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Methodologies for Assessment of Science and Technology Systems and Capabilities in Developing Countries

A Preliminary Analysis

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METHODOLOGIES FOR ASSESSMENT OF SCIENCE AND TECHNOLOGY SYSTEMS AND CAPABILITIES IN DEVELOPING COUNTRIES

A Preliminary Analysis

Report of a Workshop, September 27-28, 1979

Prepared by

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Program on Science, Technology and Society

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EXECUTIVE SUMMARY

As developing nations increase their expenditures and their expectations for progress through technology, development of improved methods to assess the strengths, capabilities, and gaps in their science and technology (S&T) systems becomes particularly important. Policy decisions at the national and regional levels and program decisions at the institutional level can benefit from an improved understanding of functional and organizational capabilities, interdependencies, and interactions. Also, external agencies interested in supporting S&T projects need methods for identifying priority areas, determining the likelihood of project payoffs, and understanding how their projects integrate with a broader range of related activities within the country.

For many years AID and other donor agencies have sponsored assessments of the traditional development sectors, particularly agriculture and health. These assessments normally give consideration to impacts of scientific and technological activities. However, they have usually been directed primarily to economic aspects, to national policies, and to production and service activities, and have given only limited attention to the S&T system and to development of scientific and engineering capabilities. Indeed, analysts with the skills and knowledge needed for authoritative assessments of S&T systems and capabilities are seldom included in the teams responsible for sector assessments. Thus, complementary cross-sectoral analyses of S&T are frequently warranted. Such analyses are particularly important in clarifying the S&T capabilities and the technical manpower levels which are required to support all the sectors, including the often neglected industry sector, and for addressing intersectoral problems such as alternative energy sources, development of timber resources, and environmental pollution.

Lessons learned in assessments of agriculture and health activities offer important messages to proposed methodologies in the area of S&T. First, the character and magnitude of the assessment should be tailored to the purpose and time scale of the effort. In this regard, many elaborate computerized assessments have not been very useful in accurately portraying country-specific conditions or providing decision makers with easily understood products. Secondly, an assessment is very important in clarifying the interfaces between the area being considered and the many other related activities within the country. Also, the knowledge and experience gained in carrying out an assessment can often be as consequential as the projects which are the direct results of the assessment. Therefore, developing country personnel should play a central role in assessments, including those conducted under the auspices of external agencies. Finally, regardless of the methodology, the effectiveness

of an assessment depends strongly on the capabilities and experience of the responsible personnel, which means that careful consideration must be given to the mix of skills and experience chosen for the assessment team.

A number of US and international organizations have analyzed S&T activities in developing countries in recent years. In most cases an ad hoc methodology has been utilized with little reference to methodologies that had previously been attempted. Considerable emphasis has been given to short-term impressionistic visits by foreign experts; comparatively little effort has been directed to meshing these observations with information from a well structured program of data collection and analysis. Some of the most recent assessments (AID, STPI, Cornell) have, however, begun to give more explicit attention to methodology as well as to cross-country comparisons.

The methodological approaches tend to fall into two categories:

(a) a functional approach with a focus on objectives and activities, e.g., training of skilled manpower, research and development, information acquisition and dissemination;

(b) an organizational approach with a focus on the agencies, laboratories, educational institutions, and other organizations that compose the S&T system.

There is, however, considerable overlap in practice. Also, each approach must identify appropriate measures of the effectiveness of the system overall and of its components. Finally, cross-country comparisons can illuminate special features of individual S&T systems and of their effectiveness.

These recent efforts and the experiences from assessments for agriculture and health permit construction of tentative guidelines for S&T assessment and set the stage for further efforts to improve the methodologies.

In the months ahead AID should consider follow-on activities to improve understanding of the role and character of S&T assessment methodologies. A workshop in Washington involving both AID practitioners and outside specialists to review assessment methodologies developed in connection with S&T loans in Costa Rica, Brazil, and Indonesia would help document important experience to dat Draft guidelines for carrying out future S&T assessments, prepared in a format similar to the existing guidelines for health sector assessments, might then be proposed. These draft guidelines could be tested in a country-specific situatior such as Ecuador, where there is current interest in AID involvement in S&T. Following such a field evaluation, revised guidelines might be prepared for broad dissemination within AID.

