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THE ROLE OF SCIENTIFIC & ENGINEERING SOCIETIES IN DEVELOPMENT

PROCEEDINGS

Of a Workshop conducted by the American Association for the Advancement of Science for the U.S. Department of State, as a contribution to U.S. preparations for the United Nations Conference on Science and Technology for Development.

May 21-22, 1979
Washington, D.C.

Jeannette Wedel
Editor

American Association for the Advancement of Science
1776 Massachusetts Avenue, N.W.

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Work performed under Contract from the U.S. Department of State Number 1019-966031

AAAS Publication Number 79-R-11

THOUGHTS AT THE AAAS WORKSHOP
ON THE ROLE OF SCIENTIFIC AND ENGINEERING
SOCIETIES IN DEVELOPMENT,
Washington, D.C., May 21-22, 1979

After several arduous sessions
With the cream of the Professions,
Making up a little list
Of ways in which they might assist
Countries that are poor, but which
Have some ambitions to get rich
By mastering the mystery
Of Science and Technology;

I am distressed to find that Pie
Stays obstinately in the Sky,
And that the troubled world is viewed
From such a lofty altitude
That not much wrong comes into sight,
And likewise, not too much that's right.

For in the course of being wise
We tend too much to generalize
When truth, as Blake calls from the stars
Rests in Minute Particulars.

Yet this thought takes us on the road
To information overload,
And it's not uniformly good
To see the trees but not the wood.

It is not easy to get rid
Of doing what we always did
And yet we hope that something new
Emerges in the distant view;

A sense that when all's said and done
Both Science and the World are one.
And that the weakest human cry
Resounds for ever in the sky.

So we must keep up the pursuit
Of Truth, and Truth's surprising fruit,
In all our several professions --
And that's the fruit of all our sessions.

Kenneth E. Boulding

FOREWORD

In convening this workshop, the American Association for the Advancement of Science recognized the potentially important, but largely unrealized, contributions which scientific and engineering societies can make to development. This recognition was also reflected in earlier Association initiatives related to the U. N. Conference on Science and Technology for Development. These initiatives, encompassing joint activities with U.S. and foreign scientific groups, have aimed at strengthening the contributions of the world scientific community to the Vienna Conference in the context of the science and technology policy issues facing that Conference.

The objectives of this workshop were simple and straightforward. They were to:

(1) identify the kinds of activities scientific and engineering societies can uniquely perform or contribute to in furthering development, and

(2) consider ways in which the activities so identified might be implemented.

The workshop set out to document both successful and unsuccessful cases where mainline scientific and engineering societies have been involved in development-related activities. It went beyond just documentation, however, and collectively brainstormed new and untried ideas of potential interest to the societies, national and international funding

agencies, and the U.S. delegation to UNCSTD.

The workshop did not concentrate on the accomplishments of individual scientists and engineers in the development arena. Nor did it dissect the role of successful development-oriented organizations such as VITA, except to use their experiences in analyzing options for the mainline societies. This was not because the accomplishments of individuals and development-oriented organizations are not important--they are. But the focus of this workshop was on the unique capabilities of the mainline societies.

Development is intrinsically practical. This explains the large proportion of engineers involved in the workshop and in preparation of the resource papers. The productive and collegial interaction of a wide spectrum of scientists--physical and social--and engineers engaged in a common task of such import was especially satisfying.

The results speak for themselves. Given the extreme temporal constraints associated with organizing the workshop and preparing and editing this report, I believe we have a product that will not only be of value at UNCSTD but will have a residual value for some months and years beyond.

More importantly, this workshop and its report can serve as a launching platform for future discussion, planning and actions by the scientific and engineering societies. The AAAS invites comments on and criticism of this report, as well as identification of relevant documents and activities and suggestions for future activities. We hope the AAAS Consortium of Affiliates for International Programs can serve as a convening and integrative agent for the societies when broad, interdisciplinary and interprofessional approaches are needed.

As important as the results of the workshop are, of equal if not

greater importance was its delineation of the primitive state of most society programs focused on development. This is perhaps not surprising given the lack of a substantial international involvement by many U.S. societies. Because of the interchanges which took place at the workshop, we know a lot more than we did about our degree of ignorance.

Of particular importance was the recognition by the workshop of the fundamental need to develop true partnerships with scientific and engineering groups in the developing countries. A logical next step, therefore, is the convocation of an international workshop in conjunction with foreign societies from both the developed and developing world to continue the momentum generated by this predominantly U.S. conclave. This task should be at the top of the post-UNCSTD agenda.

The success of the workshop was due to the hard work and talents of many individuals and organizations.

Officers and top staff from the scientific and engineering societies participated in the planning and execution of the workshop from the very beginning. The resource papers gathered together in a very few pages an incredibly large amount of information which furnished the starting point for the workshop discussions. Present and former officers of AAAS not only provided advice, leadership and counsel, but lent their wisdom and poetry to the deliberations as well.

The workshop coordinators, Jeannette Wedel and Denise Weiner, are due a large part of the credit for a workshop that was well-planned, logically structured, and smoothly run. Innovation, responsiveness to the workshop constituency, and careful attention to detail was their hallmark. Their

success in this endeavor was aided and abetted by Linda Thompson, Daloris Flaming, and Rosita Price.

Without support, financial and substantive, from the Department of State, the workshop would not have taken place. Special thanks go to Ambassador Jean Wilkowski and Simon Bourgin.

The Chairmen and Rapporteurs effectively and elegantly executed their responsibilities, meeting extremely tight schedules after shepherding discussions over very broad and complex topics.

Most important of all was the competence, knowledge, and enthusiasm of the workshop participants. Rarely has a group of such stature been assembled to discuss a topic of such importance.

The elements of the report were drafted by the Chairmen and Rapporteurs of the Working Groups and Area Caucuses. Jeannette Wedel, ably assisted by Denise Weiner, in turn did a superb job of integrating these diverse documents into the well organized and very readable report which follows.

J. Thomas Ratchford

Associate Executive Officer

June 28, 1979

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INTRODUCTION

The Workshop on the "Role of Scientific and Engineering Societies in Development" was the last of a series of four workshops conducted by the American Association for the Advancement of Science (AAAS) in connection with the U.S. Department of State's preparations for United Nations Conference on Science and Technology for Development (UNCSTD). The two-day workshop, held May 21-22, 1979 at the Marvin Center, George Washington University, Washington, D.C. involved sixty representatives from scientific and technical societies, academia, industry and government.

After an initial plenary session, the participants broke up into four working groups to discuss the unique capabilities that scientific and engineering societies can offer in:

- assistance in identifying R&D needs of a country.
- exchanging scientific and technological information.
- scientific and technological education and training.
- technology evaluation.

Each group identified specific roles for societies in each of these areas, which were then presented and discussed by four area caucuses - Africa, Asia, Latin America and Middle East - for specific application. The Workshop as a whole then reviewed each working group's findings.

The highlights of the discussions in each of these areas are summarized in the following pages.

In addition four resource papers were prepared for the Workshop as background information:

1. "An Inventory of Current Activities of Scientific and Engineering Societies in Developing Countries," Donald Marlowe, Executive Director, American Society of Engineering Education.
2. "Transferring Publicly Available Technology - The American Chemical Society's Approach," Robert W. Parry, Distinguished Professor of Chemistry, University of Utah and Gordon Bixler, Manager, Office of International Activities, American Chemical Society.
3. "The Global Network of Engineering Education Societies: Their Roles in Development of Technological Infrastructures," Merton R. Barry, Director, International Engineering Programs, University of Wisconsin.
4. "The Role of Scientific and Engineering Societies in Development," Donald G. Fink, Director Emeritus, Institute of Electrical and Electronics Engineers.

SUMMARY

The dominant focus of the Workshop and the resource papers was identification of the basic characteristics of scientific and technical societies that enable them to make significant contributions to the development process of any country. Specifically:

- they constitute a reservoir of individual scientists engineers and technicians with specialized knowledge and expertise that can be mobilized to undertake specific tasks;
- they provide a peer review system for evaluating the importance and value of scientific and engineering proposals, projects and accomplishments;
- they provide an open market of planning and delivery systems for technology, not constrained by institutional or proprietary or political barriers;
- they provide a useful teaching and educational functio through the journals, reviews, handbooks, and books they publish on accomplishments and advances in their disciplines;
- they provide a forum for information exchanges on a wide range of topics in the scientific community.

The needs of the developing countries vary widely because of the different levels of scientific and technological development in each country. Therefore, each country must identify its own needs and set its own priorities. Scientists from developed countries can only attempt to translate their knowledge based on experiences in their own environments.

In order to transfer this experience, it is essential that United States societies form a partnership with developing country scientists in any development effort. While the ideal situation would be to establish linkages with an equivalent society, flexibility is required in selecting a cooperating unit abroad. It may consist of a college or department within a university, a research or training institute, a governmental unit, or an informal network of scientists and technologists, from which a society may develop later.

Another focus was the management and transfer of scientific and technological information to developing countries and its essential role in the development process. A basic function of scientific and technical societies is to collect technical information, and condense and focus this information for transmission to appropriate audiences. United States societies can assist in information exchange by:

- publishing the results of the research and/or teaching experiences of their memberships;
- conducting meeetings at which the results of recent studies and new ideas are exchanged both in lecture-type presentations and in person-to-person dialogues, and
- sponsoring workshops or short courses or topics currently amenable to solutions or ones in need of further study.

A guiding principle of the technical societies in the United States is that the exchange of information between two parties at least doubles its utility. This should also be the principle in the exchange of information between United States societies and technical entities (societies, institutions, or individuals) in developing countries.

A strong indigenous system of scientific and technological education is essential to the progress of a developing country. United States societies can assist in this development by:

- assisting in the formation and growth of indigenous scientific and technical societies;
- developing relationships with universities to give leadership in their disciplines towards more relevant training for foreign students;
- giving honor and prestige to professional participation in international development.

The United States scientific and engineering societies have served a useful function in the development process of this country, and can serve as models in developing countries. There are many diverse, but related aspects in development which impinge upon the role of technical societies. A high degree of tenacity and patience by scientific and engineering societies in developed countries will be required in their mission to assist in creating indigenous self-generated systems in developing countries.

I. ASSISTANCE IN THE IDENTIFICATION OF R&D NEEDS OF A DEVELOPING COUNTRY

In opening the discussion, it was noted that the great preponderance of Research and Development (R&D) competence is in the developed countries, whereas there is a great need for such competence in the developing countries. Further, most of this competence is in the private sector in the developed countries, but under the government sector in the developing countries.

Moreover the needs of developing countries vary widely because of the vast differences in the state of science and engineering development in the countries which compose the developing world. Also, each country has differing publics for R&D. Thus, the R&D needs differ among 1) the advanced researcher in the university or corporation, 2) the research worker in the specific development agency, e.g. a health planner in a local hospital or clinic, or an agriculturist in a field institute, 3) the policy maker in government, and 4) the teacher/trainer in the school, institute, or college. Sometimes, a single individual fills all of these roles. Yet, the research and development needs of each is very different and the responses of the U.S. technical society should likewise be differentiated. It is important that each developing nation identify its own problems (with outside assistance where appropriate) and set its own priorities.

The discussion of the role of the technical societies in the application of research and development to the problems of developing countries covered three general areas

(A) general factors germane to the involvement of scientific and technical societies in the R&D aspects of national development;

(B) the unique activities of societies with respect to R&D;

(C) the appropriate role of societies.

A. General Factors

First among the general factors, and certainly one of the more important, is the level of technological development within the developing country. The reason is that there must be within the country a body with the qualified technical capacity to function as a counterpart to the U.S. society. Without some suitably qualified group with which to interact it is unlikely much of a lasting impact could be accomplished. The body might be a professional group or society indigenous to the country, or it may be a college or department within a university, a research or training institute, a governmental unit, or an informal network of scientists and technologists.

A second general factor is the range of relevant R&D, whether oriented toward basic science, engineering or appropriate technology, complex or simple as the case may be.

A third general factor is the type of problem. Is it one of interest to the developed countries as well as to the developing countries, such as remote sensing, or of interest only to the developing country.

A fourth general factor relates to the type of scientific or engineering discipline, whether a well established, focused discipline or an inter-disciplinary area of study or research. There was some feeling that societies are best able to impact focused problems correlating closely with their particular discipline or concern.

B. Activities of Scientific and Technical Societies

The following activities were identified as unique to societies, so far as R&D is concerned:

(1) publications;

(2) the giving of advice on planning, policy and operations in the areas of society expertise;

(3) evaluation and peer review of proposals for or accomplishments from specific research or development projects;

(4) the conduct of specific projects or programs involving studies, or professional services, and

(5) assistance in the development of new subgroups or societies based on the growth of technology.

There was a consensus that technical societies do not, as societies, effectively conduct research and development. Their members do, but the societies do not. However, it was agreed that a society could identify, from among its members, a number who are well qualified in a particular field in which a problem has been identified. That group, working with a counterpart group within the country, could plan an R&D program to attack the problem, but then the actual pursuit of the R&D would be placed in other hands, perhaps a group of scientists and engineers from

within the country. The group selected by the U.S. society would not generally engage in the research. If asked, they might be involved in periodic reviews and progress evaluations.

From the discussions four general recommendations emerged.

- First, societies can serve as intermediary agents in many R&D situations for developing countries.

In some cases this is because there can be difficulties in dealing at the level of government to government, perhaps too much red tape on one side or mistrust of motives on the other. When much of the technology is in the hands of the private sector, the developing country may be suspicious of the motives of the private firm; so a professional society, as the funnel for the transfer, might be more acceptable. Finally, the society might be the desirable point of contact because it usually enjoys some measures of respect and recognition.

- The second recommendation is that societies can stimulate the formation of scientific and technical societies within the developing country when none exist, or
- act as a catalyst in the broadening of professional society roles to encompass consideration of R&D needs of the country.

The important element is to stimulate the emergence of a problem identification capability in the country.

One example was cited by the American Statistical Association which was asked to advise on the organization of societies in Mexico and Chile. As a result of an interchange series of visits, the scientists of

Argentina, Chile, Columbia, Mexico and Venezuela also organized their own Committee: "The Latin American Committee to Promote International Relations in Statistics" which will promote the development of statistics throughout Latin America and the relations between national societies as they are being developed in Latin America.

- it was recommended that societies should continue, when appropriate or natural opportunities arise, to enter into cooperative bilateral or regional programs, such as that reported by the American Chemical Society (ACS) for its Egyptian activity.

ACS working with the Egyptian Academy of Scientific Research and Technology conducted a week-long workshop on industrial chemistry in Cairo. Americans and Egyptians met to exchange publicly available technology in five chemical subject areas that constitute serious economic problems for Egypt. The workshop contributed significantly to Egypt's ability to overcome the problems and laid the groundwork for a number of joint research projects that can benefit both nations. Currently, two of these projects have been selected for implementation by the Agency for International Development.

C. Role of Scientific and Technical Societies

One question posed was how developing countries could be more aware of the interests and capabilities of societies in the U.S. The problem was described as one of marketing.

- It was suggested that a "broker" function is needed in the same manner that Volunteers in Technical Assistance (VITA) brokers the expertise of volunteer individuals to developing countries.

An organization such as AAAS or some other new or existing group could broker the talents of professional societies. This could be regionalized or focused by groups or disciplines.

The questions of the role which professional societies might play in bringing to the attention of developing countries publicly available technology, and how to redistribute equitably the level of R&D among countries were considered, but not responded to with any viable recommendations. Similarly the following topics were discussed again with no clear conclusions:

1. Is there a role for the social sciences in evaluating, or forecasting, the social impacts of a proposed development program on the society into which it is to be introduced? Would the developing country be in a better position to judge whether to proceed with such a development with such a social impact study?
2. A primary objective of cooperative programs involving R&D should be to present a challenge to the scientists of the developed countries, as well as an opportunity for the scientists of the developing country. There should be a two-way flow of information.
3. Scientific and technical societies usually do not like to be identified with failure. Since development programs inherently contain a risk factor, are societies prepared to face the possibility of failure in cooperative development programs with developing countries? Further, some-

times it is not known for a long period of time whether a program has been successful. Can better evaluative techniques be introduced?

II. EXCHANGE OF SCIENTIFIC AND TECHNOLOGICAL INFORMATION

The role of societies in the transfer to developing countries of scientific and technological information should stress the exchange of technological information rather than a one-way flow; there should be exchange of information rather than a designated donor and a designated receiver. The exchange of information between two parties at least doubles its utility. That is the guiding principle of the technical societies in the United States as they promote dissemination of new knowledge in their journals and meetings; it should also be the guiding principle in the exchange of information between technical societies in the United States and technical entities (societies, institutions, or individuals) in developing countries.

It is necessary to realize that everything cannot be accomplished at once. A program of international technology transfer must determine needs and priorities, do first things first, and not spread itself too thinly.

There are great inequalities in the distribution of scientific and technological information between regions, or countries, or even within countries. A major priority should be efforts to reduce the inequality of access to this information, and the inequality of skills in its management and use.

The discussion of the role of U.S. societies in this information exchange centered on three areas:

(A) first, in what ways can U.S. technical societies participate in the exchange of technical information with developing countries?

(B) how can U.S. technical societies best make use of the absolutely essential face-to-face contacts that are generally recognized as the most effective mode of technology transfer?

(C) what can U.S. technical societies do to focus or concentrate useful information, reducing its volume, improving its relevance, and relating categories of refined, concentrated information to categories of users?

A. Ways Scientific and Engineering Societies can Assist in Information Exchange.

1. Most societies publish the results of the research and/or teaching experiences of the membership. Usually these are in the form of journals, review articles, and handbooks, or in some cases textbooks and training manuals.

2. Annual, topical, and other meetings are held by national societies and local chapters or branch societies at which the results of recent studies and new ideas are exchanged both in lecture-type presentations and in person-to-person dialogues.

3. Societies sponsor workshops or short courses usually on topics currently amenable to solutions or ones where progress has been slow but needs encouragement.

4. Societies maintain directories, distribute newsletters, and attempt to alert their membership on happenings of interest both on national and international scales.

B. Ways U.S. Technical Societies Can Make Best Use of Face-to-Face Contacts as the Most Effective Modes of Technology Transfer.

1. In many ways, U.S. technical societies can facilitate face-to-face contacts for the exchange of technical information. Examples include students abroad, foreign attendees at U.S. conferences, the reverse use of foreign students as information filters, and encouragement of both national and regional groupings of technical societies in developing countries.

2. Technical Society Programs. There are many useful examples of face-to-face contact possibilities where U.S. technical societies could assist: faciliate foreign tours of U.S. technologists; fund foreign participation in U.S. technical society meetings and committee activities, including editorial activities; form international committees of national technical societies to formulate programs abroad; assist in the organization and management of technical societies abroad; establish foreign divisions, sections, local chapters, and foreign associate memberships in U.S. technical societies; help foreign technical

societies to prepare proposals for funding of projects; develop joint bilateral research programs or projects (non-governmental); assist local (foreign) writing of handbooks and review articles; and encourage foreign students in the United States to study problems relevant upon their return home.

3. Dissemination of Information about Opportunities for Foreign Students in the United States. Examples include: Preparation of inventories of foreign technical societies, funded travel of staffs of U.S. technical societies, maintenance of contacts with returnees trained in the United States, and orientation programs to facilitate the entry of foreign students to the U.S. educational complex.

C. Condensing and Focusing Information by Categories through Technical Societies; Identifying Kinds of Knowledge Appropriate to User Groups.

With the very large volume of technical information now available, it was agreed that condensing and focusing such information would be of tremendous aid to developing countries. Reviews, handbooks and textbooks represent some of the more effective ways for achieving this goal. To the extent that technical societies can promote preparation of such material, they will assist in information transfer to developing countries.

It was agreed that a variety of audiences must be reached through information transfer activities and that different methods of information transfer are appropriate for different groups. The groups, their location, and the access modes are summarized in tabular form:

	Group	Location	Needs	Strengths
1)	Advanced Research Groups	University campuses, some corporations	Full range professional journals, ultimately electronic access to data bases	High level expertise voluntary service
2)	Development Workers	Ministries, local government	Pragmatic information on solving problems	Knowledge of local problems and how technology impacts them
3)	Policy Makers	Mid- to Upper-Government Level	Summaries, evaluations, case studies, Largely in print now, but cassettes may become useful if properly prepared	Knowledge of local problems, strengths and attitudes
4)	Teachers	High schools colleges, universities	Textbooks, review articles, summaries and then primary information if possible	Close contact with problems and culture

Of the above, Item 3, policy makers, has received the least attention, but some activity in this sphere has been initiated by a group known as AISLE (An InterSociety Liaison Effort). This voluntary organization is a multi-disciplinary, balanced group of scientists and engineers of all types that meets with legislators, policy makers and public administrators in an effort to make better use of scientific and engineering information in policy formuation. It has a good record so far in the U.S. and might

be expanded to the international scene. Other groups also have formal programs for transferring scientific information to local policy makers. International expansion has yet to be demonstrated.

