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FINAL REPORT

THE MAINTENANCE AND REPAIR OF RESEARCH EQUIPMENT IN DEVELOPING COUNTRIES: HOW SCIENTIFIC AND ENGINEERING SOCIETIES CAN CONTRIBUTE

A feasibility study conducted by the

American Association for the Advancement of Science
Office of International Science

May 1989

Financial support for this feasibility study was provided by the U.S. Agency for International Development (USAID), under grant number DPE-5543-G-SS-8057-00. Opinions, findings or recommendations expressed in this Final Report do not necessarily reflect the views of USAID, nor those of AAAS, its Board of Directors or affiliated organizations.

BACKGROUND

In 1988, the American Association for the Advancement of Science (AAAS) initiated a short-term effort to evaluate the feasibility of establishing a program to promote a comprehensive and cost-effective approach to the maintenance and repair of scientific research equipment in developing countries. This joint effort initially involved members of the AAAS Consortium of Affiliates for International Programs (CAIP), a broad-based multidisciplinary network of U.S. scientific and engineering societies with interests in the international dimension of their disciplines. Cooperating were regional scientific and engineering groups in developing countries of Asia, Africa, and Latin America. At the global level, the Continuing Committee on the Role of Scientific and Engineering Societies in Development provided opportunities for exchange of information and for comparison of specific approaches to the problem. Background information on the CAIP and the Continuing Committee are Appendices 1 and 2 respectively.

The first step in the feasibility study was a worldwide survey of selected governmental, non-governmental, and scientific institutions concerning their experience in dealing with the equipment problem. Based on responses to that survey, draft recommendations were developed by U.S. experts at an October 5, 1988 meeting, which was held at the training facility of the Instrument Society of America (ISA) in Raleigh, North Carolina. Appendix 3 contains information on the meeting in Raleigh, including the preliminary report which served as a basis for discussion at the December 5-6, 1988 meeting in Cairo, Egypt of the Continuing Committee on the Role of Scientific and Engineering Societies in Development.

At the December 1988 Continuing Committee meeting, the major agenda item was the equipment maintenance and repair issue. Participants from research institutions, donor organizations, disciplinary societies, and governmental agencies reported on their experience in dealing with the problem and the track record of programs initiated to address it. Participants, as listed in Appendix 4, critiqued the draft recommendations from the October meeting in Raleigh, and contributed to the development of a plan of action for addressing the equipment problem. This report covers the deliberations at the Cairo meeting and outlines next steps recommended to be taken.

Discussion by participants in the Cairo meeting on December 5 is grouped in three general categories which:

- characterize the problem, both quantitatively and qualitatively;
- survey potential solutions, comparing successes and failures;
- identify desirable next steps to be taken.

CHARACTERIZING THE PROBLEM

1. Quantitative Characteristics

A substantial number of studies of the equipment maintenance and repair problem has been conducted by academic institutions, disciplinary societies, international organizations, and donor agencies. The results of these efforts have already revealed some quantitative characteristics of the problem, e.g., the types of equipment involved, the percentage functioning properly, how many technicians are at each institution, and the number of trainers available. Among the studies cited by participants were:

- A survey of 25 anglophone member universities by the Association of African Universities was scheduled for completion in February 1989.
- In December 1988, the Chinese Academy of Medical Sciences (CAMS) completed a survey of eight major Chinese medical schools.
- Two surveys, conducted jointly by the International Foundation for Science (IFS) and the Swedish Agency for Research Cooperation with Developing Countries (SAREC), were completed in December 1988, involving IFS grantees in developing countries and research institutions in general.
- In 1984, a survey was carried out in Egypt by the U.S. National Institutes of Health.
- A study is nearing completion by the World Health Organization (WHO) concerning African equipment centers, particularly in Zimbabwe.
- A review of the problem in Vietnam was conducted in 1987-88 by the Instruments Measuring and Technique Service (MMSZ) of Hungary.
- A 1987-88 study, conducted by ENVIRON, a West German "Society for Technology, Economics and Politics," focussed on East Africa.

The results of these studies can be helpful in identifying which areas need to be addressed most urgently.

2. Qualitative Characteristics

Participants noted the following as examples of qualitative issues which contribute to the equipment problem:

- There is insufficient information flow among technicians, public servants, government officials, and university administrators. Communication between the equipment user (scientific researcher) and the technician is also often inadequate.
- Technicians can see no upward mobility in a career path, and often receive low salaries.

- The status of technicians is also often perceived to be low. This lack of prestige discourages many from entering the field and reduces the effectiveness of those in it.

- In addition to the lack of fundamental training in equipment maintenance and repair, there is a lack of continuing education for experts to keep abreast of recent developments in instrumentation.

- Purchase may not be the best way of acquiring equipment. Equipment could be rented, or shared, provided there were a registry or coordinating mechanism for such arrangements.

- User input in equipment design would help assure appropriate equipment.

- Most research institutions suffer from a lack of spare parts and comprehensive documentation, including operating manuals and manufacturers' catalogues.

- The suppliers generally have more influence than recipients in the equipment procurement process, and are not always responsive to user needs.

- Purchasers suffer from a lack of advice from suppliers, other users and disciplinary experts, both at home and abroad. They often purchase the equipment sight unseen, and without information about the equipment's performance elsewhere.

- Foreign exchange problems complicate equipment acquisition by developing country institutions.

- There is no standard instrumentation policy, or "life cycle" approach to acquiring and maintaining equipment. Purchase decisions for equipment rarely include a plan for maintenance. The equipment is purchased without considering how long the equipment will work, how much maintenance will cost over the lifetime of the equipment, and how the post-purchase costs are to be covered.

Taken together, the quantitative and qualitative characteristics of the problem reveal areas which need to be addressed most urgently, and can assist in determining potential solutions.

SURVEYING SOLUTIONS

A number of efforts are underway around the world to address the equipment problem. From those cited by participants in the December 5 meeting, four models emerged as common approaches to dealing with the equipment problem.

1. Training Approach

This approach assumes that training is the solution to the equipment problem. If more researchers are trained to use equipment properly, and more individuals are trained as technicians to maintain and repair it, the resulting increase in trained experts will remedy the problem. Efforts to strengthen training methods are also an element of this approach.

2. Increased Resources Approach

This approach sees the solution through more money being allocated by donor organizations and governments to address the problem. It assumes that by merely increasing budgets, decision makers and administrators can solve the problem.

3. System/Organizational Approach

This approach holds that a well thought-out, comprehensive system, covering all elements of instrumentation infrastructure, is needed to handle the maintenance and repair of equipment. Such a system, perhaps placed within a single national center, can be structured either as a profit-making venture, or as a governmentally-financed institution, depending on the institutional structure of a country or region. The result of such a system is increased cooperation among all elements of the equipment infrastructure, and more efficient equipment acquisition and use.