METHODOLOGIES FOR ASSESSMENT OF SCIENCE AND TECHNOLOGY SYSTEMS AND CAPABILITIES IN DEVELOPING COUNTRIES

A Preliminary Analysis

I. INTRODUCTION

In late September 1979 Cornell University, with support from the U.S. Agency for International Development, hosted a two-day workshop to carry out a preliminary analysis of methodologies for performing sector assessments of science and technology (S&T) in developing countries. There were about 25 participants divided into three categories: participants from AID; participants from Cornell University; and invited participants from other universities and agencies. (See attached list of participants.) Provision was also made for interested Cornell students and faculty to attend as observers and to contribute to the discussions.

In its statement of objectives for the workshop, AID noted that the workshop should "identify and elaborate the specific actions required to develop a methodology for S&T sector assessment in developing countries." AID proposed that the meeting consider:

--The nature of sector analysis, assessment, and study.

--Experiences in agriculture, health, and education.

--National Academy of Sciences experience in S&T policy and related workshops and studies.

--Cornell and DS/ST experience in Costa Rica.

--Cornell experience in middle-tier countries.

--IDRC experience in S&T Policy Instruments Project.

--Feasibility of sector analysis, assessment, and studies for S&T.

--Identification and elaboration of specific steps to develop a methodology for S&T assessment.

F. A. Long of Cornell assumed the chairmanship of the workshop and assembled a Steering Committee which identified the following items for consideration by the workshop and planned the program around them: reasons for interest in S&T assessment; contributions to methodology of experiences in assessments of other sectors; review and analysis of previous S&T assessment activities; identification of principal characteristics of effective assessments; and consideration of further studies to improve current procedures for S&T assessment. Several working papers were solicited from the participants and were distributed in advance. (See appendix for titles of these papers. Interested readers may obtain copies by writing F. A. Long at 608 Clark Hall, Cornell University).

II. REASONS FOR THE INTEREST AND CONCERN IN S&T ASSESSMENT

Foremost among the many reasons for increased interest in and expenditures to support S&T capabilities and systems is the rapidly growing conviction within developing countries that S&T are crucial elements for their economic and social development. The developing countries recognize the many contributions of S&T in the developed countries and in the newly industrializing nations, e.g., Brazil, South Korea, and Taiwan. Further, in many developing nations modern technologies are of central importance to increased agricultural productivity as well as to industrialization. Finally, the numbers of highly trained scientists and engineers in developing countries have increased dramatically in the past decade, thus providing new capabilities in this area.

The U.N. Conference on Science and Technology for Development held during August 1979 helped catalyze the interest and concerns that had begun to emerge in many developing countries. Three years of extensive preparation culminated in the submission of "country papers" by nearly all of the participating nations. The papers analyzed the role that S&T were playing in development and also analyzed the organizational framework within which S&T operate in each country. For a surprising number of countries, the preparation of these papers constituted the first time that the national infrastructure for S&T and the national capabilities in S&T had been explicitly analyzed within a development perspective.

Interest in assessment of S&T capabilities has also been growing within the United States. AID has long utilized formal "sector assessments" for analyzing capabilities and potentials in developing nations. As developing countries' interest in their national S&T capabilities grew, it was natural for AID to consider the role of sector assessments for S&T. Planning for the Institute for Scientific and Technological Cooperation (ISTC) also increased U.S. interest in assessment of S&T capabilities. Further, recent analysis of opportunities for U.S. cooperation with developing nations has led AID to anticipate an increase in requests from developing nations for U.S. participation in carrying out S&T assessments.

Since AID has had considerable experience with formal sector assessments in the fields of agriculture, health, and education, the obvious point of departure, when considering methodologies for S&T assessments, is the sector assessments in these previously studied fields. Given the relatively advanced state of the art in agriculture in particular, the workshop focused initially on agricultural sector assessment.

III. SECTOR ASSESSMENT FOR AGRICULTURE AND ITS IMPLICATIONS FOR S&T ASSESSMENT

Two principal speakers treated this subject, Erik Thorbecke of Cornell and L. B. Fletcher of Iowa State University. Thorbecke spoke generally about the purposes of sector assessment, the kinds of models which are used, and some of the implications of agricultural sector assessment for S&T. Fletcher spoke more specifically about AID's utilization of agricultural sector assessment, interest of developing countries in the technique, and some of the pitfalls. These presentations, the supporting papers, and the discussions underscored a number of important points.

