2.17 Scientific Instruments in Developing Countries: Addressing the Equipment Management Problems

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Introduction

Modern technology, in the form of a wide spectrum of advanced instruments and equipment, has been introduced into the countries of the less developed world. A need has thus evolved for the planned procurement, utilisation, maintenance and repair of sophisticated apparatus in industry, the health services, research and educational institutes and the agriculture sector. The situation has created a demand for an informed administration, for maintenance, repair and calibration facilities and for a cadre of technologists trained in instrumentation and employed in an advantageous career structure who are capable of maintaining this equipment.

Because of rapid changes in technology, there is also a requirement for staff re-education and continued up-dating of repair facilities as the equipment and the skills of personnel become out-of-date. The absence of such an infrastructure, at both the administrative and technical level, has placed in jeopardy huge capital investments intended for the betterment of large populations, from both the private sector and aid agencies, in a wide range of expensive equipment in organisations dealing with industry, health, research, education and agriculture. The WHO, for example, estimate that 60-80% of biomedical equipment in developing countries is non-functional (see page 179).

The problem of scientific equipment in developing countries epitomises the problems of trying to bring the benefits of modern technology to the Third World without paying adequate attention to building up local skills and a supporting infrastructure. An appreciation of the complexity of the problem has recently led to coordinated action by member states and aid organisations to address these issues. This article summarises the attempts by a number of organisations over the last three decades to provide for adequate instrument repair and maintenance and is intended as a 'management tool' to facilitate the interchange of experience and coordinated action.

International Agencies

International agency interest in this area began almost 30 years ago with the UN conference 'Application of Science and Technology to Development' held in 1963, which established an expert Advisory Committee. This Committee produced a set of comprehensive recommendations and basic guidelines in 1971 (1). Numerous conferences and seminars involved with the application of science and technology were held worldwide in the 1970s, culminating in the UN Conference on Science and Technology for Development (UNCSTD) convened in Vienna in August 1979.

The International Atomic Energy Agency (IAEA) has reported that, at any given time, between 10-30% all of the instruments it distributed over the last 10 years worldwide for technical assistance and cooperation projects were out of order. This was caused largely by the absence of efficient local maintenance and repair service capabilities (2,3). In response to this problem, which affects an IAEA ca. US$ 23 million annual instrument budget over approximately 1000 projects, the IAEA Seibersdorf Laboratories in Austria began a series of six-month ten-man fellowship programmes in November 1987, to train technicians and engineers from developing countries (4). Participants from several countries in Africa, the Middle East and East Asia have attended these courses and a Nuclear Instrumentation Network (NIN) was set up to promote continued contact between nuclear technologists and to encourage cooperation with other organisations. The NIN in African Countries (NIN/AF) has surveyed national needs and an African Regional Project (RAF/4/004) funds the training of national personnel, supplies spare parts and manuals and carries out urgent repairs (5).

The International Foundation for Science (IFS) supports young non-established scientists from developing countries to do experimental research in developing countries. As more than 70% of the support is directed at equipment and laboratory supplies, the Foundation is interested in the long-term upkeep of the hardware it provides. A 1985 survey of 500 grantees by IFS (6,7) found that between 20 and 50% of laboratory equipment in developing countries was not functional and in some institutions virtually nothing functioned. In response to this situation the Foundation instituted a 3-year pilot aid project on instrument upkeep in nine SADCC countries (8). Workshops on the operation and maintenance of scientific equipment were held in Harare (1988) and Tanzania (1990) (9); a third workshop is scheduled for Malawi in 1991. The International Centre for Analytical Technology (Luton, UK) runs these workshops for IFS with additional support from IDRC (Canada), UNFSTD, the World Bank, DANIDA and the Commonwealth Science Council. A Network of Users of Scientific Equipment in Southern Africa (NUSESA) was set up to share experiences. IFS plans a joint project with the Taiwan National Science Council, Precision Instrument Development Centre (PIDC) in Taipei to provide service and training facilities for laboratories in developing countries. IFS also has an input into the Commonwealth Higher Education Support Scheme (CHESS) which proposes technician training programmes in Southern Africa (8).

