AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
Batch 55

1. SUBJECT CLASSIFICATION
A. PRIMARY: TEMPORARY
B. SECONDARY:

2. TITLE AND SUBTITLE
Guidelines for the use of computer technology in the developing countries

3. AUTHOR(S)
Simmons,R.A.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1973	194p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
AID/TA/OST

8. SUPPLEMENTARY NOTES (*Sponsoring Organization, Publishers, Availability*)

9. ABSTRACT
(Library and Information Sciences R&D)

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAD-424	
12. DESCRIPTORS	13. PROJECT NUMBER
	14. CONTRACT NUMBER: AID/TA/OST
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

DRAFT

GUIDELINES FOR THE USE OF COMPUTER TECHNOLOGY IN THE DEVELOPING COUNTRIES

BY

RALPH A. SIMMONS

STAFF ASSISTANT FOR INTERNATIONAL COMPUTER TECHNOLOGY
INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY
NATIONAL BUREAU OF STANDARDS
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

JOINTLY SPONSORED BY THE AGENCY FOR INTERNATIONAL DEVELOPMENT
AND THE NATIONAL BUREAU OF STANDARDS

JUNE 1973

DRAFT

TABLE OF CONTENTS

I. Introduction

A. Science and Technology in Development

Science and technology offer the potential to significantly assist the less developed countries of the world to attain their aspirations of economic and social advancement. The implication of this statement--that the potential is yet to be realized--is a fact that is regrettably supported by the evidence even after the efforts from many large bilateral and international assistance programs. The reality of the gap between the capabilities of developed and developing countries is nowhere more pronounced than in the area of science and technology.

There has been extensive and successful use of major segments of science and technology in foreign assistance concerned, for example, with health and family planning, various aspects of agriculture, and in the social sciences including education and management skills. The hard fact remains, however, that there have not been comparable efforts to effectively transfer from the more developed countries the capabilities in many aspects of biological sciences and in the engineering or physical sciences. In spite of the fact that there exist many examples of notable achievements in certain developing countries, the results--in terms of the rate of development and utilization of science and technology--fall far short of the needs.

The deficiencies in their abilities to cope with modern technologies have been recognized by the developing nations as have the deficiencies in effective use of these technologies in foreign assistance been recognized by those countries and bodies attempting to speed economic and social development. Recent actions of national governments and international organizations have recognized the role that technology can play in reducing disparities that exist and in helping to close the gap between the developed and developing countries. The United Nations Advisory Committee on the Application of Science and Technology to Development (ACAST) has observed that there is a striking contrast between the industrialized countries and the developing countries whether measured in terms of the number and equipment of research institutions, the number of scientific and technical personnel, or the technology of production. The result is that only a small fraction of the world's scientific and technical resources is devoted to the problems of the developing countries.

This observation has led ACAST to provide specific guidance by a report to the Economic and Social Council for the necessary development and strengthening of basic structures, policies, and institutions in the developing countries, and for the promotion of improvements in the transfer and application of existing technical and managerial knowledge. Reports, studies and action plans have been developed in recent years by

various committees and policy groups of the United Nations Educational Scientific and Cultural Organization (UNESCO), the Organization for Economic Cooperation and Development (OECD), the United Nations Conference on Trade and Development (UNCTAD), and a wide range of similar organizations.

The bilateral foreign assistance programs of the United States Government have been guided by recent policy statements emphasizing the importance of science and technology. As an example, the President included the following in his message to Congress on March 16, 1972:

> "Finally, I would emphasize that United States science and technology can and must play an important role in the progress of developing nations. We are committed to bring the best of our science and technology to bear on the critical problems of development through our reorganized foreign assistance programs."

Similar policy statements have been made upon other occasions by the President, the Secretary of State, and the Director of the Agency for International Development. Various panels and committees have given support to such policy through numerous studies and reports.

In summary, science and technology are of major importance to the international and bilateral foreign assistance programs of the world and their effective transfer to, and utilization by, the countries of the Third World will be a significant factor in the realization of economic and social goals.

B. The Role of Computers

The computer is unique within the fields of science and technology in relationship to the potential support to economic and social development. It serves as an important tool in numerous functional activities that are at the core of the development process. Within service areas such as transportation or communications, the computer is used both to support daily operations as well as the long range planning. The uses range from support to engineering design and construction to operational control to business and fiscal activities. The support to the planning function frequently includes economic analysis, facility expansion, and operational modelling.

In the area of public administration and government operations, the computer has proved to be valuable through its capabilities to assist in information processing. When properly used, it can provide information that is more comprehensive, more timely, more accurate, more detailed and more relevant. It is especially significant to development as it can support the national planning process itself.

The effective use of computer technology demands a thorough systems analysis of the functional activity to be supported. It is necessary to have all steps of the activity arranged in logical sequence and for the detailed procedures clearly and carefully defined with appropriate data available to support each sequential step. Resources must be organized in such a way as to permit the execution of each activity in its sequence. The result of the exercise of such a disciplined review, in many cases, proves to be as valuable as the addition of the computer support itself. The resulting organizational and procedural improvements for the given activity can be a major contribution to development.

These are but a few examples of the importance of the computer to a country's economic and social development. It is assumed that the argument of whether computer technology is useful to a developing country is now over and has been decided in the affirmative. It is no longer a question of whether it should be used, but how. It is the purpose of this report to identify the problems associated with computer support and to make specific recommendations to guide those directing resource allocation through foreign assistance programs and those making policy and management decisions within the developing countries.

C. Need for Criteria and Guidelines

In theory, the developing countries have available to them the vast breadth of technologies developed through the years in the more advanced nations of the world. The rationale so often used is that these technologies need only be transferred to the developing countries and their economic development will be greatly accelerated. Not all technologies, however, are useful for all countries. The first task then is the selection of the appropriate ones to be used in specific countries and then the solution of the transfer process itself.

Since this report is based upon the assumption that computer technology is generally significant to all developing countries, the important issue here is the transfer process. In the more general sense, the transfer of technology is the process by which the achievements of science and technology diffuse through human activities, and in particular throughout the economy. New ideas pass through a sequence of activities including basic research, applied research, development, prototype application, full-scale production, sales, etc. This might be summarized by three states: i.e., invention, innovation, and diffusion. This sequential process is referred to by some as "verticle" transfer and prevails in most developed countries. In the less developed countries, however, it is a "horizontal" transfer of technology that dominates. This permits the developing country to skip the steps in

vertical transfer leading to application and to immediately gain the economic and social advantages from the use of the technology. It is essentially a diffusion process.

The transfer process from a developed to developing country is extremely complex and involves wide ranging issues of a social and political nature as well as technical difficulties. In the case of computer technology, the objective is to provide for a systematic way of utilizing computers as tools to assist in meeting clearly identified goals. This is a delicate and difficult task, however, requiring a full appreciation of the basic goals to be achieved, an awareness of the unexpected consequences of applying computer technology, and the detailed technical issues to be resolved. In addition, and probably the most significant aspect, is the infrastructure required for its successful use. The technological supporting systems that make up this infrastructure are the legal, economic and social arrangements through which the computer technology becomes available and is controlled. The infrastructure in a developing country differs greatly from that in a developed country, a condition frequently overlooked in technology transfer and the cause of many failures.

The need for guidelines to assist the administrators of foreign assistance and the officials of the developing nations is a result of the complex interactions among the

technology itself, the supporting infrastructure and the larger issues of national objectives and priorities. The mystique created around computers and the rapid growth of the computer technology have been the cause for the frequent transgression of the technical experts into the area of policy and national decisions. National officials have often been unable to cope with this technology due to misunderstandings concerning its possibilities and probabilities for support to national objectives and because of the lack of knowledge of the infrastructure required for its successful use. On the other hand, few computer scientists are in a position to make the decisions required to bring the use of computer technology in perspective with the larger national plans.

In summary, it is imperative that those responsible for major decisions and national policy be provided sufficiently detailed guidelines concerning the use of computers for development so that its full potential may be realized and resources wisely spent to achieve the desired national goals.

D. Department of Commerce and Agency for International Development Joint Project

The Assistant Secretary of Commerce for Science and Technology and the Director of the Office of Science and Technology, Bureau of Technical Assistance, AID agreed in late 1971 to jointly sponsor a project with the objective of

improving the utilization of computer technology for development in the less-developed nations. Resources made available by AID and the National Bureau of Standards have supported technical assistance from the staff of the Institute for Computer Sciences and Technology in the conduct of several tasks including assistance to AID in responding to specific requests from developing countries, technical support to AID in responding to issues arising from computer-related activities of international organizations, and the preparation of this report developing a unified framework and guidelines for considering issues related to the appropriate nature of computer activities at various levels of national development.

The first step in the preparation of this report was a survey of computer use and development in nine selected countries, i.e., Nigeria, Ethiopia, Uganda, Turkey, Brazil, Colombia, the Republic of Korea, the Republic of China, and Thailand. These countries were selected to provide a wide geographic representation and a cross section of various levels of development. In each country, the objective was to gain knowledge of the level and nature of computer activity, the factors that have led to successful use of computer technology, the principal deterrents to its use, and forecasts for its future. This information was gathered from interviews with the appropriate national policy makers and officials, the

managers of governmental computer activities, the local representatives of the major computer manufacturers, the corporate managers and computer managers of industrial and business enterprises, and the educators.

The past few years have seen increasing interest and attention being directed toward the value of computer technology for development. There have been numerous reports, studies, conferences, symposia and projects sponsored by international organizations, professional bodies, and individual countries. Information gathered in the survey has been augmented by these sources and through the participation of the author in many of these activities. This report includes a comprehensive bibliography with references to these sources. It is hoped that the bibliography itself will be of assistance to those engaged in directing the effective use of this technology.

II. Conclusions and Recommendations

The objective, to which this report is offered as a contribution, is the more effective use of computer technology by the developing countries. The intensive survey of computer use and development in the nine selected countries and analysis of the data from a variety of other sources have resulted in the formulation of specific conclusions. These conclusions have led to a series of recommendations for management actions to be implemented by those responsible for the use of computers for development. This report and its recommendations are intended primarily for the officials of the developing countries. There will be unique circumstances in the specific countries requiring the selective use or modification of the recommendations. In addition, priorities for action will vary from country to country. It is intended that the report be used as a guideline and that, in spite of the need for individual country interpretation, the establishment of a general framework of factors or criteria will prove to be a useful tool.

The conclusions are summarized in this section of the report and recommended actions described after each major conclusion. The supporting evidence and arguments for the conclusions are presented in the later sections of the report.

Conclusion 1: There are two major roles for national governments in the development and use of computer technology, i.e., the planning and direction for the total country and as a principal computer user itself.

a. National-level planning for the development and application of computer technology in the developing countries is essential to guide its effective use.

Recommendation 1: The national government of the developing country establish a central computer office to conduct the necessary planning for computer technology and direction of its use, with the following conditions.

1. It be placed high enough in the government structure to exercise effective authority preferably not reporting to any single functional ministry but to the equivalent of the prime minister.

2. It be delegated the appropriate responsibility and authority to act.

3. It be staffed with adequate numbers of competent personnel, representing knowledge of planning, management, government operations and priorities, and computer technology; there must be a critical concentration of competence to permit there to be a significant impact on all phases of the computer development.

4. It be supported by an inter-ministerial or inter-departmental coordinating committee to provide advice on priorities and requirements but not to assume the authority or responsibility of the central computer

office. The decisions necessary for effective management should not be left to a committee, but be retained by the central computer office and the cabinet officer to whom it reports.

Recommendation 2: The responsibilities of the central computer office be assigned to include:

1. The national, central planning and formulation of policies to stimulate and control computer use, assuring optimum results for resources expended and appropriate support to national priorities.