A central point is that the agricultural sector is sufficiently different from that of S&T as to make it quite improbable that formal methodologies are transferable from one to the other. The agricultural sector can be described as a vertical sector, characterized by inputs and outputs which are measurable and quantifiable. It is relatively self-contained and distinct from other sectors. As a result of these characteristics (and perhaps also because most analyses have been made by economists) the usual approach to assessment of the agricultural sector involves building analytical models, utilizing quantitative input and output data, and identifying the important variables for policy-related objectives. To the extent that a model accurately depicts the relationships among the data and the variables, it offers the great virtue of having considerable predictive capability. In principle, this characteristic is exactly what policymakers seek, since their job is to identify feasible and desirable objectives and then produce policy recommendations which have a high probability of leading to these objectives.

In practice, agricultural sector assessments vary widely in their usefulness. Thorbecke noted three criteria for evaluating the utility of models:

(i) Coverage and Complexity. This involves disaggregating the system into components that can be quantified and meaningfully parameterized. It also addresses the degree to which the model covers all the significant aspects of the sector. The extent of coverage and the degree of complexity which are utilized in the model will in the end determine the range of its predictive power. However, they also affect the cost and time for the assessment.

(ii) Explanatory Power and Realism. The model should reflect the underlying structure and properties of the sector and hence provide a realistic portrayal of the sector.

(iii) Comprehensibility and Usefulness. Comprehensibility, not only by specialists but by policymakers, determines whether a sector assessment is useful. A model which is too specialized or complex may have excellent predictive power but may not be used because it is not understood. This has too often been the case with many of the elaborate computerized models of the past.

Professor Fletcher stressed that an important element in agricultural sector assessment is the variety of needs which an assessment may fulfill. Many assessments provide detailed information to help external agencies plan the size and character of their assistance programs. Sector assessments also produce data and models which assist developing country Governments with policy formulation and implementation. Furthermore, the results of agricultural sector assessments may be useful in addressing

intersectoral relationships, particularly in relation to the overall rural development problem. Finally, the participants in sector assessments gain a good appreciation of the implications of alternative policy choices; this benefit emphasizes the importance of participation of key local officials in the assessment process.

Whether examined from the standpoint of the needs of the various interested parties or the variety of methodologies which are currently utilized, even a relatively well identified and self-contained sector such as agriculture is still too diverse and complex to lend itself easily to a single sector assessment or to a single methodology. A variable with considerable bearing on the kind of sector assessment which is appropriate is the time factor. A broadly based analysis of the agricultural sector for even a small country can take upwards of 12 months, especially if the appropriate model needs to be developed as part of the assessment. However, 12 months may be too long for policymakers to wait. In addition, some of the conclusions from the assessment may rapidly become obsolete simply because of the changing data base.

AID has been utilizing agricultural sector assessments for almost 20 years, and during this period there have been substantial changes in approaches and in utilization of the results. In 1972 there was a substantial evaluation of the sector studies of the previous several years. The evaluators noted that a number of these had been of mediocre quality and that there had been a low rate of utilization for most of the studies. At the same time, it appeared that for a number of important countries the sector analyses had been successful and of considerable use in developing sector loans. Also, they provide substantial benefit to the host Governments. The evaluators made a

number of recommendations for further improvement of the models and procedures.

From a broad standpoint of methodology and assessment objectives, S&T assessors can learn a good deal from the experiences of those working in agriculture. For example, the criteria of coverage, realism, and comprehensibility are clearly applicable to S&T studies. Looked at in more detail, however, S&T assessment will be very different. First, S&T is simply not a sector in the same sense as agriculture. It is not production oriented; it is not vertical in the sense that one moves cleanly from inputs to outputs; nor is it bounded in the same way as agriculture. S&T should be thought of as a horizontal system which cuts across all of the vertical sectors. There was a general consensus that for S&T the appellation "sector" was inappropriate and attention should be directed to S&T assessment. This conclusion does not at all imply that analysis of S&T capabilities and characteristics is unimportant. Quite the contrary. What is indicated, however, is that for a successful assessment of capabilities and needs in the broad area of S&T, there will have to be methodologies which respond to the particular characteristics of the area.

