few years the developing countries will be making considerable investments of financial resources and talented manpower in science and technology, convinced that these investments will be a significant factor in accelerating their development. The physical, biological, and engineering sciences are expected to play a critical role in the industrial sector -- not only in raising productivity but also in creating many new job opportunities. They are expected to point the way to discovery and wise development of latent natural resources -- a source of new materials and export earnings. They are expected to set the pace and the standards of excellence which will permeate the total development effort.

The reality of the gap between the capabilities of developed and developing countries is nowhere more pronounced than in the area of science and technology. Recognizing their deficiencies in being able to cope with the modern technologies that have descended upon them, the developing countries are looking to the developed countries in general, and the United States in particular, to reinforce their limited efforts to build an appropriate science and technology base.

There is an existing shelf of international technology from which the developing countries can choose, and their macro-economic policies will to a large extent determine the choice of technology. But many of the potentially most appropriate technologies are not on the shelf; the developing countries often have difficulty identifying and understanding the workings and implications of what is on the shelf; and they are sorely lacking in an ability to absorb the shelf items. These shortcomings highlight the challenge to technological infrastructure in the developing countries -- an infrastructure that cannot appear overnight but which will require patient and sustained nurturing.

The United States has pre-eminent strengths in relating science and technology to productive activities in industry and in natural resources development. We have seen that these strengths can be applied to developing country problems with great advantage for their development. While science and technology certainly cannot alone equate to development, the Green Revolution has shown that technological advances can provide a stimulus and a catalytic force for pulling together the other aspects of a total system improvement needed to accelerate development -- e.g., credit, extension, supply of inputs, marketing, and entrepreneurship. Indeed, it is in the overall system approach where the strength of U.S. science has made its mark.

Now time is running out in the developing countries, and traditional approaches and timetables are not enough. Science and technology may offer the most promising hope in halting the further dissipation of limited resources and human energy and bringing the ever increasing population into better harmony with the natural resource base. But if this hope is to be realized, our best scientists and our best technologists must become more effectively engaged in the development process.

RESEARCH PRIORITIES ESTABLISHED BY THE ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT

A. Inventory of Selected Areas

6. The Experts thought that it would be more effective to restrict the inventory of research activities to a number of key areas which would then be subject to qualitive analysis. Taking as a starting point the priority areas listed in the World Plan of Action for the Application of Science and Technology to Development [which will be submitted to ECOSOC in July (1)], they examined this list in the light of the following criteria: a) the importance of the problem in the development context: b) the extent to which the sector was relatively neglected by donor countries and international bodies: c) the likelihood of research making a major contribution to the solution of the problem.

7. Applying the above-mentioned criteria, the Experts left out most of important problem areas in agriculture, nutrition and reproductive biology which are being dealt with at international level (I.B.R.D. Consultative Group, Belaggio Group). They selected the following 11 sectors on the understanding that some adjustments might have to be brought to this list once work was in hand:

(a) Vector and pest control: biological control of insects harmful to man, agriculture, and materials; rodent, bat and bird control; reducing side effects of pesticides.

(b) Utilization of tropical forests: use of secondary species, forest inventory techniques, forest conservation.

(c) Techniques to assess hydrological potential: surface water flow, drainage and erosion patterns, relation to soil characteristics, ground water patterns and recharge capability.

(d) Mineral prospecting techniques in tropical areas: geobotanical, geophysical and geochemical techniques.

(e) Buildings and engineering construction: suitable design of buildings and construction projects, road design and construction, use of indigenous materials.

(1) See United Nations document 59 E/4962
Summary in DD-227 - DAS/SPR/71 34

(f) Schistosimiasis: Use of Molluscicides, biological control techniques, chemotherapeutic agents.

(g) Processing and preservation of food products: agricultural and fishery products.

(h) Non-conventional energy sources: solar, geothermal, tropical woods, low-grade fossil fuels.

(i) Water and sewage treatment in tropical areas.

(j) Non-food uses of agricultural products, including fibers.

(k) Industrial uses of non-agricultural natural resources.

8. The Experts specified that the inventory should include an assessment of:

(a) a "state of the art";

(b) current significant research activities;

(c) high pay-off research gaps;

(d) profile of priority research needs.

An analysis of these eleven areas conducted in this manner could provide a basis for prompt action and a persuasive document to encourage the most appropriate national and international bodies to undertake the research required. It should be borne in mind that research projects must answer a felt need in the countries which are to benefit from such research.

B. Industrial Research

9. In the matter of industrial research, the Experts recognized that it was much more difficult to make a selection. Although in industry the main consideration is the transfer of technology, with all the problems connected with private investment, licensing contracts and so forth (which, incidentally, are not within the Group's competence), it is nevertheless essential to approach the question from the standpoint of the adaptation of industrial technology as well. Adapted industrial techniques are those which are based on modern science, permit the use of local material, and make allowance for the economies of scale and capital/labour ratios specific to developing countries. (One should not use the term "intermediate" technology, but rather "appropriate" technology).