Some of the older, more conventional modes of presenting information remain appropriate for many if not all groups. The most modern, "high technology" forms of information transfer may be needed by the most advanced research groups, but become less appropriate for groups further down in the table. Even many newly formed and developing research groups may profit initially by use of hard copy materials rather than the more sophisticated means of information transfer.

It was suggested that a serious problem remains in the area of book and journal distribution. Intervention of technical societies to push for help in this problem was recommended. Regulatory agencies and funding agencies may well be approached through group action.

The three words that stress the essence of the discussion are:

First, exchange; second, contacts; and third, relevance.

United States societies have a useful role to play in all three items. Further detailed suggestions follow in this same format.

Technical Information Exchange.

1. There should be a filter to assure that investment in the flow of information from one country to another should not be wasted on information of low value or obsolete content.
2. There should be purposeful use of U.S. societies' journals to further international exchange of scientific and technological information. Possibilities include:
    a) Providing space in these publications for news of foreign activities and of non-U.S. members

b) Discussion of global interests

c) Educational information services available to non-U.S. members

d) Publicizing urgent needs for technical information or expertise for developing countries.

e) Reporting activities of U.S. technical societies abroad (accomplishments which include both successes and failures)

f) Assisting foreign authors in preparation of manuscripts for publication in U.S. journals

g) Listing of U.S. and foreign job opportunities

3. U.S. technical societies should promote and assist in the writing of technical review articles and handbooks of particular value to technologists and teachers in developing countries. (However, it is recognized that the primary responsibility for such efforts lies within the countries themselves.)

4. Explore the use of sound and audio-visual cassettes (preferably in languages indigenous to the developing countries) to transmit scientific and technological information to cultural centers abroad to enable foreign technical audiences to have increased access to complex technical information.

5. Technical societies might investigate or stimulate investigation of the following barriers to international information/exchange followed by the formulation and implementation of programs to overcome them.

a) Postal charges

b) Patent and copyright restrictions

c) Problems in shipment of heavy educational materials

d) Identification and meeting of needs for broken and open sets of serials.

6. U.S. technical societies should encourage the creation and maintenance of regional, international, and interdisciplinary technical journals.

Face-to-Face Contact with Developing Country Technical Personnel.

1. To facilitate face-to-face contacts between U.S. and developing country technical society members, it would be useful to have an inventory of their societies, identifying the names and addresses of their permanent staff members and leading personalities.

2. Foreign travel of staff and representatives of U.S. technical societies should be encouraged, especially in response to requests originating in developing countries.

3. Periodic conferences should be held in the United States and other highly industrialized nations to provide specific consideration to problems and interests of developing countries to which their representatives would be invited and given special opportunity to present papers.

4. Meetings of groups in workshops, including U.S. and developing country participants representing technical interests, economists, educators, administrators, and legislators could be useful to study issues of public interest science.

5. Members of U.S. technical societies with foreign languages skills and acquaintance with foreign culture patterns should be encouraged to employ these special skills in furthering foreign contacts with that part of the U.S. technical community they belong to. Of special importance are those scientists and engineers who are now U.S. citizens but who have family ties and language skills due to their origins in the developing countries. A directory of such persons should be prepared.
6. Liaison arrangements among technical societies in different countries should be established and supported and their activities publicized.

Information Processing for Conciseness and Relevance.

1. Conciseness.

   The particular form in which information is transmitted to a given country depends upon the technical level of that country's information system. Information should be made available to U.S. technical societies on a country-by-country basis as to the level at which information should be packaged.

2. Relevance.

   a) To a considerable extent the shape, form and priorities of the needed information transfer are determined by the user. In the developing countries, users may be assisted in determining what these criteria are, and how to apply them to incoming U.S. information.

b) Improvization is regarded as an important activity in adapting technology to the needs of a particular region or developing country. The multinational corporations need to be assisted in the effort to enable technological product modifications to meet specific needs. Technical societies may be able to help in this effort.

c) Technical societies should be prepared to provide advice to developing countries as to the appropriateness of the transfer of hazardous technology--whether in the form of industrial facilities, raw materials, products or process information.

d) Opportunities should be sought (and efforts supported) by U.S. technical societies to hold conferences in developing countries to address subjects of particular interest to the country in question.

e) While it is recognized that the impacts of applied scientific and technological information are seldom politically neutral, it would be inappropriate for U.S. technical societies to attempt to screen the outflow of information from the United States on the basis of criteria of political consequences. However, there may occur situations in which ethical restraints on information flow are obvious and appropriate (e.g. the flow of information about the production and use of dangerous drugs).

f) Whenever the opportunity arises, U.S. technical societies should make use of, and attempt to strengthen, such indigenous institutions in developing countries as libraries, archives, data repositories, universities, schools, information management systems, and local technical societies and groups.

Note: an Introductory Statement by Dr. Franklin P. Huddle, leader of this Working Group, is attached as Appendix E.

III. SCIENTIFIC AND TECHNOLOGICAL EDUCATION AND TRAINING

The development of a strong indigenous system of scientific and technological education is essential to the progress of a developing nation. This is no small task. Looking at the experience of the Western European and North American countries, it can be argued that the task requires a century for its accomplishment. Since the goal is clear, the question before us may be stated thus: "What contribution can the scientific and engineering societies in the developed countries make towards the more rapid development of a system of scientific and technological education in the developing countries?"

This issue has been on the agenda of the U.S. societies for the last quarter century, and much good work is in progress, some is continuing and some remains to be begun. The experience of the past and suggestions for the future have been recorded in such publications as:

"The Role of U.S. Engineering Schools in Development Assistance" - National Research Council - 1976

"Educating Engineers for World Development" - American Society for Engineering Education - 1975

"Science Development - The Building of Science in Less Developed Countries" - PASITAM PRESS - 1976

"Paradisia and Dominatia: Science and the Developing World," Foreign Affairs 53, 699 - 1975

Nevertheless, development assistance has not been either a major element or a high priority item on the agendas of the major U.S. technical societies. What has been accomplished has usually stemmed from the inspired efforts of a few leaders who sensed the importance of the issue.

The discussion of elements feasible for developing a strong indigenous system of scientific and technological education in a developing country covered these main areas:

(A) importance of indigenous scientific and technical societies,

(B) relationships with universities,

(C) prestige in international relations, and

(D) the "brain drain."

A. Importance of Indigenous Scientific and Technical Societies

It was concluded that the presence of indigenous apolitical scientific and engineering societies is an important, if not essential, component of the development process:

- as an indication of the essential cohesiveness of the scientific and engineering society, as demonstrated by the commitment to disinterested public service inherent in such an organization;
- as a vehicle for promoting an enhanced social status, in his own society, for the scientist, engineer and technician. This status is essential to the engagement of an appropriate fraction of bright young people in these professions;
- as an agent for setting professional standards;

- as a convenor of continuing education for the professionals.

National academies alone cannot perform these functions. The academie and societies have complementary roles to play, providing necessary points of linkage between elites and between professionals active in current technologies.

A number of difficulties were noted in this concept. Technical societies in the developed countries are apt to be more divided into technical specializations than those in the developing countries, making direct linkages more difficult. Also, in cultures where the family and tribal influences are strong, organization of national structures may be difficult Scientific institutes, research councils, and similar entities may be the central reference points for indigenous professionals and may be the appropriate linkage points for U.S. societies.

B. Relationships with Universities

United States universities currently provide higher education for nearly 250,000 foreign students each year, about 80% of whom are self, family or country-of-origin supported. There are many areas in which society to university relationships can make a great contribution to international development.

1. The societies can contribute to the establishment of programs to improve the selection of students from developing countries to be educated in the technically advanced countries. A prototype program of this type is working in the field of physics.
2. Societies could improve their services to their foreign student members. Currently, there is little effort to develop programs of particular interest to the foreign student.

3. Societies could organize joint efforts among universities, governments and industries to provide more relevant programs of graduate study for foreign students.[1] There seems to be general agreement that little change is required in undergraduate programs, but that more could be done to orient the student to resources available in the U.S. concerning their own countries, and to focus their graduate studies on problems relevant to their own country's needs and problems. Such students would then be encouraged to produce development-oriented theses and dissertations within the contraints of disciplinary topics and academic excellence. Cultural identification is essential.

4. Societies, working with universities, can organize lecture series, summer seminars, and forums for foreign students or scholars on the role of the scientist and engineer in those policy-making positions which involve relations between science, technology and development. There could also be refreshers for engineers and scientists who have been engaged in policy-making for a period of time and would benefit from exposure to scientific and engineering courses at the cutting edge of their disciplines.

5. Societies could provide U.S. universities with scientific and technical personnel experienced in working abroad, as a source of information on the languages, cultures and traditions as well as the political and social sensitivities of the countries from which the student body is drawn.

1) see p. 36

6. U.S. societies have much experience in the matter of continuing education for engineers. The American Society for Engineering Education recently convened the first international symposium on continuing education at the Autonomous University of Mexico, April 1979, and the Association for Media Based Continuing Education for Engineers has initiated a program of providing videotaped lectures to foreign engineers through their local universities. Imaginative programs of this type should be extended. Societies should experiment with use of satellite communications.

7. Societies and universities should encourage programs which contribute to scientific and technological literacy of the public in developing countries. The Singapore Science Center, for example, circulates a journal of middle level technical information to 20,000 readers, and Korea is placing high priority on the implementation of programs for the better public understanding of science.

8. There should be opportunities for foreign graduate students to intern with U.S. media (newspapers, book publishers, TV and radio stations, etc.), perhaps following the model of the very successful AAAS Mass Media Science Fellowship Program. Other societies with their massive publication programs, could organize such experiences.

9. Societies should be of particular service and value to teachers of science and technology in developing countries. Investigation of the opportunities for service here should be undertaken by the

U.S. societies and federal agencies.

10. U.S. societies can develop orientation courses for incoming foreign graduate students to provide them with a) English language training, b) remedial statistics and methodological training, c) orientation to the requirements and theoretical orientations of the discipline in the U.S., d) resources for completing research on their home area problems that are available in the data and library archives in the U.S., and e) special workshops on R&D resources and techniques available in the United States. An example is the Economics Institute offered each summer by the American Economic Association in Boulder, Colorado; the American Sociological Association is developing a similar program.

C. Prestige in International Relations

There are several problems in the area of "prestige" which impede the contributions which U.S. scientists and engineers may make to foreign development, or which are internal to the developing country. Scientific and engineering societies, because of the tremendous leverage for peer approval which they exercise, can play a major role in alleviating these problems.

1. The reward structure of the U.S. academic community does not give adequate recognition to interest and participation in the development process. Promotion and tenure policies of U.S. universities do not provide incentives (in fact, they provide disincentives) to participation by young faculty. This is almost equally true of the professional community. Societies much confront this problem, and with universities, modify the incentive system to encourage greater participation. The disruptive effect to established career patterns

of periods of foreign service must be minimized. Professional societies, by honoring service in the cause of development, can provide critical peer recognition needed to assure wider participation and support.

2. Developing countries can make better use of their scientists and engineers who have been educated abroad as resource persons for U.S. societies trying to define and analyze problems in development.

3. Foreign students in the U.S. sometimes are unable to secure maximum advantage from their educational programs because of a reluctance on the part of their peers to recognize the contribution of practical experience to advances in science and technology. The lack of prestige for "hands on" experience in their own cultures leads to excessive reliance on theoretical work. U.S. and foreign societies should strive to raise the prestige of applied scientific investigations in their own cultures, if the development process is to succeed. The societies should draw industry into this, and society-industry-university seminars on this topic could be organized for new students entering the U.S. educational system.

4. The recognition and prestige of regional organizations for scientific and technological cooperation must be raised, even at the expense of the world organizations. At least in engineering, experience indicates that the regional organizations are the most effective, being better equipped to recognize and solve problems arising from language and cultural differences, which become intractable in a world-wide organization. The existence of global

organizations must not be permitted to denigrate the regional federations.

It was agreed that the proposed Institute for Scientific and Technological Cooperation should use the U.S. technical societies as a principal channel for assisting societies and universities in developing countries in securing for them:

(a) Access to U.S. literature by supporting programs designed to make U.S. technical literature available in countries where foreign exchange in lacking. (At one time the State Department supplied differential foreign exchange to provide U.S. non-technical literature abroad.) Both research literature and engineering practice-oriented journals are necessary.

(b) Continuation, for five or ten years, of membership in U.S. societies, after students return to their homeland after studying in the U.S.

(c) Services which complement the educational process in the U.S., such as methods of: 1) accreditation of curricula, 2) linking practical training with technical education, 3) providing interdisciplinary seminars, 4) assisting the orientation of new students in the U.S. higher education system, and 5) preparing graduates for reentry to their own cultures.

(d) Information on developments in secondary school pre-science education, such as the Physical Science Study Comittee and Biological Sciences Curriculum Study curricula in the U.S.

(e) Access, at reasonable rates, to invitations for foreign students to attend meetings of science and technical societies in the U.S.

The American Association for the Advancement of Science and the American Political Science Association now do this. (Agency for International Development and International Communication Agency contracts used to support this concept.)

(f) The services of U.S. societies as convenors of technical colloquia. The U.S. societies have highly developed peer review systems for selecting the real experts on any technical topic.

(g) Access to the best U.S. thinking on manpower supply and demand. The linking of the planning for national productivity with the scientific and technical manpower requirements is a difficult but necessary task.

(h) Assistance in the development of the technical infrastructure at the secondary school level, equivalent to the interests of young U.S. persons with hobbies such as ham radio operators, model airplane builders, home garage mechanics, etc.

(i) Support for a visitors registry, matching the availability of U.S. scientists travelling abroad with departments, laboratories or societies abroad which would welcome person-to-person contact with U.S. experts. A similar registry might be developed for foreign persons visiting the U.S.A. There should be an international common market in technically educated persons.

D. The "Brain Drain"

Agreement on the causes, consequences and responsibility for the so-called "brain drain" was not reached. However, it was agreed that the best response of the societies was for them to pursue rigorously the improvement of the social conditions and status of the engineer and scientist in their

<u>own countries</u>. Technical societies should encourage discussion of the appropriate use of indigenous and expatriate manpower (and womanpower) in the development process. The societies should give leadership to efforts toward identification of the contributions of technologists in various areas, and to provision of information to foreign graduate students about opportunities in their home country or region. A registry of information on scientific and technical opportunities available in foreign areas could be important.

In addition, the societies could assist in recruitment of teaching personnel for foreign institutions, including not only professors, but those experienced in laboratory organization, instrument maintenance, equipment, construction, and technical reporting.

Finally, it was agreed that the interdependence of the modern world calls for the existence of a highly mobile, highly intelligent class of technical personnel who will serve as an international corps, to be available wherever the world development process has the greatest need. In such a situation, the competitive concept of a "brain drain" would become obsolete. Further research on the international mobility of technical personnel is badly needed.

1) See Appendix F: Franklin J. Ahimaz, "The Organizational Need: an Institutional Triumvirate."

IV. TECHNOLOGY EVALUATION

In discussing the role of scientific and engineering societies in technology evaluation, there was immediate consensus that the societies can play an effective role in technology evaluation for the special needs of the developing countries. This is possible in view of the considerable expertise of the members of the societies, their sources of information drawn from the experience of the societies in technology evaluation for their own countries, and their ability to easily and quickly identify the sources of technology as well as their capability to assemble teams of experts for specified programs. It then remains to identify the manner in which the professional societies can undertake functions of technology evaluation for developing countries and the mechanisms that could facilitate such functions. It was considered not feasible to identify all possible technologies for developing countries. On the other hand, it was decided to indicate the processes by which a technology evaluation can be undertaken in an effective and efficient manner.

The discussion of the role of societies on technology evaluation covered these areas:

(A) basic considerations,

(B) nature of processes,

(C) mechanisms, and

(D) impediments.

A. Basic Considerations

The fundamental consideration in the involvement of the professional societies in technology evaluation for developing countries is in effect to enhance the indigenous capability of the professionals in the developing countries for better technological evaluation in accordance with the needs of their societies. The professional societies of developed countries can only attempt to translate the experience acquired in their own environment for adaptation in developing countries.

B. Nature of Processes

The technical societies in developed countries have over the years undertaken a range of activities in technology evaluation in the context of their own countries. The group listed examples of such activities as follows:

1. Location and supply of individual scientists with special knowledge and expertise. Professional society headquarters staff are experienced in this function and able to make specific referrals.
2. Provide ad hoc searches for technological options through appointment of expert task forces and committees. Such expert groups can investigate technological options in depth and produce helpful position papers.
3. Cooperate in cost/benefit studies, as in 2. above, through identification of and collaboration with recognized experts.
4. On request provide state-of-the-art opinions derived as in 2 above.
5. Collect and utilize experiences gained in applications of technology in developing countries. Useful information derived from firsthand experience can be transmitted to both developing and

developed countries.

6. Participate in the early stages of determination of need for particular technologies in developing countries, so as to add credibility and strengthen confidence in choices made.

7. Moderate over-expectations with respect to technological or economic benefits to be derived from application of new technologies.

8. Assist the proposed U.S. Institute for Scientific and Technological Cooperation (ISTC) now being formulated through the U.S. Congressional process.

9. Serve as mediators between developing countries and U.S. labor or industry. Because U.S. labor and industry recognize possible risks through cooperation with developing countries, there is need for sound scientific counseling. American labor and industry must be shown that job security and product markets can be improved by investment in cooperative projects with developing countries. Under proper surveillance, such projects can be mutually beneficial.

10. Technical societies, by definition, carry out a useful teaching and educational function for the general public. Published scientific information and information presented at scientific meetings benefit the public and can be transferred to developing countries.

11. Assist in establishing professional societies in developing countries. U.S. technical societies can serve as models in this regard. Because they have served a useful function in the U.S., it is likely that they would be useful to scientists and citizens in developing countries.

12. Assess future technological directions. By virtue of familiarity with new scientific developments, such trends can often be best recognized from the professional society vantage point.

13. Focus interdisciplinary insights and opportunities--again, by virtue of unique perspectives. Volunteers of staff can often apply knowledge born of experience to the solution of interdisciplinary or multidisciplinary problems.

14. Facilitate informal communication and circulation. Members of professional societies communicate within an informal network of telephonic and written communication. New ideas can thus be communicated rapidly and have served to advance the state of art in all scientific disciplines.

15. Provide an open market of planning and delivery systems, not constrained by institutional or proprietary barriers. Such systems are not usually accessible without the help and intervention of scientific societies.

16. Social science organizations can help resolve the motivation and cultural problems related to technological choices and potential consequences. They will have the behavorial and social insights to help materially in making technological evaluations and technology transfers effective.

It was recognized that this list was not comprehensive by any means nor was it given in any order of priorities. Many of the technical societies in developed countries would like to be involved in most of the above activities, some in a limited number of them and some in none at all. However, it was agreed that given the proper environment, modification and

encouragement, many of the technical societies in developing countries would be able to achieve an extension of these processes to the benefit of their countries.

C. Mechanisms

In order to encourage the technical societies in this type of a mission, several approaches were suggested. There was agreement that each of the interested technical societies should explicitly include in its mandates a statement of desire for involvement in assisting the developing countries in better technological evaluation. Technical societies must take the initiative and demonstrate a commitment. The role of technical societies in aiding developing countries could be supplemented and augmented by government agencies. In particular, funding for these initiatives, if they are to be of a scale large enough to be of any practical consequence, must come from governmental organizations, those in the developed countries and international organizations.

Technical societies can show this commitment in various ways:

(1) By publishing international journals, or

(2) By organizing international congresses, symposia or colloquia.

Publications

In the case of publications, it is often economically advantageous for a given U.S. professional society and a group of overseas societies to collaborate in a publication venture. A case in point is the International Journal of Systematic Bacteriology, published by the American Society for Microbiology with the help of the International Association of Microbiological Societies. The Optical Soci-

ety of America, for example, published an English translation of the Soviet Journal of Optical Technology, as well as the Russian language Optics and Spectroscopy. Numerous other professional societies have published translations of books authored by Western or Eastern Europeans, and Latin Americans. In such mutual endeavors, professional societies can find a healthy mixture of altruism and self-interest and public service and profit.

Interciencia is a trilingual journal of science and technology for development published by the Interciencia Association, a federation of eight associations for the advancement of science in the Western Hemisphere.

International Meetings

The United Nations Conference on Science and Technology for Development is itself an example of an international meeting for exchange of information within a defined subject area. Numerous other international congresses, symposia and colloquia have taken place for disciplinary scientific exchange, and some of these have been of special value to developing countries. An example is the Vth International Conference on Global Impact of Applied Microbiology (GIAM V) held in Bangkok, Thailand in November, 1977.

A constituent part of GIAM V was a Symposium on Indigenous Fermented Foods. This symposium was noteworthy for bringing scientists from developing countries into contact and communication on the compelling international questions of food, nutrition and hunger. Information was exchanged on nutritious and inexpensive foods of value to populations of lower economic status in developing countries. Pro-

fessional societies are equipped to organize meetings of this sort for the benefit of international science.