Sector assessments have also been used by AID and perhaps other donor agencies for the health sector. This sector, in contrast to agriculture, is not a production sector, and inputs and outputs are much more difficult to quantify. Experience with health sector assessments is more limited than for agriculture, both in terms of years of experience and in numbers of countries covered. While health sector assessments did not play a major role in the workshop's consideration of S&T assessments, AID's recent approach of issuing guidelines for health sector assessments may offer an appropriate format for the S&T area.

IV. THE COMPONENTS AND CHARACTERISTICS OF THE S&T SYSTEM

Even though it is clear that the S&T system as an entity differs considerably from the sectors which AID and other donor agencies explicitly consider, it is not hard to reach general agreement on the principal components of the S&T system and the important characteristics which relate to national development. Briefly, the components of particular interest are: the cadre of trained manpower, i.e., the scientists, engineers, and technicians; the S&T institutional infrastructure which consists of the various public and private agencies and enterprises which produce S&T and which apply them to a variety of end uses; the S&T components of the production systems; the information systems which on the one hand garner information on S&T from the outside world and on the other hand disseminate information within the nation. There are various ways to categorize the elements of the S&T system. One way which Cornell scholars had found useful in earlier studies is set forth in Figure 1.

Figure 1

FUNCTIONS OF THE SCIENCE AND TECHNOLOGY INFRASTRUCTURE

	Education & Training	Adaptation, Development & Research	S & T Services
PUBLIC & PRIVATE SECTOR ACTIVITIES	Scientists and Engineers Teachers Technicians Skilled Labor Managers	Technology Choices Engineering Facilitation Design and Modification Development and Demonstration Basic and Applied Research	Information Extension Patents Testing and Quality Control Maintenance and Repair
INTERNATIONAL ASPECTS	Overseas Training Expatriate Instructors	Technology Transfer International Research Networks	Expatriate Advisors International Services

This approach which emphasizes function is useful in obtaining an overall view and has turned out also to be useful in cross-country comparisons. An alternative approach is to categorize by organization. One of the virtues of the organizational approach is that it simplifies analysis of the linkages among the components of the system, linkages which are vital to the effectiveness of the system. A brief listing of the principal organizations that typically enter is:

1. The educational institutions which produce the scientists, engineers, and technicians;

2. The Government support agencies which fund the various S&T activities of the public sector;

3. The policymaking bodies which set the goals and objectives for S&T;

4. The research institutes which generate new knowledge;

5. The information agencies which receive information from within and outside the country and those which disseminate information to the local groups that can benefit from it;

6. The enterprises, public and private, which utilize S&T in their production and service activities;

7. The support organizations which enhance the functioning of the system.

Two kinds of linkages are essential for the functioning of this S&T infrastructure: linkages among the various organizations which constitute the S&T infrastructure, and linkages to decision makers and S&T users. Many of these linkages are obvious and are easy to analyze in terms of depth and effectiveness; other are much more difficult to assess. Perhaps the

least understood linkages are those between the "modern" S&T system and the traditional, rural, and often "informal" components of the nation's activities. These linkages are frequently ineffective, and a serious assessment of S&T capabilities cannot avoid an analysis of such linkages.

V. STUDY EFFORTS WITH METHODOLOGICAL IMPLICATIONS FOR S&T ASSESSMENT

Since S&T are deeply involved in almost all elements of national development, it is hardly surprising that studies of specific S&T capabilities are frequently carried out. Many studies have been supported by donor agencies such as AID, UNESCO, the World Bank, and the Organization of American States. These in-country studies have tended to focus on specific national objectives involving S&T, e.g., energy, agriculture, education, and public health. As noted earlier the commitment to produce a "country paper" for the 1979 United Nations Conference on Science and Technology for Development was, for many nations, the first time that a serious national attempt had been made to catalogue S&T activities on a broad basis and to consider systematically national policies for S&T. As a consequence many of these country papers constitute a valuable starting point for S&T assessments.