2. The preparation of forecasts for computer development and the appropriate subsidiary plans such as education and training.

3. The establishment of policies and controls for hardware and software acquisitions. The extent of this control beyond the national government users will be dictated by individual national policies and limits of national governmental authority.

4. The establishment of, or recommendations for, regulations influencing computer use such as customs duty and import tariffs, patents and copyrights, rate structure for data transmission, and a wide range of technical standards.

5. The identification and removal of non-tariff barriers to computer use including the development of appropriate mechanisms for the required financing.

6. The review of computer development and use to protect society from its possible adverse results.

7. The identification and stimulation of the infrastructure necessary to support the use of this high technology.

b. The computer is a tool of major importance to public administration and to government operations; it supports three broad applications in government, i.e., general management, specific functional responsibilities, and scientific and technical endeavors.

Recommendation 3: The central computer office be delegated responsibility for the development and implementation of plans and controls of computer use by national government offices, in addition to that for procurement, including:

1. The development of government personnel policies, including salary structures, career development plans, and education and training.

2. The recommendations for the degree of centralization for direct computer services in the government.

3. The guidance for, and review of, feasibility studies for new computer applications in the government.

4. The provision of scientific and technical advice to government offices in all phases of computer technology and its application.

Conclusion 2: Inadequate education and training has been a major deterrent to effective use of computer technology. Although each country must develop its own set of requirements and priorities, the most important educational needs are extended orientation in computer technology for senior managers, an increase in competent systems analysts and designers to develop new computer applications, and additional experienced computer installation managers.

Recommendation 4: A national computer education plan be developed to include the identification of needs, assignment of priorities, and outlines of programs, leading to a national awareness of computer technology and the needed numbers of qualified personnel in all phases of computer activities.

Recommendation 5: The responsibility for the educational planning be placed in the central computer office. (See Recommendation 2)

Recommendation 6: The government sponsor computer orientation seminars for senior functional managers both in government and in the private sector. They should be conducted on a rotational basis until all senior managers have attended and should be planned to continue for middle management.

Recommendation 7: A high priority be given to the education of systems analysts and designers to develop new computer applications and improve existing systems.

Recommendation 8: Special projects be conducted to improve and extend the capabilities of the computer installation managers.

Conclusion 3: The technical information available to computer specialists in developing countries is inadequate to meet their needs.

Recommendation 9: The government assign to its central computer office the responsibility for developing programs for more effective communication of technical information; such programs to include consideration of all communication media, e.g., personal contact through technical societies, symposia for selected topics or functional applications areas, and more effective dissemination of technical literature.

Conclusion 4: The importance of the infrastructure required to support computer technology is frequently underestimated and the components of the infrastructure not fully understood or recognized.

Recommendation 10: Action be taken by the central computer office to make the responsible government officials aware of the full range of technological subsystems required to support computer technology.

Recommendation 11: The central computer office, as a part of its planning function, identify the required technological subsystems, evaluate the effectiveness of each, and outline priority actions for corrective measures, as appropriate.

Conclusion 5: The computers in developing countries are used primarily for business-oriented applications such as payrolls and inventory control systems and expansion into other areas has been slow.

Recommendation 12: The computer be introduced as an accepted and essential tool in university programs for engineers, scientists, economists, public administrators and other appropriate disciplines.

Recommendation 13: Priority be given to the education and training of systems analysts and designers. (See Recommendation 7)

Recommendation 14: Develop mechanisms for the identification and encouragement of the use of "twining" relationships between functional organizations in the developing countries and those of similar activities in developed countries as an effective way to speed the technology transfer.

Conclusion 6: Very limited use is being made of the computer as a tool in the process of national economic development planning.

Recommendation 15: Special task forces be created to review the planning process to determine the needs to provide for more effective computer support, such reviews to be supported by external consultant teams of economic and computer specialists.

Recommendation 16: Continued efforts be made to collect accurate and complete data to support this economic planning function.

Conclusion 7: At the earlier stages in computer use in a country, its threat to employment is minimal upon the society but as the country becomes more industralized and computer use expands its impact on employment is a more significant issue.

Recommendation 17: The feasibility studies for new computer applications include an analysis of its expected impact on employment.

Recommendation 18: The objectives leading to the decision to use a computer in a labor-intensive area be other than savings in labor cost, e.g., improved quality of output, improved timeliness of work, and capability to do a job not otherwise possible.

Recommendation 19: A comprehensive public educational effort be undertaken to explain the advantages offered through computer support and to demonstrate control in areas of potential

harmful social effects. This recommendation requires very selective application depending upon local conditions.

Conclusion 8: Inadequate personnel policies and low pay are principal causes of poor utilization of computers within the governments of the developing countries.

Recommendation 20: The establishment of computer occupations as recognized professions in civil service structures of the developing countries.

Recommendation 21: The conduct of salary structure surveys and comparability analysis with pay for similar jobs in the private sector followed by corrective action.

Recommendation 22: Personnel policies be established giving full recognition and status to computer specialists and providing for special considerations for continuing education and training.

Conclusion 9: There is very limited exchange of information even among the computer specialists within the government of many of the developing countries with the result that critical resources are wasted in efforts to solve the same or similar problems independently in many different installations.

Recommendation 23: Provide for the use of formal and informal mechanisms for the exchange of technical information, especially for specific problem solutions within the government.

Recommendation 24: Assign the central computer office the responsibility to develop and maintain an inventory of government hardware, software, applications and programming languages by organizational user. This should be extended to the private sector if circumstances permit.

Conclusion 10: Management information systems, supported by computers, offer a means of major improvement to the fundamental functions of management, i.e., planning, organizing, directing, controlling, and evaluating, but they have not been generally recognized in the developing countries.

Recommendation 25: A separate and distinct educational effort be undertaken within government to orient managers on the power of the management information system, of the availability of existing program packages, and of the organizational implications in their use. This should include demonstrations for senior management, and evaluation of the possible applications.

Recommendation 26: Information sciences and technology be considered for introduction to formal educational programs at the stage where computers have received general acceptance and management data is reasonably well-organized.

Conclusion 11: Physical supporting subsystems for computer operations such as a reliable power supply at reasonably constant voltage levels, air conditioning, reliable communications, supplies, and equipment maintenance are frequently difficult to adequately provide for in the

developing countries, cause interruptions in service and present unusual problems. Such difficulties have not proved to be insurmountable, however, and have frequently delayed computer use but usually not prevented it.

Recommendation 27: The government identify all supporting subsystems required for computer support, evaluate their acceptability, and develop plans for corrective action as appropriate. This could be made a part of the national planning outlined in Recommendation 2.

Conclusion 12: The developing countries have concentrated on the issue of centralization of computer services in the national government frequently to the exclusion of the other centralized functions needed. Standardization is such a function and its neglect is beginning to have an adverse impact on computer development.

Recommendation 28: The central computer office be assigned the responsibility to develop a program of standardization in the computer field in cooperation with the existing government standards organization.

Recommendation 29: The standardization program include consideration of eight major areas or categories: i.e., 1) software, 2) documentation, 3) data, 4) hardware, 5) communications, 6) ADP environment, 7) applications, and 8) acquisition standards. Priorities should be set among these areas and for specific projects within each area.

Recommendation 30: In the formulation of the standards program, consideration be given to the functions of the technical development of standards and ADP standards management, including the determination of the impact of standards; the development and monitoring of standards policies and procedures; and a plan for the implementation, maintenance and ensuring compliance with standards.

III. Computers and National Governments

A. Introduction

The role of the national government of a country as related to computer technology can be divided into two broad areas: i.e., the development, direction, and control of the role of computer technology as a national resource; and the development, direction and control of the use of computers within the government itself. The political philosophy and structures of a country will have much to say about the degree of authority the national government will have over the development and use of such a technology. Regardless of the differences in authority and in mechanics for implementation, however, there is a need for national governmental action if the most effective use is to be made of computer technology and of the national resources directed for its development. A wide range of national policies and regulations need to be examined in the light of their impact on the use of computers and on their role in the economic and social development of a country. These include such issues as financing, export/import regulations, customs and tariff regulations, labor policies and salary structures, educational plans, standardization, and national research and technical programs.

The role of the government as a computer user concerns itself with some of these same issues but, in addition, focuses particular attention on the selection and development

of specific applications, the organization and management of the computer resources, the regulations and controls for the acquisition of these resources, and the provision of required technical subsystems. Governments of many of the developing countries have been the first computer users and have set the pattern for the development and use of this technology in the private sector as well. Effective use within the governments is significant, not only for the government operations themselves, but because of the influence on the total development of computer technology.

B. Responsibilities for Computer Development

1. National Planning

National-level planning for the development and application of computer technology in the developing countries is essential to guide its effective use. This conclusion is obvious with the acceptance of: 1) the large expenditures necessary for computer development; 2) the need to import the hardware and much of the software and accompanying technical support; 3) the shortage of foreign exchange in many developing countries; 4) the significant contribution computers can make to the acceleration of the rate of economic development; 5) the infrastructure needed to sustain computer activities; 6) the profound and far-reaching social impact created by the introduction of computers; and 7) the importance of the planning function as a part of good management. Circumstances will vary

in each developing country and the importance of each of these seven factors will vary accordingly. However, there is no country that can escape the ultimate conclusion and resources must be provided to support this planning activity. Equally important is the creation of adequate structures and mechanisms within which this planning can take place. There is an inescapable responsibility and role for national governments of the developing countries in the planning for computer use.

The major elements of management, although defined somewhat differently by various scholars and authors, are generally agreed to include planning, organizing, directing, controlling and auditing. In the concepts of effective management, none of these activities may be omitted or neglected and yet the beginning point, the planning, has a history of being overlooked. This oversight may be complete omission, at least from any organized approach, to inadequate time and resources being allocated for an acceptable result to be expected.

The planning function required by a national government in the computer area should begin with the development of the goals for the program for computerization. These can be stated at several levels and each are necessary to serve as base lines against which all following activities can be tested. The broader objectives will almost always have been already set for the general economic and social development programs of a country. These should not be taken for granted,

however, but examined and understood before the formulation of more specific goals. The objectives can be expected to provide direction that will affect the selection of the secondary goals and the priorities assigned to them.

Assume, for the sake of example, that a country has stated as a national objective the more effective use of selected areas of high technology to accelerate the rate of economic development. In addition, it has been recognized that computer technology should be one of these selected areas and a goal has been established to provide for the most economic and efficient installation and use of computer systems. It can be further assumed that computer technology is already in use but no comprehensive plan exists to insure its effective use or expansion. What sort of national plan should be developed?

The essential ingredients are as follows:

a. The actions to be followed for the selection and development of application areas. Depending on the authority of the national government, it may either actually control such actions or take steps to educate and promote their use.

b. An outline of actions leading to the identification of resources required and their sources.

c. The development of the appropriate and related plans for education and training. This is described in detail in Section IV of this report.

d. The governmental actions necessary to insure adequate technological supporting system components.

e. The establishment of governmental structures for the implementation (and development) of this national plan.

The pattern of the introduction of computers in the developing countries has been frequently one of interest of a manager in computers, ordering of hardware through whatever firm was immediately available, the installation of this hardware, and the direct transfer of some clerical routine to the computer. This has frequently led to disasterous results because of the lack of consideration of the many supporting needs as well as the probable poor selection of functions to be automated. Any national plan must provide for the application of systems methodology to the solution of the problems: 1) What activities should be automated; and 2) What are the important considerations in the planning for such automation. National decision-makers and those approving funds for computer development should insist on a national plan supported by appropriate feasibility studies leading to the solution of these problems.