Because disease agents do not recognize or respect geographic boundaries, much medical attention has been given to problems of international health. The World Health Organization has helped in the control of major diseases on worldwide scale. Because of one WHO program, it is now possible that smallpox has been eliminated from all parts of the globe. Professional societies have cooperated with WHO in this effort and have contributed substantially to the encouraging results.

In the summer of 1978 a tissue culture conference was conducted in Nairobi, Kenya with the assistance of WHO and the Food and Agriculture Organization (FAO) of the United Nations. The conference, held at the International Laboratory for Research on Animal Diseases, was unique in providing both information and training for scientists of developing nations.

In August 1977 a Seminar on Desertification was conducted in Nairobi, Kenya cosponsored by AAAS, the Association Francaise pour l'Avancement des Sciences, the British Association for the Advancement of Science, the East African Academy, the Indian Science Congress, and Interciencia Association. This international scientific seminar, convened immediately preceding the U. N. Conference on Desertification, reached agreement on a set of critical indicators crucial to monitoring and evaluating desertification. Currently the chosen indicators are being tested and validated at four development sites in India, Iran (the working party report is completed, further

work is pending), Mexico and the United States.

In October 1978 the Asian Regional Seminar on the Contributions of Science and Technology for Development was held in New Delhi. This seminar, conducted by AAAS, the Indian National Science Academy, and the Indian Science Congress Association, provided specific examples of new programs, projects and technologies; identified problems and priorities in applying science and technology; and made recommendations for government policy planners. It was a recognized non-governmental initiative relating to the August 1979 U. N. Conference on Science and Technology for Development.

The United Nations could help in providing an international directory of participating societies. It has been reported that the proposed Institute for Scientific and Technological Cooperation will have such information.

D. Impediments

The group briefly examined the nature of impediments that occur in the effective involvement of technical societies between developed and developing countries.

Firstly, the structure of obstacles such as postal rates, tax laws, tariffs, patents, trademarks, etc., were identified. The group felt that it should be possible to arrive at mechanisms that will reduce the effects of these structural obstacles. Secondly, there are social and political obstacles which will need longer-term solutions. Thirdly, there are cultural, linguistic, geographical and other obstacles which need to be recognized in evolving mechanisms for interaction among technical societies.

V. ASSISTANCE IN ESTABLISHING SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPING COUNTRIES

These societies by their very nature have a unique role in the development process of any country. Basically they can: (a) assess the appropriate use of the profession for the betterment of society, (b) serve as a vehicle through which individual members maintain and promote the integrity of the profession, (c) establish standards and ethics for the practice of the profession, and (d) provide continuing education for the professionals.

The United States' scientific and engineering societies have served a useful function in the development process of this country, and they can serve as a model for developing countries. It was the consensus of the group that U.S. societies should contribute to the development of indigenous scientific and engineering societies by having programs:

(a) Honoring distinguished colleagues from developing countries;

(b) Making research awards to individuals of developing countries;

(c) Conducting international seminars on the functioning of a technical society;

(d) Establishing and strengthening linkages between U.S. and comparable foreign societies;

(e) Welcoming foreign members from developing countries; adjusting dues requirements to account for shortages of foreign exchange;

(f) Supporting efforts of developing countries to produce translations or media-based materials in their own languages;

(g) Relating problems of developing countries to technical disciplines in developed countries through topical seminars, conducted both at home and abroad. The example of the American Chemical Society/ Egyptian National Research Center seminar is worthy of emulation, and is deemed to be very cost effective.

(h) Maintaining rosters of societies and society officers in developing countries. This could be done by some multidisciplinary society in the U.S., perhaps the American Association for the Advancement of Science. This could then be available as a resource for U.S. societies or individuals wishing to establish linkages abroad.

(i) Maintaining a roster of successful contributions by U.S. societies to the international development process, which successes could then be emulated by other U.S. and foreign societies in other disciplines.

(j) Providing internships and seminars to inform persons in the developing countries of the intricacies of society operations.

(k) Providing information on the processes of setting professional standards and furnishing continuing education to professionals.

Technical societies can often increase their impact and effectiveness if they band together in coalitions. Several such coalitions of scientific societies and of scientific and engineering societies now exist in the United States. One is known as the Council of Engineering and Scientific Society Executives; another is the Council of Scientific Society Presidents. Other collections of scientific organizations form so-called "umbrella" societies, such as the American Association for the Advancement

of Science, the American Institute of Biological Sciences, the Federation of American Societies for Experimental Biology, the American Institute of Physics, the American Institute of Chemists, the Federation of Materials Societies, etc.

The roles of scientific and technical societies in development are constrained by the following considerations: (a) how science is actually conducted in a given country, for example the nature of support and the roles of individuals and governments; and (b) the relationships between science and technology and the developmental needs, both economic and social. The diversity and interconnected aspects of these considerations will require a high degree of tenacity and patience by technical societies in developed countries in their mission to assist in creating an indigenous self-generated technological base in developing countries.

THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

May 21-22, 1979

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THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

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LIST OF PARTICIPANTS

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THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

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THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

Working Group III: Scientific and Technological Education and Training

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THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

Working Group IV: Technology Evaluation

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THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

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THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

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THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

Area Caucus: LATIN AMERICA

LIST OF PARTICIPANTS

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THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

Area Caucus: MIDDLE EAST

LIST OF PARTICIPANTS

Leader: George A. Doumani

Rapporteur: David Burns

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THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

May 21-22, 1979

AGENDA

Monday, May 21, 1979		ROOM
9:45 a.m.	Registration (coffee and donuts will be available)	426
10:30 a.m.	Convening of the Workshop	426
	Welcome William D. Carey Executive Officer, AAAS	
	Summary of AAAS - UNCSTD activities and objectives of Workshop J. Thomas Ratchford Associate Executive Officer, AAAS	
	Summary of Resource Papers	
	"An Inventory of Current Activities of Professional and Engineering Societies in Developing Countries" Donald E. Marlowe	
	"Transferring Publicly Available Technology - The American Chemical Society's Approach" Robert W. Parry	
	"The Global Network of Engineering Education Societies: Their Roles in Development of Technological Infrastructures" Merton R. Barry	
	"The Role of Scientific and Engineering Societies in Development: Present Perspectives and Future Prospects" Donald G. Fink	
12:00 noon	Luncheon - President's Room, Faculty Club William D. Carey, Presiding	
	Speaker: Ambassador Jean Wilkowski U.S. Coordinator for the U.N. Conference on Science and Technology for Development	

Monday, May 21, 1979 (continued) ROOM

1:30 - 3:30 p.m. Working Groups - Session I

1) Applied Research and Development: the organization of projects and the assembly of R&D teams capable of providing solutions to important problems, at least through the initial stages. 426

Group Leader: John Calhoun
Rapporteurs: Roger Harrington
Robert Walleigh

2) Scientific and Technological Information: the generation, dissemination, abstracting, indexing and retrieval of scientific and technical information 409

Group Leader: Frank Huddle
Rapporteurs: Clanton Black
Robert Parry

3) Scientific and Technological Education and Training: the selection of students and teachers, the building of faculties and institutions, and the integration of students into work and life. 416

Group Leader: Donald Marlowe
Rapporteurs: William Vogeley
Marie Perinbam

4) Technology Evaluation: the identification of possible technologies for developing countries, the process of selecting the most appropriate and those most likely to succeed, and the role of policy research. 418

Group Leader: M. Anandakrishnan
Rapporteurs: Iwao Ishino
Robert Acker

3:30 p.m. Coffee Break

3:45 - 5:45 p.m. Working Groups - Session II
(Same rooms as Session I)

6:00 p.m. Reception and Dinner - Adam's Rib Restaurant
Anna Harrison, Presiding

Speaker: Kenneth Boulding
"A World Association for the Advancement of Science"

7:30 p.m. Plenary Session 426

Group Leader: Leonard Rieser
Rapporteurs: Jeannette Wedel
Denise Weiner

8:30 p.m. Preparation of draft reports

Tuesday, May 22, 1979		ROOM
8:15 a.m.	Coffee, donuts, juice	426
8:45 - 11:00 a.m.	Area Caucuses	
	Africa Leader: Earl Scott Rapporteur: David Wiley	414
	Asia Leader: Mangalam Srinivasan Rapporteur: Michael Moravcsik	426
	Latin America Leader: Jorge Sabato Rapporteur: Anders Lunde	413
	Middle East Leader: George Doumani Rapporteur: David Burns	411
11:00 - 11:15 a.m.	Coffee Break	
11:15 - 12:45 p.m.	Working Groups - Session III	
	1) Applied Research and Development	426
	2) Scientific and Technological Information	413
	3) Scientific and Technological Education and Training	411
	4) Technology Evaluation	414
1:00 p.m.	Plenary Session with Sandwich Luncheon	426
2:30 p.m.	Adjournment	

APPENDIX A

AN INVENTORY OF CURRENT ACTIVITIES OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPING COUNTRIES

By

Donald E. Marlowe
Executive Director
American Society for Engineering Education

AAAS - State Department Workshop IV
May 21-22, 1979
Role of Scientific and Engineering Societies in Development
Washington, D.C.

1. Introduction

An "inventory", in the strict sense of "the quantity of goods and materials on hand" is not practical in the field of the Societies' activities in developing countries. These relationships are so frequent and so diverse that the basic data is simply not available, and the sort of questionnaire/survey required to develop the data would, in itself, be a major undertaking. What is possible, however, as a result of information passing through my hands in my position as the executive director of the American Society for Engineering Education, is a presentation of a sample of the activities of the science and engineering societies, divided into major categories of dispensers and users of information. Even the term "Society" has its difficulties, and I have chosen to include the activities of certain federations of societies, as well as of individual professional societies . I have also included some relationships with more developed countries, as, with small modification, these could serve as prototypes for similar relationships with less developed countries. This discussion, therefore, cannot be regarded as exhaustive, but rather as indicative of the overall situation during the last few years.

2. General

The activities of the professional science and engineering societies seem to be directed toward a series of distinct groups, and this presentation will be thus subdivided. Somewhat arbitrarily, the groups chosen are:

Individuals

Private groups

Professional societies

Nations or ministries

Institutions

Libraries or information centers

International standards organizations

Regional organizations

Organizations for continuing education

There is nothing absolute about these groupings, nor does this classification entirely eliminate omissions or redundancies, but it will aid in understanding many relationships.

3. Individuals

a) Foreign visitors, while touring the USA, frequently visit engineering and science society headquarters, particularly in Washington and

New York, for information on society functions, and for assistance with their itineraries. This is particularly true of presidents and directors of foreign societies.

b) Societies are working with universities to help the foreign student to become acclimated to the USA, and to optimize his education while in the USA.

c) Societies are assisting in the development of programs for preparing the foreign student for reentry to his own country after completion of his degree program.

d) Most societies have nonnational members who receive all of the benefits and publications of national members.

e) Requests for information from abroad will ordinarily be referred to a USA society member capable of supplying the requested information.

f) AAAS has arranged special symposia for students from abroad so that they might voice their concerns in the forum of the Annual Meeting.

4. <u>Private groups</u>

a) Many of the societies have helped to arrange tours

of groups of these USA members to other countries. Recent examples have been tours to Russia, People's Republic of China, Nigeria, etc. In turn, the societies have reciprocated by serving as hosts to similar groups visiting the USA. Such exchanges increase understanding of both parties.

b) On a more formal basis, the American Chemical Society has sent a formally structured group to give one-week seminars on distinctive topics in chemistry for their peers in India and Egypt. This type of seminar results in a direct and valuable transfer of technology.

c) The American Statistical Association has arranged several seminars in Latin America in response to expressed desires of local mathematicians.

d) The Association for Engineering in Medicine and Biology has sponsored the organization of an acoustics diagnostic facility in Egypt, accelerating the process by several years.

5. <u>Professional societies</u>

a) USA societies have assisted in the formation of counterpart societies in many countries. The American Society of Mechanical Engineers assisted

in the establishment of the Canadian Society of Mechanical Engineers. The American Society for Engineering Education initiated the first meetings of the Southeast Asia Association for Engineering Education.

b) USA societies have authorized formation of sections of their own organization in many foreign countries. The Institute of Electrical and Electronics Engineers has 30,000 members organized in non-USA sections. A foreign section of a USA society may be more easily started than an indigenous society, but hard currency for payment of dues may be difficult to secure.

c) Collaboration between USA and foreign societies has resulted in the organization of many valuable symposia. The American Association for the Advancement of Science symposia on arid lands, the American Society of Agricultural Engineers symposia on cereal production, the American Society for Engineering Education symposium on continuing education for engineers, and the several symposia proposed by Engineers Joint Council as a follow-up to UNCSTD 79 are merely examples of these.

6. Nations or ministries

a) Although without official status, USA professional societies frequently find themselves dealing with representatives of foreign governments, often because of the lack of a corresponding professional society in a less developed country. These contacts are usually made at the level of the Minister of Education or the Minister of Science (or Technology). Examples of such contacts are requests for surveys of existing or proposed systems of higher technical education (American Society for Engineering Education in South Korea and Afghanistan); requests for surveys of the state of a particular technology (Bioconversion by the American Association for the Advancement of Science); or (Energy in Latin America by the American Society of Mechanical Engineers). The American Association for the Advancement of Science has held periodic seminars for the science attachés in the many embassies in Washington.

7. Institutions

USA societies have contributed greatly to the founding and development of institutions of postsecondary education

in less developed countries. This involvement occurs at all points in the development cycle ranging from feasibility studies, (American Society for Engineering Education and the Indian Institute of Technology at Kanpur), to provision of Deans and Directors, (Hoelscher at the Asian Institute of Technology, Shen at the Malaysian Institute of Technology), to education in the USA of prospective indigeneous faculty members and to continuing evaluation (American Society for Engineering Education and the University of Peshawar).

Another area of significance is the development of projects of cooperative research between institutions in different countries, particularly when the topic of research is identified by the less developed country. The research publications of the science and engineering societies provide the best means for identifying projects and collaborators, but much more must be done to reach the level of cooperation seen in agriculture and medicine.

8. Libraries and information centers

There are many paths by which the publications of USA science and engineering societies find their way to the less developed countries. But before detailing some

of these, let us recognize the fact that, however great the information flow may be, (and it is substantial), all knowledgeable visitors from the USA to the less developed countries report that what they find is that the actual information on the site is old, sparce, fragmented and often completely missing. Do not be overly impressed by the variety of distribution schemes. Our colleagues in the less developed countries are often terribly isolated from the mainstream of their specialty, and furthermore are well aware of and frustrated by their isolation.

a) I have already mentioned that most USA engineering and science societies have foreign members, often amounting to a few percent of their membership. These members receive certain journals automatically, and are entitled to member rates on specialty publications, but the unavailability of foreign exchange often restricts the choices of the foreign member.

b) Some overseas libraries subscribe to society journals and transactions, and some USA societies contribute copies of their journals to overseas libraries. There is no consistent pattern -- a

great many ad hoc arrangements have developed as a result of personal contacts between society members.

c) For a number of years the American Society of Mechanical Engineers (R. Lea) ran a program which collected, packed and shipped boxes of recent but discarded technical publications to overseas libraries. Of course this did not guarantee complete series of periodicals. For reasons of cost, it was necessary to conduct this program with volunteer workers.

d) Any modern system of information exchange should also consider nonprint materials (cassette , film, videotape, etc.) and also consider such important auxiliaries as translations, abstracts, indices and computer retrievals. Very little of this exists in less developed countries.

e) Some discussions have been held with State Department personnel regarding a program of use of blocked currencies to aid in transfer of USA society journals to less developed countries, as was done with American literature some years ago, but the concept has no priority.

f) The USA societies have contributed to the development of several journals which are open to authors of countries active in the development process. Among these are Interciencia (American Association for the Advancement of Science); UPADI Magazine (Engineers Joint Council); Boletin de Ensenanza de Ingenieria (UPADI Engineering Education Committee); and Technos (American Society for Engineering Education).

9. International standards organizations

There are two major international organizations engaged in development and promulgation of international technical standards -- the International Standards Organization and the International Electrotechnical Commission. These standards frequently find their way into the laws and regulations of all countries engaged in international trade, and have an immense impact on the development and application of new technology. Topics subject to international standardizations range all the way from computer software to containerization, from radiation tolerance to screw threads. The engineering and science societies contribute expertise to both ISO and IEC, in the form of identifying experts, arranging for participation, running

of secretariats of standardization committees, distribution of standards, testifying on proposed government regulations, etc. As soon as a developing country establishes any significant industrial base, it will find it necessary to participate in the formulation of international standards, both to move their own products in international commerce and to protect their own interests.

10. Regional organizations

The engineering and science societies, in addition to reciprocal relations with their counterparts in other nations (ASME, USA and IME, UK; IEEE, USA and Popov Society, USSR; ASEE, USA and JSEE, Japan), affiliate with many international and regional organizations which play a very important role in transfer of technological information. Very often, in such cases, the USA representation to such groups is an ad hoc, or occasionally permanent, federation of those USA societies which are interested in participating. The USA, for example, maintains constant contact with the World Federation of Engineering Organizations, the European Society for Engineering Education, the International Council of Scientific Unions, the Pan American Federation of Engineering Societies, the International Geophysical Union and many others.

In engineering, the regional relationships appear to be more fruitful than the world organizations. The reverse appears to be true in science. Although it is important to maintain such relationships, it must be accepted that cooperation (except in education) is necessarily limited, because the regional organizations have no means of financing, except the rather modest dues paid by the participants.

11. Organizations for continuing education

It is now accepted, as fact, that provision of means for continuing (or lifelong) education for the practicing engineer is an essential component for the maintenance of an effective engineering community. Mechanisms for accomplishing this are still under development, ranging from the Swedish system of "study leaves" to the current USA system (or nonsystem) of market pressures. Nevertheless, continuing, or lifelong, or recurrent education must be a formal part of any nation's effort to develop itself, and USA engineering and science societies have been active in providing opportunity for these experiences in the USA. What they have learned may have international applications as well.

In the USA, the engineering and science societies

have become principal providers of continuing education. J. Klus estimates that 50% of the enrollments in continuing education courses in the USA are in courses arranged by the professional societies. In this area, the professional societies may be regarded as copartners of the universities. In April of 1979, the American Society for Engineering Education sponsored, with the Autonomous University of Mexico, a World Conference on Continuing Engineering Education, at which a number of innovative approaches were described.

a) The Engineering Society of Finland has formed an "Engineering Organizations Continuing Education Center" with a goal that 10% of each engineer's working time should be devoted to continuing education.

b) The Institute of Engineers (India) is creating an Engineering Staff College which will be responsible for continuing education and will operate in as many as 70 centers.

c) The Canadian region of the Institute of Electrical and Electronics Engineers has developed the concept of a Traveling Road Show which presents important topics to members in a sequential tour of

eight cities.

d) Continuing education in the West Indies has been successful using the ATS-6 satellite.

e) A consortium of USA universities, known as the Association for Media-Based Continuing Education for Engineers, is producing and renting full videotaped courses on advanced engineering topics.

While the entire field of continuing education has yet to settle into a common format, it is clear that successful programs, particularly in countries with dispersed populations, require sustained efforts both by the universities and the professional societies. These two groups may yet have to forge new types of organizations to meet this social need.

12. In summary then, engineering and science societies have contributed to the growth of developing countries by making available their expertise, both technical and organizational. As in most scientific and engineering endeavors, the first step is the careful designation of the problem or the objective. All of our experience indicates that the developing country must play the major role in problem definition, and to do this successfully, the country must have an indigeneous technical infra-

structure. The professional societies of developed countries can provide expertise to assist, but they cannot lead.

However, once a problem or objective has been defined, there is a wealth of knowledge, derived from past successes and failures, which the professional societies can bring to bear in attempting to find solutions. As indicated in this paper, problems may occur to individuals, groups, institutions, nations or regions. I have attempted to show, by a sampling of their experiences, that USA science and engineering professional societies have had experiences at all of these levels. The examples could be expanded almost without number. Many of the examples chosen have been in the nature of experimental thrusts, undertaken at the initiative of the societies. Those reported have been successful, probably an equal number have not. As a result of these endeavors, the societies are aware of a number of things which do work. There has been more progress in this area than in properly identifying real problems and in seeking assistance of the societies in their solution.

APPENDIX B

TRANSFERRING PUBLICLY AVAILABLE TECHNOLOGY

The American Chemical Society's Approach

by

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and

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AAAS - State Department Workshop IV
May 21-22, 1979
The Role of Scientific and Engineering Societies in Development
Washington, D. C.

Abstract

Following a planning period of some two years, the American Chemical Society and Egypt's Academy of Scientific Research and Technology (working through its National Research Centre) held a workshop on industrial chemistry in Cairo, Egypt. The timing of the workshop--November 28-December 7, 1977--coincided with President Anwar El Sadat's historic visit to Israel. Twenty-one Americans and some 200 Egyptians met to exchange publicly available technology in five chemical subject areas that constitute serious economic problems for Egypt. In the judgment of all participants and observers, the workshop contributed significantly to Egypt's ability to overcome the problems and laid the groundwork for a number of joint research projects that can benefit both nations. At this time, two of these projects have been selected for implementation by the Agency for International Development.