10. Private firms are reluctant to allocate part of their R & D resources to adaptation or innovation schemes for developing countries. Furthermore, they are not keen to allow their machinery to be adapted by the developing countries themselves. It would therefore seem that incentives from the advanced countries, in the form of subsidies for R & D in this field, are needed. Presumably, another requirement would be to establish some kind of institutional substructure in the advanced countries to support and identify the activities to be undertaken in regard to the adaptation of techniques to developing countries. In this connection, the representative of the Development Centre recalled that the Council of Europe, on the occasion of its Seminar on the International Voluntary Service, had advocated the establishment of an international centre for information on appropriate technology and that the Development Centre had been asked to collaborate on this project.

11. The Experts recommended, as a first step, that, as part of the inventory, activities initiated by governments and public agencies for the adaptation of industrial technology, especially in connection with plant process and product design for the small scale manufacturers, should be evaluated. This exercise, which could be added to the 11 areas of the inventory, would give an account of studies of specific industrial installations, the development of new processes, products and materials, and the adaptation of existing ones, and the development of new techniques for the manufacture, maintenance and repair of plant and equipment. Donor countries would also be asked to give particulars of the institutional facilities at their disposal for this kind of activity.

C. Overall Survey

12. The analysis by areas is directed towards specific action. The fact remains that for information purposes a more general survey of donor countries' research activities, geared to the problems of developing countries, appears desirable. Donor countries would thus have a better knowledge of what each is doing, together with data which might prove useful in international assemblies. This inventory, which would be relatively simple and quickly compiled, and preferably not crowded with statistics, would give particulars and, if possible, assessments of the main research programmes and projects of donor countries. The Experts think that, initially at any rate, the survey should be confined to programmes financed by aid funds or to activities undertaken by other official bodies clearly identifiable as being intended to benefit developing countries.

SECOND DEVELOPMENT DECADE

Science and Technology

(55) Concerted efforts will be made by the developing countries, with appropriate assistance from the rest of the world community, to expand their capability to apply science and technology for development so as to enable the technological gap to be significantly reduced.

(56) Developing countries will continue to increase their expenditure on research and development with a view to attaining, by the end of the Decade, a minimum average level equivalent to 0.5 percent of their gross product. They will endeavor to inculcate, among their people, an appreciation of the scientific approach which will influence all their development policies. The research programme will be oriented to the development of technologies that are in line with the circumstances and requirements of individual countries and regions. They will put particular stress on applied research and seek to develop the basic infrastructure of science and technology.

(57) Full international co-operation will be extended for the establishment, strengthening and promotion of scientific research and technological activities which have a bearing on the expansion and modernization of the economies of developing countries. Particular attention will be devoted to fostering technologies suitable for these countries. Concentrated research efforts will be made in relation to selected problems the solutions to which can have a catalytic effect in accelerating development. Assistance will also be provided for building up and, as appropriate, for expanding and improving research institutions in developing countries, especially on a regional or subregional basis. Efforts will be made to promote close cooperation between the scientific work and staff of the research centres in developing countries and between those in developed and developing countries.

(58) Within the framework of their individual aid and technical assistance programmes, developed countries will continue to increase their aid for the direct support of science and technology in developing countries during the Decade (to reach an average level equivalent to 0.05 percent fo their gross national product). Moreover, they will give increased attention in their research and development programmes to the specific problems of developing countries and for this purpose will endeavor to provide additional resources (aimed at

reaching, by the end of the Decade, a target of 5 percent of their research and development expenditure). Effort will be made to incur a significant proportion of this expenditure in developing countries. In cooperation with the developing countries, developed countries will continue to explore the possibility of locating some of their research and development projects in developing countries. Private foundations, institutions and organizations will be encouraged to provide further assistance for expanding and diversifying research activities of benefit to developing countries. In relation to their aid and investment policies, developed countries will assist developing countries in identifying technologies which are appropriate for their circumstances and in avoiding the utilization of scarce resources for inappropriate technologies.

(59) Developed and developing countries and competent international organizations will draw up and implement a programme for promoting the transfer of technology to developing countries, which will include, inter alia, the review of international conventions on patents, the identification and reduction of obstacles to the transfer of technology to developing countries, facilitating access to patented and non-patented technology for developing countries under fair and reasonable terms and conditions, facilitating the utilization of technology transferred to developing countries in such a manner as to assist these countries in attaining their trade and development objectives, the development of technology suited to the productive structure of developing countries and measures to accelerate the development of indigenous technology.