There have been numerous outlines for such studies, each with slight differences, but each containing the same basic principles. The fundamental steps or parts include the history or background leading to and stating the need for a specific system; the objectives or goals to be achieved by the new system; a functional description of what the system is to do and the services it is to provide; the performance specifications including volumes of items for processing and response times; the design specifications including a description of the proposed system of hardware and software to meet the stated requirements; and an analysis of the technical and economic feasibility of the system. For a developing country, it is particularly important that this study include an estimate of resources required for the staff and the source of the required competence; a review of the availability of the physical facilities including power supply, air conditioning and supporting services; identification of resources for maintenance support and source of this support; and the educational and training requirements for the necessary staff development. Such a study should be required by whatever level of management to which the authority for approval of resources has been delegated. The national plan should use whatever mechanisms are available to encourage or require the preparation of such a feasibility study for each installation planned.

The preparation of these studies and their review require competent staffs, as does the preparation of the national planning itself. Thus, the need for an effective program of education and training is established at the outset. Prior to the development of adequate governmental and/or national staffs, the feasibility study will have to be prepared by a consultant group and further help obtained in reviewing and interpreting the study for decision. Local nationals should be used to whatever degree possible as dictated by available competence. In any event, representation of the functional activity being automated should participate in the study at least as observers so that there may be a learning experience of systems and methods used. The educational and training effort described in Section IV will have to be conducted concurrently with the preparation of this type of study and with the national planning. The obvious dilemma is that "it" all needs to be done at once

When accomplished at all, it has not been unusual to find that the first feasibility studies done in the developing countries have been prepared by the hardware manufacturers. No matter how effective a job they may have done, and examples can be found of both good and bad, there is no way that there can be assurance of objectivity because of the presence of the monetary motivation from hardware sales. Therefore, if independent consultants cannot be hired for this

task, then at least advisors should be retained to assist in the evaluation of the study prepared by the hardware manufacturer. Such practice would be in the best interests of all parties.

An essential element of the national planning is the use of available mechanisms, or creation of new ones, to provide for the necessary resources to support the development and use of computer technology. A major deterrent to its use in many of the developing countries is the severe shortage of foreign exchange. The installation and use of computers require a relatively high initial investment not only for the acquisition of hardware but also for the costs involved in the physical installation and in the education and training of the personnel. In spite of these factors, the governments of many of the developing countries rarely have a clearly defined policy for the financial support. In addition, the costs of continued operation are frequently underestimated and even overlooked. This is particularly true of the resources needed for personnel, software development, and maintenance. It is not uncommon to find hardware costs are only about one-half or less of the total operating costs. Failure to provide for this additional expense has been a major contributing factor to the underutilization of computers which is so common in the developing countries.

The government ADP plan should be explicit concerning the financing issue. A policy should be established for governmental assistance and criteria identified governing eligibility for this assistance. It could take many forms from direct government subsidy through loans or grants, special tax relief systems, favorable depreciation allowances, reduced import duties, etc. Each country will have to develop its own mechanisms for such help and these mechanisms will be determined, of course, by the degree of authority permitted the national government in the various areas. Whether the solution is through central control or through a system of incentives and promotional efforts, the important point is that the financing of the use of computers is not to be left to the decisions for each individual case but that a planned and coherent policy be established. As a part of such a policy, the procedures and mechanisms for applying for and administering foreign assistance should be clearly established. Some degree of central coordination would seem highly desirable to insure optimum use of the resources obtained through foreign assistance programs.

The restrictions imposed by import duties and customs activities warrant a careful review and examination by the governments of the developing countries. The import duty levied against computer equipment is as high as 85% of the purchase

price in some countries. It is recognized that many complicated and interrelated factors enter into the establishment of taxation policies, including the import duties. The plea being made here is that each government review the particular impact such policies have on the development and use of computer technology in their country. Effective use of computers offers the potential for improved and expanded economic activity. It is urged that consideration be given to the use of technical controls and regulations, such as the requirement for thorough feasibility studies, for the acquisition of computers rather than excessively high import duties. It is recognized that under-utilization of hardware has led to such duties as a means of encouraging more effective use of available equipment. It is questioned whether this leads to the desired results. This is an issue requiring the attention and careful consideration of the most responsible officials of government.

The complications of custom regulations often make it extremely difficult to operate an activity utilizing high technology. The procedures in many countries are exceedingly difficult to follow and add considerable expense to any given operation. This expense is frequently passed on to the ultimate customer, for example, in the higher cost of spare parts. In addition, delays caused by customers complications have had serious results on computer installations

in many countries. It is not unusual to find a computer out of operation because of the lack of a part delayed in the customs process. The result is an inoperative expensive piece of equipment, a costly delay in the performance of the functions assigned to the equipment, and management disenchantment with computers. This latter result can be disasterous as it will discourage further use of the computer where it can make a substantial contribution.

The inadequate understanding of the importance of the technological supporting system components to the effective use of computer technology has been a major problem. A computer is a piece of hardware and many managers have expected to be able to acquire the "magic box" and simply put it to work. Fortunately, we have passed this period in most countries and there is at least an awareness of the many factors involved. It remains the problem of the government in most developing countries to develop the infrastructure needed to support this technology, including all of the system required components. This includes such diverse considerations as the development of a university-based scientific foundation to steps insuring a continuing power supply at constant voltage levels. If one will consider the total environment within which the computer must operate as a "system", then each part can be viewed as a component. As in any other system, a missing component can either make the total inoperative, or, at best, very inefficient.

A very important component requiring government attention and action is that of standards. They are consensus-derived agreements on how the design, performance and other characteristics of products, processes, materials, services, procedures, and systems are to be described and, when possible, measured. They are established and managed by a suitable authority. They are a recognizable mechanism for achieving compatability or interchangeability of products, processes, services, or systems. As such, they serve the purpose of making a customer, engaged in developing a system, independent of any single seller. The customer may select between sellers when he knows that their offered product or services meet standards permitting interchangeability between them and his other system components or processes.

As described in the Introduction to this report, the transfer of technology, which is of major importance to the use of computer technology in the developing countries, is essentially a diffusion process. This initiates with the assumption that there has been a successful application of computer technology to a particular service or to the production of a given product. The goal of diffusion is to take advantage of this improvement that has occurred as a result of computer technology and to spread this improvement and the application of the technology as widely as possible within the communities which can benefit. The diffusion

process is not dependent upon technology so much as it is upon the management of a technological application to gain maximum benefit. It is dependent upon obtaining agreement among the many organizations to which this new application is intended to expand. Diffusion depends on the formulation of the proper legal, contractual, ethical, regulatory and trade arrangements that make it possible for computer technology to be initiated and extended as rapidly as possible. Standards are an essential part of these arrangements and are critical to the diffusion of computer technology. Although this seems obvious, governments and other appropriate bodies have been slow to respond to the need.

The role of the governments of the developing countries in data processing standardization should be directed toward the implementation of those standards which would increase the rate and spread of the diffusion of successful computer technology. These types of standards include those for performance, for levels of service, for documentation of products and services, for procedures to be followed, for representation of data and for measurement, accuracy and calibration of devices and equipment. Timing is critical as standardization too late usually results in the adoption of defacto standards and too early runs the risk of stifling the development of technology. Regardless of the problem of timing, however, one of the most important steps for the government of a developing country to take, relative to computers, is to include in its planning provision

for a major standardization activity. The general trend has been one of too little too late.

One of the most advanced concepts in computer support is that of computer "networking." This is a set of independent computer systems interconnected by telecommunications lines to permit interactive resource sharing between any combination of systems and customers. Teleprocessing is the popular term used to describe computer networking. Teleprocessing systems can be as simple as a single computer to which several remotely located access terminals are connected via standard telephone lines, or as complex as a nationwide network of large scale computer systems interconnected by highspeed dedicated communications lines.

This advance in the state-of-the-art holds special significance for the developing countries. It provides a means of extensive resource sharing, of equality of access to and an equality of quality in public services, and the basis for the development of real time control of geographically dispersed activities. Not everyone who needs computer services can afford a computer, and, conversely, not everyone who has a computer needs all of the services he has available. Similarly, those who do own computers cannot afford to develop all the software and data banks they would like to have. The networking, or teleprocessing, offers the opportunity to share these vital resources. It also makes it possible for

people geographically dispersed to enjoy equal public services. Health care quality need no longer be solely dependent upon local availability of physicians when computer networking is available to make specialized knowledge accessable to all.

This new technology, linking computers and communications, can make it possible to bring the advantages of computers to the developing countries where otherwise it migh not be possible to overcome the problems of skilled manpower shortages and inadequate resources for hardware acquisition. It also brings, however, added pressures for governmental planning. Communications systems need upgrading in many countries to support error-free data transmission. Rate structures for communications use need to be examined and incentives provided f resource sharing through networking. Special programs for standardization will be required. Teleprocessing is not offered as the panacea for the computer problems of the developing countries. However, it is important enough to warrant knowledge able investigation and should not be discounted as "too advanced" without a determination of the facts. To the contrary, studies, investigations and even limited installations using teleprocessing are underway in many of the developing countries. What is urgently needed is full government involvement, planning, and action.

The decision to make use of computer technology as a tool to advance economic development requires a substantial commitment by the national government. The essential planning, as described, necessitates the assembling of a staff of adequate size and capabilities to meet the challenges and provide the managerial and technical guidance. The structure established for the staff and its placement in the governmental organization are of great significance. This staff will require access to the sub-ministerial and ministerial levels of government, but needs to be guaranteed an independence of activity as free of political pressures as possible. If it is to accomplish its mission, it must be able to maintain technical objectivity and credibility and to report to a level of government where there exists adequate authority to cause compliance with resulting directives and decisions. From the time of the installation of the first computer, it is not too early to begin the development of such a computer planning staff.

As a general observation, those countries that have created such planning staffs have committed similar mistakes. It is not placed high enough in the government organization; it is understaffed; and it lacks the necessary mix of competencies. Considering these handicaps, it is remarkable that they have been able to make what impact they have on the government. , planning and priorities. These problems and their solutions are the same as those confronting the government computer

operational centers and are discussed in more detail later. The need for a highly competent staff with capabilities in management, computer science and government planning cannot be overstated. The development of such a staff is probably the most critical national investment in the attempt to effectively use computers.

2. The Government as a Computer User

The governments of most countries of the world are now using computers in their operations. As might be expected, the number of computers and applications vary widely. It has been a common pattern, however, that the governments have been early, if not the first users in their countries. This is not surprising when the characteristics of these early applications are examined. They each include large volumes of data, repeated use of the same data, and

repetitive and involved computations. These characteristics are typical of applications easily suited to the advantages of a computer. For example, the processing of the population census was one of the first major uses made of a computer in the United States, as it has been in many other countries.

The government applications of computers in the developing countries can be placed in one of three broad categories: management, functional, or scientific and technical. The management category includes personnel, finance and supply systems. Within the functional category are the applications of the mission-oriented ministries including health, education, transportation, utilities, agriculture, and trade. The computer support to development planning is also included in this category. The scientific and technical applications include the use of the computer for engineering design, research and analysis in such areas as hydrology, meterology, and highway construction. There is no way to generalize on the various uses in the developing countries without referring to their extent of computerization. A classification scheme for just such a purpose was included in the 1971 United Nations report, The Application of Computer Technology for Development. The four levels in this classification have been designated as initial, basic, operational, and advanced. The scheme is used in Section IV. E. of this report where foreign assistance for education and training is discussed and each level is briefly

defined. The initial level is characterized by no operational computers in the country while the advanced level connotes extensive use of computers and a full range of related professional activities.