UNESCO. In response to the 1976 UNESCO General Conference resolution 2140-42 urging action on the issues and problems of instrument upkeep, a global consultation meeting of specialists was held in Paris in 1978 (10) attended by representatives from Singapore, Ghana, England, Philippines, Indonesia, Argentina and France. There followed a series of regional workshops on training instrument technicians in Indonesia (11), anglophone Africa (12,13) and francophone Africa (14). Details of courses in Kenya for earth science technicians (15) and a proposed course for seismic technicians (16) were provided at UNESCO conferences in East Africa and a survey of instrument maintenance courses operating in African Institutes was carried out for UNESCO (17). The UNESCO-initiated **African Network of Scientific and Technological Institutions (ANSTI)** runs a technician training programme with support from the Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ) and a project for manufacturing chemistry equipment in developing countries, in conjunction with the **International Union of Pure and Applied Chemistry.**

The World Health Organisation (WHO). Between 60% and 80% of laboratory and diagnostic equipment in developing countries is non-functional (18), leading to the description of some Third World regions as the 'graveyards of biomedical equipment' (19). In response to this situation, WHO held the first interregional meeting on the maintenance and repair of health care equipment in Nicosia in 1986, attended by participants from 25 countries, international organisations , aid agencies and major manufacturers (20). The recommendations from this conference led to a Global Action Plan (21) which emphasised awareness promotion, policy formation and policy initiation, information exchange, improvement of national health care technical services, and manpower training (WHO/EMRO operates a Regional Training Centre for Health Technologists at the Higher Technical Institute in Nicosia, Cyprus). A comprehensive overview of approaches to the health care equipment problem is provided by a Round Table and discussion among national and international experts (22). Surveys of medical equipment policies have been carried out in China (22) and São Paulo, Brazil (30, 31). WHO recently carried out a joint workshop in Nairobi with GTZ on public health maintenance strategies in the developing world (24). An excellent article on the need for appropriate healthcare laboratory technology in developing countries is available (25), as is a comprehensive report on modern hospital technology management (26).

National Agencies

The National Institute of Health (NIH), USA Department of Health and Human Services has a Biomedical Engineering and Instrumentation Branch (BEIB) which participates in equipment repair and maintenance programmes (27). The agency operates with the **US Agency for International Development (USAID)** on programmes in Egypt (28) and with the **Pan American Health Organisation (PAHO)** on programmes in Latin America (29). In São Paulo State, the public health system has 560 hospitals, 2100 health centres and 10 research and manufacturing facilities. The healthcare equipment policy devised and implemented for these facilities has been described (30, 31). Guidelines for designing medical instruments for use in developing areas of the world, based on the author's experiences in Jamaica, China and Egypt, have been provided in another publication (32). NIH also cooperates with USAID (see page 180) on projects to improve the repair of clinical equipment in the Caribbean.

Overseas Development Administration, UK (ODA) and the **British Council** provide assistance to the Nigerian university system under the University Equipment Maintenance Project. This involves four pilot Maintenance Development Centres at universities in Zaria, Ile-Ife, Bauchi and Calabar. (This project overlaps a World Bank activity to fund maintenance programmes in all Nigerian universities). The purpose of the ODA project is to encourage the development of a maintenance rather than a replacement culture in the universities. Four pilot Maintenance Development Centres (MDCs) have been established, maintenance technician training programmes are under way and workshops have been organised on relevant topics. The University of the West of England at Bristol (UWE) (formerly Bristol Polytechnic), which has been running courses in equipment maintenance over the last 15 years, is the consulting institute for this project.

UWE also repair equipment, supply spare parts and develop outreach courses for other universities in Nigeria. Between 1982 and 1989, ODA employed UWE to develop a teaching laboratory and repair workshop for scientific equipment in the University of Alexandria. ODA are cooperating with the Swedish International Development Agency (SIDA) in an extensive programme to upgrade technical colleges in Sri Lanka funded by a US $ 16 million loan from the Asian Development Bank. A loan of US $30 million is proposed for a second phase of this programme. The British Council and ODA are also cooperating with the World Bank in an instrument maintenance facility for Indonesia. The International Centre for Analytical Technology (ICAT) in Luton (UK) is providing a training and consultancy input to this project and Gallenkamp Ltd are supplying equipment (L Orton, private communication). Westminster College in the UK is also involved in a wide range of instrument maintenance training programmes for developing countries.

The Swedish Agency for Research Cooperation with Developing Countries (SAREC) has studied the equipment problem and progressed to holding a workshop on 'Repair, Maintenance and Development of Scientific Instruments' in Madras in 1986 in conjunction with the **Federation of Asian Scientific Academies and Societies (FASAS)**. They intend to hold a similar session in Singapore and to publish two comprehensive documents on the equipment issue and on policy issues. This agency cooperated with the Trieste-based **International Centre for Theoretical Physics (ICTP)** in a meeting in Tanzania on the manufacture of physics equipment. A second agency in Trieste, the **Third World Academy of Sciences,** awards small grants to institutions in developing countries to purchase spare parts.