4. Regional Approach to Locating Manufacturers Representatives

Participants suggested manufacturers' representatives be assigned to regions rather than to specific countries. The representative would then travel among the institutions involved, having a broader experience with the use of the equipment throughout the region.

* * * * *

An important element in all of these approaches, which can either facilitate or impede productive equipment usage, is the in-country environment for equipment acquisition. For example: Is the policy environment compatible with efforts to procure and use research equipment effectively? What is the state of disrepair of the equipment? How much capital (or foreign exchange) does the country have for investing in equipment and its upkeep?

PLAN OF ACTION

Participants identified the following steps to be taken by disciplinary societies to address the equipment maintenance and repair problem. It is not envisioned that all of the suggested activities will be undertaken at once, but that selected ones will be initiated from which experience will be gained to determine how other activities should proceed.

1. Communications Network

A communications network should be established to facilitate transfer of information among equipment users in like disciplines. For example, a biologist would have access to information on his colleague's experience in using a certain type of microscope. Such information could include the manufacturer from whom the equipment was obtained, whether or not a maintenance contract was part of the purchase agreement, how reliable the equipment is, how responsive the manufacturer's representative is, what the estimated down-time for the equipment is, etc. Such a network would include international organizations as well, such as the United Nations agencies, the International Council of Scientific Unions, and the World Health Organization.

2. Procurement Policy

A procurement policy for research and medical equipment in developing countries should be developed which considers all aspects of equipment acquisitions, and use over its expected life. Involved would be all relevant individuals and institutions: users, donors, suppliers, accountants, and government officials. The elements of the procurement policy will be shaped by the local cultural, political and economic environment, with local working scientists themselves playing a major role in procurement policy formulation.

Participants agreed on the need for an overall equipment policy, or investment policy, which considers equipment procurement as a financial investment in the future, and makes decisions based on the long-term implications of such transactions. Problems associated with donors selecting inappropriate equipment, or with insufficient knowledge at the user end regarding equipment selection, could be solved by an overall instrumentation policy incorporating standardization, communications mechanism with policymakers, and a systematic approach to equipment procurement and utilization. One of the most important concepts would be that of "life cycle" costs, i.e., equipment that is inexpensive to purchase initially may actually be a very high cost item over time if substantial maintenance is required. The future cost of maintenance and repair must be a consideration in the decision to procure equipment.

3. Conferences/Meetings

Topical conferences should be held to bring together the principal parties involved in the equipment problem: donors, intermediaries, manufacturers, policymakers, users, and accountants. Examples of appropriate topics suggested by participants include:

a. **Model Procurement Policy.** A conference should be convened to address this topic as discussed in Section 2 of the Plan of Action, above. Participants would include policymakers, donors, suppliers, manufacturers, recipients, users, and financial experts. The aim of the conference would be to develop a model procurement policy to be subsequently adapted to the specific needs of individual countries.

b. **The Policy and Decision-making Environment for Equipment Acquisition.** Such a conference would primarily involve policy makers from developing nations who would examine elements of a desirable policy environment for procuring equipment. Elements to be considered include: procedures for hard currency transfers; customs and other tax regulations; and procedures for streamlining government approvals.

c. **Systems Approach to the Equipment Problem.** The objective of such a conference would be to develop an institutionally-based approach for the procurement, maintenance, and repair of research equipment in a specific country or region. The system would reflect a well-planned, coordinated effort to handle equipment systematically in a manner most appropriate to a specific country, in accordance with the procurement policy of the country or region.

d. **Training Approach to the Equipment Problem.** The conference would examine the elements of an effective training program for preparing equipment users, technicians and calibration experts. It would also address the training of trainers, an important link in disseminating skills throughout the research community.

The topical conferences would be international in scope but would be held in different regions of the world, with each venue selected according to the relevance of the topic to the particular venue. Considerations involved in selecting meeting sites include: overall level of economic development of the country with relation to the topic; which local institutions would most benefit from certain topics; degree of experience of local research communities with conference topics.

4. Encourage Pilot Efforts

There are a number of pilot projects already underway around the world. These need to be encouraged and examined so that experience gained from these efforts can be applied to other projects. Examples include:

- A joint project involving AAAS; the Instrument Society of America; the China Association for Science and Technology (CAST); the Chinese Instrument Society (CIS); and the Chinese Academy of Medical Sciences (CAMS). Under this effort trainers will be trained to subsequently educate users and technicians in the maintenance and repair of primarily medical research equipment. Initially, the program will concentrate on eight major Chinese medical schools; it is envisioned that it will be expanded to other institutions in China, and then to other regions of the developing world.

- The Instruments and Measuring Technique Service (MMSZ) of the Hungarian Academy of Sciences is prepared to cooperate with the UN International Development Organization (UNIDO) in establishing a Maintenance and Repair Center in Ho Chi Minh City, Vietnam. The center will initially include consulting services, a national register of regional instrumentation, and a maintenance and repair service. A system for renting equipment will be developed at a later date.

- An institution such as the Cairo Scientific Instrumentation Center is a model worthy of emulation. The Center offers training courses taught by local personnel, tools, workshops, and other support services, including a library and a spare parts department.

- The International Centre for Theoretical Physics and Third World Academy of Sciences (ICTP/TWAS) manages an equipment donation program, linking surplus equipment from European laboratories with requests from developing country institutions.

- The American Physical Society, with support from the U.S. Department of Energy, provides certain relatively small yet essential research costs for Latin American colleagues, including the purchase of small equipment items. The program provides per diem for scientists visiting U.S. institutions, page charges to publish in U.S. journals, subscriptions to U.S. journals and small items of equipment. Equipment provided includes components to extend the range or capability of existing equipment, instruments to improve an experiment, different material samples, and replacements for broken parts.

- The UNESCO-initiated African Network of Scientific and Technological Institutions (ANSTI), with support from the West German Agency for Technical Cooperation (GTZ), runs a technician training program. Training has taken place in fields such as biochemistry, agricultural engineering, electrcial engineering, surveying, and remote sensing.

It is important to determine how success of pilot projects can be sustained. Projects will be studied to find the best means for continuing the results, such as the possibilities of privatization, joint ownership of a repair enterprise, or government subsidization. The results of this evaluation should be reported to donor organizations, policy makers, and research institutions to improve the maintenance and repair of research instrumentation in developing countries.