At the "basic" level, the computers both in and out of government are used almost exclusively for what might be termed business-oriented applications. Examples are personnel records, payrolls, financial accounting, inventory control, and billing. Included are usually large statistical systems for the government such as census, customs, trade, and taxation. As more computers become available and a country's classification changes to "operational", there is increased use of the computer in scientific and engineering functions and more sophisticated applications in management sciences and operations research. Even at this point, however, there is very little use made of the computer as direct support to economic and social development planning. The major obstacle to more effective use and to the upgrading of the application is the lack of adequately trained systems analysts and designers. Steps to provide this training, coupled with orientation programs for functional managers to make them aware of the potentials offered by the computer, can provide the best means for extending the useful application of the computer.

The very definition of the "advanced" level of computer activity requires its use in all areas of government operations. Applications will be found in all three categories of management, functional operations, and scientific and technical work. Very few of the developing countries, however, will be found at this level of computer use.

The creation of the four "levels" of classification depending upon the extent of computer use, as suggested in the report of the United Nations, is entirely arbritrary. There are, of course, no firm lines dividing one level from the next. The real situation is that of a broad spectrum reaching from those countries without a single computer to those with advanced use of the latest techniques. The great majority of the developing countries find themselves somewhere from the basic level (with about a dozen computers) to the operational level (with from 80 to 100 computers in the country). The government is usually an early user of the computer, as has been stated, and the lower the level a country is on the classification spectrum, the higher will usually be the percentage of the total computers that are within the governments.

The development and growth in computer use in the government brings with it the problems of management and organization. This could be said about any new endeavor but these issues are of unusual significance in the case of computer activity.

Computer technology is a tool to be used in the accomplishment of the mission and functions of the various government offices. It is not a separate function unto itself but must always be regarded as a servant of those engaged in the discharge of the functional activities. The government managers would do well to insure that the mechanisms for the use of this tool do not dominate the purposes or functions to which they are related. Those engaged in providing computer services should always remember their purpose is that of serving and be able to accept this role without the interpretation that it is in some way demeaning. This principle should always be kept in mind as the government organizes to use this technology.

On the other hand, the capabilities provided by the computer are such that they have a profound effect on the fundamental management and organizations of the very functional activities it is supporting. The computer offers a here-to-fore unheard of capability to process and handle information--the principal commodity of management. In the past few years, much has been said and written concerning the significance of information in the control and direction of any activity and, more specifically, of government. It has been realized that "he who possesses and controls the information wields the power" and many are now also aware that the computer can make information available in a manner and time never before possible.

Thus, the issue of the organization and control of computer facilities in the government is a delicate one and can have far-reaching impact.

The issue of organization for computer activity in the governments of the developing countries has focused frequently on the degree of centralization of data processing equipment to the exclusion of the equally important problems of computer management. As a country is introducing computers in the government, is it best to establish a central computer facility or to permit each ministry to acquire its own hardware for its particular needs? The resolution of the degree of centralization to be established is a difficult problem for any manager, but particularly so for those unfamiliar with the advantages and difficulties encountered in the use of computers.

There are valid arguments to be made in support of both centralization and decentralization. Centralization offers certain economies due to scale. It is possible to have lower overall computer costs when the work is done on a large computer rather than a series of small ones. More efficient use can probably be made of the technical personnel and staff in a large, central installation. Centralization offers opportunities for specialization and the technical quality of the computer operations can often benefit. The larger computers are more versatile and are able to perform complex processing operations more efficiently. The centralization tends to encourage more

effective integration of activities and the availability of relevant data is improved. And, finally, the need for the many government users to be bothered with the details of operating a computer center is reduced through concentrating the responsibilities in a central staff.

Proponents of decentralization also have significant points that can be made. It is an axiom of good management that a manager is provided control over those resources required to meet his responsibilities. Computer services can be considered one of these resources and, therefore, should not be removed to some central authority over whom the manager would presumably have no control. The essential cooperation between the functional user and the computer staff can be better assured when they both report to the same official. Better team work can be expected and less delay in the development and implementation of needed services. In some situations, the case can also be made that the degree of sophistication of the technical staff can be less for the use of the smaller machines that are required for effective use of a large computer.

There is no single answer to the issue of centralization vs decentralization of government computer services that can be developed for all countries. Each must evaluate the factors as they relate to the peculiar circumstance in its own environment. The rapidly changing technology available must be one of these factors for consideration. The emergence

of teleprocessing, or networking, is making it possible to more efficiently use central computers through remote terminals and communications. This technology will alter the previous arguments for and against centralization and can be expected to change organizational decisions. It offers the capability to use a central computer without the usual dependence on the central staff. Teleprocessing, however, requires suitable communication facilities, as previously discussed, which do not exist in many of the developing countries.

As a general conclusion, it is recommended that the early installations of computers in government be on the basis of central service to meet the first priority requirements. The expansion of this capability should be fully supported by appropriate feasibility studies and the alternatives of centralization vs decentralization evaluated by a high level and impartial government authority with the help of appropriate and objective technical assistance.

The need for central <u>management</u> of computer planning and the establishment of regulations and technical guidance for the government activities has been all too often lost in the issue of the degree of centralization of computer <u>operational</u> facilities. The importance of the development, implementation and evaluation of national planning for the use of computers has already been discussed. Additional functions that need to be performed by a central governmental computer staff include: 1) scientific and technical advice and guidance

to government offices on such subjects as equipment capabilities; system development; advances in the state-of-the-art, and applications design; 2) establishment of system procurement policies and procedures, including feasibility study criteria and review, and hardware and software selection; 3) development of personnel policies, including salary structures, career development plans, and education and training; 4) and the development of a program of standardization as described under the section on national planning.

Some countries have already come to the conclusion that, in order to obtain the maximum benefit from computer technology, a central governmental authority is needed to develop the national regulations and policies required and to manage and implement them. There are two major problems associated with the creation of this staff:

1) the development and retention of competent personnel; and
2) the organizational placement of this staff.

The government personnel programs for computer specialists in the majority of the developing countries are seriously inadequate. It is not uncommon to find that the pay for a computer specialist in the government service is from one-fifth to one-third that for a similar position in the private sector in a given country. This results in the use

of government services as a training ground and the best performers are subsequently hired away by industrial and commercial enterprises. This practice has caused the government personnel turnover to be unacceptably high and has left its installations and staffs with too few competent people.

Since computer technology is so new in the developing countries, computer science has not been recognized by the government personnel systems as a separate and distinct profession. There is no provision for their identification and inclusion in civil service classification schemes and no established criteria for positions. This has made it impossible to have adequate career development plans for those engaged in the various tasks related to the computer.

These inadequacies have had serious effects on the attempts to develop better government computer operational centers and ADP management staffs. It has been a factor in the dissatisfaction of the government computer users of a central computer service and has contributed to the proliferation of computers in the government as the various users seek to supplant the unacceptable service with their own operations. It has also been a factor in the difficulties many of the countries have experienced in developing needed national policies and management direction. It is not unusual to find such activity being done by a staff with general management experience but with little or no ADP training and background.

The "people" resources are extremely critical in the successful use of computers. The planning for these resources deserves the same systematic approach recommended for hardware and software selection. First, what are the needs of the government service for computer specialists? This can be answered on several levels. Goals should be clearly stated for the computer activities, including the operational service centers and the management staffs. Then for each position there should be specific criteria established, i.e., the responsibilities defined and the knowledge and experience specified. These positions should be reviewed and appropriate classification structures developed to accommodate them. A realistic pay schedule must be established with full recognition given to pay for comparable jobs in the private sector and for jobs of similar responsibilities in the government service. The governments can expect to have to pay higher salaries to the computer specialist than to other government employees holding positions of similar responsibilities because of the newness of the technology and the shortage of trained people.

The other factors of importance to any good personnel program require special attention in the computer field because of the severe competition for capable people. These include the development of sources of new employees, effective selection procedures, training programs after employment, and a dynamic career development program including opportunities for interaction with others in the same profession, job rotation,

personnel evaluation, promotion opportunities and professional recognition. It cannot be repeated too often that people are the most important resource in the equation that leads to more effective use of computer technology and the available facts indicate the governments of the developing countries have generally not been successful in hiring or retaining adequate numbers of competent computer professionals.

The subject of the governmental role in the use of computers should not be left without reference to study and/or control commissions established by many countries. Such groups, or committees, have been frequently created as the government officials have wisely perceived the need for some central mechanism for the coordination of the interests and activities of all ministries in the ADP field. In the early stages of computer development, these committees are frequently expected to serve in a capacity exceeding their capabilities, such as decisions in hardware selection. The members quickly discover the need for technical competence and, thus, invariably recommend that a separate full-time staff be created. The usefulness also breaks down if they are expected to provide the active management for the government ADP activities. This becomes management by committee and is very seldom successful. The responsibilities for the government ADP management staff and operational services must be placed with selected individuals (or single individual if these two

activities are combined) and the necessary authority must accompany the responsibility. In addition, these individuals must report to an official sufficiently high in the government structure that there is adequate authority available to be exercised or delegated.

This is not to say the interministerial committees do not have a place. On the contrary, they can provide a most important service. Their principal role should be as an advisory body to the senior official to whom the ADP staff leader and operational managers report and to these individuals themselves. These committees can help guide the formulation of the ADP policies, facilitate the communications and understanding between the users and the technicians, provide guidance in the development of integrated systems supporting the needs of more than one group, and serve as an evaluative body insuring the responsiveness of the services and policies to the needs of the operating arms of the government.

Education and Training

Introduction

"Education and training for the application of computers to accelerate the process of economic and social development must receive first priority." This statement emphasizing the importance of education and training is the first conclusion presented in the United Nations' study entitled The Application of Computer Technology for Development. The theme is continued in the draft of the UN's second report on computers where education and training are presented as the most fundamental prerequisites for the successful application of computer technology for development. The importance of education in this context is supported by virtually all those engaged in any way with the use of computers in the developing countries. The United Nations agencies have each expressed their belief in its significance as have the international professional organizations and the individual developed and developing countries themselves. The survey work conducted by NBS in the nine selected countries produced overwhelming evidence that inadequate education and training have been the principal deterrents to more effective use of this technology. Regardless of the present extent of computer use or level of economic development and, although the type of educational requirements may vary, there can be no question that it is the major need to be fulfilled to permit more

effective use of the computer. The infrastructure necessary for this effective use has been frequently neglected and the cornerstone of this infrastructure is education and training for managerial and technical personnel at all levels. The introduction of education or orientation concerning this technology for the general public is also important but the need and approach must be carefully evaluated for each country.

B. Background

The introduction of computer technology in many less developed countries was frequently within a university, or in the statistical offices of the national government, or in the business offices of a major industrial or commercial firm usually with international affiliations. The equipment manufacturer has usually played a major role in these early installations and application. It has been a frequent pattern that the manufacturer will not only install the equipment but provide the first application programs and supervise the early months of operation. In the course of this work, the manufacturer has often been the only source available for any level of education and training.

The manufacturer-provided training has had an emphasis on input preparation, elementary programming and machine operation. There had to be priority given to those functions and tasks essential to the use of the computer for

specific applications. The immediate objective was to implement the selected applications and to provide for continuing computer support in these areas. It is not surprising that this training has been strongly oriented toward the hardware being used in the specific installation and emphasized techniques and procedures rather than broader principles and concepts. The end result has been a cadre of training technicians or programmers capable of performing within a narrow range of activities directly associated with specific applications and with a given set of hardware. This is not to criticize this approach. It is simply a recounting of the facts as they have occurred.

There have also been significant efforts made by selected universities of the developing countries to establish the fundamental educational programs needed in computer sciences and related disciplines. It is not possible to generalize on this effort or its success as there is such a wide range among the countries of levels of economic development, of computer use, and of educational programs. In many cases, however, the universities have become involved with computers at an early stage in their introduction in a country and have established at least a basic level of training for their use.

The degree of sophistication and extent of availability of the university programs for computer science education is one measure suggested by the UN report on the application of

computers for development to be used in classifying the countries according to their use of computer technology.