Contributions by American employers of the time for the Americans to prepare for and then attend the workshop and costs for the American Chemical Society to organize and conduct the workshop resulted in about $7.00 of benefits for every single dollar in the AID grant to support American transportation and per diem expenses.

TRANSFERRING PUBLICLY AVAILABLE TECHNOLOGY

The American Chemical Society's Approach

In considering why scientific and engineering societies can be such effective performers in helping transfer science and technology among nations, we should like to offer the following five major reasons:

- Their memberships represent a reservoir of expertise that can be tapped to undertake tasks that will transfer the proper science and technology effectively. Not only do they have members who are expert in each of their profession's subdisciplines but even more importantly for some needs their members are in top administrative, financial, legal, and governmental positions as well.
- Their practices provide a mechanism for selecting the right people for given tasks through use of the peer review system that is standard operating procedure in scientific and engineering professions for judging the importance and value of scientific and engineering accomplishments.
- They provide a neutral ground for managers, scientists, and engineers from industry to deal with publicly available science and technology, thus avoiding the sensitive area of transferring proprietary information and practices.
- They have continuity of contact with past accomplishments and have a means of being alerted to advances in their discipline through the journals, magazines, and books that they publish. Moreover, the

advantage applies to all subdisciplines a society serves, not just a few subdisciplines as is generally the case with individual industrial companies, government agencies, and even universities.

- They have access--and indeed often initiate--the latest improvements in secondary and university education in their discipline as well as provide continuing education.

The ACS Experience

The foregoing points may not have been explicitly stated when the ACS took its first steps leading to participation in technology transfer programs. However, they certainly were implicit in its efforts, and they are the basis for the success the Society has had. What follows we hope will demonstrate their truth.

Some five years ago, the ACS, led by then ACS President William J. Bailey, Research Professor of Chemistry at the University of Maryland, decided to expand its efforts in the international arena. The task of generating new international programs was assigned to a reorganized Committee on International Activities. Comprised of 17 ACS members with strong interests in international matters, the committee soon devised a number of projects for the Society's consideration. Among them was to form cooperative research and education projects with chemists and their organizations in developing countries. In exploring the possibilities for establishing such projects, Dr. Richard L. Kenyon* and one of us (RWP) visited a

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* Dr. Kenyon at the time was Director of the Public, Professional, and International Communications Division of the ACS. He died from a heart attack in March 1976. His skill, diplomacy, and wise counsel are remembered by all who knew him.

number of embassies in Washington. At them we outlined and discussed ways in which exchanges might be carried out using publicly available technology. In most cases, the ideas were accepted as noble, but there was not enough real enthusiasm to initiate any kind of positive action. In short, work was required, and the entropy term (enthusiasm) was not large enough to make the process spontaneous.

Our reception at the Egyptian embassy, however, proved to be strikingly different. Prior to our visit, one of us (RWP) had talked informally with Dr. Fawzey Sherif, a former faculty member of the University of Alexandria and at the time a research chemist with Stauffer Chemical Co. in Dobbs Ferry, N.Y. Dr. Sherif noted that a program of the type envisioned probably would be received enthusiastically by the Egyptians, and he suggested that we talk to Dr. Ahmed M. Azzam, Minister for Cultural Affairs and Director of the Education Bureau at the embassy. Dr. Azzam did indeed receive our proposal enthusiastically and immediately began working to convert the abstract ideas into a meaningful program. His vigorous leadership at that crucial period was essential to successful development of the project.

The Egyptian Project

Shortly after our visit, Dr. Azzam contacted Dr. Abdelmoneim Aboul-Azm, President of Egypt's Academy of Scientific Research & Technology, and Dr. Mohamed Kamel, Director of Egypt's National Research Centre. They suggested a workshop dealing with chemical research and development important to Egypt be held in Cairo. They noted that funds might be available from the Agency for International Development to support such a project, and they identified 12 broad chemical subject areas in which they

believed exchanges would be most helpful. In subsequent discussions, the list was narrowed to five topics to give a project of manageable proportions.* They were:

1. Pesticide analyses and syntheses.
2. Mineral beneficiation and metallurgical waste processing.
3. Corrosion control and metallurgical analyses.
4. Chemical modification of cotton.
5. Utilization of fibrous raw materials.

We were to learn that each one of these topics is of great importance to Egypt and that each must be studied in relation to the peculiar geographic and climatic conditions of Egypt.

Grade-school geography taught most of us that Egypt is a gigantic desert through which the Nile River flows. We had heard that rainfall in most of the country approaches zero as a limit. While every member of the team of Americans who eventually traveled to Egypt knew these and other facts about Egypt, none of use was quite prepared for the full meaning of the facts until we visited the country and saw the problems at firsthand.

Egypt is a land of sun and dust. Since before the days of the pharaohs, Egyptians have built their culture around the Nile, using its waters for irrigation, cooking and washing, and transportation. It has been wisely stated that Egypt is the gift of the Nile. Still, the generosity of the Nile is limited. The realities are demonstrated by a set of depressing

* To the great credit of the Egyptians, they did not ask for very expensive, highly technical equipment for a laboratory, such as a 300 megahertz NMR but instead identified for study real problems that were retarding their economic progress.

statistics. In 1907, Egypt's population was about 11 million. The narrow ribbon of land along the banks of the Nile provided 6 million acres of arable land to support those 11 million people, and there was thus about half an acre of arable land per person. By virtue of very hard work, very intensive agriculture, and very high yields per acre, Egyptians produced enough food to maintain themselves.

Today, 40 million people live in Egypt, but there's still about 6 million acres of arable land. The ratio has thus shrunk to about one sixth of an acre per person, compared to the former one half acre or to the U.S.'s approximately 5 acres of arable land per person. As a result, Egypt is no longer self-sufficient in food. In 1977, for example, it imported $1 billion worth, including 3.5 million tons of wheat. Now, projections for the future are frightening. The birthrate is very high, and population is growing rapidly. Population is projected to reach 60 million by the year 2000. If arable land remains at 6 million acres, Egypt will have one tenth of an acre per person. Standing room would begin to be at a premium.

Faced with these statistics, one is almost overwhelmed by the appeal of the Aswan High Dam, for it offered the possibility of putting more land under cultivation. So far, however, the results are disappointing for a country facing starvation, and even benefits are tempered by unforeseen problems. Newly reclaimed land, for example, is giving only 20 to 50% of the expected production. Moreover, the annual floods no longer occur, and their benefits are lost. Annual floods renewed land fertility every year for thousands of years. In addition, the floods

washed insect pests down to the Mediterranean along with excess salt left behind by water that evaporated. The Aswan High Dam controlled these floods for the first time, but in doing so it cut off a valuable source of fertilizer as well as stopping the washing effect that removed insects and salt.

The land responded rapidly to these changes. Fertilizers and insecticides are now of great importance. Some relatively rich agricultural areas will have to be drained carefully and irrigated to avoid creeping salinization of the soil.

In light of these and other harsh facts, each of the subjects selected by the Egyptians for a technology exchange project makes much sense. Let's consider each of them individually.

Pesticide syntheses and analyses. It is clear that Egypt cannot share its crops with bugs. Insecticides would appear to be the answer. The Egyptians are not only interested in making insecticides and in developing new ones, however. They also have a very real and special interest in any residues that drain back into the Nile and affect crops and people downstream. Moreover, Cairo with its 11 million people, is very much concerned with residues that might contaminate its drinking water. And, of course, pesticide decomposition products could be affected by Egypt's climate and crop production patterns. Clearly, the problem is a complex one, and the best possible science and technology are needed for its solution.

Mineral beneficiation and metallurgical waste processing. Egypt is rather sparsely endowed with natural resources. Its iron and phosphate ores, for example, are low grade. Furthermore, its iron ores are high in

alkali chlorides that cause problems. Using marginal-grade ores is the forerunner of a worldwide problem, and improving such ores for commercial exploitation is a high-priority goal. In Egypt's case, their use is key to its iron and fertilizer industries.

Corrosion control and metallurgical analyses. Corrosion is a worldwide problem, but it seems particularly important to Egyptian scientists. Again, it is a problem with special features related to the Egyptian environment. Because of the high alkali halide content of Egyptian iron ores, sinter grates corrode rapidly in Egyptian steel mills. Moreover, Egyptian steel appears to corrode more rapidly under some conditions than steel made elsewhere. Corrosion is also particularly troublesome where steel products, such as pipes and pipe supports, are buried in the Egyptian soil. Clearly, the problem has great economic importance to both Egypt and the U.S., and a truly cooperative research and development program would be helpful.

Chemical modification of cotton. Cotton's improvement is essential to the Egyptian economy, as cotton is Egypt's main cash crop and its central commodity for generating foreign exchange. To allow it to compete with man-made fibers, cotton must be modified, so that cotton fabrics launder well and dry wrinkle-free, resist attack by microorganisms, do not fade readily when dyed, and have long lives.

Use of fibrous raw materials. Although the Egyptians were the first people to make a paper (papyrus in about 500 B.C.) from reeds growing along the Nile, they now have a serious problem. Paper and related products

made from wood are vastly more serviceable. Egypt, unfortunately, does not have trees nor does it have Canada's vast forests on its northern border. As it happens, fibrous raw materials such as sugarcane bagasse and rice straw are abundant in Egypt, and paper and similar products can be made from them. Learning how to process such materials effectively, however, is a major challenge for chemical technology.

The foregoing topics don't include academic chemistry as it is conventionally taught, but rather real-life chemistry as dealt with by industry and government. To find people qualified to head teams in each of these five "real-life" areas and also members for each team, the ACS assembled a selection committee consisting of Dr. David Breslow, Senior Research Associate, Hercules, Inc.; Dr. Milton Harris, formerly vice president of Gillette Co.; Dr. John Sheehan, Professor of Chemistry, Massachusetts Institute of Technology; and the authors. This committee solicited names of candidates from a wide variety of sources in a typical peer review process based on the following criteria:

- Recognized stature as a chemical scientist and demonstrated ability in administering research programs.
- Especially sensitive to the need for a country such as Egypt to achieve immediate practical results to hasten industrial development and moreover to achieve results that would be technically and economically appropriate yet not destroy valued cultural conditions and traditions.
- Demonstrated ability in dealing with scientists, engineers, management personnel, and government officials from a different culture.

- High degree of personal motivation with respect to the objectives of the program, both scientifically/technically and socially/politically.

From among the many experts suggested, the committee identified five team leaders and two to four members for each team having truly outstanding qualifications:

Pesticide analyses and syntheses--Dr. Philip C. Kearney (team leader), Chief, Pesticide Degradation Laboratory, U.S. Department of Agriculture; Dr. Etcyl H. Blair, Director of Health and Environmental Research, The Dow Chemical Company; Dr. Nathan F. Cardarelli, Director, Environmental Laboratory, University of Akron; Dr. M. Talaat Shafik, International Divisions, American Cyanamid Company; Dr. Arthur D. F. Toy (associate director of the American delegation), Director, Eastern Research Center, Stauffer Chemical Company.

Mineral beneficiation and metallurgical waste processing--Dr. Milton E. Wadsworth (team leader), Professor of Metallurgy and Associate Dean, College of Mines and Mineral Industries, University of Utah; Dr. Roshan B. Bhappu, Vice President and General Manager, Mountain States Research and Development; Dr. Douglas W. Fuerstenau, Chairman and Professor, Department of Materials Science and Engineering, University of California, Berkeley.

Corrosion control and metallurgical analyses--Dr. Howard L. Gerhart* (team leader), Director, National Coatings Center, Carnegie-Mellon Institute

* Dr. Gerhart died in March 1979 after a long and distinguished career in the fields of corrosion research and corrosion protection. His many friends and colleagues miss him greatly.

of Research; Dr. Ray M. Hurd*, Consultant, Austin, Texas; Dr. Henry Leidheiser, Jr., Director and Professor of Chemistry, Center for Surface and Coatings Research, Lehigh University; Dr. Robert C. McMaster, Regents Professor Emeritus, The Ohio State University.

Chemical modification of cotton--Mr. George L. Drake, Jr. (team leader), Research Leader, Protective Finishes Research Group, U.S. Department of Agriculture; Mr. G. Cecil Daul, Manager, Eastern Research Division, ITT Rayonier Corporation; Dr. J. David Reid, Textile Consultant, New Orleans, La.; Dr. J. William Weaver, Professor, Textile and Fiber Sciences, University of Delaware.

Utilization of Fibrous Raw Materials--Mr. Marvin O. Bagby (team leader), Research Leader, Fibrous Products Research, U.S. Department of Agriculture; Dr. Conrad Schuerch, Professor of Chemistry, State University of New York; Dr. Kyle Ward, Jr., Professor Emeritus, The Institute of Paper Chemistry.

It proved to be impossible for the American participants to meet and have a briefing session before leaving for Cairo. However, the papers they were to give, as well as the ones the Egyptians were to give, were circulated in advance to give all participants knowledge of the points that would be stressed. Moreover, the Americans in each term had known each other professionally long before the workshop was planned. This acquaintanceship plus their thorough knowledge of the technology involved contributed to the creation of a smooth-running delegation.

* We are also saddened to have to report the death of Dr. Hurd in 1978. He made a strong contribution to our efforts, and the value of his work is demonstrated by the fact that one of the recommendations with which he was directly associated has been selected for implementation, as we shall recount shortly.

Egyptian participants were selected by Dr. Abou-el-Azm and Dr. Kamel. Team leaders, all from the National Research Centre, were:

Pesticide analyses and syntheses--Prof. Dr. Nazih Latif, Professor and Head, Pesticide Chemistry Laboratory.

Mineral beneficiation and metallurgical waste processing--Prof. Dr. Ahmed Adel Abdul Azim.

Corrosion control and metallurgical analyses--Dr. A.M. Shams El Din.

Chemical modification of cotton--Prof. Dr. A. Kantouch, Head, Textile Research Division.

Utilization of fibrous raw materials--Prof. Dr. Yehia Fahmy, Head, Cellulose and Paper Laboratory.

We were very impressed by the very high level of technical competence of these men and the 10 to 50 other Egyptian chemists who participated in each group.

The NRC/ACS Chemistry Workshop

Spanning two weeks, the workshop had two primary objectives: first, to give participants from the two countries an opportunity to exchange technological information immediately in the workshop's subject areas and secondly, to plan research and development projects that, if funded, would hasten Egypt's industrial development.

The workshop formally began on Monday, November 28, 1977, with a plenary session in which leaders for each country exchanged greetings and spelled out their hopes for the workshop. Then a series of four plenary lectures followed on topics of broad general interest. Dr. Arthur D.F. Toy of Stauffer Chemical Company described the steps one major American chemical company uses to translate laboratory chemistry into an industrial operation and how chemical, engineering, economic, and safety factors are inter-

woven in all decisions. Dr. Shams El Din then described the organization of the National Research Center and NRC's interest in shifting its focus from academic research to research to solve industrial problems. Dr. Etcyl Blair of Dow Chemical covered yet another aspect of research project management in a lecture describing the research necessary to bring a pesticide onto the market. Dr. A.A. Abdul Azim concluded the initial general session by describing how the Egyptians were attempting to bridge the interface between laboratory research and industrial practices.

Following these opening plenary lectures, participants separated into the five subject area working groups. American participants reviewed recent major accomplishments in their areas of expertise, and selected Egyptians described recent research accomplishments in Egypt and suggested needs they saw for future research.

Following these formal presentations during the first three days, the Egyptians then took their American counterparts on tours of industrial plants typical of those that future research and development was expected to benefit. Egyptian and American participants then reconvened in Cairo again in the subject area working groups and in light of the formal papers and the plant tours devised preliminary research and development proposals for which the ACS and the National Research Centre agreed to seek support.

Before describing the progress we have made toward the workshop's second objective (securing support for recommended projects), we should first note that a number of contacts developed shortly after the workshop. Egyptian scientists, for example, spent several weeks in the laboratory of Dr. Wadsworth at the University of Utah supported by funds that Dr. Wadsworth secrued. Similarly, corrosion experts from the National

Research Centre spent time with Dr. Gerhart at Carnegie-Mellon and with Dr. Leidheiser at Lehigh. Dr. Philip Kearney, meantime, interested the U.S. Department of Agriculture in considering provision of support for three research projects in subject areas related to those in the workshop. As of this writing, project plans have been prepared but final decisions haven't been made on funding.

Workshop Recommendations

Intense discussions during the workshop's final three days resulted in recommendations for eight major research and development projects for which funding was to be sought:

1. Industrial internships--a project to place Egyptian chemists in U.S. laboratories for brief periods to help develop rapidly and at reasonable cost the manpower Egypt needs that is skilled in chemical processing technology, in practices to protect workers and the environment from harm, and in techniques to manage research and development programs on an industrial scale.
2. Continuing education courses--a project to update the training of Egyptian technical and management personnel immediately by using audio-visual courses already available in the U.S. in chemical subdisciplines and in industrial research management practices.
3. Development of molluscicides--a project combining product research and development in Egypt and in the U.S. with extensive field trials in Egypt of molluscicides in controlled-release forms to rid Egypt of the snails that are vectors for highly debilitating schistosomiasis.

4. Development of herbicides--a project to (1) transfer to Egypt the current, publicly available technology on controlled-release herbicides for aquatic weeds, (2) develop new controlled-release aquatic herbicide technology to provide effective control under Egyptian irrigation conditions and practices, and (3) make the developed products and practices available for American agriculturists to adapt to U.S. conditions.

5. Mineral beneficiation--a project to develop processes to (1) upgrade Egypt's marginal-grade iron ores and prepare furnace feeds from the upgraded ores, (2) beneficiate Egypt's marginal-grade phosphate ores to produce phosphate fertilizers by the wet process, and (3) recover fluorine from wastes from Egypt's aluminum and superphosphate plants.

6. Chemical modification of cotton--a project to devise ways to (1) apply finishes simultaneously to improve properties of cotton textiles, (2) add durable-press properties to cotton fabrics treated to have flame-retardant properties, (3) graft vinyl polymers on cotton to provide properties not obtainable by other methods, and (4) modify present processes to conserve use of energy and water during cotton finishing operations.

7. Utilization of wool wax--a project (1) develop improved processes for scouring wool at optimum efficiency, (2) determine markets in Egypt for the wool wax recovered during scouring, and (3) devise processes with which different grades of wool wax and of lanolin can be produced in Egypt to supply the markets there.

8. Corrosion control--a project to improve the National Research Centre's corrosion laboratory in a major way, combined with research and development to improve detection and control of corrosion in Egypt's petroleum recovery and refining industries.

Search for Support

Earlier we noted that the workshop had two purposes--to exchange technological information immediately during the workshop and then to recommend research and development projects to be conducted in the months following. Both purposes were important, to be sure, but the second to have continuing cooperative efforts is doubtless the more important. Americans have served as consultants in many developing countries in the past and still are doing so today. It is our opinion, however, that too often their trips have been for one time only. Unless there is continuing contact, the enthusiasm that is generated initially soon dissipates, and progress rapidly slows. Both the Egyptians and we were determined that the momentum generated by the workshop would not be lost but instead that continuing relationships would be developed.

Shortly after the workshop, therefore, the ACS submitted a proposal to the Agency for International Development in Cairo seeking support for the recommended projects. We had hoped that our proposal would be evaluated as a separate initiative of the American chemical community as represented by the ACS and not become a part of other programs. AID responded that it could not fund a separate program, but it did agree that the proposed projects could be considered for support under a program started in Egypt just a few months earlier.

This program, the Applied Science and Technology Research Program, is a multi-year, multi-million-dollar effort sponsored AID and the Arab Republic of Egypt. Its purpose is to hasten Egypt's industrial development, and it proposes to do so by improving physical facilities for research and development in Egypt and by assisting in training Egyptian research and development scientists and engineers in modern industrial research practices. Improvements to facilities will include a major upgrading of Egypt's library resouces (including computer storage and retrieval capability) and extensive purchases of instruments and equipment. This two-pronged approach will thus at one time provide physical and information facilities more adequate for Egypt's needs and also improve Egyptian personnel skills in a learning-by-doing R&D atmosphere under the guidance of American chemists.

AID agreed that the ACS projects all met criteria for funding under its program. It noted, however, that budget constraints would prevent funding all projects at one time. Accordingly, the Egyptians were asked to assign priorities to the projects as a basis for making final selections. In a two-step process, the eight projects were narrowed first to five (industrial internships, herbicide development, chemical modification of cotton, corrosion research, and wool wax recovery and refining) and eventually to two (corrosion research and wool wax recovery and refining). The two projects were approved for implementation this past November.

Approval for funding was based only on outlines of the projects, so the next step was to prepare complete project designs for each project. Once more the selection committee comprised of Drs. Breslow, Harris, Sheehan, and the authors put a peer review system into operation to select two corrosion experts and one wool processing expert to work with

Egyptian principal investigators in preparing the final project designs. Dr. Henry Leidheiser, Jr., a member of the original corrosion team, was selected as one of the corrosion experts, while Dr. Earl Snavely, Jr., Research Associate at Mobil Research and Development Corp. was selected as the other. For the wool wax project, Mr. Louis Mizell, Manager of New Market Outlets for the International Wool Secretariat, proved to be the unanimous recommendation of those consulted.