CHARACTERISTICS OF SCIENTIFIC AND ENGINEERING SOCIETIES

Participants at the meeting identified a number of characteristics which are unique to disciplinary societies worldwide, and which place these societies in a comparatively advantageous position for actively working on the equipment problem. These unique attributes include:

- Human resources are available from volunteers and retired experts who have substantial experience. Participation in disciplinary society activities is of value to the members and actually enhances their regular work, thereby providing an incentive to do so.

- Credibility is accorded the societies by equipment suppliers, donors, and users, and by the policy community, because of the reputation of disciplinary societies for giving objective, factual advice.

- The broad, interdisciplinary nature of societies in general facilitates work on the equipment problem across disciplines.

- The independent, non-governmental and non-profit status of societies strengthens their role as non-partisan advisors.

- The tradition of prestige and academic authority of societies engenders respect for their opinions. The practice of peer review and other advisory functions of societies further enhances their influence.

- Societies produce specialized resources such as books, journals, manuals, courses, etc.

- An efficient communications network exists as a matter of course among scientists and engineers by virtue of the unique peer relationships existing among scientific colleagues.

Given the unique characteristics of scientific and engineering societies noted above, it is most appropriate to involve mainstream disciplinary societies throughout the world in efforts to address the equipment problem. Societies' credibility and influence with donors would be of substantial assistance. Partnerships could be established or strengthened between scientific and engineering societies in developing countries and their counterparts in the developed world. Such linkages among peers worldwide would be particularly effective mechanisms for accomplishing the goals of a broad-based equipment initiative.

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AAAS CONSORTIUM OF AFFILIATES FOR INTERNATIONAL PROGRAMS (CAIP)

The AAAS Consortium of Affiliates for International Programs (CAIP) is a broadbased multidisciplinary network of scientific and engineering societies with interests in the international dimension of their disciplines. The Consortium is comprised of "regular members" drawn primarily from AAAS affiliated societies, and "corresponding members" representing foreign scientific and engineering societies.

OBJECTIVES

Formed in 1976 the objectives of the CAIP are to:

- Facilitate communication among CAIP member societies about international concerns and programs of common interest.
- Provide a forum and a mechanism for raising the concerns of the scientific and engineering community, through its professional associations, regarding international science policies and priorities and to present these to policymakers.
- Encourage cooperation and coordination among members on multidisciplinary projects with international aspects.
- Stimulate new and/or expanded international science activities by Consortium members.

MEMBERSHIP

Currently 70 AAAS affiliates belong to the Consortium as "regular members." An initiative undertaken in 1989, is the extension of CAIP membership to foreign societies as "corresponding members."

Regular members designate a representative and staff liaison from their society to the Consortium. There are no dues, however member societies do submit an annual letter report to the CAIP describing their international activities during the preceding year and are responsible for supporting their representative's expenses for participation in CAIP activities. This includes representatives' attending a minimum of one Consortium meeting each year and, if elected to the Steering Committee, to attend at least two steering committee meetings each year.

Corresponding members also designate a representative to the Consortium. As with regular members, there are no dues, and corresponding members also submit an annual letter report to the CAIP describing their activities during the preceding year. Representatives of corresponding member societies are welcome to participate at their own expense in all CAIP meetings and activities, but are not currently eligible for election to the CAIP Steering Committee. Corresponding members have an important role to play in CAIP activities ongoing or to be developed in their region of the world.

To request either regular or corresponding membership in the Consortium one must submit a request in writing for affiliation with the CAIP. The request should include designation of a representative and staff liaison as appropriate, and a brief report on the international interests and activities of your society. Requests should be sent to the CAIP Coordinator, AAAS, 1333 H Street, N.W., Washington, D.C. 20005, USA.

GOVERNANCE

Governance is provided by an elected Steering Committee as stipulated in the CAIP Charter. The Steering Committee maintains oversight of CAIP-sponsored programs, develops and recommends policy and operations guidelines, and coordinates selected activities in collaboration with corresponding members and other societies and organizations in foreign countries.

COMMUNICATIONS

Communication among CAIP members is facilitated by a newsletter, Consortium Notes, published quarterly. The newsletter contains articles on international activities of Consortium members, announcements and updates of ongoing Consortium projects, and a calendar of future international activities. Consortium members contribute written materials for the newsletter and representatives serve as guest editors. In addition, a Consortium Directory of CAIP members is compiled and distributed annually. The Directory contains the names, addresses and other data on the representatives and staff of each member society, descriptions of CAIP member organizations, information on the activities of their international committees and services, privileges, and special awards accorded to foreign members and foreign scientists and engineers, brief descriptions of CAIP activities and background information on the Consortium. Consortium Notes and the Directory are distributed free of charge to all Consortium members.

The Consortium also holds an annual luncheon meeting in conjunction with the AAAS Annual Meeting and a spring meeting in Washington, D.C. each year.

ACTIVITIES

A cross section of Consortium activities is given below. Additional information on each activity can be obtained from the CAIP Coordinator.

- International Seminar on the Role of Scientific and Engineering Societies in Development
- Equipment Maintenance and Repair in Developing Countries
- Journal Distribution Program
- Caribbean Regional Seminar
- U.S.-West German Seminar on Exchanges
- Global Initiatives Project
- NSF Bilateral Programs Review
- African Regional Seminar on the Role of Scientific and Engineering Societies in Development in Sub-Saharan Africa.
- Global Seminar on the Role of Scientific and Engineering Societies in Development
- CAIP-sponsored symposia at AAAS Annual Meetings
- CAIP-sponsored AAAS Science Attache Seminars

CAIP MEMBERS

American Anthropological Association
American Association of University Professors
American Chemical Society
American Educational Research Assoc.
American Geological Institute
American Geophysical Union
American Institute of Aeronautics and Astronautics
American Institute of Biological Sciences
American Institute of Chemical Engineers
American Institute of Chemists
American Mathematical Society
American Medical Association
American Nuclear Society
American Oil Chemists' Society
American Physical Society
American Phytopathological Society
American Psychological Society
American Society for Cybernetics
American Society for Engineering Education
American Society for Horticultural Science
American Society for Information Science
American Speech-Language-Hearing Assoc.
American Statistical Association
Association of College and Research Libraries, ALA
Association of Southeastern Biologists
Biophysical Society
Ecological Society of America
Entomological Society of America
Institute of Navigation
Institute of Electronics and Electrical Engineers
Instrument Society of America
International Studies Association
Linguistic Society of America
Marine Technology Society
Medical Library Association, Inc.
National Association for Research in Science Teaching
National Council of Teachers of Mathematics
National Science Teachers Association
National Speleological Society
Operations Research Society of America
Optical Society of America
Population Association of America
Rural Sociological Society
Sigma Delta Epsilon
Sigma Xi