C. Educational Planning

The importance of education and training has been supported and underscored by all associated with computer use in developing countries. The critical issue is how to attack this problem--how to respond to what is an agreed truism. The objective can be simply stated. The task facing each developing country is the determination of the "right kind" of education for the "right numbers" of people. An educational plan is highly desirable if the proper balance is to be achieved of educational and training programs which will, in turn, provide the needed numbers of qualified personnel in all phases of computer activities.

The literature abounds with studies, reports, case reviews, and records of conferences dealing with the subjects of computers, education and development, or some interaction of the three. But, as so accurately pointed out by Gotlieb in his paper presented at the Rio Symposium on Computer Education for Developing Countries held in 1972, the hard data on the specific theme of that conference is scarce. What seems to be so often lacking, is a systematic approach to the solution of the educational need, ignoring preconceived ideas and unsupported opinions. The problem must be taken beyond the point of platitudes to hard facts and emotions must

be replaced by logical and supportable rationale. The national resources in question and the potential impact on the economic development demand the investment to support the use of the best system engineering techniques in this educational planning. As was pointed out by Dr. Marvin Johnson at the Cairo conference, the cliche "plan your work and then work your plan" has provided management with an effective approach for the guidance of industrial and business activity for many years. It is equally applicable to this issue.

A suggested approach to the educational planning would be to follow the logical steps frequently recommended for a feasibility study for an entire system, for, in fact, the educational process can be thought of conceptually as a system. A brief review of the steps for a typical plan follows.

1. Goals

The broad goals or objectives, of the educational "system" should be stated in clear and concise language. For example, it should include reference to the development of skills required for the expected or desired growth of computers over a specified period of time, and the achievement of effective use of these computers for economic and social development. It could also address the necessary development of public attitudes and managerial understanding of this technology. Whatever the appropriate goals for a specific country, they form the broad framework within which all

following steps can be judged. All phases of the plan must be able to stand the test of evaluation against these goals.

2. Levels of Education and Training

This phase of the plan is concerned with the identification of the various levels of education and the categories within these levels. It is intended to answer the question "what education or training is needed." For example, it is possible to single out three broad levels of education, i.e., general public education, managerial education, and education and training for the technical personnel engaged in some phase of computer activity. Within this latter area, the very use of the two words "education" and "training" implies the wide range of levels involved. This range can be bounded by the sophisticated, advanced graduate school education in computer sciences on the upper end and vocational training for computer operators and those engaged in data preparation on the lower end of the spectrum. The importance and purpose of the education in each level should be stated with some explanation of the desired relationship among them. This discussion should still be in non-technical terms and without concern for how such education would be accomplished.

3. Educational Needs

The use of the term "need" implies a quantification and an establishment of priorities. What is the magnitude of the educational requirement for the three broad levels and

categories as established? For example, how many managers should receive some indoctrination over what period of time? What skills are required within the technical area in what numbers and over what period of time? Which are the most important to immediate results; which are essential to long range development; and which can be postponed with the least detrimental effect? The development of these requirements is probably the most critical step and yet the most difficult. Resources will probably preclude the simultaneous response to all needs and the careful design of priorities will provide the balanced program so essential to most effective use of the technology. There are numerous examples of poor balance in the education and development of skills. Some countries have rapidly responded to the growth of computers with a crash program for the training of programmers. The result, in some cases, has been an excess of programmers with inadequate provision for capabilities in systems analysis. The inbalance in skills has resulted in ineffective use of the hardware and poor utilization of scarce resources.

The review of the use of computer technology in the nine countries selected for this specific project by AID has led to some specific conclusions concerning the need for computer education and training. Although each country must develop its own set of requirements and priorities, the following were found to be generally valid.

a. Orientation in computer technology is urgently required for senior managers in both government and commercial organizations. There is a general lack of appreciation of the potentials of the computer on the part of senior functional managers such as subcabinet officers and divisional heads. Equally as important, and also found lacking,

is an understanding of the major problems and pitfalls associated with the use of the computer as a tool in a given functional activity. It is imperative that the decisions concerning the use of computers should not be made through default by the technicians. They are in no position, because of the lack of knowledge of the broader issues and because of conflicting motivations, to make these decisions. Their input, however, must be communicated to the manager so that the technical issues can be included in the decision-making process. If the manager has no background knowledge there will be no effective communication and no basis for the evaluation necessary to lead to the decision. The need for this education of the managers as a high priority has been expressed by representatives of government, commerce, education and the computer industry in the developing countries. This expression came from all levels, i.e., cabinet ministers, corporation vice presidents, professors, and computer technicians.

b. Computer systems analysts and designers are in critically short supply. It has been common practice for the early applications for computers to be transferred from previous systems in which varying degrees of machine support may have been used. This transfer process has been with little or no fundamental change in the system, involving simply doing on a computer exactly what was previously done

on another machine. It is now usually done faster than before but that may be the only difference. Programmers have been trained to help in this transfer and to modify and improve the performance of these applications. The use of the computer in many installations has not gone beyond this transfer process. The major obstacle is the lack of qualified systems analysts and designers to perform feasibility studies for the determination of selected functions appropriate for computer support, to design the computer processes for these selected applications, and to guide the implementation of the computer program development to the point of accepted operations. Again, this lack has been identified as a principal deterrent to effective utilization of the computer by those involved in the developing countries.

c. The absence of adequately trained and experienced computer installation managers is a third major problem. This is an area of a real dilemma for the developing countries. Mr. Dessau of UNDP best expressed this problem in his presentation at the Rio conference as follows:

> "It is generally realized that computer specialists only become real professionals through an extensive learning process. Educational background such as engineering, mathematics, statistics, economics or computer science, etc., is regarded essential

> for filling jobs as computer specialists. However, only additional on-the-job training or work as a trainee in the computer center environment for a longer period of time will produce a truly useful and knowledgeable person who can, as an example, manage computers."

The computer manager is critical in any installation but his importance is even magnified in the developing countries. His responsibilities and role serve as prime examples of the inability of pure education to provide adequate preparation for the demands for actual performance. Particularly in a developing country, the computer manager will be expected to be able to perform all, or most, of the technical tasks under his direction, to be able to provide effective training and direction to his employees, to be able to communicate with his bosses, and to deal with a wide variety of external forces such as the hardware manufacturer's representative. He must be an expert in personnel management, in financial and budget matters, in hardware and software, and in public relations. He needs formal computer and management training and lengthy on-the-job training. And the developing countries need such capabilities now. Such is the dilemma. The only solution appears to be direct assistance from experienced installation managers. Depending upon the particular circumstances this help may be

available from within a given country, from other countries in a particular region, or from so-called developed countries. To be effective, this assistance must be direct personal guidance with a guarantee that the consultant will not take over the operations directly but teach the incumbent the techniques of installation management.

It is not enough that we talk about education and training in general as the first priority of more effective use of computers in the developing countries. We know much more about the problems and the areas requiring concentration. It is necessary to emphasize that each country has its unique needs but, the previously identified educational requirements can be substantiated as valid generalizations.

4. Educational and Training Specifications

This phase of the plan includes the development of the specific educational and training programs to meet the needs identified. It should outline the steps to be taken to provide the education needed, including such details as requirements for teachers, fixed facilities, course content, travel, external expert assistance, and a schedule for implementation. It should include adequate detail to permit estimates of resources for each segment of the plan.

It is all too frequent that educational or training programs are prepared that include only this step of the planning process. For example, a need may be perceived for advanced computer science education at the graduate school

level. A plan will be developed for such a program and steps taken as a result of such isolated planning runs the danger of supporting a specific area without regard to its priority within the total educational requirements. It also does not provide for the determination of the appropriate balance of skills relative to the expected national demands. Such a program is usually valid and needed in its own right but this is no guarantee that it is the wisest step to be taken by a country where resources are in particularly critical supply.

5. Evaluation

This is a phase frequently overlooked in the planning for any system or activity. The total planning process is an iterative one requiring feedback from results for modifications as appropriate. The implication of a continuing process is all-important. There are at least three areas of the educational planning that should be under constant review, i.e., the technical acceptability, the economic feasibility, and the acceptability to the ultimate "user" or manager. The technical acceptability deals with course content, adequacy of facilities, the imbalance of resources such as teachers vs. pupils, and whether or not the schedule as established is proving workable. The economic feasibility is a review of the level of resources being expended compared with the results of the program and with the expected availability of the resources. This

would include a determination if the resource estimates were reasonably close to actual requirements and the modifications of the plan as necessary because of economic considerations. The acceptability to the manager requires an evaluation by him of the results of the educational plan, the adequacy of skills available in numbers and quality, and a restatement of his needs which, in effect, starts the recycle of the planning process.

D. Technical Information

The importance of effective communication of technical information related to computers and their use cannot be overstated. This information is needed in a variety of forms by managers, systems analysts and designers, hardware engineers, programmers, researchers, and installation operators. As in other technologies, this free exchange of information is the life blood of the computer industry in the developed countries. One researcher builds upon the work of others; applications designers take the results of the researchers and put them into practice; ideas for more effective operations management are developed from the successes and failures of others; and programming techniques are improved upon and applied through the exchange of information among the programmers.

The opportunities for such communication are many and varied in the developed countries. Direct, personal contact with individuals having special skills and knowledge is usually as close as the nearest telephone. Conferences and

symposia abound in the many speciality areas of computer sciences and management. Reports, studies and the technical press have grown at a very rapid pace and the principal problem is the organization and handling of this literature for quick and specific retrieval. The issue is one of selectivity from a great volume of information.

The less developed countries face quite a different problem. The computer specialist or manager attempting to develop and implement computer applications or to do related research in these countries is usually very isolated from others engaged in similar efforts. The degree of this isolation depends, of course, on the stage of computer use and activity in the particular country but in most cases there are a very limited number of people to whom one can turn for consultation. This lack is particularly critical in the computer field as great dependence is placed on the direct exchange of ideas and on learning through on-the-job training.

This isolation places a premium on the availability of current technical literature. The range of technical literature on computers includes text books, periodicals, research journals, technical studies and reports, notices of meetings and their reports, and advertisements of new products. In spite of the recognition of the importance of this literature and its emphasis in reports and conferences, the lack of

technical information is a severe problem in most of the developing countries. The representatives interviewed in the nine countries visited as a prelude to this report identified this paucity of available technical information as a deterrent to more effective computer utilization. In addition to the availability issue there is the problem of the language in which the literature is written. The vast majority of information in the computing field is in English and it has become almost the universal language of this field. It is necessary, therefore, to provide for either translation of this literature; for the development of a working knowledge of English by those involved or some combination of these alternatives.

The issue of adequate technical literature cannot continue to be overlooked. Managers must be encouraged to provide the resources for the acquisition of this material as an integral part of the budgeting process for a computer activity. Educational planning should include the necessary action for effective dissemination of the technical literature once it has been acquired. Project planning for the introduction of new or additional computer capability should include resources to provide the needed technical information support. An approach to such planning might be the inclusion of an arbritrary percentage of the total project cost for this information support. Such an allocation can be looked upon

as protection or insurance for the effective use of the investment being made in the total project.

E. Foreign Assistance

Not only are education and training the most critical needs for the developing countries, they also represent one of the most susceptible areas for improvement through foreign technical assistance programs. There is much evidence for this statement. Intergovernmental international bodies, international professional organizations, individual developed countries, private foundations, individual educational institutions, and commercial enterprises have each participated in programs to assist developing countries in computer education and training. These efforts continue today. There are outstanding examples of successful results that have been recounted in reports and studies. There are, of course, also a limited number of stories of failures. Unfortunately these failures are seldom documented in any detail and the opportunity for others to learn from these mistakes is diminished.