During a four-day stay in Cairo this past January, the three ACS experts and the Egyptian principal investigators prepared the necessary project designs, including detailed plans for the different stages of work to be undertaken and the schedules to be followed, and complete descriptions of the personnel and budgets required. Some paperwork still remains to be completed as of this writing, but we expect the actual research and development to start in a very short time now.

Plans for Future Projects

We believe the Egyptian project has demonstrated how a scientific ciety can conduct a technology exchange project:

- Its members--and equally importantly the employers of its members--are willing to participate. Only one of the 21 chemists approached as first choice said he could not join the group, and he did so only because he felt one of his associates would be more appropriate (and not so incidentally, a person right behind him on our list anyway).
- We faced no difficulties with proprietary information. All of the discussions involved industrial processes, but so much information is publicly available that at no time did any of the American members have conflicts of interest involving proprietary information.

This was true for the industrial members of the teams as well as for the academic members who might have had access to proprietary information because of their extensive experiences as consultants for industrial companies.

- The project proved to be extremely cost effective. Because of the prestige associated with participating in a project with a leading scientific society, American employers readily make time and facilities available. We have not analyzed all costs for the project in detail. However, it would not be unreasonable to estimate consultant fees at about $500 per day for the caliber of Americans in the workshop. Allowing at least two weeks for each to prepare for his role in the workshop and two weeks for the workshop itself, the Americans devoted about 420 man-days to the program. Had there been a charge for this time, the cost would have been at least $210,000. Actual costs, however, were about $35,000 for transportation to Egypt and for per diem during the workshop plus ACS administrative costs to organize and conduct the workshop. A scientific society's multiplier factor is readily apparent from such figures.

The Egyptian project is now well under way toward reaching its objectives, and the ACS is at about the midpoint in its next similar venture. This one will be undertaken in cooperation with the Indian Chemical Society, and it will be supported by the National Science Foundation on the U.S. side and the Department of Science and Technology on the Indian side. It won't be quite as large as the Egyptian project, having probably eight Americans as participants rather than 21 and dealing with three subject areas rather than five. It will have the same overall objectives, however, of first exchanging technological information and then planning research and

development projects that can be conducted cooperatively to hasten India's development.

Using the Egyptian project as an example, we have also discussed what the ACS can do with the U.S. Department of State, the Agency for International Development, and more recently with officials who are involved in forming the Foundation for International Technology Cooperation or whatever agency results from President Carter's proposal of a little more than a year ago for revamping U.S. foreign aid programs. Our efforts, the efforts of other societies, this workshop, and the forthcoming UN Conference on Science and Technology for Development we expect will do much to speed the success all of us would like to have in developed and developing countries alike.

APPENDIX C

THE GLOBAL NETWORK OF ENGINEERING EDUCATION SOCIETIES: THEIR ROLES IN DEVELOPMENT OF TECHNOLOGICAL INFRASTRUCTURES

By

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AAAS - State Department Workshop IV
May 21-22, 1979
The Role of Scientific and Engineering Societies in Development
Washington, D. C.

1. Introduction

The principal feature of engineering education is the nurturing of a problem-solving mind set in its adherents. Modern engineering education in the industrialized countries is characterized by its breadth and flexibility and by the range of social problems which the engineering student is encouraged to consider as challenges to his problem solving abilities and techniques.

Prerequisites to the applications of science and technology to development are the existence of both the facts of science and the "technologists" to apply them to the full range of "problems" that beset mankind. Thus the education of engineers, technologists and technicians is an integral, if not to say fundamental element of the development process.

The preparatory conferences, seminars and workshops for the U.N. Conference on Science and Technology for Development, and the majority of the "country papers" contain a fundamental point of agreement arising from an underlying theme: Human resources are at once the key to and ultimate purpose of the development process.

Discussions focused on human resources inevitably come down to formulations of "a better, more human life for all." What needs to be recognized is that the development of requisite conditions for the "better, life," however defined in any country or culture, is both end product and part of the ongoing process.

A brief examination of the role of engineering education societies in the formation of the technological resource base is in order. I should like to describe in some depth some of the oldest and most

influential societies, and further to make you aware of the international network of similar societies now working. Finally, I should like to make some recommendations which grow out of these observations.

2. The American Society for Engineering Education (ASEE)

The choice of ASEE as the first such society for discussion does not proceed from pure parochialism but rather from the fact that it was the first, for long the only, and still is the largest society devoted wholly to the development and improvement of the education of engineers.

The society was founded during the Columbian Exposition of 1893 held in Chicago, Illinois. It was then called the Society for the Promotion of Engineering Education, with worldwide membership open to all engineers engaged in the education of future engineers. One need only think of the optimism of the "Victorian" period in the industrialized countries and the accompanying public faith and confidence that science and technology would bring about material well being, to realize that at its founding the society's purpose was "development," through training, of those who would be instrumental in bringing that well being about.

ASEE has always had an international membership and provided contacts among colleagues from different countries. Perusal of the Journal of Engineering Education, the society's monthly publication, reveals that it was a vehicle for technology transfer and development. A steady flow of articles brought engineering education systems and methods in European countries to the attention of U.S. educators, and vice versa.

The society has continued to play a role in the exchange of information and promotion of contacts among educators. The publication of Technos, a quarterly devoted to engineering education and the development

process, was begun in 1970. Two World Congresses were conducted subsequent to the first in 1893. The second was in 1965 -- again in Chicago -- and the third in 1975 in Estes Park, Colorado. The theme there was Educating Engineers for World Development.

ASEE has an international division for members whose interests extend outside their own countries and a Joint Committee on International Activities to keep abreast of new programs and activities of interest or concern to members of other divisions and to advise the board of directors, at its request, on international affairs of interest or concern to the whole membership.

ASEE has, through its constancy in the pursuit of excellence in the formation of engineers in the U.S., contributed significantly to the industrialization process here throughout the twentieth century. The society has provided a forum for representatives of industry, government and the teaching profession to meet, exchange views and formulate recommendations which has influenced the quality of the profession. Two major ASEE studies in this quarter of the century have set the major directions of engineering education in the U.S. and the world. These were the Grinter Report[1] and the Goals of Engineering Education reports.[2]

Perhaps the significant point to be made about these reports in the context of the UNCSTD is that they related engineering education to the main trends and perceived needs of the U.S. at distinct stages of its economic and social development as well as to the state of technical knowledge at their time. It should be carefully noted that knowledge of the processes followed by the groups who prepared these reports could be of major benefit to engineering education societies in many countries

and particularly to the less developed ones.

ASEE has given encouragement and assistance to engineering educators from many countries in developing their own societies and associations. In addition to the World Congresses already mentioned, members and the headquarters staff have participated in joint workshops early in their histories, with the education committee of the European Federation of Engineering Societies (FEANI), The National Association of Schools and Faculties of Engineering (ANFEI) in Mexico, the Japan Society for Engineering Education, and the Pan American Association of Engineering Societies (UPADI). Additionally the ASEE has responded to requests for advice from and has exchanged publications with these engineering education societies, and the executive officers entertained educators from many lands who have visited seeking information about the society, its functions, and the role its plays in this country.

ASEE has worked closely with the development of the Permanent Committee on Engineering Education of the UPADI since its founding in 1962, and provided informational assistance for the Indian Society for Technical Education, and the Venezuelan chapter of ASEE. ASEE was also active in EUSEC and a founding member of the Committee on Education and Training of its successor, the World Federation of Engineering Organizations (WFEO). This recounting is an illustrative rather than exhaustive list of the network of communication and influence of the society and its members.

The preparations for UNCSTD have enjoyed the attention and participation of the society and many of its members beginning with the U.N.'s own preparations and subsequently in the U.S. beginning with Secretary Kissinger's meeting in December 1976. A portion of the mid-year and annual

conference programs of the International Division has been devoted to UNCSTD, with distinguished members of both the U.S. and U.N. preparatory commissions as speakers. World Bank and the Interamerican Development Bank as well as the United Nations Development Program (UNDP), the United Nations Education Scientific and Cultural Organization (UNESCO), and the United Nations Industrialization Organization (UNIDO) have sent program speakers to the International Division's meetings to discuss with society members the role of engineering education in the development process.

ASEE cooperated with the Department of State (AID) in conducting a study of the needs for technical/technician education in several Central and Latin American countries,[3] and with the National Academy of Sciences/ National Academy of Engineering, Office of the Foreign Secretary, in a study of the role of U.S. Engineering schools in technical assistance.[4]

UNESCO has long had attention and cooperation from ASEE, beginning early, with formation of the U.S. National Commission for UNESCO. Vigorous participation of the U.S. in the 1968 UNESCO Conference in Paris on the teaching and training of engineers, established the climate in which cooperation has continued -- particularly with the Division of Technological Research and Higher Education, Engineering Education Section. An ASEE member has served on each of the UNESCO working groups in engineering education, and the society furnished two chairmen as well as editors of three of the sector's publications.[5] The Paris Conference in 1968 set the direction which the sector has followed for the past decade, that is to assist developing member states to develop their technical human resource base and foster evolution of regional and national engineering education societies through sponsorship of founding conferences and support

for publication of regional journals and specialized conferences. Through UNESCO guidance, their underlying theme has been to focus on the position, role and responsibility of the engineer in economic and social development. In this endeavor, the aims and activities in I.D. of ASEE and UNESCO run parallel. These efforts, particularly over the past decade, have established an infrastructure which can now be used to make available to the least developed countries the knowledge and experience of the many members of societies from countries in various stages of technological development. A brief list of those societies and summary of their activities follow.

3. The network of engineering education societies

AEESEA, Association for Engineering Education in South East Asia

Activities: Conducts annual meetings, organizes and conducts regional and national seminars on subjects of concern to engineering educators.

Membership: By country originally, now offers individual membership.

Headquarters: College of Engineering
Seoul National University
Changnyang, P.O. Box 105
Seoul 130, Korea

President: Chai-sung Lee

Publications: One. Journal of Engineering Education in Southeast Asia. Two issues annually.

Editor: Ki-jun Lee

CEC, Commonwealth Engineers' Council

Commonwealth Assessment Board

Activities: Assessment of quality of educational programs of institutions, schools and colleges upon application by the body. Furnishes a panel of experts to evaluate the programs and render a report. The aim is to facilitate mutual recognition of the qualifications of engineers where the standard is comparable.

Headquarters: Commonwealth Engineers' Council
The Council of Engineering Institutions
2 Little Smith Street
London, S.W. 1
United Kingdom

CEEMA, Committee on Engineering Education in Middle Africa, 1967

Activities: Meets triennially for information exchange on curricula and syllabi, collects and shares basic physical data with engineering implications, organizes conferences, promotes cooperation with industry.

Memberhip: By institution.

Headquarters: Governed by Steering Committee

Chairman: J.M.K. Dake, Dean
School of Engineering
University of Zambia
Lusakka, Zambia

Executive Secretary: Stephen Jels Talitwala
University of Nairobi
Nairobi, Kenya

Publication: Journal of Engineering Research and Education in Middle Africa, annual.

Editor: T.A. Kasim
Department of Electrical Engineering
University of Lagos
Lagos, Nigeria

COPISEE, Permanent Conference of Engineers of South Eastern Europe

A non-governmental organization of National Unions of Engineers of South Eastern Europe (Bulgaria, Cyprus, Greece, Romania, Turkey and Yugoslavia).

Activities: Organizes congresses on education and training and technical symposia.

Headquarters: COPISEE
Zina Kanther Building
13 Patheou Street
P.O. Box 1401
Nicosia, Cyprus

Officer: A. Protopapas, President

FAE, Federation of Arab Engineers, 1963

Engineering Education Committee, 1966

Seven member education committee chosen by the Federation Supreme Council.

Activities: FAE contributes to the solution of the problems of engineering education in the Arab countries through the activities of their permanent committee of engineering education. The committee conducts conferences, seminars

and workshops, conducts evaluations of scientific degrees, promotes the continuing education of engineers, publishes papers on engineering education and is the channel of cooperation with other regional and international bodies.

Headquarters: 28 Ramses Street
Cairo, Arab Republic of Egypt

Officer: A. El-Erian, Secretary General

Publication: Newsletter of Engineering Education

FAOE, Federation of African Organizations of Engineers

Activities: An organization of twelve engineering associations. The organization consists of engineering associations in Nigeria, Egypt, Sudan, Sierra Leone, Kenya, Ghana, Libya, Algeria, Morocco, Tunesia, Mali and Senegal. It is attempting through sharing of knowledge and experience to improve engineering education among the members and to foster development of some specializations through continuing education programs.

Headquarters: 30 Ramses Street
P.O. Box 1158
Cairo, Arab Republic of Egypt

Officer: M. Selim, Assistant Secretary General

FEANI, Federation Europeenne D'Associations Nationales D'Ingenieurs - Training Committee, 1949

Activities: Conducts surveys of manpower needs, holds seminars and conferences dealing with both initial and continuing education of engineers and access to the profession. FEANI

cooperates with the European Economic Community (EEC) Council of Europe, Organization for Economic Cooperation and Development (OECD), as well as the World Federation of Engineering Organizations (WFEO), International Labor Organization (ILO), and UNESCO.

Membership: An association of societies of twelve European countries represented by their national organization of engineers or if a country has more than one, by a commmittee of the several.

Headquarters: 4, Rue de la Mission - Marchard
Paris 75016
France

Chairman: Education Committee
U. of Mocafico
E.P.F.L. (Ecole Polytechnique Federal de Lausanne)
Switzerland

SEFI, European Society for Engineering Education, 1973

Activities: Annual conferences, seminars and workshops to promote development and improvement of engineering education and cooperation between engineering educational institutions and working groups.

Membership: Institutional, individual and industrial members. Institutional members are teaching institutions of higher level having full responsibility for awarding academic degrees and professional qualifications. The industrial members may also include professional associations.

Headquarters: SEFI

Rue de la Concorde 60

B 1050 Bruxelles, Belgium

Officers: Gabriel Fragniere, Secretary General

Prof. Niels Krebs Ovesen, President

Danish Engineering Academy, Copenhagen

Publication: European Journal of Engineering Education (quarterly)

Editor: Alec L. Marshall

Sunderland Polytechnic, Sunderland, G.B.

Publisher: Elsevier Scientific Publishing Co.

P.O. Box 211, Amsterdam, Netherlands

SEFINEWS - Newsletter

SEFIGUIDE - Working group reports

UPADI, Pan American Federation of Engineering Societies, 1935

Education Committee, 1958

Activities: The Education Committee conducts a congress on engineering education biennially with the Convention of UPADI. Alternate years it meets at the time of the International Meeting of the Board of Directors and conducts a Roundtable on an international subject. Catalyzes and jointly conducts seminars and congresses on engineering education subjects with UNESCO and national engineering organizations in member countries. The Education Committee relates to other regional and world organizations such as ASEE, FEANI, SEFI, WFEO and AEESEA through participation in their congresses and by exchange of information.

Membership: UPADI - National organizations of engineers. If a country has more than one it is represented in UPADI by a committee of their representatives. The Education Committee is composed of representatives of national engineering education societies or committees.

Headquarters: UPADI
Insurgentes Sur 753
Mexico 18, D.F.

Officers: President Ing. Carlos Lopez Rivera
Ing. Salvadore Herrera, Executive Secretary
Education Committee: Ing. M.A. Yadarola
Mariano Moreno 435
Cordoba, Argentina

Publication: Bulletin - Ensenanza Ingenieria

Editor: Ing. Vladimir Yackovlev
Apartado 51566
Caracas 105, Venezuela

WFEO, World Federation of Engineering Organizations, 1968

Committee on Education and Training, 1970

Activities: The Education and Training Committee meets biennially, appoints task forces/working groups to give attention to matters of mutual concern, and to make recommendations to the Executive Committee and General Assembly. The Committee cooperates with UNESCO and the national and regional members of WFEO to promote the improvement of engineering education therein.

Membership: WFEO is an organization of national and regional engineering associations throughout the world. The education and training committee is composed of 24 members with the country selected by the executive committee and individuals recommended by the member society and confirmed by the General Assembly which meets biennially.

Headquarters: WFEO
19 Rue Blanche
Paris 75009, France

Officers: C. Herselin, Secretary General

Committee on Education and Training

H. Bhattacharyya, Chairman
S. Gokhale Road
Calcutta 700020, India

B.T. Nagrani, Secretary

4. National engineering societies

This paper has thus far focused on the regional engineering education organizations. Countries with membership in all the regional societies may have a national education society or alternatively, an education committee within the association of professional engineers.

In some countries the professional organization has a great legal influence on the structure and content of engineering education through responsibility for accrediting training programs in the schools and/or governing entry into the profession, that is, the licensing function.

While most national engineering education organizations are concerned

with both maintenance and improvement of education preparatory to entry into professional practice, during the last two decades many have also devoted considerable energy to cooperation between and among engineering societies in order to assure comparable standards of performance. Furthermore, increasing attention is given to the role that engineering now plays and will play in the future in the processes of development. Through the inclusion of conference topics such as "the role of the engineer in regional development," "the responsibility of the engineer for protection of the regional and global environment" and "the education of engineers for world development," the professional organizations seek to stimulate thought and to provoke appropriate action among their members, in educational institutions and government ministries and agencies. Conferences and congresses with themes such as "engineering education for the 21st century," "cooperation in the formation of engineers for national development," "engineering education and training methodologies for improving the indigenous engineering capability of developing countries," help these societies lend currency to these ideas, bring a certain respectability to members who wish to devote themselves to them, and raise the consciousness of governmental bodies as to their importance.

5. Corollary observations

The partial list cited here gives evidence of a structure of engineering education societies throughout many countries of the world. There also exists a structure of regional and worldwide committees and working groups which are channels of cooperation among these societies, be they governmental or non-governmental in character. These structures could be used to enhance the flow of information among countries and to assist the

less developed countries, in particular, in their struggle to enhance the welfare of their people through provision for meeting basic human needs. This network of engineering education societies can be used to identify experts interested in and capable of assisting development of local institutions including schools, societies and governmental support systems necessary for training the human resources. Without these activities, development plans remain paper exercises. Engineering education societies through the presently existing structures could be responsible, together with a local organization, for conducting workshops and short courses to help overcome lack of knowledge, to share techniques, and in particular, to provide stimulation and reinforcement to those individuals trying against great odds to make modern science and technology better serve their cultures.

It should be recognized that much of the world still proceeds on the basis of inter-personal relationships and an aural tradition. Response to an outstanding teacher and the impact of a face-to-face dialogue is much greater than the impact of his published books and articles in many cultures, particularly in less developed countries. Costly though it may seem to get a group of people together under the auspices of one of the engineering education societies, in many parts of the world this method is not only the best, but often the only way that information can flow and enthusiasm for action can be generated.

The U.S. has participated in the founding or development of many of the societies mentioned above and the American Society for Engineering Education has provided a model upon which some of them have been formed. However, ASEE has not been able to participate as vigorously or to respond

to requests for collaboration or assistance in proportion to the opportunities afforded. The nature of voluntary organizations, where much of the work of a society is done by volunteers on a rotating basis, and where membership dues provide the funding, limits ASEE as well as other like organizations in the extent to which they can engage in international activities. It is often regarded as ironic by the volunteers that technical education, an area of the national life which still enjoys such high prestige abroad and for which there is such demand, as witnessed by the tremendous numbers of foreign engineering students here, enjoys so little support by U.S. governmental agencies to engage in cooperative enterprises with colleagues abroad.

6. Recommendations

a) Workshops and symposia should be conducted for some engineering educators from abroad who are currently in the U.S. and planning to return home. These workshops and symposia should be designed to increase their knowledge about and enhance their abilities to develop and administer technical education institutions.

b) Workshops and symposia should be conducted for some from this group which will better prepare them for research supervision and administration.

c) Workshops and symposia should be conducted for some among this group to focus on modern educational methodology and techniques which will be important in the future in their own countries. These could be planned and conducted through the auspices of ASEE.

d) Workshops and symposia should be conducted abroad in conjunction

with local or regional education societies, where they exist, on the above subjects. These workshops could be planned through the ASEE utilizing its numerous members abroad as well as those within the U.S. as well as the network of alliances it has with similar organizations as noted above.

e) The Department of State, through whatever appropriate mechanism, should avail itself of this network for pursuit of national goals of promoting economic and social development and peaceful relations while depending upon the experts in technical education to formulate the content and means of cooperation within broad guidelines as to purpose.

f) There should be a mechanism of support, perhaps through the new institute for international technical cooperation, and similar in operation to the AID/NAS/NAE (Office of the Foreign Secretary) arrangement whereby a base of support (general activity agreement) is given on an experimental but regular basis for three years, with a work plan and specific project activities arrived at by mutual agreement and subject to initiation by either party or in response to requests from abroad for collaboration. The general activity agreement should provide for basic staff support to plan and manage the international activities.