American Society for Metals
American Society for Microbiology
American Society for Pharmacology and Experimental Therapeutics
American Society for Quality Control
American Society of Agricultural Engineers
American Society of Agronomy
American Society of Animal Science
American Society of Civil Engineers
American Society of Mechanical Engineers
American Society of Plant Physiologists
American Society of Zoologists
American Sociological Association
Society for Applied Anthropology
Society for General Systems Research
Society for Research in Child Development
Society for the Scientific Study of of Religion
Society of American Foresters
Society of Economic Paleontologists and Mineralogists
Society of Exploration Geophysicists
Southern Society for Philosophy and Psychology
U.S. Metric Association
Volunteers in Technical Association
The Wildlife Society

CAIP STEERING COMMITTEE

Thomas Malone (1991)
Sigma Xi

Walt Whitman (1991)
Society of Exploration Geophysicists

Lynne Neufeld (1990)
American Society for Information Science

William M. Sangster (1990)*
American Society of Civil Engineers

Irving Engelson (1993)
Institute of Electrical and Electronics Engineers

Robert Aangeenbrug (1993)
Association of American Geographers

Judith Grassle (1992)
American Society of Zoologists

J. Lawrence Apple (1992)
American Phytopathological Society

*Chairman

- - - - - - - - - -

Barry D. Gold, CAIP Coordinator

January 1989

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CONTINUING COMMITTEE ON THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN DEVELOPMENT

The Continuing Committee was formed following the Global Seminar on the Role of Scientific and Engineering Societies in Development, held in New Delhi, December 1980. The dominant theme of the Global Seminar was that scientific and engineering societies have certain characteristics which enable them to make unique contributions to the development process in any country, and they constitute a reservoir of talented scientists, engineers and technicians with special knowledge and expertise that can be mobilized to undertake specific development-related tasks.

With participants from all parts of the world, the Committee seeks to facilitate the exchange of information and ideas between scientific and engineering societies and other institutions and individuals interested in utilizing science and technology for development. Continuing Committee members serve as "focal points" for geographical areas of the world, channeling information specific to that area. The Committee provides advice and counsel to organizations involved in implementing the recommendations of the Global Seminar.

The Committee has fostered the creation and strengthening of regional scientific and engineering groups. In 1984 the Federation of Asian Scientific Academies and Societies (FASAS) was created with Committee co-chair A.K. Sharma as President. Leaders from Interciencia Association (IA) have participated in Committee meetings, and the Committee inspired the landmark African Regional Seminar on the Role of Scientific and Engineering Societies in Development in December 1984. Various international conferences have resulted from Committee initiatives.

AAAS shares responsibility for the Committee Secretariat with the Indian National Science Academy (INSA) and the Indian Science Congress Association (ISCA). The Committee has met annually since 1982 when it held its first session in Calcutta. Both the 1983 and 1985 meetings were held in New Delhi; in 1984 the Committee met near Munich at the conference center of the Max Planck Society. In 1986 the Committee met in Beijing, hosted by the China Association for Science and Technology. The 1987 Committee meeting in Puerto Rico focussed on regional activities of scientific and engineering societies and was held in conjunction with a Caribbean Regional Seminar. The 1988 Committee meeting, held in Cairo, was followed by an International Seminar on the Role of Scientific and Engineering Societies in Arab Development. In September 1989, the Committee will meet in Helsinki, hosted by the Work Efficiency Association.

One example of an area in which the Committee has been particularly active in recent years is in addressing the problem of maintenance and repair of research equipment in developing countries. In concert with scientific and engineering groups around the world, the Committee was instrumental in a feasibility study to develop a comprehensive and cost-effective approach to the maintenance and repair problem. The major agenda item at the Committee's 1988 meeting in Cairo was the equipment problem. Participants from research institutions, donor organizations, disciplinary societies, and governmental agencies reported on their experience in dealing with the issue and on the track record of programs initiated to address it. A Plan of Action was developed comprising four concrete steps to be taken by disciplinary societies worldwide to address the equipment maintenance and repair problem.

One means of communication between the professional societies in science and engineering around the world and the Continuing Committee is the newsletter "Scientific and Engineering Societies in Development." It serves as a forum for the exchange of experiences, suggestions and ideas concerning the role of scientific and engineering societies in development; the formulation of needs and problems; the offer of specific expertise and knowledge to meet those needs; and in general a means to engineer better communications between societies around the world. Editorship of the newsletter is shared by AAAS and ISCA.

For further information, contact one of the Newsletter co-editors:

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May 1989

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AGENDA

Meeting on Maintenance and Repair of Research Equipment
in Developing Countries

October 5, 1988
8:00 a.m. - 5:00 p.m.

Instrument Society of America
Raleigh, North Carolina

MORNING SESSION

Chair: Al Novak

8:00 a.m. Continental Breakfast at ISA

8:30 a.m. Introduction and Welcome
Glenn Harvey, Executive Director, ISA

8:45 a.m. Review of Project Background
J. Thomas Ratchford, Associate Executive Officer, AAAS

9:15 a.m. CAIP Involvement: Role of ISA and Other CAIP Societies
William M. Sangster, Chair, CAIP Steering Committee

9:45 a.m. Case Study: The APS Experience
Roy Rubinstein, Fermilab

Break

10:15 a.m. Role of Government, Universities and Other Organizations

10:45 a.m. Results of CAIP Survey and Other Sources

- Magnitude and Character of the Problem
- Experiences with Addressing the Problem

11:15 a.m. Preliminary Report Overview

12:00 p.m. WORKING LUNCH - DISCUSSION OF PRELIMINARY REPORT

A F T E R N O O N S E S S I O N

Chair: William M. Sangster

1:00 p.m. Discussion of Report Continued / Revisions Suggested

1:30 p.m. Discussion of Potential Ways to Address the Problem and Draft Recommendations

3:30 p.m. Outline of Future Steps

- Agenda of December 5-6 meeting in Cairo
- Role of ISA and other CAIP societies
- Role of Government, Universities and Others
- Potential funding sources

5:00 p.m. Adjourn

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MEETING ON MAINTENANCE AND REPAIR OF RESEARCH EQUIPMENT IN DEVELOPING COUNTRIES

October 5, 1988
8:00 a.m. - 5:00 p.m.