The major criticism that might be made of many of the past and present programs for educational assistance is the absence of an educational plan for the country involved. As previously discussed, without such a plan there can be no assurance that the programs being undertaken are addressing the priority problems. An investment in the planning process

as described will be more than repaid by increasing the effectiveness of the total resources made available through all sources for education. Many of the developing countries have recognized this need and are in various stages of evaluating and planning their educational requirements. This should be the first area of exploration for possible foreign technical assistance. Requests for specific help in educational matters should be evaluated in reference to such planning.

Since this report is intended to serve as a general guide for those directing the use of computer technology in the developing countries and for those providing foreign assistance to this process, there will be no attempt to develop specific solutions to the educational problem. It is believed, however, to be of some value to review the mechanisms available for this assistance and to make some evaluative observations concerning their usefulness. This can best be done by considering the issues as related to the developing countries within the classification scheme established in the 1971 United Nations report, The Application of Computer Technology for Development. This is considered necessary as the use of the mechanisms for educational assistance will vary so widely depending upon the extent of economic and computer development of a particular country.

1. Initial

The first level in the UN classification has been designated as "initial" and is characterized by no operational

computers in the country, only a few nationals have had any contact with computers, and the only sources of information are the computer salesmen. These conditions mean that such a country will be concerned with the preparation necessary preceeding the first hardware installation. What are the most desirable steps to be taken to provide the education and training to permit effective use of this first installation? What continued expansion can be expected and how will this effect the early educational programs?

It is obvious that extensive external assistance will be required. There is no absolute pattern that should be followed but some general observations can be made. The senior managers, those who will make the decisions concerning a commitment to computer use, should receive an early indoctrination. Ideally, such executive-type training should be obtained without hardware bias and might best be sought from other than a manufacturer. There will be no way to develop adequate skills in the indigenous personnel to the level where they can accomplish the feasibility studies for first applications and to conduct planning for the hardware acquisition and all required supporting subsystems. These actions will have to be accomplished by experts brought into the country for this express purpose.

The managers should insist that once they have made the decision to proceed, resulting from their evaluation of the

feasibility study, the next phase of planning include the provision for the education and training. Consideration should be given to advanced computer science education for several individuals and acceptance that this will require two to three years of study at some foreign center of excellence. Training for those engaged in the actual operations should begin as soon as a hardware selection is made. This training can be made a part of the manufacturer's responsibility but should be guided and evaluated by a consultant who should be available from the time of the preparation of the feasibility study through at least the first year of operation. Although the manufacturers have provided excellent training in many circumstances, without which there would have been no way to introduce computer technology, their profit motivations make it difficult for their advice to be accepted as objective. There is no way for the senior manager to evaluate this advice without the assistance of an "impartial" consultant. The presenence of a competent individual in this capacity is an important ingredient to a successful program.

It is particularly important that much of this early training be on-the-job and it would be desirable to have the first months performed in an installation using the same hardware as ordered and applications as similar to those scheduled for early implementation as possible. This might best be obtained through a "twining" relationship between the

using organization in the developing country and an organization in a developed country (or another developing country) engaged in similar functions. The training can continue on the hardware installed within the country assuming a staff of experienced operators and programmers will be imported for a significant period of time.

A very important point that should be understood and accepted prior to a decision to introduce a computer is that the resources that must be invested in people, including training and salaries, will probably exceed that required for equipment. Skilled people are the most important ingredient in effective computer use. For development, employees such as programmers and systems analysts are needed; for operation, the services of managers, operators, etc., are essential. In practice the two activities usually coexist. Some sort of computer installation is required to check out developmental efforts. And almost every installation engages in continuing development as old systems are modified and new ones begun. Such a capability is an absolute necessity in the developing countries. The optional combination of manpower resources and hardware expenditures will clearly depend upon relative costs and on the services which the installation is supposed to provide. There is no uniformly "correct" ratio of hardware costs to total expenditures. However, many installation managers devote one-third to one-half their budget to equipment.

The first hardware installation in a country should not be judged in its effectiveness by the hours of computer time spent in productive applications. It will necessarily serve as an educational tool. Training can now begin in earnest within the country on its own equipment. The educational and training plan can be built around this first installation and growth planned from this point. Early expansion into a local university, if this is not the location of the first installation, would be a most important step in the pattern of evolutionary growth.

There is no way to prevent the need for external assistance in the early operations. It is most important, however, that this external assistance be required to include a strong element of education and training in all of its phases. For example, it will probably be necessary to import an installation manager for the first year or two of operations. One of his most important tasks will be the training of his replacement. There should be provision for the gradual transition of the role of the external expert from one of line management to one of consultation to the individual being trained to assume the responsibility of installation manager.

2. Basic

The second level of computer use has been designated by the UN report a classification of "basic". It is characterized by some understanding of computers by

government and commercial managers; a limited number of computer installations with a few nationals involved; some use of computers in government operations; and limited computer education and training in the country.

The education and training available at this point in computer use in a country is still frequently very dependent upon the capabilities of the hardware manufacturer. It is typical that the early applications programmers receive their basic training from the firm that has installed the computer. As previously suggested, it is important to have an experienced consultant available to guide and evaluate this training. However, at this stage of development, there probably is no effective alternative for this training.

The mistake frequently made is that no steps are taken to progress beyond this source of programmer training. Specifically, it should be recognized that systems programmers will be needed as soon as they can be trained. This is difficult as few formal courses exist in this area and there is no good alternative to having the trainee learn through on-the-job participation with experienced personnel. Graduate courses in computer sciences are excellent sources for systems programmers, particularly after they have had several years of applications programming experience. Until such competence can be developed, the management of the early computer installations in a developing country would be well

advised to obtain the services of at least one experienced systems programmer through external assistance and independently from the hardware manufacturer.

The "basic" level would be a critical stage for the country to obtain external assistance in the development of a refined educational plan and to insure steps are taken to develop an expanding graduate level effort in computer sciences as the basis for the education of the educators. Guidance should be sought from other countries where such graduate programs exist. In addition, this is not too early for the introduction of the computer into the university programs in a wide range of disciplines. At least plans should be developed, if personnel capabilities and hardware are not yet available, for the inclusion of course material leading to the use of the computer as an accepted tool in, for example, engineering, economics, business administration, and physical sciences. Again, assistance from institutions where such programs are active would be invaluable.

3. Operational

This third level assumes a rather sophisticated capability in the use of the computer. There is assumed to be extensive understanding of computers by the managers in the public and private sectors. Some of the installations have large computers and design and produce their own software. Computer applications have expanded beyond the business and

statistical functions to such areas as science, engineering, and medicine. Centers for computer education and training have usually been developed by this point and frequently degree programs have been started.

The foreign assistance in education appropriate for those countries at this stage in their use of computers should stem from a national educational plan. It is surprising the number of countries that have reached this stage and have yet to make a systematic review of their computer educational needs and planned accordingly. If no such plan exists, any foreign assistance in education should be directed toward its development. Recognizing there will be exceptions to this statement, assistance for a particular educational effort should only be provided when there can be a demonstration of its need and its relationship to all phases of education and training clearly established. As previously stated, the desired objective is a balanced educational program that will develop the appropriate mix of computer scientists, analysts, programmers, operators, etc. This will require a full range of education and training from graduate courses to vocational programs.

Technical assistance for the implementation of any phase of the educational plan for countries in the "operational" category should be based upon a closely coordinated cooperative effort with significant participation by local

nationals. These countries have nationals with sufficient experience, competence and knowledge to guide their future development of computer use. Assistance can be expected to be required to insure the local experts are current with the latest state-of-the-art, to provide consultation services in the refinement of various educational programs, and to provide guidance in the development of specific applications.

4. Advanced

The "advanced" classification level for computer activity in a country implies general understanding of the significance of the computer by activity managers and its widespread use in the public and private sectors. The number of computers is growing rapidly and new applications are being developed regularly. Computer sciences has been accepted as an established progressional activity and there is a complete range of educational programs.

The technical educational needs of such countries can be satisfied, in general, by their own internal capabilities. The relationships with technical personnel from other countries can now be more of a peer level exchange than of assistance from a developed to developing country. Educational assistance can best be accomplished by providing resources where needed for the technical personnel from these countries to fully participate in advanced technical symposia and conferences. Their educational needs are similar to those of

the technical personnel in the developed countries; i.e., exchange of information and discussions with others engaged in similar research, development projects, or applications.

V. Computer Applications

The uses of computers are frequently grouped into five major categories according to the type of functional operation being supported, i.e., business-oriented processing, scientific and technical applications, industrial production and control, information management, and education. The following examples are given in order to better describe the activities under each category:

Business-orientation: accounting, payroll, inventory

Scientific and engineering: highway design, meteorology, economic analysis

Information management: data storage and retrieval systems, library automation

Industrial: process control, quality control

Education: computer-aided instruction, specific educational programs

The applications found in the developing countries vary, of course, according to the level of development achieved in any particular country. A brief treatment of the computer uses as they vary with the level of computer technology in a particular country is found in this report under the section on the Government as a Computer User. For countries in the "basic" to "operational" levels, probably the appropriate range for the majority of developing countries having up to about 100 computers, they are being used predominately for business-oriented processing. The computers in labor

industrialized countries have generally replaced conventional punch card equipment, with government taking the lead in their introduction. Examples of the business-oriented applications can be found particularly in the public and private service sectors and include payroll, accounting, inventory control and the like for government, transportation, banking, communications, and other utilities. As additional computers are introduced and education and training begin to provide expanding skills, computer applications extend to engineering activities and limited scientific uses.

This growth pattern has been largely influenced by the existence of functional activities with procedures effectively systematized and, therefore, susceptible to computerization; by those activities where adequate data exists or can be easily collected for processing; by the availability of computer programs capable of supporting a given application with little or no modification; and by the experience and knowledge of the computer personnel involved. There is nothing wrong with this pattern. In fact, it is probably a logical way to gain early computer experience. However, to some degree, the situation has been one of having a solution available--in this case a computer and specific programs--and looking for a problem that can be solved. It is time for a change to a thorough examination of the needs for economic development and the establishment of a program of responsive computer support.

The planning implied in this approach has been discussed in this report under the government's responsibilities for computer development, but special consideration for the use of computers in the economic development planning itself is essential.

Computers and computer technology have played a central role in the growth of modern economics by providing an essential bridge between the accumulated body of formal theory on the one hand, and the growing availability of large data bases, on the other. The result of this crucial bridging function has been the growth of modern econometrics and, more recently, an increasing application of economics to the formulation and testing of alternative policies and programs for dealing with social and economic problems.

Development planning literature reflects an increased use of quantitative analysis. Three types of models have been used extensively by economists engaged in analyzing and planning economic growth. Aggregative macro-models, which apply to the entire economy, have been employed to deal with single aggregates such as consumption and investment, and to project growth rates of national income. Sector models, emphasizing agriculture, exports or industry, have been used to plan and allocate resources between competing investment projects. Finally, interindustry models have provided a means of analyzing the relationship between sectors during the growth process.

In the past five or six years, there has been a major new development in the use of computers in economics. The innovation has occurred in connection with a growing interest among economists in the analysis of public policy issues, especially in such fields as education, health, and poverty. Economic issues are prominent in all of these fields because in these, as in other public policy issues, it is of crucial importance to ask and to investigate four key questions, all of which have a predominant economic component: How much does each proposed policy alternative cost? Who will pay? How large are the benefits? Who will receive them? Work in all of these fields has involved a typical and crucial role for computers in providing the necessary bridge between initial theory, and a large and growing assortment of data bases relating to these problem areas.

Although examples can be found of the use of these three types of models in planning economic growth in the developing countries, the use of the computer in such a planning process has been limited. One of the main obstacles to using both input-output analysis and linear programming models for these countries lies in their great demand for accurate statistical information. Often the technology, which the development plans consider, does not yet exist in the country being studied. Hence, estimates based on the experience of other nations must be utilized.