One of the first U.S. groups to give explicit attention to S&T capabilities in developing nations was the National Academy of Sciences. Its typical approach has been to enter into a collaborative, week-long discussion within a developing nation on some particular element of the support for or application of S&T. These NAS workshops serve important functions in setting a framework for in-depth analysis of topics and for general catalysis of S&T activities. They do not, however, pretend to provide an overall S&T assessment.

The World Bank has for some time been giving explicit attention to S&T capabilities and has been prepared to support improvements in the S&T infrastructure. At the workshop Kamenetzky noted that he had recently summarized the reasons for interest in national technology policies and had outlined the elements of a country study of these policies. Although his analyses do not reflect formal World Bank policy, they provide an indication of World Bank thinking on the importance of technology policies and the desirable components of an assessment of S&T capabilities.

The recent interest of AID in broad assessments of S&T structures and capabilities is reflected in the AID project paper on S&T for Costa Rica. This project is designed to "strengthen Costa Rica's capacity to plan, conduct, and apply to its productive processes scientific and technological research which takes into account the needs of Costa Rica's poorest groups and the rational use of its natural resources." The background discussion and the description of the organizations that will carry out elements of the project constitute an analysis of a significant portion of the S&T infrastructure of Costa Rica and of some of the capabilities of this infrastructure. This paper is a good illustration of the desirability and use of an S&T assessment. It also indicates the types of contributions U.S. support can make to enhancing S&T capabilities.

One of the most interesting recent efforts to analyze S&T activities in a comparative way and to draw general conclusions from country data is the large Science and Technology Policy Instruments Project (STPI). This project, which was funded by the International Development Research Center of Canada, consisted of a parallel set of studies by country teams from ten developing

nations and a general analysis of the implications of these parallel studies. The specific focus of this study was not on S&T assessment per se but rather on the following two questions:

> "What can developing country Governments do to insure that their technology and industrialization policies are consistent with national development objectives?" and, "What ways and means are available for implementing policies?"

However, in addressing those questions the individual country teams carried out a number of assessment activities directed to the S&T structures and capabilities of the nations.

Dr. KunMo Chung, who was a major participant in the STPI study, summarized for the workshop the points he felt were most relevant to S&T assessment. He focused particularly on national policy instruments to attain policy objectives for technology and for industry. As STPI sees it, there are two broad classes of policy instruments for S&T, one explicit and the other implicit. The former includes policies that are specifically designed to deal with "science policy" issues; the latter arise indirectly from broad incentives and constraints which are imbedded in general economic and development policies for the country. A third element that impacts on the effective utilization of S&T in a nation was labelled by Chung as "contextual factors". These relate to public understanding, Governmental stability, level of education, etc. The simple matrix for S&T functions and activities set forth in Figure 2 illustrates the different impacts of these factors. Two important points which Chung made are indicated by the heavy crosses on the matrix. The explicit policy instruments, in his judgement, have their main impact on <u>supply</u> of technology. In contrast, the more subtle and less obvious implicit policy instruments dominate in determining

the demand for technology. A far more detailed analysis of the STPI effort and the conclusions from it are to be found in the Main Comparative Report of the STPI project. (Sagasti, 1978)

Figure 2

INFLUENCES	SUPPLY SIDE: New S&T Services & Skills	LINKAGE AREA: To Production System; Between S&T Institutions	DEMAND SIDE: For Domestic & Foreign S&T
EXPLICIT POLICY INSTRUMENTS	•R&D institution bldg. •R&D with production •Manpower develop.	•S&T information services •Eng. consultancy	•Reg. of technology import
IMPLICIT POLICY INSTRUMENTS	•Nat'l education system	•State enterprises	•Export-oriented industrializati •Foreign capital inducement •Trade policy
CONTEXTUAL FACTORS			•S&T popularization movement •National security

Since the STPI study involved parallel efforts within several countries, commonality in approach and methodology was important. Early in the project a formal set of "methodological guidelines" was developed with the strong implication that the individual study teams would utilize most of the recommended guidelines. The published guidelines are of interest and suggest steps to minimize the fortuitous and anecdotal elements that can plague S&T assessment.