Instrument Society of America
Raleigh, North Carolina

Participant List

Satinder Ahuja, Ciba-Geigy Corporation, and Member, International Committee, American Chemical Society

Sandra M. Burns, Senior Program Associate, AAAS Office of International Science

Carolina Carter, Program Associate, AAAS Office of International Science

John Daly, Office of the Science Advisor, U.S. Agency for International Development

Glenn Harvey, Executive Director, ISA

Sam Joseph, Chairman of Microbiology Department, University of Maryland

Douglas Kolb, Director, Education Services, ISA

Al Novak, Technical Director, Swagelok Company, and ISA Representative to the AAAS Consortium of Affiliates for International Programs

Roy Rubinstein, Fermilab, and Chair, International Committee, American Physical Society

William M. Sangster, Dean of Engineering, Georgia Institute of Technology and Chair, Steering Committee, AAAS Consortium of Affiliates for International Programs

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REVISED PRELIMINARY REPORT

FEASIBILITY STUDY OF A PROGRAM TO PROMOTE THE MAINTENANCE AND REPAIR OF RESEARCH EQUIPMENT IN DEVELOPING COUNTRIES

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11/28/88

(Prepared for consideration at 12/5-6/88 meeting in Cairo of Continuing Committee on the Role of Scientific and Engineering Societies in Development)

BACKGROUND

Scientific research, testing, evaluation, and clinical practice in both industrialized and developing countries are increasingly dependent on modern, accurate, well-functioning equipment. Donor organizations have been generous in supplying research equipment to institutions in developing countries. Their efforts have generally been less far-sighted in dealing with the challenges associated with keeping equipment functioning, as it should, over its normal lifetime.

Quantifying the magnitude of the inoperative or malfunctioning equipment problem is difficult. Estimates of the proportion of equipment not functioning properly at any point in time in research institutions in developing countries vary from 75 to 90 percent. Further attention to delineating the equipment problem is an important first-order task.

It is already clear, however, that among the hardships that scientists and engineers in developing countries face are several that revolve around research equipment. Not only are there major deficits in necessary instrumentation, but the equipment that is in place in universities and other research laboratories suffers serious malfunctioning attributable to poor or absent maintenance and/or repair capacity.

In a recent survey of grantees of the Swedish-based International Foundation for Science (IFS), covering close to 500 researchers in 67 countries, scientists said they found a principal impediment to progress in their research--second only to general lack of funding--has been the purchase and upkeep of necessary equipment and other facilities. Respondents reported that repairs took up to six months to occur--if indeed they occurred at all--and that waiting for foreign technicians to come on site usually meant a wait of five to ten months.[1] At the same time the Swedish development agency SAREC has completed case studies of the equipment problem in at least ten developing countries; lack of manpower with appropriate competence seems to be the overriding obstacle to effective use of research equipment.

Among the specific problem areas identified thus far are:

- lack of standardization
- lack of research management expertise
- decentralized approach to equipment maintenance and repair
- graduates of technical education and training programs tend to prefer office assignments to field assignments
- lack of incentive pay scale
- low status traditionally accorded technicians
- lack of trainers and teachers of trainers
- abundance of obsolete equipment
- donations of equipment not suited to the local research environment

[1] "Purchase, Use and Maintenance of Scientific Equipment in Developing Countries," Interciencia, Vol. 13, No. 2, March-April 1988, pp. 65-70.

- lack of hard currency
- logistical problems in procurement, such as customs procedures, transport, etc.
- inaccessibility of spare parts

Although the equipment problem in developing countries is complex and multifaceted--ranging from technical barriers such as the increasing diversity and sophistication of scientific equipment and economic constraints such as lack of foreign currency for spare parts or servicing contracts to limitations in human factors such as lack of trained technical personnel--the problem nevertheless appears amenable to thoughtful, well-focused approaches.

AAAS FEASIBILITY STUDY

The American Association for the Advancement of Science (AAAS) has initiated a short-term study to evaluate the feasibility of establishing a program to deal with the equipment problem. On the U.S. side, this will be a joint effort involving key members of the AAAS Consortium of Affiliates for International Programs (CAIP), a broadbased multidisciplinary network of U.S. scientific and engineering societies with interests in the international dimension of their disciplines. The Instrument Society of America (ISA), with an instrument repair training facility in Raleigh, North Carolina, which is unique in the world, will be the lead U.S. s ciety in this effort. Financial support for the feasibility study has been provided by the U.S. Agency for International Development (AID).

On the developing country side, AAAS is cooperating through regional groups with which it regularly interacts in Asia (Federation of Asian Scientific Academies and Societies); Africa (African Academy of Sciences, Pan-African Union of Science and Technology, and Association of African Universities); and Latin America (Interciencia Association). At the global level the Continuing Committee on the Role of Scientific and Engineering Societies in Development, in which AAAS plays a major role, will provide opportunities for broadbased exchange of information and for comparison of specialized approaches to the problem.

The initial step in this feasibility study was to conduct a survey of institutions around the world, both governmental and non-governmental, concerning experience with the equipment problem and potential solutions. This involved two components. First, in August and September 1988, a survey was conducted among member societies of the AAAS Consortium of Affiliates for International Programs (CAIP). An article appeared in the Summer 1988 issue of the CAIP newsletter Consortium Notes, requesting that societies submit information on their activities addressing the equipment problem. Second, in addition to the survey conducted among CAIP members, AAAS contacted international organizations whose missions concern developing countries.

The data received was compiled into this preliminary report for consideration on October 5 during a meeting at the ISA facility in Raleigh, North Carolina. At the October 5 meeting in Raleigh, representatives from several U.S. scientific and engineering societies and donor organizations plus other experts reviewed the preliminary report and developed draft recommendations to discuss with institutions in developing countries. These

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draft recommendations can be found on page 11 of the report. It is expected that additional activities involving CAIP members and international organizations will be identified over the next few months.

This preliminary report first briefly outlines activities identified by AAAS thus far as being conducted by U.S. scientific and engineering societies, societies which belong to the AAAS CAIP. Second, a review is given of worldwide donor agency programs. Third, attention is given to initiatives of developing countries organizations. Finally, the next steps in this feasibility study are outlined.

CAIP ACTIVITIES

The following activities were identified by Consortium member societies as noted.

American Institute of Biological Sciences (AIBS)

In the 1970's, AIBS helped establish postgraduate work in clinical engineering in cooperation with the University of Belgrade, Yugoslavia. With support from the National Science Foundation, AIBS and the University organized a series of seven seminars on biomedical engineering. In 1972-74, in cooperation with a scientific group in Tunisia, AIBS coorganized a conference on biomedical engineering held in Tunis. They also conducted a survey among biomedical institutions in Tunisia, resulting in a report which was presented to Tunisian authorities. The objectives of the meetings in Tunisia and Yugoslavia were to: promote biomedical engineering, advance collaboration in the application of technology to health care, and provide a basis for regional or national workshops on biomedical engineering.

The extensive AIBS biomedical engineering program in Egypt dates to 1972, coincident with the planning of workshops in Yugoslavia and Tunisia noted above. An Egyptian representative attended the final session of the Yugoslav series, and cooperation between AIBS and Egyptian colleagues resulted, specifically to convene international conferences on the life sciences.