As data collection in the developing countries improves, aided by the computer, the use of such models for planning growth should become more worthwhile.

In spite of the obstacles to computer-supported planning, this is considered to be an area of great potential to the developing countries. The few examples of successful application provide ample evidence of this potential. The NBS survey work of computer use in the nine selected countries revealed very little effort being directed toward this type of application.

There can be no general solution proposed to the problem of the selection of applications for priority support from computer technology. In fact, the key to success is to depart from generalizations and to examine in detail the benefits, problems, and requirements for each specific possible application. The solution to this need is the feasibility study as outlined under national planning. It is nothing more than a systematic presentation of all factors related to the problem beginning with the statement of the objective to the detailed analysis of the feasibility of the particular application, including the technical and economic aspects and the proposed system's acceptability to the user.

It is not possible in this report to provide exhaustive treatment to the subject of computer applications in the

developing countries. There are numerous reports and studies concerning various aspects of computer use and these are referenced in the bibliography for the reader to pursue according to his particular area of interest.

VI. Standards

The fundamental objective of more effective use of computer technology can be significantly enhanced by the selective development and implementation of computer and communications standards. Their importance was briefly referred to in the section of this report on national planning where standards were defined as consensus-derived agreements on how the design, performance and other characteristics of products, processes, materials, services, procedures, and systems are to be described and measured. They are a recognized mechanism for achieving compatibility or interchangeability and, thus, are of unique importance to the developing countries where there are severe shortages of skilled manpower and resources for computer development.

There are eight major areas in which standards should be considered, i.e., 1) software, 2) documentation, 3) data, 4) hardware, 5) communications, 6) ADP environment, 7) applications, and 8) acquisition standards. Of these, standards for software are especially significant to countries with little indigenous analyst or programmer capability. The absence of adequate software standards often blocks the transferability of programs from one installation to another and forces the rewriting of the programs. This is an expensive and time-consuming task and may be simply impossible in a developing country for lack of technical personnel even if the resources can be found.

The computer world today is dominated by software, the schemata which makes possible the desired applications of any computer system, and it has become the major obstacle to all our attempts to channel the power of computers to serve societies best interests. As computer use has grown, most of the problems and issues of computer utilization have been in software and management of computer resources. The customer's interest in hardware and software is secondary; the principal concern is the service the system will provide. Software standardization can directly contribute to higher quality service, but the rapid growth of the computer industry has greatly complicated the attainment of this objective.

The benefits of standards to the computer customer are numerous. They should provide him with assurance that he has made a proper selection that proves to be cost effective. He should be assured that he has acquired a software product that is usable in a variety of applications. Ideally, when effective standards are available and applied, the computer customer has only to worry about performance and price in his selections. Unfortunately, such is not the case today even in the developed countries.

Probably one of the greatest immediate benefits to the computer user can be achieved by requiring quality control procedures during software production and documentation of software products against prescribed standards. This is admittedly difficult because of the absence of product performance or design specifications for software. Other

than benchmark tests and simulations, there are no uniformly useful market tests for software. Their absence, however, places even a greater need on the use of quality control procedures to insure that product components meet certain standards, are within allowable error tolerances or are produced using prescribed techniques. These procedures can be invoked even when more complex design or performance specifications cannot be developed. They can serve as an important step in obtaining optimum results from limited programmer resources and the resulting programs will permit more effective use of hardware.

The documentation of software has traditionally been an area of neglect by the programmer and by his manager. The results of such neglect are obvious. Optimizing the program becomes more difficult without adequate documentation and the effective use of the program becomes dependent upon the individual who wrote the program. Its transferability is difficult and its later maintenance and improvement may not be possible. A program's utility is enhanced by the ease with which other people can use it. In the developing countries this transferability is critical. The ability to share computer software extensively is directly dependent upon the uniform documentation systems for describing computer programs. Documentation exists at many levels: for the person who wishes to know how to use the program; for the

person who wishes to know the methodology implicit in it; for the person who wishes to follow the coding; and for the person who wishes to modify the program. Standardization of the documentation will be a major contribution to each.

As computers receive wider acceptance, it becomes increasingly important that the codes adopted for data representation be as standard as possible. The interchange of machine-readable data between systems, the interlocking of files, and the improved efficiencies through the use of standard conventions are compelling reasons for a program of data standardization. For example, a standard code representation for political subdivisions in a country will simplify keyboarding and data input, permit the direct entry of machine-readable data from one system into another, and simplify the understanding of data output. The correlation of statistical data related to these political subdivisions is an important task within a government and data standards are essential if the full benefits of computer support are to be realized.

Reference has already been made to the unique possibilities offered by teleprocessing, or computer networking, to the developing countries. The sharing of computer facilities and data through such networking can mean very substantial savings in resources and skilled manpower. The ability to benefit from the linking of computers and terminals by communications,

however, is very much dependent upon a wide variety of standards. The electrical characteristics of the pulses on communications lines, the codes used, the protocols for establishing connections between computers and terminals, and error control procedures are but a few examples of the items or activities requiring standardization.

The developing countries have an excellent opportunity to reap major advantages through standardization of computer applications. The development of applications systems and programming are expensive and require skills that are in short supply in the developing countries. It seems senseless to design and build individual payroll and inventory systems, for example, when the basic functions are identical, or very nearly so, in many commercial and public enterprises. There has been little such sharing of know-how in the developed countries, particularly the United States, due to competition. It would appear that the developing countries cannot afford the duplication of effort resulting from the lack of such interchange. At a minimum, the governmental and quasi-governmental activities should be able to gain through applications standardization.

The possibilities for major economies and rapid spread of computer technology through international interchange of applications programs should not be overlooked. Developing countries in a given region, for example, have an excellent

opportunity to gain through such sharing and exchange. There are two principal obstacles to be overcome. One is the many variations of computer applications programs for the same basic function as a result of the absence of standardized solutions. The other is the unwillingness to cooperate on a regional basis because of national pride and competition. Both can be overcome by enlightened leadership in governmental and professional circles.

Standards for the use in acquisition of hardware and software can be effective tools in dealing with the sellers of these products. Technical specification standards, properly used, can help in assuring the acquisition of good quality products and also in stimulating competition by insuring a maximum degree of interchangeability of both hardware and software.

The questions facing the officials of the developing countries are do we need computer standards and, if so, which ones are important, how are they selected, what should be done about their development, and how is their use promoted? It is hoped that the first question--are they needed--will be answered in the affirmative. This will be a change as the results of the Bureau of Standards survey revealed little interest--or at least little action--to conduct a computer standardization program.

The other questions are much more difficult to answer and, in fact, there can be no single answer to each that is appropriate for all countries. It does not seem profitable to enter into generalizations in this report. Rather, it is urged that the appropriate government officials, computer experts, and standards officers cooperate in a review of the needs of the country and develop appropriate plans. It is suggested that little standards development work be attempted in most developing countries but the major effort be directed in the transfer of existing standards from other countries and the International Organization for Standardization (ISO) to meet the priority needs as identified. Contact is invited with the United States National Bureau of Standards in this regard.

APPENDIX I

COUNTRY SURVEY RESULTS

I. Introduction

The collection of information concerning the use of computers in the developing countries was a major task in the program to provide for their more effective application in the developing process. On-site surveys were conducted in nine countries, i.e., Nigeria, Uganda, Ethiopia, Turkey, Brazil, Colombia, Korea, the National Republic of China, and Thailand. These countries were selected to provide a wide geographic representation and a cross section of various levels of economic and computer development. In each country, the objective was to gain knowledge of the level and nature of computer activity, the factors that have led to successful use of computer technology, the principal deterrents to its use, and forecasts for its future. This information was collected from interviews with the national policy makers and officials, the managers of governmental computer activities, the local representatives of the major computer manufacturers, the corporate managers and computer managers of industrial and business enterprises, and the educators.

II. Survey Results

The names and titles of the individuals interviewed and the summary of information collected are given in the country summaries presented in this appendix. Additional detailed data is available at the National Bureau of Standards concerning

various aspects of computer activity in each of the nine selected countries.

NIGERIA

Interviews:

Government:

E. E. Adewole, Chief Statistician, Federal Office of Statistics

G. O. Awomolo, Head, Data Processing Unit, Federal Office of Statistics

Mr. Faladun, Demographer, Federal Office of Statistics

Education:

Prof. O. J. Fagbemi, Director, Institute of Computer Sciences, University of Lagos

Prof. Morrison, Acting Head of Computer Center, University of Ibadan

Manufacturers Representatives:

IBM World Trade Corporation -

Gordon Biddie, West African Manager

Richard von Wasmuth, Nigeria Manager

NCR Corporation -

B. G. Gray, Nigeria Manager

Summary of visit:

There are 35 computers in Nigeria (as of May 1972); 29 are IBM equipment and six are ICL. About 45% of revenues received by IBM in Nigeria come from the Nigerian government with 30-35% from the oil industry and 15% from the distribution sector of the economy. The largest computer currently in

operation is the IBM 360/40 at Shell-BP and this firm has about 70 people in ADP activities, with all being Nigerian except the managers. The majority of the IBM computers are in the range of the 360/20's to 30's.

The Nigerian Government's use of computers has grown rapidly, as the government has grown, in the last few years. The following is a summary of the information given by representatives of the Federal Office of Statistics:

1. Centralization of computer activities in the Nigerian Government is urgently needed. Those on the computer center staff of the Office of Statistics felt that any centralized facility must be separated from any single ministry to permit the most effective support to all customers. The various government ministries have argued for their own computer facilities and a government committee report recommending centralization has had little impact.

2. There is a salary disparity between ADP employees in government and those in industry that favors industry by ranges from 3 to 1 to 5 to 1 for comparable jobs; ADP is not a recognized profession in the civil service structure and there is no career pattern for those engaged in ADP activities; government trains the personnel and many leave for jobs with industry.

3. The lack of adequate numbers of trained personnel is a major problem.

4. Most government computers are seriously under-utilized; most are used for 100 hours per month or less; there is no provision for shift work and overtime pay is not available.

The Nigerian Government established a committee to develop recommendations for all aspects of ADP activities in the government, including acquisition of hardware, fisca control, and operating support. The study produced by the committee supported centralization of policy, control and services but no action has been taken. The impression was left that there is little hope of internal cooperation among the ministries concerning ADP development without unusually strong central direction from very high up in the government. This direction does not seem imminent. (The IBM West African manager personally supports continued decentralization. He feels that due to the lack of any coordinating mechanism or provision for priorities to be established and controlled that centralization would not be workable. He also made a case for the need for more specific application experience.)

The discussions with the NCR manager included a description of this firm's activities in Nigeria and some of the general problems in doing business in this area. NCR employs about

300 people in Nigeria; there are only ten expatriates and one-half of the top management staff is Nigerian. The largest equipment NCR has in Nigeria is the 500--a visible record device with slow paper tape input and output. The banks and government offices are the principal customers. The manager, expressed the opinion that training was his number one problem in doing business. There are three sources for his EDP customer engineers, i.e., NCR technicians in other areas, employees hired after training outside of Nigeria, and university graduates. Individuals move through a training cycle from programmer to senior systems analyst in about four years. Although the university graduates can compress this time, the NCR management is less satisfied with their work. These graduates seem to feel that the jobs available are beneath their dignity once they have finished a college education. There are few jobs, however, where graduate engineers can apply their newly-acquired skills and the NCR jobs are largely of a maintenance nature. The manager stated that he has experienced no serious regulatory barriers to doing business.