The recently completed studies by teams from Cornell on the role of S&T infrastructures for industrialization in three developing nations constitute

a partial but significant approach to S&T assessment. Two reports from these studies have been published; one on methodology and one on cross-country comparisons. Three additional reports are near completion. Because the principal components of these studies were country visits of only three weeks duration and because team membership differed somewhat among the visits, reservations about the depth of coverage and generality of the conclusions are warranted. However, there were compensating features in the methodology which merit mention:

1. Team members were senior scientists and engineers with considerable experience in disciplines of relevance to development and in overseas activities.

2. Substantial prior research and discussions occurred before every visit.

3. Considerable effort was given to a common approach for the visits, and the principal organizations to be visited were identified in advance.

4. Data collection was a large component of every visit, and extensive post-visit analysis of the data was emphasized.

5. Preliminary conclusions were discussed with experts from the State Department in Washington and the U.S. Embassies, and to a limited extent with organizations in the developing countries.

6. Explicit consideration was given during the visits to the technological requirements of public and private sector enterprises and their attitudes concerning local S&T capabilities and institutions.

The Cornell study was designed to analyze the performance of the various components of the national infrastructures for S&T as they related specifically to industrialization. The approach was to focus on three principal elements of the infrastructure: those concerned with production of trained manpower; research, development, and acquisition and adaptation of new technologies; and providing technical and scientific services. Figure 1 further elaborates the functional approach which was used. This approach was very useful in planning interviews and visits, in identifying needed data, and in helping to integrate information from various agencies and institutions. Further, the functional approach directed attention to overall system performance and the many factors which bear on effective application of S&T. More details on the development of the methodology are given in the recent Cornell publications.

VI. WORKSHOP RESPONSES TO CURRENTLY AVAILABLE METHODOLOGIES

Workshop discussion on the utility of these various methods of S&T assessment and on the most promising new directions was wide-ranging and vigorous. There was, however, a general consensus with respect to a number of items. There was broad support for the position that the role of S&T for development is indeed crucial and that, therefore, explicit assessment of the characteristics and the capabilities of national systems of S&T is important. Usually, such assessment cannot be adequately subsumed within assessments of "vertical" development sectors. Analysts with the skills and knowledge needed for authoritative assessments of S&T systems and capabilities are seldom included in the teams responsible for sector assessments. Cross-country analyses are often important for clarifying how S&T can support several sectors, including the often neglected industry sector, and for addressing intersectoral

problems such as alternative energy sources, development of timber resources, and environmental pollution. There does not now exist any generally acceptable "standard" methodology for S&T assessment. Indeed there is some debate even as to the precise coverage required for S&T assessment. As one question, should assessments routinely strive for full coverage of the entire S&T system or does it make more sense to focus on specific components, e.g., S&T for industrialization or agriculture or public health? A second question is, how much emphasis should be given to assessment of S&T capabilities for assisting the "traditional" rural technologies where new directions are more likely to come from the efforts of individual entrepreneurs than from professional scientists or engineers?

There was a consensus on the directions to follow in developing improved methodologies. The goal should be a recognized and accepted framework for analysis which could be used equally well by donor agencies, international organizations, host Governments, and other development practitioners. The methodology should permit assessment of individual S&T activities and also linkages among them and between them and Governements and other users of S&T. The methodology should give considerable attention to the interplay between S&T activities and national policy planning.

There was general agreement that the methodology should become somewhat more standardized and more formal and should rely more heavily on reliable data and less on anecdotal material. Standardization of format will facilitate cross-country camparisons and reduce duplicaton of efforts by donor agencies. Indeed, the general trend of methodology development should be towards more explicit models and more quantitative analysis of data, although not to the extent characteristic of some of the large, computerized models for agricultural

sector assessment.

There was a broad consensus for insuring active participation by policy-makers, scientists, and engineers from the host countries if S&T assessments are to be realistic and useful. Active participation by interested local agencies (for example, those interested in obtaining a loan for expansion of some element of the S&T system) will ordinarily be possible. Another type of desirable participation is involvement of independent experts from universities or foundations of the developing country, both in planning the details of the assessment and then in helping to evaluate implementation of resulting programs and projects.