The 1974 agreement signed by Presidents Nixon and Sadat on "Principles of Relations and Cooperation" between the two countries facilitated AIBS projects in Egypt, eventually leading to a "U.S.-Egypt Biomedical Engineering Workshop in March 1976, with support from NSF. The workshop was coorganized by AIBS and Cairo University. As a result of workshop recommendations, the first biomedical engineering department at an Egyptian university was established at Cairo University in 1976, together with a Research and Maintenance Centre for Scientific and Electromedical Equipment. From 1976-1982, AIBS consultants continued to provide advice and counsel to the Department and the Centre. The objective of training clinical engineers for work in Egyptian hospitals and providing Ph.D. research opportunities has been realized. As of 1982, twelve students were working on their M.Sc. and Ph.D. degrees; approximately 30 students complete the B.Sc. degree annually. The first hospital repair and maintenance service center was established in 1982 at the Cairo University Kasr El Ainy General Hospital, with three additional centers planned. The centers are under the auspices of the Ministry of Health with the direct coordination and cooperation of the University Department of Systems and Biomedical Engineering.

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During the early 1980's, AIBS and AAAS explored the convening of joint workshops on biomedical engineering in cooperation with the Centre for Biomedical Engineering which is located on the campus of the All India Institute of Medical Sciences. The Centre is a particularly appropriate venue for examining the equipment problem because, in addition to developing new instrumentation and training personnel, it also services the medical equipment of the neighboring 1000-bed hospital.

Two workshops were planned to address the following areas of concern identified by the Centre:

- o diversity of equipment
- o preventive maintenance scheduling
- o equipment safety
- o medical school biomedical instrumentation courses.

Despite intensive efforts by AIBS, funding failed to materialize for this unique initiative.

The American Physical Society (APS)

The American Physical Society, working through Fermilab in Illinois, has had grants from the National Science Foundation and the Department of Energy to cover certain relatively small yet essential research costs for Latin American colleagues, including purchase of small equipment items. The program began in 1980 with the aim of primarily assisting the growth of Latin American physics and, to a lesser degree, stimulating the study of high energy physics. The current $100,000 grant from the U.S. Department of Energy (DoE) being administered by Fermilab provides funds for: per diem costs of Latin American scientists visiting U.S. institutions; page charges for Latin American scientists to publish in U.S. journals; subscriptions to U.S. journals; and small items of equipment. Two representatives in Argentina, Brazil, Chile, Mexico and Venezuela solicit and judge requests for assistance from researchers in their countries. Grant administrators in the U.S. approve or disapprove the requests based on the proposed research plan, the physics involved, and how the equipment will be used. The purchasing and administration is then handled by Fermilab, with the equipment being shipped directly to the Latin American institutions. The biggest problems encountered involve the ever-changing and complex customs regulations of each country.

Most of the equipment shipped under this program is less than $500, yet these small increments can make an enormous difference in outcomes. Such requests include:

- o components to extend the range or capability to extend the range or capability of existing equipment
- o instruments to improve an experiment
- o different material samples
- o replacements for broken parts

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The American Association for the Advancement of Science (AAAS)

In its own Western Hemisphere Cooperation Program (WHC), AAAS has addressed the equipment problem in collaboration with Argentina and, more recently, Chile. In the former instance a notice in Science for equipment donations brought forth offers that were then reviewed here for appropriateness and serviceability and subsequently sent to a U.S. port for Argentine-financed shipment. Getting underway in a revitalized U.S.-Chilean cooperative science and technology arrangement is a similar equipment donation project that will utilize the fleet of CODELCO, the Chilean copper consortium, for overseas shipment and will rely on the Chilean Academy of Sciences for oversight within country.

The Instrument Society of America (ISA)

The Instrument Society of America (ISA) sponsors an array of relevant activities throughout each year, on-site in North Carolina and off-site at client locations, focused on training in instrument use and maintenance. Its 1987 Ecuador project is a proven model of potential significance here. CEPE, the Ecuador national petroleum group, approached ISA a year ago to carry out a needs assessment. Two ISA experts subsequently spent a week in Esmeraldes, Quito, reviewing the current training situation and documenting its pervasive needs in a 100-page report. Follow-on activities included training of two Ecuadorian leaders in North Carolina for eight weeks and a two-week installation phase in Ecuador, administered by the newly trained trainers backed up by an ISA expert. ISA has also explored cooperation with the Chinese Instrument Society.

INTERNATIONAL DONOR ORGANIZATIONS

Swedish Agency for Research Cooperation with Developing Countries

A few years ago, the Swedish Agency for Research Cooperation with Developing Countries (SAREC) initiated a study on the equipment problem. The study included the sponsorship of engineers in developing countries, and consultation with other donor organizations. SAREC's objective is not simply to state the problem, but to formulate a series of alternative mechanisms for addressing the problem. It aims to determine the most feasible and realistic approaches to dealing with the equipment issue.

SAREC's contacts with developing country scientists are channeled a) through some 80-90 Swedish research departments which have collaborative ties with respective departments in developing countries, b) via direct contact with scientists in developing countries whose individual research agendas are supported by SAREC, and c) other scientists in developing countries.

Among the meetings sponsored by SAREC in developing countries was a workshop on "Repair, Maintenance and Development of Scientific Instruments", held in Madras, July 15-18, 1986. The workshop was co-organized with the Federation of Asian Scientific Academies and Societies (FASAS). Among the issues addressed at the Madras meeting were training, regional spare parts banks, and manufacturing service contracts. A similar session has also been convened in Singapore.

SAREC is currently completing two volumes for publication, one a comprehensive document on the equipment issue based on a number of cases and the other a report on policy issues with recommendations of future directions for donor agencies in dealing with the equipment problem. Although the major focus of SAREC's work is the donor community, it is also relevant for academic and research institutions, and the scientific community at large.

International Development Research Centre (IDRC)

The IDRC of Canada sponsored a 1985 investigation of "The Procurement and Maintenance of Scientific Equipment in the Southern African Development Coordination Conference (SADCC)." A representative of the National Council for Scientific Research (NCSR) of Zambia visited equipment centers in Kenya and Ghana, the result of which was a recommendation for a Central Workshop for Maintenance, Service and Repair of Scientific Equipment. In the NCSR representative's final report, reflecting his own views and not necessarily those of NCSR, the following ideas were put forth: establishment of a Central Workshop for the Procurement, Maintenance and Repair of Scientific Equipment in the SADCC Region; establishment of a directory of major scientific equipment in the area; identification of focal point institutions and individuals for communications purposes; discussion of equipment procurement problems. Consultations with experts in other African countries were also recommended.