Allowance should be made or authority given to collaborate in joint projects of mutual interest which may be partially supported by other national or multi-national development agencies. As an example, the Committee on Engineering Education in Middle Africa (CEEMA) has had support from the Geselschaft für Technisches

Zusammenarbeit (GTZ) and the Deutsche Stiftung für Entwicklung (DSE) of West Germany. Other engineering education societies in developing countries have had some support from the Canadian International Development Agency (CIDA) or its IDRC; regional societies have had encouragement and modest support from UNESCO. Funding should make it possible for ASEE to cooperate with such organizations as well as the societies themselves in furthering the development of the human resource technological infrastructure of the less developed countries, to do so in a timely manner and with the ability to make firm commitments.

g) The Director General of UNESCO has indicated a desire to cooperate more closely with the U.S. intellectual and academic community in carrying out the recommendations of UNCSTD. The structures and mechanisms within the U.S. government system should be developed to make closer cooperation and more timely response possible within overall policy guidelines developed mutually among the U.S. government agencies and the technical academic community.

Notes

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APPENDIX D

THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

Present Perspectives and Future Prospects

By Donald G. Fink, Director Emeritus,

Institute of Electrical and Electronics Engineers

There can be no doubt that engineers and scientists have a vital role to play in the developmental processes by which the nations of The Third World will bring greater health, safety, prosperity and self-reliance to their peoples. But the topic of this Workshop is not the role of scientists and engineers; it is the role of their professional societies, which is another matter entirely. So let us, first, define what roles these societies perform for themselves and their members; second, question how they have been and are becoming effective in the international sphere at large; and third, show how they are and can become effective in that most difficult area of international relations the mutual support of the developed and the developing nations.

This paper is confined to a particular set of professional societi whose members practice engineering, the applications of natural science and social science. These three groups are involved with the special needs of the developing countries only on a limited scale. They have a much larger role to play than they presently undertake, a heavier responsibility in fact, than many of them understand is demanded of them.

Professional societies and their member services.

Professional societies are formed to serve a branch of engineering, a field of science or a realm of scholarship by bringing together the resources of the most eminent of their respective practitioners. These

provide leadership and serve as a center that attracts the resources of the much larger group of less eminent people, the "working members of the profession." Once established, these societies grow and prosper only to the extent that they serve the interests of their members. They are not altruistic or philanthropic but they do manage, by and large, to preserve an enlightened self interest and a reputation for expert judgment within their fields of competence.

Professional society publications.

Their principal function in serving their members and their professions is the publication of refereed papers in their journals, transactions, proceedings and conferences records. The strength of their publications starts with the committees of expert members who arrange for conferences, invite papers, select among proffered papers, and subject them to informed scrutiny by expert referees. In science there are few bars to publication aside from intrinsic merit when the authors are employed in the academic world and in non-military government. But in applied scientific work in industrial laboratories and engineering there are limits to the publication of proprietary information, and that cloaked in military security. For all that, the vast majority of the new discoveries and advances of science and engineering find their way into the publications of the professional journals, often within months and at most within a few years of the time the work reported was performed.

The scale of scientific and technical publication by professional societies is staggering. The American Institute of Physics produces 100,000 pages of archival material every year. The American Chemical Society produces 35,000 to 40,000 pages annually. Among engineering societies, the Institute of Electrical and Electronics Engineers (IEEE), an Institute embracing thirty-six sub-societies, has an output of 30,000 refereed pages per year. Similar programs of publication on a smaller scale occur in all the developed nations, and in a few of the developing ones.

The annual outpouring of papers and books in science and engineering has outrun the capacity of even specialists to keep tabs on it unassisted. So indexing and abstracting institutions, notably INSPEC in Great Britain, Chemical Abstracts and Engineering Index in the U.S.A., have turned to computerization of bibliographic references. Most large libraries in the developed world and many in the Third World now have computer-assisted access terminals for searching these and other compilations of scientific and technical literature. This is a resource of gargantuan proportions, available to the world at moderate rates by telephonic and satellite data links.

While this publication and retrieval effort is of great potential value to the Third World, we must not be misled into the belief that it has been designed for the developing countries. Engineering and scientific society publications are designed to serve their respective memberships. In the U.S.A. and other developed countries this is a trained and sophisticated audience, attuned to capital-intensive systems, used to highly automated methods of manufacture, service and use of the products of scientific discovery and engineering development.

But, as has been repeatedly emphasized, the developing nations in dealing with the problems of the poor populations, need labor-intensive methods, and can usefully acquire large capital-intensive systems only after the most careful study of the cost-benefit equations which justify loans from financial institutions or grants from the developed World. So there is a large mismatch between the design of professional publications and their use in solving developmental problems.

One feature of the files of society publications of benefit to the development process is too often lost sight of. This is the vast reservoir of information on technical methods that served the developed nation's needs in earlier days, available in the back-copy files of libraries. This useful information is often dismissed as "second-hand" and "cast-off". A joint effort among members of a society in the developed world with opposite numbers in a developing country, reviewing the past literature for technology applicable in development today, would I believe yield valuable dividends, particularly in the fields of civil, mechanical and electrical engineering. The mechanism for such joint efforts exists in the World Federation of Engineering Organizations (WFEO). This organization has already been active in the field of engineering information systems in joint conferences between engineers of the Arab countries and those of the western democracies and the U.S.S.R.

Other functions of professional societies.

A second function of professional societies of significance to the Third World is the identification of special expertise and competence of particular members. In part this function is performed merely by listing the vitae of the authors of timely and significant papers. Another is the device of the "grade of member," starting with the Student Grade for engineers and scientists in training and advancing through intermediate grades to the Fellow Grade which is conferred as a mark of special competence and distinction. Still another is the awarding of prizes and medals for outstanding scientific or technical achievement. Most important, is the ability of the headquarters staff of many professional societies to identify qualified members who are in a position to accept the responsibility, either on a volunteer or paid-consultant basis, to assist in decision-making, in the application of science, and in engineering planning.

This latter service is perhaps most effectively provided by the academies of science and engineering, whose prestige commands respect and requires complete objectivity on the part of the experts they identify. But no academy can match the depth and variety of trained workers that comprise the much larger memberships of the professional societies. To be specific, in 1978 the National Academy of Engineering had 912 members, including foreign associates. Of these 265 were members of IEEE, less than two tenths of one per cent of that Institute's total membership.

A third function of the professional societies is the influence they exert, within their respective countries, on the standards of excellence demanded in university curricula and faculty for the training of scientists and engineers. Closely allied are standards of professional conduct and ethical practice, and the chartering or registration of engineers who have demonstrated their qualifications to accept responsibility, in public works and elsewhere, for the welfare of the public at large.

A fourth function (and there are many more, of less significance to our discussion) is the establishment of technical standards and safety measures, the promulgation of scientific constants and other data, and the refinement of scientific and technical terms to more exact meaning in several languages as the art progresses.

Space does not permit extending this list or going into specifics. Suffice it to say that the output of professional societies produced in the normal course of their business is available to the Third World, as indeed it is to all other parts of the World where the resources for its acquisition exist and the trained personnel are available for making use of it.

But the mere availability of this mass of knowledge does not insure its effective use by developing nations. It is to this problem, and its political, atavistic, social, religious and economic components, that the members of the social science societies are now turning their attention. One problem is purely economic.* Full coverage of the massive output of all current science and engineering publications does not come cheap. Selective search among automated bibliographic files,

backed by acquisition of a copy of a particular useful paper from among the many non-useful ones revealed by such searches, requires a great deal more than desire for useful knowledge. It requires the availability of funds which in turn depends on national political and social support. It is of course necessary that a nationally self-sufficient developmental program in science and engineering applications shall embody at least a minimal, and growing, supply of engineers and scientists, adequate to select and use the technologies their countries need and can afford.

Status of current international involvement.

Other background papers presented to this Workshop list in detail the existing international and inter-society programs that bear on, or are potentially fruitful for, the development process. I will not cover that ground except to present my view of the present perspective, which is little short of dismal in the total context of professional society work.

The host organization of this meeting, the American Association of the Advancement of Science, provides interesting evidence. AAAS has 287 affiliated organizations and academies, among which are nearly all the major engineering and natural science societies of this country, and others in the fields of social science. A questionnaire, first issued by AAAS in 1975 and reissued this year, asked these 287 organizations to reveal the extent, if any, that each was engaged in international activities. In 1975, 101 AAAS affiliated organizations replied, of which only 25 per cent stated that they were active in the international sphere, while another 50 per cent had interest in international contacts but no institutionalized international program.

Taking a rough cut at these results, which are confirmed this year, we see that no more than 10 per cent of the AAAS affiliated organizations have any substantial interest or involvement in international matters. The other 90 per cent have marginal contact abroad, or none at all. That is not to say that this large majority does not serve foreign members; but it does say that they do nothing special for them. These societies, numbering more than 250, are "national" in the most literal sense.

Undismayed, AAAS set up a Consortium of Affiliates for International Projects and in 1976 invited 14 affiliated organizations to attend a planning meeting. As I read the record since that time this Consortium (now embracing 79 of the AAAS affiliated organizations) has had as one of four or five main areas of interest "the transfer of science and technology to the developing countries." But the Consortium has been cautious not to idealize this role and until the present series of workshops, sponsored by the Department of State in preparation for UNCSTD, there has been no organized Consortium program addressing the problems of scientific and technical development. The record also shows that only two of the most active societies have, unassisted and on their own initiative, embarked on cooperative programs-in-situ in the developing nations (the American Statistical Association and the American Society for Engineering Education). Others have worked through multidisciplinary and intermediary organizations like WFEO and ICSU.

IEEE's transnational governance.

Such provincialism, while present in the majority, is absent in many of the larger and more influential societies, like the Engineering Founding Societies, the Physics Institute and the Chemical Society. But only one American society known to me, is organized against nationalistic provincialism. This is the IEEE. It is no accident that the designation "American" does not appear in the name of the IEEE, although its corporate predecessor was the American Institute of Electrical Engineers. When its merger with the Institute of Radio Engineers was proposed to the respective memberships in 1962, it was explained that the merged organization would be "transnational", and that this mode of organization would in fact be central to its Constitution. As a result, IEEE today has ten directors elected on a regional basis by members. Six of these are elected in the United States, one in Canada, one in Latin America, one in Europe, the Near East and North Asia, and one by members residing in "the remainder of the world", which includes members in Japan, Australia, New Zealand, India and smaller groups in Asia and Africa. The incumbent non-U.S.A. elected directors reside in Winnipeg, the Hague, San Juan and Hong Kong.

IEEE is the largest engineering society in the Western World (in the U.S.A., only those embracing medicine, nursing and teaching are larger). Its membership abroad is growing at a rate some three times as great as in the United States. The success of its overseas organization efforts is attested by the existence of 65 local sections scattered throughout the world outside the borders of the United States, including active sections in Poland, Yugoslavia, Egypt, Israel, and Iran. In all, the international non-U.S.A. membership of IEEE (as of February, 1979) comprised more than 16 per cent of the total membership, which then exceeded 193,000.

I have taken this occasion to describe IEEE's structure from conviction that its form of government, with transnational aims implemented through voting power, is one that deserves imitation elsewhere in the professional society world.

I must state that IEEE's concern for its overseas members, whether they live in developed or developing countries is based on the same technical and professional requirements for these members as for the others. As a matter of fact the number of Fellows of the IEEE, per capita of membership is higher in Europe than in the United States. So IEEE is a mechanism for trained engineers of all countries to find common ground. Its publications, as in professional societies generally, are concerned with the leading edges of its sciences and technologies, and it makes little provision for the special needs of the less well trained except through its Student Programs. IEEE finds its contact with the Third World through an intermediary, the World Federation of Engineering Organizations (WFEO), of which it has been an active participant since 1965.

To the best of my knowledge, essentially all of the professional societies with which we are here concerned, in the United States and elsewhere in the developed World, follow a similar pattern. They provide a common ground for meetings, discussions, conferences and publications among well-trained practitioners, and they make few if any special provisions for the needs of engineers and scientists in the Third World.

The enlightened self-interest of the civil engineers.

There are a few exceptions to this rule, and I mention in particular the American Society of Civil Engineers. ASCE published in its core publication, "Civil Engineering", less than a year ago a special report "Development of OPEC nd the Third World Nations." ASCE's concern for technical development rests on the enlightened self-interest of its members. Uniquely among engineering societies, the majority of its members are self-employed and gain their livelihood from individual entrepreneurship and that of the leaders of partnerships, consulting firms and similar non-industrial organizations. Moreover, the special needs of the developing nations, particularly those of their rural poor, involve works central to the field of civil engineering: water supply, irrigation, sanitation, road and building construction, public transportation and the like.

Among the rich developing nations within OPEC these public works take sophisticated forms indistinguishable in technical content from those of the developed World. But among the poorer nations modern capital-intensive civil engineering is, most of the time, the wrong prescription for their needs.

The ASCE effort has been to bring that fact home to its members, and to point out that those who hope to secure contracts for their services from the Third World must employ an innovative approach based on thorough knowledge of local conditions, including political factors involving governmental planning and direct involvement in project planning of local professional people and even of the workers involved. This publication (Civil Engineering, Vol. 48, No. 8, pp. 47-75, August, 1978) is well worth the attention of all engineers and scientists interested in the development of the Third World.

One contribution in that issue is worth particular attention for the lessons it teaches about the transfer of technology to the Third World. It was written by M.G. McGarry of Canada's International Development Research Centre, a unique organization that channels money appropriated by Parliament into worthwhile international development programs and is a model for the developed world to emulate. McGarry points out that sanitary piped sewers, the unquestioned necessity for non-rural areas of the developed World, are in fact technically inappropriate and scandalously wasteful of capital for the rural and suburban areas of the developing countries. He lists several cost-effective, adequate, safe and socially acceptable alternative systems of local treatment which involve long established technology. He points out that the leaders of the development world are, themselves, often not enthusiastic about these less costly and more effective low-technology approaches, preferring "to impress their constituencies and the rest of the world with nothing less than the latest and most sophisticated technology that the industrial world can offer." He also makes the flat statement that many Western consulting engineering firms, retained by developing countries for feasibility studies, are so constrained by their lack of experience which local conditions that they consistently recommend piped sewage and in some cases refuse outright to consider any alternative. McGarry is a world authority on water and sewage systems for development and is so outspoken and influential that he and his associates in the IDRC are sometimes referred to as the "Water Mafia."

ICSU and COSTED.

The involvement of scientific societies in the international sphere is likewise at the cutting edges of their respective fields, with little or

no concessions to the special needs of overseas members and the development process. They, like the engineers, tend to use intermediary, multidisciplinary organizations to exert their influence internationally.

The most prestigious organization in international science is ICSU, the previously mentioned International Council of Scientific Unions, comprising nineteen Unions in the principal scientific disciplines and 65 "national members." The U.S. National Committees of these ICSU Unions are financially supported by the National Science Foundation, and are in some cases supported otherwise by the respective scientific societies, which serve to identify and nominate the Committee members, to arrange for and administer travel grants, and even to take an active part in soliciting and refereeing papers for international conferences sponsored by the Unions. These processes tend to be elitist; it is a mark of international recognition in one's field to serve on an U.S. National Committee for an ICSU Union.

The parent ICSU organization, as a multidisciplinary umbrella embracing most of the fields of pure and applied science, has recognized many responsibilities that cross the lines of the individual Unions. One of these formed in 1966 is COSTED, the ICSU Committee on Science and Technology in Developing Countries. COSTED lies a long way from the scientific societies, organizationally speaking, but it does have an active program.

For many years prior the end of his term this year, Dr. Roger Revelle has been the U.S.A. member of COSTED. Revelle, who was elected to the National Academy of Sciences 22 years ago, and has been an active contributor to the Academies' international efforts for most of the time since, is a preeminent member of the American scientific

establishment who understands the byways and pitfalls of the development process. He is full of wisdom and has an embracing personal empathy for the poor and underprivileged people of the world.

The U.S. National Committee for ICSU (the parent body) is the Board for International Organizations and Programs (BIOP), supported by NSF funds and administered by the NRC Commission on International Relations. On it sit the Foreign Secretaries of the National Academy of Sciences and the National Academy of Engineering, members of NAS and NAE and others experienced in ICSU and international science and engineering. Particularly influential in this Board of engineers and natural scientists is member David Apter of Yale University, one of our country's most distinguished social scientists.

The Academies, NRC and BOSTID and the Stever Report.

These Academies as well as the American Academy of Arts and Sciences are also involved in the affairs of the professional societies dealt with here. The connection is indirect, but real. The leaders who serve as officers and directors of the professional societies are in many cases members of these Academies, and many others are active in the volunteer programs of the National Research Council. So the professional societies have an entree to the academy staffs and organization they need only tap to gain the benefit of academic international programs (and in fact to participate in them, through nomination of experts). Those professional societies who desire to become more active in helping the Third World development process will find a cordial welcome as well as a large reservoir of knowledge and programmatic experience.

The focus of work in development within the NRC's Commission on International Relations is BOSTID, the Board on Science and Technology for International Development, whose first chairman was Roger Revelle. BOSTID published in 1978 a nine-year summary of its activities in the period from 1970, listing funding sources and program summaries of work conducted in and for 45 developing countries, as well as summary records of its Advisory Committee on Technology Innovation and other advisory panels and study groups. This Board is in the thick of the development process, in real time; it can be a potent source of inspiration and guidance for the professional societies as they undertake their obligations in international development.

BOSTID is an ongoing institution. The Academies are also called upon, to take on ad hoc assignments at the request of the federal government. When the Department of State first faced its task of preparing for UNCSTD, it addressed a request to the Academies (through their operating arm, the NRC) to study and report on appropriate positions to be taken by the United States at that Conference, with particular reference to the program initiatives that our country could suggest and offer to support. The response of the Academies was rapid, thorough and timely. The result is "U.S. Science for Technology and Development: A Contribution to the 1979 U.N. Conference."

Everyone attending this Workshop, and everyone else interested in UNCSTD and the part to be taken by the United States during and after that Conference, should obtain a copy. (It is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, Stock Number 052-003-00546-8). Produced by five Study Panels and

an Executive Committee under the Chairmanship of H. Guyford Stever, with able support from many volunteer resource people and a dedicated and expert staff, it is a monumental volume worth detailed study. Busy people who cannot undertake detailed studies should consider as required reading, nevertheless, the 37 pages of the first Overview Chapter. Nowhere else have I seen so cogent and informed a statement of what development of the Third World means intrinsically and what is required of U.S. science and engineering to undertake our country's obligations and opportunities in respect to that development.

Just two of the issues addressed in the first chapter are "Autonomy and Independence" (of developing countries), page 3 and "Technology Transfer and the Problem of Proprietary Knowledge" pages 4 and 5. The proposed program initiatives embrace the work of many engineering and scientific societies. The short titles are: Increasing Food Supplies (four proposed program areas); Health and Related Needs (four program areas); Urbanization and Industrialization (four areas); Management of Resources (four areas) and General Initiatives (six areas). Under Management of Resources the four areas are the development and use of energy, remote sensing and other applications of satellite technology, sustained multiple use of forest resources, and research on the marine environment. One area of universal concern to the professional societies appears under "information sharing" in General Initiatives.

Societies and Governments.

Thus far in this paper we have confined our attention to the so-called "NGO's" - the Non-Government Organizations - which comprise the national professional societies and academies and international organizations not part of governments. But in the last analysis the levers of power and influence

in the world of development are moved not by NGO's but by governments. In the international sphere, governments operate by treaty agreements through IGOs, the International Government Organizations of which the centerpiece in the World today is the United Nations.

Professional societies cannot take their proper place in the development process without understanding governmental organizations and participating in their programs. One mechanism for such contact now exists in the National Commissions for UNESCO, groups of citizens and representatives of NGO's in the nations taking part in UNESCO's work. The U.S. National Commission for UNESCO was established by Congress. Its Commissioners come from many walks of life, including Senators and Congressmen and public figures in state and municipal office. More than half the membership of the Commission consists of representatives of some sixty NGO's from nearly every field of education, science, culture and communication within UNESCO's charter. Among the societies and academies currently represented are the AAAS, the American Society for Engineering Education, The National Academies and National Research Council, the American Academy of Arts and Sciences, the Social Science Research Council, the American Sociological Association, the American Institute of Biological Sciences and the American Geological Institute.

The Commission's major activity in support of science is Man and the Biosphere (MAB), a UNESCO program for which it provides the U.S.A. staff and through which substantial funding for U.S. participation has been obtained from such agencies as the Department of the Interior and the Forestry Service. The MAB program links together on a worldwide basis the environmental concerns of the UNESCO member nations, developed and developing,

and attempts to devise cooperative action based on sound scientific and technical methods of measurement and treatment. MAB has a wide constituency and a good press, almost uniquely today in the striving rhetoric that surrounds so much of the work of the United Nations and its specialized agencies. Other aspects of UNESCO's scientific program are reviewed regularly in cooperation with the Commission by the Academies' BIOP Committee on the UNESCO Science Program.