The US Agency for International Development (USAID) supports projects in Latin America through the NIH as described above. It has supported a facility in Nepal for instrument repair and a Caribbean regional maintenance service. The Agency also funds a programme where hundreds of personnel are brought from abroad to the USA for training.

Scientific and Engineering Societies

American Association for the Advancement of Science (AAAS). The Directorate of International Programmes in this Association carried out a feasibility study of Equipment Repair in Developing Countries during 1988-89 (33) which was funded by the USAID. A worldwide survey of selected government, non-government and scientific institutions was carried out and recommendations based on the survey results presented at a 1989 meeting held at the Instrument Society of America facility in Raleigh. Studies described in the survey included a 25 university review by the **Association of African Universities** and a 1987-88 assessment of problems in Vietnam by the **Hungarian Instruments Measuring and Technique Service (MMSZ).** UNIDO and MMSZ are preparing to establish an instrument centre in Ho Chi Minh City. A German study conducted by ENVIRON concentrated on East Africa. At a subsequent meeting in Cairo in December 1988, a plan of action was evolved for addressing the equipment problem. AAAS activities in this area have currently been temporarily suspended (J H Taylor, AAAS - private communication).

The AAAS **Consortium of Affiliates for International Programs (CAIP)** has 70 scientific and engineering societies as members. Of these, the **American Institute of Biological Sciences (AIBS)** organised seven biomedical engineering programmes in developing countries during the early seventies, with support from the National Science Foundation, starting with one in Dubrovnik (34). The programme continued in Tunis and major facilities for maintenance and training have been established in Cairo, with the assistance of AIBS consultants (33). An account of the activities of other CAIP members will be found in the AAAS survey document (33). A **Continuing Committee on the role of Scientific and Engineering Societies in Development** was set up in 1980 and meets annually. It seeks to facilitate the exchange of information and ideas between scientific and engineering societies and others interested in utilising science and technology for development. It publishes a newsletter 'Scientific and Engineering Societies in Development' obtainable from the AAAS.

The **International Council of Scientific Unions (ICSU)** through its **Committee on the Teaching of Science** has conducted a workshop in Nairobi for repair and maintenance technicians (35) and ICSU's **Committee on Science and Technology for Development (COSTED)** is involved in work in this area (36).

Programmes within Developing Countries

Institutions with instrument maintenance and repair courses for technicians are to be found in six African countries, viz. Ghana, Kenya, Nigeria (five centres), Swaziland, Tanzania, and Zambia (17). Singapore and Indonesia have UNESCO-initiated courses (10).

The **Central Scientific Instrument Organisation (CSIO)** has been established by the **Indian Council of Scientific and Industrial Research (CSIR)** mainly as a training facility (37). Seven **Regional Sophisticated Instrument Centres (RSIC)** have been established by the **Indian Department of Science and Technology** to develop new instruments and provide equipment services (33). (For further details see Section 2.13).

The **International Centre for Insect Physiology and Ecology (ICIPE)** in Kenya maintains and repairs equipment for outside organisations in addition to providing a service for its internal requirements.

The **HEJ Research Institute** of Karachi employs equipment experts at salaries similar to those of researchers. This policy has avoided the low status traditionally accorded to these technicians and increased the productivity of the Institute (33).

Sources of Information

A preliminary investigation of some 10 computer data bases was carried out to locate those containing references to publications on instrument management in developing countries. Appropriate sources were found in NTIS (10), Engineering Information Inc. (15) and INSPEC (22), representing 43 distinct references. IAEA documentation, the 6th, 7th, 8th, 9th and 11th proceedings of the IEEE annual Engineering in Medicine and Biology conferences and the proceedings of the IEEE AFRICON 87 conference are very relevant (38, 39, 40). Fifteen agencies were contacted for details and replies were received from the seven organisations acknowledged below. Much of the detailed information in this area is not available in the public domain. Many accounts of workshops and seminars with particulars of institutions, participants and courses covered are hidden in the files of large agencies. As a consequence, much information of potential use to organisers of assistance programmes is not easily accessible.

Conclusions

The causes of unsatisfactory instrument maintenance in developing countries have been well documented (13, 20, 22, 25 and 41). They involve a complex interplay of circumstances including:

- Poor organisational policies within the donor and recipient governments and aid agencies with little on-the-ground evaluation or provision for on-going maintenance.
- A lack of appropriate information and the means for its dissemination.
- Insufficient and inappropriate manpower development and training.
- A poorly developed and supported technical service.

Ways will have to be found by all the agencies involved to overcome these problems through collaboration, the pooling of experience and resources, standardisation and joint procurement policies, otherwise the developing countries will continue to be denied the benefits which modern technology could provide for their populations.

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