U.S. Agency for International Development

The U.S. Agency for International Development (AID) has supported several programs to address the equipment issue. Through the National Institutes of Health, AID supported a project for biomedical equipment in Latin American countries. It also provided support for an initiative in the Caribbean wherein local entrepreneurs were encouraged to set up and run research facilities. (see NIH below) AID has also worked with RONAST, a scientific and technological organization in Nepal, to assist in establishing an equipment maintenance and repair facility. In addition, AID brings some 12,000 people per year to the U.S. for training, half of which involves mission-designed training programs.

U.S. National Institutes of Health (NIH)

Since 1981, the NIH and AID have jointly undertaken projects to improve the regional capability for the repair of hospital clinical care and laboratory equipment located in the Eastern Caribbean. This has included efforts to strengthen the maintenance of hospital clinical care and laboratory equipment in Jamaica, Grenada and Belize. The Regional Program for the Eastern Caribbean aims to: strengthen maintenance resources on each island; develop a regional cadre of maintenance personnel; and develop regional training capability. NIH determined that maintenance and repair centers were most successful in the region when run by local entrepreneurs.

NIH has also cooperated with the Pan American Health Organization and the Mexican Ministry of Health in a program to strengthen the capability to train hospital maintenance personnel in Spanish-speaking countries of the Americas. The program involved three major activities: development of a Spanish language training curriculum; training of technicians from Spanish-speaking countries in the basics of biomedical equipment maintenance; and

strengthening the capability of a prototype regional training center in Mexico for hospital equipment maintenance personnel.

NIH is also conducting a project to strengthen Egypt's capability to manage its hospitals through the development of a prototype equipment maintenance center. The center would then be used as a model for establishing centers elsewhere in Egypt. The three major components of the program are: equipment maintenance; equipment evaluation; and user training.

NIH is currently working with the Egyptian Academy for Scientific Research and Technology (ASRT) to strengthen Egypt's ability to maintain and repair scientific equipment. This endeavor evolved from the program noted above for establishing equipment centers, and aims to provide in-country training for equipment technicians at the centers.

U.S. National Science Foundation

In November 1976, NSF sponsored a conference at the National Research Centre in Cairo, Egypt, on "The Management of Laboratory Instruments." The conference was organized by the Instrumentation Systems Center for the University of Wisconsin at Madison and the Egyptian National Research Centre. The major recommendation was that "... a national consortium be established in Egypt with the mission of developing and maintaining an outstanding national resource in instrumentation; and having purview, cognizance and governance over a national program embodying several fundamental components of instrumentation capabilities."[2] Of the numerous recommendations, the following have been implemented:

- appointment of an Instrument Coordinator in each laboratory
- inventory of all laboratory instrumentation in Egypt
- establishment of a central library of instrument manuals

Other International Donor Organizations

Through the **International Foundation for Science (IFS)**, headquartered in Sweden, obsolete equipment is made available to experts in developing countries, together with spare parts, manuals, and extra supplies.

The **Japanese government** has provided substantial financial support and equipment to the Chulalongkorn University in Thailand to establish the Scientific and Technological Research Equipment Center (STREC). STREC provides training in maintenance and repair of research equipment, and also develops research instruments.

An instruction manual written by the **International Development Program of Australian Universities and Colleges** is being translated into several developing country languages.

[2] Management Systems for Laboratory Instrument Services, N.E. Huston, ed., The Instrument Society of America, 1977, p. 49.

UNESCO and the International Union of Pure and Applied Chemistry conduct a program for manufacturing chemistry equipment in developing countries, thereby circumventing the problem of importation from abroad.

The **British Overseas Development Agency (ODA)** and the **Swedish International Development Agency (SIDA)** have assisted in the strengthening of technical colleges in Sri Lanka (see below for more details).

DEVELOPING COUNTRY SITUATION

A number of institutions in developing countries have taken the initiative to address the equipment problem. Briefly, sample projects underway include:

The **Third World Academy of Sciences (TWAS)** in Trieste, Italy, has a program wherein small grants (up to $500) are awarded to developing country institutions for the purchase of spare parts. Also in Trieste, an **International Centre for Theoretical Physics (ICTP)** program links developing country requests for equipment with equipment donations from industrialized country organizations. The ICTP has also organized a meeting on the manufacture of physics equipment, held in Tanzania with support from the Swedish Agency for Research Cooperation with Developing Countries (SAREC).

With assistance from the **British Overseas Development Agency (ODA) and the Swedish International Development Agency (SIDA), Sri Lanka** has undertaken a major effort to upgrade technical colleges. In Phase I of the program, British and Swedish consultants advised Sri Lanka experts in drawing up equipment specifications, formulating guidelines and setting up workshops on technical training. Such labs and workshops took place at 10 of the 24 Sri Lanka technical colleges, with many of the training sessions at the engineer-technician level or craft level. Such sessions address the important issue of training technicians sufficiently at levels which are traditionally accorded lower status but which are vital in maintaining equipment in operating condition. During Phase II, equipment will be upgraded and more technical colleges are expected to be established. A major National Technical Training and Teaching Development Center is also planned. The Asian Development Bank provided a $16 million loan for Phase I; a loan for $30 million is anticipated for Phase II.

To address the problem of traditionally low status accorded technicians, equipment experts at the **H.E.J. Research Institute in Karachi** are employed at pay scales like those of the researchers. The result is that the Institute, which uses a great deal of advanced chemical equipment, is notably very productive.

A substantial training program is conducted at the **Central Science Workshop in Dar-es-Salaam, Tanzania.** For managerial responsibilities, however, the facility still depends on experts from other countries.

The **International Centre for Insect Physiology and Ecology (ICIPE)** in Nairobi provides maintenance and repair services to outside organizations as well as to the Centre's own research staff. This provides both additional revenues for the Centre and additional experience for the equipment staff.

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The **Indian Council of Scientific and Industrial Research (CSIR)** has established the Central Scientific Instrument Organization (CSIO) primarily for training purposes. The **Department of Science and Technology of the Indian government** has established seven Regional Sophisticated Instrumentation Centres (RSIC) with the aim of providing equipment services, as well as development of new instrumentation.

A **Chinese Instrumentation Center (CIC)** has recently been established in Beijing with financial support from West German organizations. The Chinese Instrument Society is currently exploring cooperation with the Instrument Society of America in preparing training materials for use in the new CIC.

Equipment Surveys

The China Academy of Medical Sciences, Peking Union Medical College, the China Association for Science and Technology and the Chinese Instrument Society, along with the Instrument Society of America and AAAS, are jointly planning a unique means of addressing the equipment problem. As a first step, the Chinese Academy of Medical Sciences, under the leadership of its President, Dr. Gu Fang-Chou, is conducting a survey of the status of equipment in eight of the eleven major Chinese medical schools. A sample survey form is attached. The objective is to initiate a pilot training program in the Chinese medical schools, expand it to cover a wide segment of scientific research institutions in China, and then to transfer it cooperatively to appropriate institutions and organizations in other developing countries, particularly in Africa.