The ad hoc approach is also available for direct contact with the responsible American government agencies, such as the Agency for International Development (AID) through which the majority of U.S. development funding is channeled and, perhaps in the near future, through the proposed new Institute for Technological Cooperation (ISTC) in legislation now being debated by Congress. The ISTC would take over from AID the research and development and international collaborative planning functions. If legislated into being, it should be a key operation in the post-UNCSTD responses of the United States. If so, it should soon thereafter begin a dialog with the societies for their contributions in supplying information and expertise in particular development areas.

Another example of the ad hoc approach occured in June 1975 when a Conference of U.S. Professional Associations was sponsored by the Department of State in conjunction with Meridian House International. Held in the Acaiemy of Sciences auditorium, its theme (developed in four workshops) was "The Role of Professional Associations in an Interdependent World."

The record of this State Department Conference is now out of print, but a photocopy can be obtained with the cooperation of the staff of the NRC Commission on International Relations. It makes interesting reading. One particular paper by Dr. Roger Revelle is an absolute must for any professional society officer or staff director considering his society's obligations in the world of international development. Dr. Revelle's speech is entitled "Ten Commandments for International Cooperation by Professional Associations".

Societies and the Corridors of Power.

Professional societies in science and engineering in the United States have had a tradition, based primarily on tax law, of keeping at arms length with government - in the passage of legislation and election of public officials in particular and in all areas of political strife in general. This scene is slowly changing. The larger engineering societies have staffed offices in Washington to keep tabs on Congress, the Administration and the Federal Agencies - a new attempt to know about and influence the national government. This is a first step, of course, in achieving an effective presence in the government's efforts in support of Third World development.

While these changes are occurring it is still true that the great majority of the world of engineering and science - both the practitioners and their societies - is far from the center of the government scene. This fact led Professor Myron Tribus of M.I.T. to write in the pages of Mechanical Engineering (April, 1976, pages 24-28) a paper entitled "Along the Corridors of Power - Where Are the Engineers?". He points out that there are more engineers than lawyers in America, but that the legislative branch is overwhelmingly peopled by lawyers, that in the regulatory commis-

sions having a technical responsibility there are few technically or scientifically trained chairmen or commissioners. Says he,"...the decision makers, scrambling to maintain prestige and power, block the intelligent and unbiased search for the best way to use technology. To help rectify this situation, engineers must join the decision makers. But first they must learn the ABC's of achieving power and unlearn the patterns of thought that keep them from transcending their training" (underlining added). Strong language! It is equally applicable to scientists, including social scientists.

Why Deeper Involvement in Development - and How?

I now turn to the final part of this paper, the future prospects of professional society impact on the development of the Third World. The first question that must be answered is Why? Second, if a convincing reason can be given to the societies, how then are they to proceed?

Why indeed are so few American societies concerned at all with international affairs and fewer still with specific programs to aid the development of the Third World? For that matter, how did those few societies that have such programs become involved in them?

I trust that many of the answers will emerge in the background papers and discussions of this Workshop. ASEE can speak to their program, which now embraces several regional groups of nations concerned with adapting engineering education curricula and methods to their particular needs. In my view, ASEE's program can be explained in a simple phrase: it helped fill a vacuum. Virtually everyone in a position of responsibility in developing nations agrees on the need for trained engineers and scientists, natively trained and natively thereafter employed.

To fill this need at present, there are presently 24,000 foreign students in American engineering schools. But many of these will not take their training home. How much more satisfactory to aim at training science and engineering students in their own countries? ASEE is merely putting to use a tool they have, in a new area of application. The force of practical idealism, plus a genuine concern for the 70 per cent of the World's population in deep poverty, are working here. But above all, ASEE is doing on a broader scale what the society is already equipped to do, adapting it to a new set of conditions.

The same can be said of the work by the American Statistical Society in Latin America. It has long been evident that a developing nation, to meet its own needs in its own way with the help of others, must first know itself, know its resources, its demographic forces and limits, its export and import markets, and a host of other information that is collected and statistically analyzed as a matter of course in the developed nations. The statistical methods are applicable to all nations, but care in the selection and modification of statistical parameters is no less essential in Ghana (to cite a nation that does well) than it is in the United States. So ASA went forth to the developing nations of Latin America to teach, to help set up schools of statistical science, and to study the local scene so that appropriate adaptations of methods could be found and applied.

We have already reviewed the special conditions that give impetus to the civil engineers' interest in the Third World. They too meet the criterion of applying what they know best, to a new set of local conditions, in an effective way that will bring credit and reward to those actually involved on the scene.

But the question of society involvement in development programs is broader than that. The questions of energy supply, food supply, nuclear proliferation, population explosion, and the increasing appearance of terrorist attempts to attain political and economic ends - these tell us all that the World cannot long remain divided on the traditional axes -- rich-poor, north-south, east-west, developed or developing -- without grave peril. Peril to everything that we have or aspire to, whether we are engineers, scientists, other professionals or ordinary citizens.

In earlier days the proposition was put nationally by Benjamin Franklin at the signing of the Declaration of Independence when he said: "We must all hang together, or assuredly we shall all hang separately." Today that proposition applies internationally. No organization can stand aside from that imperative, least of all the engineers and applied scientists whose knowledge, objectivity, and powerful techniques are so essential.

Most officers and staff executives of the large professional societies will not challenge this outlook nor debate the need. What they often do say is that they have resources, and member support, for pursuing only the leading edges of their respective sciences and technologies. Advanced science and advanced engineering, not diluted for application by the developing nations, is their dish of tea.

No one will question that the whole World must have the best and most advanced science and engineering it can get, if civilization is to survive. But it must also have international equity, pride and purpose, if civilization is to survive. To see that the Third World gets the methods, the wherewithal, the technical know-how and all the other sine qua

nons of an improved standard of living is a task that cannot and must not be ignored by the societies we are addressing here.

But such programs are costly to plan and execute; they require staff support and funds for travel. Many societies cannot assume much if any of the additional financial burden. But the outlook is changing today. Increasingly tomorrow - post-UNCSTD - external support of worthwhile professional society initiatives will be easier to find.

From the beginning, a careful distinction must be made between the present-day centralized, capital-intensive technology of, say, electric power generation and the corresponding low-capital decentralized systems needed for the rural poor. I chose electric power as an example because a high-technology method of decentralized power supply called "cogeneration" is opening some new doors (and some old eyes!) in the United States. In cogeneration a single office building may generate all its own power in a backed-up generator system it owns. The heat produced by the generator is used to heat and cool the building. Economy of energy consumption results, but two stresses appear at once: who is to pay the capital charges on the cables and transmission - line capacity no longer used by such installations and how can a multiplicity of separately discharging generator stacks be arranged to meet pollution standards. Neither question need rise in the rural areas of the developing nations.

Such applicable advanced technology may be comparatively rare. The main task of the science and engineering societies of the developed world may well be adapting older technologies (e.g. local treatment vs. piping for sewage) or extending established techniques to new conditions of use. This is an extra effort, which must be accommodated without in-

terference to the more advanced conferences, publications and other activities that are the societies' life blood. The balancing of advanced and applicable programs on either shoulder has been managed by several societies without pain and with much reward. Their example can be followed by many more.

It is my conviction that the question of involvement in development programs will be answered in the affirmative by many more societies. The reasons may take many forms. One is the appearance of strong leadership. Dean Hoelscher, before he took the presidency of the American University at Beirut (and since), has been one such leader in engineering education. Or the reason may simply be the established interests of members who get personal satisfaction and livelihood from solving, or assisting to solve, the particular technological rebus that, when solved, meets some of a nation's previously unsatisfied needs.

Along the way to this greater involvement will arise trials and tribulations. There is a body of informed opinion that excepts UNCSTD will have more than its share of political rhetoric and national name-calling, the effect of which may well be to "turn off" the enthusiasm of many professional society leaders. But that will not change the need. Moreover, international science and engineering are not without their own resources.

Last March in Singapore, a Symposium, the largest assemblage on international NGOs ever convened, met under the chairmanship of Dr. Thomas Malone, Foreign Secretary of the National Academy of Sciences. Present were delegations from WFEO, ICSU and many other organizations. This symposium confirmed that four levels of international cooperative scientific and technical activity were planned: a network of institutes

in developing countries, where problems could be identified from their point of view; a switching mechanism in the nongovernmental sector to link developing country problems with the resources of talent (the societies included) in the industrialized nations; a proliferation and confederation of donor institutions like Canada's IDRC; and a revitalization of the UN system for the application of science and technology to development, with more active relationship to the NGO's.

If Yes, then How?

If, as I am convinced, many more professional societies will soon elect a more active role in international development, how shall they proceed? I suggest that three approaches are open: In the first, one waits until called upon by one of the established government agencies or by the academies, to take part into a project requiring the particular depth of expertise available through the society in question. While waiting, the officers, and staff of the society should familiarize themselves with the documents mentioned in this paper, particularly the Stever Report and the BOSTID nine-year summary.

There is no time nor energy available for re-inventing the wheel in this business. The obvious application of what a society knows best is all too often not what is best for the developing countries (e.g. civil engineers and piped sewage).

This first approach has the disadvantage of being too passive to provide the public image of global concern that many societies are now striving to present. But, considering how many societies there are that are completely new to the international sphere, it has much to recommend it.

In the second approach, more particularly applicable to those societies that already have an active high-science or high-technology international program in place, is to actively seek a part in the

established development programs of AID, IFTC (if and when established), the UNESCO Commission, BOSTID, WFEO and ICSU/COSTED. The Office of International Services of AAAS has the names, addressees and telephone numbers of the staff directors of each of these agencies; through them contact can be made with the chairman and members of agencies and boards.

Such an approach can express general interest and desire to participate, but it is much more telling if it offers a specific attack on a specific problem facing the agency in question. It must be remembered that the Academies and their staffs, in particular, already have their own channels of access to the staff and membership of each society. What they need is not mere access, but activity that only the society can provide or that only the society has had the wit and energy to plan and propose.

The third approach is to become active at once without waiting on others. The examples of the engineering educators (ASEE) and the statisticians (ASA) mentioned above are to the point. The society officers and staff ask themselves, "What is that we know best that, modified to meet local conditions, can be of immediate use to the Third World?" In the fields of energy, food supply, industrialization, urbanization, health, management of resources, information sharing (each with detailed analysis in the Stever Report) there are dozens of opportunities that professional societies can seize upon in such an effort. Granted, they cannot do so without spending money for staff, travel, and organizational follow-through. The question of where that money will come from is a key issue to be debated in this Workshop.

The special role of societies in the use of proprietary information.

One of the other background papers for this Workshop deals with the problem of the Third World's need for proprietary information. This is

an issue that will be central to much of the discussion at UNCSTD, and it is one in which the professional societies of science and engineering have a particularly important role to play.

Perhaps no label is more mis-applied than "proprietary" to the store of scientific and technical information. In rapidly advancing fields such as electronics and aerospace, the proprietary information vital to its owner's interests last year is open information this year, but no one has bothered to change the label. Moreover, the protection of proprietor's rights by patents is by no means universal. Patented devices and processes are free to be used in countries where no patent protection has been applied for, which is the case in the great majority of developing countries. In any event patents teach only the general principles of the inventions they cover, not the detailed know-how of putting the principles to practice in the laboratory or the manufacturing plant.

Here the role of the societies is one that neither government agencies nor the academies are so well qualified to fill. The "proprietary" status of current information is best known to practitioners actively using the information in their daily work; the chances are better than one in two that each such practitioner is a member of a professional society. Using the normal channels of communications within that society, substantial knowledge can be gained as to the actual availability of requested information, as contrasted to its nominal unavailability under proprietary conditions.

No one who understands the nature of human enterprise will base a plan for the use of information on the assumption that an employee will knowingly jeopardize the proprietary interests of his employer (and

particularly so if he is self-employed). But by the same token, the employee will be most interested in finding new uses for information that, in high science or high technology, has outlived its initial utility, i.e. is no longer so valuable to its owner as it once was. The decrease in value does not imply that no return will be asked for its use, but it does imply that the return, via licensing or other means, will be more modestly priced.

I conclude with the observation that use of expert knowledge and plans in the Third World is subject to many impediments, but proprietary interest is not a major impediment. The principal need, within the developing countries, is not formal knowledge, which is available in abundance. It is know-how, the local adaptations and adjustments that put the available knowledge to use, where, when and how it is needed. The people of the developed nations best fitted to assist the Third World to develop that know-how are not the eminent leaders. They are the "working members of the profession" that constitute the membership-in-depth of the societies. How to organize that resource, stimulate it to action, and support it with adequate funds--these are the questions that must be faced and answered before the societies can meet in full the challenge of the development needs of the World.

APPENDIX E

Introductory Statement Prepared

by Franklin P. Huddle

for the Working Group on

Scientific and Technological Information

By way of preliminary entry into the subject of international transfer of scientific and technological information, I refer you to the Eleventh Chapter of Genesis describing the building of the Tower of Babel. Verse Six of that chapter says: "And the Lord said: Behold, the people is one, and they have all one language; and this they imagined to do." Translated into modern terms, the statement can be interpretated to mean that a human society that has learned the practice of cooperation and the arts and skills of communication can make significant progress toward any reasonable social or technical goal.

Next, consider the format for international transfer of science and technology proposed by Francis Bacon in his New Atlantis. He writes as follows:

"We have twelve that sail into foreign countries...who bring us the books and abstracts, and patterns of experiments (from abroad). "We have three that collect the experiments which are in all books." "We have three that collect the experiments of all mechanical arts, and also of liberal sciences, and also of practices which are not brought into arts." We have three that try new experiments, such as themselves think good." "We have three that draw the experiments of the former four into titles and tables..." "We have three...looking into the experime of their fellows to draw out of them things of use and practice for man's life and knowledge...". "Lastly, we have circuits or visits of divers principal cities (of our own country) where...we do (make known) such new profitable inventions as we think good."

Over the years I have had quite a good deal to do with the design and operation of institutions to manage technical information about materials. In the course of this experience I have heard a great deal said about "user surveys" to provide design criteria in setting up such centers. I have even been responsible for several surveys myself.

The wisdom that comes out of such surveys can be epitomized in one short sentence: Users use information centers. Or, to put it another way: Information centers are used by users.

In the management of information its various forms need to be recognized, because these appear at different points in the management process, and are differently handled. I suggest that at least six different forms of information need to be distinguished:

(1) Documents. These are reports and publications, the so-called "hard-copy" reproduction of the author's words.

(2) Data. These are tabulations and enumerations, quantitatively expressed.

(3) Facts. These are the core of the matter - the pure "information" without the trappings, ready to be absorbed into the body of knowledge - the new - what the abstract of a report should contain.

(4) Evaluations. These are the evaluation or analysis of data or facts by a qualified expert.

(5) Reviews. These incorporate bodies of related sets of facts and evaluations.

(6) Handbooks. These incorporate the information consolidated in reviews, along with previously established knowledge in more permanent and systematic form.

A major fraction of the total content of useful information consists of facts about technology, and particularly that part of technology that involves the management and manipulation of resources, chiefly materials, for social purposes. In developed countries, the problem is one of achieving a stable economic balance as fewer and fewer members of the working population are involved in the actual handling of materials. At the same time, developed countries are able to afford to maintain a larger fraction of their populations in educational institutions and in scientific research institutions.

On the other hand, in developing countries, a measure of progress i the increases in total value in monetary terms that can be produced from resources produced locally, so as to narrow the difference between the unit value of imports and exports.

In both developed and developing countries, the problem is essentially a technological one; and the application of the skills to achieve their respective goals is essentially the problem of acquiring and applying information. However, the developed countries have according to this model - proportionately fewer users of information and more discoverers of information; while the developing countries have proportionately more users, especially new users, and fewer discoverers. Accordingly, organized information management in developed countries would seem to be likely to emphasize the needs of discoverers, while in the developing countries the emphasis would logically be on the needs of users. It would also be logical to suppose that in a developing country the highest priority should go to the management of immediately useful technology, and then to incremental refinements and enlarged scope of technology, and to the teaching broadly of the basic sciences of physics, chemistry, and biology.

The point to remember is that technology is the exclusive province of no nation. It is possible for every country to learn from every other country. One of the values of the special science and technology of information management is that it offers a way to facilitate the total flow of useful information from those who have it to those who need it.

In practice, the barriers to this flow are mostly the common-sense ones: problems with languages, the mails, locating knowledgeable people in other countries, finding the money to pay for subscription to foreign journals, and more important, meeting the costs of subscriptions to such major sources of consolidated information as Chem Abstracts and the metals abstracts.

One way the developing countries can remove these barriers is by selectively identifying those technological areas of greatest concern, and establishing their own technical evaluation centers to assure access to the world's knowledge store in such areas of concern. From the start, however, the intent should be to facilitate a two-way information flow. Information should be gathered not only from abroad but also from workers in the field within the developing country itself; and it should be supplied not only within the country, but also to foreign users. By making itself a part of the global network of information exchange, the new center can help to maintain its own bonafides, trade knowledge for knowledge, establish the reputation of its country's engineering technologists and scholars, and perhaps even draw to itself graduate students and postdoctoral fellows interested in carving careers for themselves in a new and challenging environment. By selecting areas of technical concern of local importance the center can develop a valid claim for support from government and local industry. By demonstrating the consequences of its work, in terms of knowledge and technical prestige, the center can support its own further development and justify its further claims for support at home. By its demonstration of technical excellence, it can also win financial support from other countries

subscribing to its services, as well as providing the basis for personnel exchanges and resident scholars.

Consider, then, what the model of a two-way flow of technical information between a developed and a developing country should look like: It should consist of users, information services, information holdings, and some sort of coordinating institution to bring about adaptive changes in national information service. Each of these has its own needs. Thus, users need to know what existing information services can do; they need ready access to information at any point in the system; they need answers to direct questions; and they need "information analyses and syntheses in relatively narrow but critical areas."

The services need to know user needs; they need to have gaps in service capabilities identified and linkages among individual services strengthened; they need to know the capabilities of other services; and "the system as a whole needs professional capability for analyzing, synthesizing, and refining its information holdings and for providing users with specific information upon request."

The information holdings need to be purged and modernized; hard-copy and resume are needed; a master reference file to data collections should be established; and services should be able to transfer and convert machine-readable records and data elements to each other without information loss.

The coordinating group needs to know the problems of both users and services; it needs liaison with national and international organizations; it needs to promote applied information sciences; and it needs a factual basis for determining gaps, redundancies, and deficiencies in the scopes, coverages, and linkages of existing services.

In addressing the question of costs of information services, and who should pay them, there are a number of different theories. For example:

One theory of information systems is based on the expectation that the proper use of technical information justifies basic and applied research investment by converting it into a taxable technological property in the hands of the entrepreneur.

Another theory is that since the public has invested in government-supported research and development and since the results of applying the fruits of R&D are publicly beneficial, the dissemination of technical information should be treated as a free public service (like the public library).

Another theory is that because information is so unmistakably of economic value to the entrepreneur, the costs of delivering it to all users should be defrayed by the users.

Another theory is that user charges are difficult to impose because the request must precede receipt of the information, but its utility cannot be determined until after it is received so that the user can't see what he's paying for.

A number of problems can be identified in the international transfer of technical information. I have already mentioned the problem of language barrier which is certainly one of the most serious obstacles to international flow of technical knowledge.

Another is the sheer volume of the literature in which the knowledge appears. According to one source, these were 120 million pages of scientific information published in 100,000 journals in 1970,

the rate or volume doubled every 8.5 years, with professionals wasting 30 percent of their time searching for needed information not readily at hand, and spending a quarter of their time keeping up to date on information in their own fields.

Another problem is the time lag from the point of information generation to the point of publication.

The problem of paying for the management, accessibility, and dissemination of information is another serious matter.

Then, too, information services tend to catalog information in terms of the generator, rather than the user.

Literary quality of technical articles is a persistent problem.

Other problems to be mentioned include the quality of entries in data banks and abstract collections, the need for periodical purging of obsolete or dated items, the problem of completeness of both facts and bodies of knowledge, the problem of winning the voluntary cooperation of institutions and agencies in reporting research in progress as well as research results, and the problem of integrating information into review articles and handbooks as it stands the test of time.

Clearly, when technical information is needed as an input in the process of formulating national policy in science and technology it needs to be combined with social, economic, and political information in a system designed specifically for the purpose, instead of being packaged in a discipline-oriented system designed by technical specialists in one discipline to be used by other technical specialists in the same discipline.

This workshop is presented with a great many questions. Not all of them, I am sure, can be answered here. However, a useful purpose will be served in enumerating them for future consideration.

They are, without any pretense of completeness, as follows:

1. What technical information should be available to users?
2. Is it possible to approach on a systematic basis the problem of consolidating and codifying data and information?
3. How can this body of knowledge be structured for storage, analysis, and access for retrieval to be more efficiently responsive to established consumer needs?
4. What methods of information management could ensure the international compatibility and exchange of technological information?
5. What first steps would be most cost/effective toward a global system for technical information management?
6. What would be a reasonable and feasible set of long-range goals for such information management?
7. Where should the initiative be located for a positive program in this field?
8. Who should pay the costs of information management?
9. How can the social and economic value of information services be demonstrated?
10. How can the computer be sensibly incorporated in our information systems?
11. How can the information contents of individual papers or deposited units be increased without reducing information content?