VII. A TENTATIVE SET OF PLANNING GUIDELINES FOR S&T ASSESSMENT

At this early stage in the development of a methodology for S&T assessment, it is premature to prepare a detailed set of guidelines as, for example, has been done by the AID Bureau for Latin America for agricultural sector assessment. At the same time, a tentative set of planning guidelines can be helpful both as a "checklist" of items to be considered in designing an assessment and as a first attempt to develop a more standardized approach. The tentative outline which follows is an initial effort to assist in these two directions.

A. General Characteristics of an Assessment Methodology

1. Capability for accurate description of the S&T system and elucidation of S&T interrelationships and linkages.
2. Explanatory power: Does it help in the understanding of the empirical evidence?
3. Comprehensibility: Is the approach understandable and can

conclusions and recommendations be developed in a form that can be appreciated and used by non-experts, especially policymakers.

4. Usefulness to decision makers: Does the assessment respond to the initial objectives set for it? Does it contribute explicitly to policy and program decisions?
5. Will the assessment be available in a timely manner, i.e., soon enough to impact on the decisions which provided the motivation for performing the assessment?

B. Explicit Delineation of Objectives for the Assessment

1. The purpose: Is the assessment actuated by analysis of a projected loan, request for technical assistance, reorientation of the educational system, new directions in rural development, determination of budget priorities, etc?
2. The scope of the assessment: Does the study encompass the entire S&T system or is it oriented toward some specific aspect of it? Is the focus toward the S&T system itself, e.g., training, R&D, technical services, or toward the role of S&T in a particular activity, e.g., forestry development?
3. The depth and complexity of the assessment: Are there constraints which stem from availability of time and resources or result from narrow objectives?

C. Advance Preparation for the Study Effort

1. Participants, expecially those from the U.S., must devote

considerable time and attention to developing the procedures to be followed and to familiarizing themselves with the background aspects of the country and its S&T system. This preparation should provide a preliminary identification of visits and analyses to be made in the country, clarify kinds of data which must be sought in the country, and permit advance identification of priority problem areas. Also, it should enhance the credibility of the visiting team with host country participants and agencies and improve the quality of field interviews.

D. Composition of the Assessment Team

1. Balance of disciplines: Participation by scientists and engineers is essential for credibility and for authoritative technical judgements. Participation by social scientists is equally important. Economists are almost always needed, political scientists can be very valuable, and sociologists can contribute to understanding organizational dynamics.
2. Breadth and stature of team members: Should be respected in their disciplines. Broad knowledge of development process is strongly desirable.
3. Host country participation in study team: Representatives of the Ministry of S&T or equivalent agency. Host country university staff or other non-Governmental experts.

E. Activities during the Country Visit

1. Interviews with relevant agencies, educational institutions,

enterprises, etc.

2. First hand observation of activities and laboratories.
3. Interactions with economic and S&T officers in Embassies, AID Missions, and Consulates.
4. Obtaining up-to-date data from Government offices, local libraries, and S&T institutions on various aspects of S&T system, including information on acquisition and dissemination of technology.

F. Post-Visit Analyses

1. Analysis of data obtained and development of effective presentations.
2. Integrating data from visits in terms of initial objectives and purpose.
3. Cross-country comparisons.

G. Length of Study

1. Short studies may suffer from lack of credibility and should only serve limited objectives.
2. Too extensive studies can be perishable since the situation changes with time.

H. Approach to Assessment

1. Because S&T is a horizontal sector, a variety of approaches are conceivable depending on objective of the assessment.
   a. Organizational approach: Appropriate for study of individual operational components, e.g., Ministries of science and technology, educational systems.
   b. Functional approach: Focuses attention on problem issues

and areas. Facilitates incorporation of private sector activities. Useful for analysis of operational (in constrast to formal organizational) linkages.

2. Desirability of developing analytical models
3. Utility of cross-country comparison
   a. Encourages standardization of methodology.
   b. Reveals specific weaknesses.
   c. Improves baseline for qualitative judegement in different social settings.
   d. Particularly useful in comparing different approaches to specific functions.
4. Special concern for Information Systems relating to S&T
   a. Partly covered by analysis of linkages.
   b. Information systems which receive data from abroad are of particular importance for technology choices and for keeping abreast of developments in basic science.
   c. Information systems which disseminate results to users can be particularly important for the small producer, e.g., village entrepreneur or rural agriculturalist.