A similar survey is being undertaken by the **Association of African Universities (AAU)** under the leadership of its Secretary-General, Dr. Donald Ekong. Questionnaires are being sent to the deans of the relevant faculties, i.e. sciences, agriculture, engineering and medicine, in university members of AAU. Documentation on this initiative is attached.

NEXT STEPS

The first version of this preliminary report, "Feasibility Study of a Program to Promote the Maintenance and Repair of Research Equipment in Developing Countries," was prepared for consideration at an October 5, 1988 meeting at the ISA training center in Raleigh, North Carolina. At this meeting representatives from several U.S. scientific and engineering societies and donor organizations plus other experts revised the preliminary report and developed draft recommendations to discuss with institutions in developing countries. This revised version of the report is being circulated worldwide for comment.

At the December meeting in Cairo, Egypt of the Continuing Committee on the Role of Scientific and Engineering Societies in Development, a major focus will be the equipment maintenance and repair issue. Donor organizations will be invited to attend and all participants will jointly evaluate this revised preliminary report and identify specific roles for the

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regional groups in implementing an equipment maintenance and repair initiative in their respective regions of the world. Such regional organizations include:

- Federation of Asian Scientific Academies and Societies
- African Academy of Sciences
- Pan-African Union of Science and Technology
- Association of African Universities
- Interciencia Association.

At the meeting in Cairo, participants will pay particular attention to recommendations formulated at the October meeting in Raleigh (see "Recommendations" below) and to sample pilot projects also proposed in Raleigh (see "Proposed Pilot Projects" below).

FINAL REPORT

By April 1989, the final report of this feasibility study, with recommendations for a plan of action, will be issued by AAAS and distributed among U.S. and international scientific societies and other interested organizations. A major gap identified by several institutions over the last few months concerns a regional approach to addressing the equipment problem. This is an area where AAAS, its affiliated societies, and regional organizations with which it cooperates worldwide, can provide a unique approach to tackling the equipment problem. It is anticipated that a comprehensive program will be formulated involving several discrete projects tailored to regional needs for addressing the equipment problem. Several potential projects are noted below.

RECOMMENDATIONS

The following recommendations were formulated at the October 5 meeting in Raleigh, North Carolina by representatives of U.S. scientific and engineering societies and donor agencies. These recommendations and the proposed pilot projects noted in the subsequent section will be considered by developing country experts at the December 1988 meeting of the Continuing Committee on the Role of Scientific and Engineering Societies in Development, to be held in Cairo.

1. In considering requests for equipment support, donor agencies should require that the proposed project include a plan for ensuring maintenance, repair and calibration. Donor agencies should also have the proposals peer reviewed by scientists or engineers from the appropriate discipline. The membership of AAAS and its affiliated societies represent a unique resource for the peer review.

2. There is a need to increase the visibility among the general scientific and engineering community of the developed countries of the equipment problem. One means of achieving this would be to disseminate information on the problem widely throughout the AAAS and affiliated societies network.

3. Experts in developing countries may determine a need for guidance on laboratory management. The general membership of AAAS and affiliates should be made available to provide such on-site advice at

the request of developing country experts, concerning standard operating procedures, maintenance schedules, calibration standards, etc.

4. In designing and selecting equipment for use in developing countries, consideration should be given to special environmental problems which may harden the operation of equipment. Examples include such concerns as humidity, or frequent fluctuations in voltage.

5. Special attention must be paid to unique cultural and social factors in each country.

6. An examination should be made of successful activities, laboratories or research facilities already in place to determine both why they are successful and if they can be replicated elsewhere. Examples include the successful research facilities in Thailand, the success of the Fermilab experience in facilitating equipment acquisition by Latin American research institutions, and the unique Scientific Instrumentation Center in Ghana.

PROPOSED PILOT PROJECTS

The elements of the equipment problem are multifaceted and too diverse to be solved by one organization or sector on a global basis. There are, however, several possibilities of addressing the problem with the combined efforts of the mainstream scientific and engineering societies around the world. Based on deliberations at the October meeting of U.S. experts in Raleigh, the following are proposed as sample pilot projects:

1. Establish a program to award small grants for the purchase of basic research equipment and spare parts. Most requests from Latin America to Fermilab are on the order of $500.

2. Establish an exchange point for catalogues and manuals of research equipment. This information could be built into a computer base and would not only include manufacturers' catalogues, but would also have relevant publications of AAAS and its affiliates such as the annual AAAS "Guide to Scientific Instruments," and equivalent publications of the American Physical Society or the Instrument Society of America.

3. Establish a training program wherein expert trainers from the Instrument Society of America would provide one of its on-site courses at an appropriate institution in a developing country. The plan would call for technicians or researchers in that institution to come to the ISA facilities in North Carolina a year later for supplemental training. The overall training program would aim to prepare participants for properly operating equipment, as well as for imparting their skills and knowledge to colleagues in their home institution.

   It is recommended that 3-4 sites be selected for the program, in different regions of the world, and that the program be initiated one site at a time so that each subsequent course benefits from the

experience of previous ones. Local arrangements for the courses could be coordinated by regional organization such as:

- o Federation of Asian Scientific Academies and Societies
- o Interciencia Association
- o Association of African Universities
- o Pan-African Union of Science and Technology
- o African Academy of Sciences

4. Training course could be offered to graduate students from developing coutnries who are studying at institutions in developed countries. In addition to the fact that less travel money is needed for such a project, this has the unique benefit of training young scientists who represent the future scientific sector of their respective countries. The linkage established between the student and his industrialized country colleagues also provides a solid foundation for future communication as the student advances in the science establishment of his home country.

   Initially, it is proposed that such a course be offered at ISA to developing country students in the Research Triangle Park (RTP) area, near the ISA training facility. The RTP involves three institutions: Duke University, the University of North Carolina, and Wake Forest University, all of which have science and engineering students from developing countries.

5. Meetings should be convened at which experts from scientific and engineering societies, scientific research institutes, governmental organizations charged with science and technology policy, donor agencies and suppliers could discuss the equipment issue. These fora would aim to determine policies appropriate for regions or for individual countries by providing for open dialogue between equipment users, scientists and engineers, suppliers, and policy and decision makers. Regional organizations such as FASAS, IA, PUST, AAU or AAS would convene and organize the meetings; AAAS and its affiliates would stand ready to facilitate the process and offer any expertise required by the developing country convenor.

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