12. How can the information storage bank be purged of obsoletes?

Let me conclude this introductory statement by noting that the primary burden of effort in the transmission of technical information is on the receiver. It is easier to send information than to receive it. Also, the transfer of technology cannot be pushed--it has to be pulled.

There is also great danger when the information receiver asks the wrong question. And great potential cost to the user can result from such mishaps are:

--the receipt and engineering application of incorrect information;

--the misuse of information owing to failure to learn its special constraints;

--belated recognition of uncertainties resulting in delay and inaction;

--insistence on great redundancy to overcome insecurity caused by previous mistakes; and

--difficulties in sorting out or evaluating conflicting data from competing information systems of differing quality.

Let me start the discussion by reminding you of the peculiar quality of information as an article of commerce. When two parties exchange items of equal value, the sum of their values is the same before and after the exchange. But when two people exchange facts, information, or technology, the sum of their values doubles. That is to say, each party has two pieces of information, four in all. This principle justifies the formation of technical societies in the

United States. In view of the further circumstances that virtually every country can learn from the technology of every other country, it seems reasonable to propose that ways should be found to enlarge the scope of operation of the various technical societies, and their information exchanges, to international--indeed global extent. The ultimate question to be addressed here is how to go about doing this.

APPENDIX F

THE ORGANIZATIONAL NEED: AN INSTITUTIONAL TRIUMVIRATE

To Structure and Offer Relevant
Engineering Education at U.S. Universities
For International Students.

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May 11, 1979

THE ORGANIZATIONAL NEED: AN INSTITUTIONAL TRIUMVIRATE.

I. EVOLVING TRENDS

International students enrolled at U.S. Universities and Colleges are fast becoming a significant minority group within the U.S. student population. Over 235,000 international students were enrolled at U.S. Universities for the 1977-78 academic year; and projections are that this number will most definitely increase, and increase significantly.

> "The Saudi Arabians will continue to send more students to this country. The present emphasis is at the undergraduate level but there is every indication that many will remain on for graduate programs. Futhermore, Saudi Arabia itself will soon be graduating a good number of undergraduate students and they will be seeking graduate training in the United States. The Nigerian need for trained manpower continues, and the capacity for that training at home is limited. There is every indication that the numbers will continue to rise. Other countries such as Brazil and Indonesia have both shown significant growth in the last few years. A newest country to enter international education at the end of this decade is China. By the spring of 1979 these exchanges will be well underway and there is every indication that the numbers will be very large."*

* Trends in International Student Admissions - Needs and Responses - Ms. Cassandra A. Pyle, Institute of International Education; Proceedings College-Industry-Education Conference, February 1979.

12 percent of undergraduate engineering degrees and 27 percent of doctoral engineering degrees awarded by U.S. Universities were for international students. Among other findings of the Institute of International Education's survey** of U.S. Colleges and Universities in 1977-78 are:

- Members of the Organization of Petroleum Exporting Countries accounted for 31.2 percent of all foreign students in the U.S.;
- Engineering and Business continued to attract the largest numbers and proportions of foreign students. Students in engineering made up 28.8 percent of all foreign students;
- 80 percent of the foreign students were supported by their own families, their home governments or private agencies in their home countries, rather than by the U.S. government or American Colleges and Universities; and
- U.S. government support for foreign students had fallen by about 50 percent.

II. THE DILEMMA FACING U.S. UNIVERSITIES

The International student demand for higher education is occurring at a period when U.S. Universities are experiencing financial difficulties. The lean years facing many U.S. Universities are marked by no growth, retrenchment, declining enrollments, oversupply of staff members, underutilized facilities, costs far exceeding income and an increased demand for accountability. The contagious Proposition 13 mania has spread to haunt institutions of higher learning as well. The Bakke decision may force universities to become unduly cautious about admitting international students to special educational programs structured to meet the needs of developing nations.

** OPEN DOORS/1977-78, Institute of International Education, New York.

Under such a state of uncertainty, it is unlikely that U.S. Universities will respond positively to the rising demand from international students. On the other hand, engineering education might be the least controversial and easily exportable commodity we have to offer the international community. It may be more readily exportable than our political system, our economic structure or our sophisticated technology. From the University's standpoint, involvement in international education can be viewed as a source of income, rather than a drain on university resources.

To organize and respond effectively to the evolving trends in international engineering education, a joint effort is required. The participants in this joint effort should include the U.S. government, a select group of U.S. Universities, and U.S. industries engaged in international programs. The three entities should become active partners in the joint venture. Without the full participation and cooperation of each member of the TRIUMVIRATE, it will be difficult for the U.S. to plan and offer a marketable educational package designed to meet the needs of the international community. The commitment from each member of the TRIUMVIRATE should be firm and continue over a minimum period of ten years. After that period, it would be necessary to evaluate the program with inputs from the international participants. This does not imply that there would be no change in the program as originally conceived. In fact, there should be ongoing assessments and modifications of the program based on regular inputs to feedback mechanisms.

III. THE MARKETABLE ENGINEERING EDUCATIONAL PACKAGE

a) CURRICULUM

At present, there is concern that the engineering educational program for international students may not be "relevant and appropriate"

for meeting the needs of emerging nations. If a specially organized engineering degree program for international students is structured, such a program may be too restrictive and viewed as "second class" education by the international community.

The undergraduate engineering curriculum in the U.S. is aimed at providing a firm understanding of the basics in science and engineering principles so that a student can appropriately apply the scientific fundamentals and problem solving methodology to problems that may arise in his/her field of interest. I submit that a firm grasp of the fundamentals together with the techniques and approaches to analyzing and solving engineering problems is needed for all students whether the student practices the engineering profession in the U.S. or abroad. At the graduate level, however, there needs to be some flexibility in the educational program.

The flexibility recommended in the graduate program would permit an international student to conduct research on a topic relevant to his native country and to utilize the research towards his/her masters (or Ph.D.) degree. Such a flexibility already exists in some Professional Masters Degree Programs at U.S. Universities. The advantage of such a program is that:

- it allows the student to conduct research on a topic of relevance to his/her home country;
- it provides the student with the opportunity to demonstrate his/her competence to officials in the student's home country and thus find a suitable placement consistent with the student's training and interest;

- o it permits a professor from a university in the home country to serve as the student's research advisor in the field. The host country advisor may also serve on the student's thesis committee thereby strengthening linkages between the U.S. and foreign engineering institutions.

At the graduate and undergraduate levels, there is need for sound counseling by an informed group of faculty members. The counselors should be aware of the developmental plans and problems in each student's native country. If a graduate student is determined to pursue an educational program that is highly specialized and of little immediate relevance to the needs of his/her home country, then the student should be advised of the potential problem of finding employment in his/her native country, and the likelihood of the student becoming a brain drain candidate.

III. (b) THE JOB-RELATED TRAINING PROGRAM

A common deficiency in the background of an international engineering student is the lack of exposure to engineering field experience and to the use of a wide range of engineering tools and methods. Engineering students at the undergraduate and graduate levels may not have had the opportunity to work with a wide array of tools, to tinker in a basement workshop, to assist in a family home building project, or to build models and enter science contests at schoools. It is impossible to correct for the absence of gradual engineering exposure during the formative years by a massive dose of practical training at the college level. Yet some engineering training program is necessary that will provide the students with an understanding of engineering field experience, engineering management practices, and a recognition of the dignity of manual labor.

The marketable educational package refers to engineering educational program at the undergraduate level with minor changes in existing curriculum. At the graduate level there should be some flexibility in thesis research effort. The package should include a training component that provides exposure to engineering field experience and engineering management.

Some U.S. Engineering Colleges that participate in Cooperative Program with U.S. Industries, have successfully organized and conducted training programs for U.S. engineering students. What is needed for the international engineering students is a similar cooperation from a group of U.S. Industries, Research Institutes, Experimental Stations, etc. that have active programs aborad. An International Cooperative Program in the U.S. for a year will provide the international students with the missing link in their total educational experience.

Undoubtedly, it will be beneficial for U.S. industries to link with U.S. educational institutions to organize and offer such a training program. It can provide U.S. industries with promising trainees for future employment in their overseas operations. Host governments that are deciding on contracts for engineering work, might look favorably at U.S. industries, construction firms and research institutions that participate in the training programs for international students.

III. (c) THE PROBLEMS WITH IMPLEMENTING THE TOTAL PROGRAM

There is a problem in offering such an engineering educational package. The international students receiving such training might likely become a brain drain from the developing country. The brain drain problem is a burning issue and is on the agenda for the 1979 UN Conference

on Science and Technology for Development (UNCSTD). The Program of Action*-prepared by the UN Conference Secretariat-reflects the concerns of some 105 UN member countries that prepared National Papers for UNCSTD. According to the Program of Action:

> ".....Make a thorough evaluation at the national level of the "brain drain" problem with a view to identifying measures for stemming and reversing the emigration of skilled manpower; and to this effect provide due social status to scientists and technologists...."

Another problem is that U.S. immigration laws and visa classifications make it difficult for international students to participate in such a training program. U.S. visa classifications need to be modified to permit international students to benefit from such a training program. Also, before a host government agrees to sponsor a student to this integrated educational program, there must be a clear understanding between the student, the host government, and the U.S. government that the student will return to his/her native land on completion of the educational package in the U.S. Such clearly drawn contracts will help control the brain drain of international students participating in this program.

IV. FUNDING

To organize and put together such a marketable engineering educational program comprising engineering education and job related training, it will be necessary for funds to be made available to U.S. universities and industries. There should be an incentive and reward system built into the program so that U.S. universities and industries that participate in the joint venture will find it attractive to complete for inclusion in the program.

* Preliminary Programme of Action: Note by the Secretary General on UN Conference on Science and Technology for Development. Dated March 1, 1979.

As a start, maybe 3 to 5 Centers in the U.S. should be created where different types of engineering educational packages can be offered. The program at each Center will be publicized and fully paid participants sought. Sustained financial support from a U.S. Government Agency will be necessary for a 10 year period to develop the program into an attractive and marketable export product. Beyond that period, the program should become self-supporting.

V. RESPECTIVE ROLE OF TRIUMVIRATE MEMBERS

(a) U.S. UNIVERSITIES

- Review liberal and natural/social science elective courses in undergraduate engineering curriculum at U.S. universities (presently 10 such courses are required for ECPD accreditation) to recommend a liberal course program that will be appropriate for international students.
- Structure a flexible graduate program that will enable international students (masters or doctoral candidates) to conduct their thesis research in their respective countries; and to explore opportunities for faculty members from host educational institutions to serve as thesis research advisors to these students. A parallel counseling program is vital to the success of the program.
- Interact with a select and interested group of U.S. institutions that have programs abroad to structure the training component of the engineering educational package. The list of U.S. institutions should represent the breadth of engineering activities appropriate to developing countries - industries,

construction firms, consulting engineering firms, management organizations, research institutions, etc. It might be appropriate to include some of the U.S. government institutions such as Experimental Stations, Bureau of Standards, etc.

- Devise mechanisms for selecting institutions for training in international students.

- Monitor the training program with representatives from the U.S. training institutions. Ground rules for gaging successful performance in the training program should be established and administered.

- Manage the educational and training components of the engineering package. Feedback mechanisms that provide justification for modifying the program should be instituted.

- Administer the entire program which includes financial aspects of the project, preparation of annual reports and a complete review of the project after 10 years.

V. (b) U.S. TRAINING INSTITUTIONS

- Participate with U.S. educational institutions in a coordinated training program for international students; identify supervisors who will oversee the training and evaluate the progress of participants.

- Prepare outline for and cost of training program; also establish minimum number of trainees consistent with facilities available at institutions, the length of training program, accommodation for trainees, etc.

- Cooperate in preparing the annual reports and the final evaluation of the project.

V. (c) U.S. GOVERNMENT AGENCY

- Assist in suitably modifying visa classifications that will permit students to complete the education and training programs without violating immigration rules.
- Assure that participants will return to their native countries on completion of the program.
- Furnish start-up funds and a ten year grant so that the program can quickly take roots and become self-sustaining as early as possible; and definitely before the ten year period.
- Engage in government to government promotional efforts that will provide fully paid students to the program. However, the U.S. educational institutions will decide on whether or not to admit a particular student to a program.
- Feed inputs from USAID field programs that define the type of engineering needs in particular developing countries. This information will be valuable to structure "add-on" programs if needed.
- Participate in establishing mechanisms for collecting fees, living expenses, etc. for students sponsored by foreign governments, foreign institutions, etc.
- Cooperate in annual evaluations and the final assessment of the project.

VI. CONCLUSION

The demand for appropriate engineering education for international students is rising steadily and the number of international students seeking admission to U.S. Universities is increasing significantly. A TRIUMVIRATE comprising U.S. Universities, U.S. Industries, and U.S. Government Agencies

can structure and offer the best marketable engineering educational package to meet the demand. The sooner the programmatic and organizational needs are recognized, the earlier can the U.S. respond positively to the rising demand. Such a response can be beneficial to each member of the TRIUMVIRATE and appropriate to the needs of the international student community. By creating the TRIUMVIRATE, the U.S. can demonstrate its commitment to helping developing nations generate the type of technical and professional manpower needed in developing nations.

APPENDIX G

AAAS CONSORTIUM OF AFFILIATES FOR INTERNATIONAL PROGRAMS

The AAAS Consortium of Affiliates for International Programs was formed in 1976 to facilitate communication among professional scientific societies who have expressed interest in international aspects of their disciplines; to stimulate joint programmatic activities and cooperative programs through establishment of a broadbased multidisciplinary network of associations; and to raise the concerns of professional associations regarding international science policies and priorities. Currently 79 AAAS affiliates have nominated representatives to the Consortium. The objectives of the Consortium are to:

1) facilitate the flow of information among Consortium members about international concerns and programs of common interest;
2) encourage cooperation and coordination among members on on-going projects;
3) encourage new and/or expanded international science activities by Consortium members.

The Consortium Notes is a newssheet prepared by the AAAS Office of International Science, serving as Secretariat for the Consortium, and distributed periodically to all affiliate representatives to the consortium. Its purpose is to present information on the international activities of AAAS and the Consortium members, on government agencies and other institutions' international programs, briefs on future international meetings, recent publications etc.

Activities so far have included arranging seminars for formal exchange of information; luncheons and individual meetings with Consortium representatives for informal exchange of information.

I. Information Activities

Seminars: Consortium members participated in several problem-oriented seminars organized by the AAAS Office of International Science (OIS). These included: Defining Federal Organization for International Science and Technology, International Science Education Programs, Non-Governmental Organizatic (NGO) Initiatives Related to the U.N. Conference on Science and Technology for Development, and the symposium on Informatics for Development. In 1978, a small subset of the Consortium held a workshop to study the relationship between ethnic groups, poverty and their resource base in Kenya and Tanzania.

Informal Information Exchange: Affiliate representatives attend No-Host luncheons organized by OIS for administrators in U.S. agencies concerned with the scientific and technological components of international development programs. Topics discussed at the luncheons include: New Uses of Advanced Technologies in Developing Countries, Bilateral Scientific Agreements, U.N. Conferences, and Scientific Freedom and Responsibility. In addition, affiliates were invited to attend seminars which AAAS held for science attaches posted to embassies in Washington. These seminars focussed on International Implications of U.S. Food Policy, the programs of the Information Industry Association and the Office of Technology Assessment, and Legislation relating to Research on Recombinant DNA.

II. Workshop on "The Role of Scientific and Engineering Societies in Development"

Consortium representatives participated actively in the early planning of the workshop, and provided an invaluable source of information and advice. It is likely that the Consortium will play a central role in follow-on activities that focus on the role professional societies can play in the development process.

III. Future Plans

The potential for the Consortium to support cooperative programs of Consortium members has been largely unrealized. The array of such activities is broad, including such diverse opportunities as a survey of the international activities of Consortium members (and other scientific and engineering societies) to be compiled and distributed as a Directory of Professional Society Activities in International Science and Technology. The Directory could be distributed to scientific societies, government agencies, and international organization--providing a valuable resource document.

The Consortium could undertake a series of activities aimed at increasing cooperation between scientific societies and U.S. government agencies. Such activities might include increasing participation of affiliates on government advisory panels, cooperation in designing and implementing scientific exchange programs, and increasing scientific and engineering society input concerning implementation of bilateral scientific agreements.

As of May 1979

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APPENDIX H

Summary of some Current Roles of the
AMERICAN SOCIETY OF PLANT PHYSIOLOGISTS
in Information Exchange with other Countries

The American Society of Plant Physiologists has the stated purpose of ---promotion and encouragement of the growth and development of plant physiology as a pure and applied phase of botanical science.

Today it is clear that the Society has evolved into an international organization such that the flow of information on plant physiology is moving worldwide. To give some definite illustrations of the information flow into and out of the Society from other countries, I wish to use the following statements.

30% of the manuscripts published in our journal, PLANT PHYSIOLOGY, originated outside the United States in 1978.

25% of the total membership reside outside the United States.

50% of our PLANT PHYSIOLOGY subscriptions are shipped each month to addresses outside of the United States.

16% of the abstracts published for our 1978 annual meeting originated outside of the United States.

The Society encourages sub-sections in smaller or more convenient geographical regions where a group of interested plant physiologists wish to organize and meet. Until last year we had a Latin American Section of the American Society of Plant Physiologists. Last year they wished to become an independent organization and the American Society of Plant Physiologists encouraged them to do so. Seemingly this example could be followed anywhere in the world.

Just a few statistics about the American Society of Plant Physiologists for reader orientation. Our membership dues and journal subscriptions are separate.

Total Membership:	3343 (May, 1979)
Official Journal:	PLANT PHYSIOLOGY
Total Journal Subscriptions:	5100 (May, 1979)

Submitted by
Clanton C. Black, Jr.
President, American Society of
Plant Physiologists

APPENDIX I

ASIA FOUNDATION PUBLIC SERVICE FELLOWSHIP PROGRAM

The Asia Foundation Public Service Fellowship Program offers young Asians of appropriate professional backgrounds and experience an opportunity to intern in public and private service institutions and agencies anywhere in the United States for a period of 3 to 9 months. The Program provides local agencies with the services of a professional who will be able to contribute to the actual work of the agency and to add a viewpoint deriving from a different cultural background. At the same time, the Program provides these representatives of Asian institutions and agencies with a new dimension of experience which will assist them to meet the needs of their own societies.

The Asia Foundation grants international travel expenses and a stipend to the Fellows, who are carefully chosen on the basis of applications submitted through The Asia Foundation field Representatives in 12 Asian countries. It is expected that they will speak English well enough to function in any agency to which they are assigned.

The United States host agency or organization is expected to provide the planning and supervision which will make the Fellowship a productive and educational experience. The Fellows are expected to contribute by working for and with the agency 30 hours a week, leaving some time for independent and directed study. The Fellows commit themselves to returning to their countries at the end of the internship.

Over thirty-five Fellows from eleven countries have interned in American agencies since October 1972. The fields represented include librarianship, community development and manpower training, law, urban planning, legal aid, junior college administration, public television production and journalism, social work, voluntarism, vocational rehabilitation, and banking.

The Program is administered by The Asia Foundation's home office in San Francisco.

THE ASIA FOUNDATION

PROFESSIONAL GRANT PROGRAMS BY GENERAL AREAS OF FOUNDATION INTEREST

EDUCATION

University Education

Social Sciences

American Political Science Association
American Psychological Association
American Sociological Association

Natural Sciences

American Association for the Advancement of Science
American Geophysical Union
American Institute of Biological Sciences

Secondary and Post-Secondary Education

American Association of Colleges for Teacher Education
American Association of Community and Junior Colleges

Counseling and Testing

American Personnel and Guidance Association
National Association for Foreign Student Affairs

Educational Administration

American Educational Research Association

LAW AND PUBLIC ADMINISTRATION

Legal Education

American Bar Association
Association of American Law Schools

Judicial Administration

American Judicature Society

Research and Publications

American Society of International Law
The Law and Society Association

Government Planning and Administration

American Society for Public Administration
American Society of Planning Officials

Legal Services

National Legal Aid and Defender Association

MANAGEMENT, MANPOWER AND ECONOMIC DEVELOPMENT

Business Management

American Assembly of Collegiate Schools of Business

Research and Publications on Economic Development

American Economic Association
American Statistical Association
Midwest Economic Association
Society for International Development

URBAN AND RURAL COMMUNITY AFFAIRS

Urban Community Affairs

National Conference on Social Welfare

Provincial and Rural Community Development

American Home Economics Association

PUBLICATIONS, LIBRARIES, AND MEDIA

Book Distribution and Libraries

American Library Association
Society of American Archivists

Language Training and Research

Teachers of English to Speakers of Other Languages

Media Training and Research

Association for Educational Communications and Technology
Association for Education in Journalism

REGIONAL COOPERATION FOR ASIAN DEVELOPMENT

Asian Area Studies

Association for Asian Studies
International Studies Association
Japan Society