VIII MAJOR CONCLUSIONS AND RECOMMENDATIONS

1. Assessment of S&T systems and capabilities likely to be of increasing interest to developing countries and to donor agencies, and particularly AID and the World Bank.

   The scope and character of assessments will vary, depending on the particular objectives.

2. No standard methodology exists for S&T assessment. Two broad approaches have been used, organizational and functional. The first focuses on the institutional components of the S&T system, or some partial element of it such as individual or groups of agencies, laboratories, and educational institutions. The functional approach considers all contributors, national and international, to the important functions of the S&T system, e.g., education of scientists and engineers; vocational training; technology acquisition, adaptation, and development; and support services of various sorts. Each approach has its uses, and there is considerable overlap between them.
3. There will probably be an evolutionary movement to more standardized methodologies with more emphasis on analyses and interpretation of data and less on anecdotal material. Models which can accept quantitative data will increasingly be used, but the variety of assessments that will be required virtually precludes the use of only a single model.
4. Participants in an S&T assessment should be capable, experienced individuals with the stature and recognition that will assure their acceptance by the host country. Scientists and engineers will invariably be involved, but social scientists, especially economists, have important contributions to make. Collaborative participation in assessments by experienced experts from the host country is strongly desirable.
5. A number of further steps can usefully be taken by AID in the months ahead to improve the methodology for S&T assessments.

a. An internal (or internally supported) study effort, focused on AID needs, could examine in more detail the methods used by the World Bank, Cornell University, and other groups. The objectives would be to define more sharply broad areas of commonality and to identify specific useful procedures for AID purposes.

b. A small workshop in Washington, principally of AID and ISTC personnel, could examine recent AID analyses to support S&T-related project loans, e.g., Costa Rica, Indonesia, Brazil. The objective of the workshop would be to identify specific procedures and approaches which seem most contribbutory to a useful S&T assessment.

c. Based on these and other inputs, AID could draft an AID-oriented set of operational guidelines for S&T assessment. These in turn might be tried out in a country setting, as for example, the proposed analysis for Ecuador. Following this experience, revised guidelines might be widely disseminated within AID.

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WORKSHOP ON

DEVELOPING AN APPROACH TO THE EVALUATION OF SCIENCE AND TECHNOLOGY AS A BASIS FOR PROGRAM DECISIONS BY U.S. AGENCIES

CORNELL UNIVERSITY,

September 27-28, 1979

F. A. Long, Chairman

SEPTEMBER 27

8:30 am	Coffee and Doughnuts
9:00 am	Welcoming remarks by F. A. Long
9:10 am	AID Interests in S&T Evaluation and Its Relationships to Sector Assessments Feldman (AID)
9:30 am	Significant Aspects of Sector Analysis and Assessment with Illustrations from Agriculture Thorbecke (Cornell)
10:15 am	Experience in Agriculture Sector Assessment and Implications Report: Fletcher (Iowa State) Comments: Riordan (AID)
11:15 am	Coffee break
11:30 am	Approaches to Transferring Scientific Findings into Field Programs in Health and Nutrition Habicht (Cornell)
12:30 pm	Lunch for Participants (202 Uris Hall) Anandakrishnan (U.N.) "Interests and Concerns of Developing Countries for External Support of S&T Development"
2:00 pm	S&T Assessment Methodologies Report: Schweitzer (Cornell) Observations: Rabinowitch (NAS) Mason (OAS) Kamenetzky (World Bank)
3:30 pm	Coffee break

SEPTEMBER 27 (continued)

3:45 pm	S&T Case Studies
	Highlights of the Science and Technology Policy Instruments Project (STPI) Chung (Polytechnic Institute & NSF)
	Establishing Priorities for Allocating Funds to Rice Research Barker (IRRI and Cornell)
6:00 pm	Reception, Ramada Inn
7:00 pm	Working Group to Define Issues Chairman: Hughes (Cornell)

SEPTEMBER 28

8:30 am	Coffee and Doughnuts
9:00 am	Report of the Working Group on Issues Hughes (Cornell) et. al.
10:15 am	Coffee break
10:30 am	Discussion
12:00 pm	Lunch for Participants (202 Uris Hall)
1:00 pm	Development of Conclusions and Recommendations: Where do We Go From Here?

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