The IBM office in Nigeria has its own IBM 360/20 and will soon upgrade to a 360/30. Shell-BP, one of their principal customers, is planning to upgrade to the 370 series and when this happens IBM plans to move the 360/40 now at Shell to their own offices. There are pending orders for three

370/135's in various government offices, a 370/145 has been delivered to the University of Lagos although it was not in operation in May of 1972, there are at least three orders for 360/20's or 25's, and IBM is promoting the System 3 for replacements of the smaller 360's. There is no independent software activity in Nigeria so all software assistance to the user comes from IBM. The IBM representatives stated that there was no problem from concern over unemployment due to computer use. There are no unions in Nigeria; the "extended family" is the central unit and resources are shared within this group. It frequently includes over 100 people, many with the remotest blood ties. The general citizen does not know enough about the circumstances to be concerned about the computer's impact on employment, in the opinion of the IBM officials. These officials made the following comments when asked about regulatory barriers to doing business.

1. There is a quota system for expatriates in Nigeria; IBM originally was permitted 21; this has now been reduced to 12 but does not represent a serious problem.

2. Individual laws are passed from time to time that cause troubles; for example, a law was passed about a year ago that <u>everyone</u> in the country was to get a raise in pay.

3. There is an import duty of 42% on equipment such as a computer. IBM Nigeria buys a computer from IBM UK, for example, at a wholesale price. The 42% is computed against the wholesale price and passed on to the customer in a single charge at time of installation whether the customer is buying or leasing. Additional difficulties identified by the IBM representatives were as follows:

a. There is a high loss of shipments of parts into Nigeria; it frequently takes three orders to get one through and in IBM's hands in Nigeria.

b. Communications are very bad, particularly with other countries; the telephone system is undependable; therefore, all support activities are complicated.

c. Physical support, i.e., site preparation, power supply, etc., is a serious problem; it is difficult to get proper construction work accomplished; all installations require voltage regulation equipment as voltage fluctuates significantly; power failures occur frequently; the Shell-BP firm spent $100,000 to provide their own constant power source.

In the face of all of these difficulties, IBM representatives emphasized that the most significant problem preventing improved computer utilization is the inadequate pool of trained personnel. The most critical areas are:

1) the lack of knowledge at the managerial level of scientific management techniques and the potentials of effective use of such tools as computers; 2) the need for systems analysis and design capabilities to provide for the development of total production systems within which a computer can be inserted as an effective tool; and 3) additional and more advanced programmer training. IBM is supporting educational activities at the University of Lagos (providing a visiting lecturer and advanced work for one Nigerian overseas) and originally built the computer center at the University of Ibadan and provided training for a two year period for representatives from East and West Africa. In the opinion of the IBM manager, there will be a minimum of five years of educational development required to begin to solve the training problem and there is not much that can be done to rush it.

The IBM representatives strongly supported the points made by government representatives that there is need for government recognition of the professional status of those working in the ADP field and that salaries needed major revision within government.

There are five universities in Nigeria and four have computers. IBM equipment is used at Lagos, Ibadan and Ife and an ICL computer is installed at Zaria. Visits were made to both the University of Lagos and the University of Ibadan, located at Ibadan about 90 miles from Lagos.

At the University of Lagos, Prof. O. J. Fagbemi, who has become extremely active in UN activities and symposia dealing with computer use and education in the less developed countries, discussed the manpower and educational problems in Nigeria in general. A survey was made in 1968 of manpower requirements for ADP-trained personnel in Nigeria and resulted in an estimate of a total of 166 in all categories. Prof. Fagbemi feels that this figure should now be about 200. He estimates that this equates to a total of 3,000 engaged in work related in some way to computer activity. In 1968, there were 800 in computer-related work, of which 60 were programmers or above in technical training (15% were Nigerian). There were 14 installations in 1968 and there are now 35 in the country.

Prof. Fagbemi provided a detailed description of the courses, planned or underway, in the computer sciences institute of the university. These include extension courses, an undergraduate program in computer sciences that is due to begin next year, a post-graduate certificate course in software systems and systems analysis, a post-graduate degree program in computer sciences, and an international post-graduate diploma course in computer sciences sponsored by the UN. It was estimated that about 60 people were currently involved in the extension courses

and 16 in the UN-sponsored diploma course. It was expected to have 12 in the post-graduate degree course in the fall of 1972.

Prof. Fagbemi stated that there is a shortage of trained programmers, analysts and managers; there is an excess of key punch operators as a result of training given for the last census activity. He expressed particular concern for the need for systems analysts to effectively identify appropriate applications for computer support. He discussed the government ADP committee study and expressed his strong personal support for centralization. (Fagbemi was a member of the committee and a power behind its work.) The first study was completed in 1968 but no action taken. It is now being updated. It included recognition of the need for improved government pay scales, centralization, and more education and training.

The University of Lagos was operating an IBM 1620 in May of 1972 and had taken delivery of a 370/145 with three 2780 remote job entry terminals and five 2741 terminal devices. There was a building under construction to house the 370 that was scheduled for completion in June. (Later information revealed slippage in the schedule but it is understood to now be in operation.)

Prof. Fagbemi, when questioned about the use of computers in economic development planning, stated that the Ministry of Economic Development and Reconstruction was aware of the potential of such assistance but there was no evidence that a computer is actually being used in such planning.

Prof. Morrison, a U.S. citizen, was serving as Acting Head of the Computer Center at the University of Ibadan while the Nigerian who is head of the center was in the U.S. getting a doctorate in computer sciences. The Center has an IBM 1620 and a 360/25. They are planning to upgrade to an IBM 370/135 in a couple of years. IBM built the center building at Ibadan in 1967, installed the 1620, and conducted courses for two years as a regional training center for Africa. They have since turned the building and computer over to the University.

The computer at Ibadan is centered around support to all departments of the University rather than primarily serving as an instrument for teaching computer sciences. There is no degree program in computer sciences at the present time although one is scheduled to begin in about a year. There is a small graduate program in computer sciences as a part of the mathematics department. Prof. Morrison feels that it is most important to keep the orientation toward applications in

all disciplines rather than toward computer sciences per se.

The IBM 360/25 is used for two shifts for a total of 175-225 hours per month. The staff, with the exception of Morrison, is entirely Nigerian. The facility was well-cared for and appeared to be efficiently run.

ETHIOPIA

Interviews:

Government:

Ministry of Finance -

Gabriel Fassil, Director General, General Accounts

Tewolde Berhe, Acting Data Processing Manager

Imperial Highway Authority -

Jack Gunther, Supply and Equipment Manager

Solomon Berhann, Chief, Data Processing Branch

Imperial Board of Telecommunications -

Gabriel Tedros, Acting General Manager

Constantain Protogerellis, Finance Manager

Central Statistical Office -

Bogale Demissie, Supervisor of EDP

Manufacturers Representatives:

IBM World Trade Corporation -

H. G. Leet, Ethiopia Manager

Burroughs Machines, Ltd. -

G. B. Soodeen, Ethiopia Manager

UN Economic Commission for Africa:

Ademola Banjo, Head, Science and Technology Section

Summary of visit:

A survey of data processing facilities in Ethiopia was made in November 1971 by Ato Bogale Demissie, Electronic

Data Processing Supervisor of the Central Statistical Office. The following are highlights:

1. There are twelve data processing installations in Ethiopia, including the IBM 360/20 computer at the Economic Commission for Africa.

2. All installations are in Addis Ababa except one IBM 360/20 at the Imperial Ethiopian Navy in Asmara.

3. All the computers are rented except the IBM 1440 and 1130 at the Imperial Highway Authority both of which have been purchased.

4. The present operational applications are standard business-oriented activities, statistical work and limited engineering support.

5. Activities with computer installations include public corporations such as the Telecommunications Board, Electric Light and Power, Water Administration, Ethiopian Airlines, Imperial Highway Authority, and the Franco-Ethiopian Railway Company; central government activities such as the Ministry of Finance; the Armed Forces; and the Addis Ababa Municipality.

This study closes with the following:

"The use of decentralized, small and not powerful equipment installed in various government agencies minimize the output and efficient use it renders to the Central Government. The unbalanced and uneconomical aspects of the EDP configurations, the staffing of all levels, and the

accommodation problems in various installations are such that any improvement made in one direction increases the difficulties in another. I (Ato Bogale) suggest if one powerful big computer is installed at the central place replacing the decentralized equipments with coordination of all the various government agencies a more efficient output can be achieved."

Thus the problem of centralization versus decentralization is seen as critical in Ethiopia.

Ato Bogale expressed the following opinions related to ADP in Ethiopia:

1. It has been important in the country's development and will play an even more important role in the future.

2. The major problem is the underutilization of the present hardware.

3. Personnel problems are serious; there is no standard salary structure and no provision in civil service for careers in ADP fields.

4. Industry and quasi-governmental activities are paying much higher salaries than government for comparable positions. Thus, the government trains the personnel only to lose the better ones to other activities.

In the Central Statistical Office, Bogale--the manager--is the only systems analyst and there is only one programmer, who is really a trainee. Two of his people are currently receiving training at the U.S. Bureau of Census.

There is no provision in government service for other than one shift of operations. No overtime can be paid. Computer utilization averages only about 100 hours per month. The shortage of trained technical personnel is acute and there are no in-service training programs for users or managers.

The 360/20 installation at the Central Statistical Office, although very shorthanded, appeared to be well organized and managed.

The IBM manager in Ethiopia, Mr. Leet, has had lengthy experience in East Africa and actually wrote most of the original programs for the Statistical Office in Kampala, Uganda. (All computers in Ethiopia are IBM except the Burroughs of the Ethiopian Airlines.) In his opinion, the major obstacle to more effective computer utilization is the education of management at the second level--immediately below the ministerial level. It has been his experience that the EDP manager has no one of authority to whom to present his problems that can understand in any meaningful way. Leet has had the same difficulty in presenting the IBM approach to officials of the government. It has been difficult to gain the interest in, and appreciation of, computers at the senior policy level. In Leet's opinion, there have been no signficant difficulties with operator or programmer training; most offices are using Ethiopians. He also stated that availability of

spare parts has not been a problem of any significance. The same is true of supporting services and activities.

Leet stated that there has been no interest demonstrated in the use of the computer in the development planning itself. His competition in Addis Ababa is Burroughs who took away IBM business from the Ethiopian Airlines. Leet is selling customers System 3 replacements for the 360/20 at lower total rentals. This is his major promotional effort at present.

Ato Gabriel Tedros was acting general manager of the Imperial Board of Telecommunications while the manager was in the UK for a one-week IBM course in computer technology. The Telecommunications Board uses an IBM 360/20 payroll, billing, and personnel records. The utilization is less than 100 hours per month. The Board is investigating the use of computers as a management and planning tool. They have made use of Swedish programs for network planning. In the 1974-78 planning period the Board will invest over E$100 million, therefore, effective planning is very important to them. Gabriel is a strong believer in the importance of highway and communications development as keys to the country's economic and social development. Improved planning is needed in both areas. There is no hardware or systems analyst capability available to support computer application to this planning process in Ethiopia. Ato Gabriel talked of the need for more

effective planning throughout the government and expressed the hope that such a capability--supported by computer technology--could be rapidly developed. The computer support at the Imperial Highway Authority (IHA) was reviewed with Mr. Jack Gunther, the equipment and supply manager, and with Ato Solomon Berhann, the chief of data processing. The IHA has an IBM 1440 and 1130; the 1440 is used for payroll, personnel, equipment inventory and maintenance; the 1130 is used for highway design, earthwork cut and fill, vertical and horizontal alignment, bridge design and contouring. There is a 1627 plotter used with the 1130 for cross-sections and other design applications. Computer support is not provided in highway route selection and planning. The IHA computers are used for two shifts. The employees have been with IHA sometime; turnover is low. The staff includes three programmers--the rest are computer operators and keypunch operators.

The computer installation of the IHA was neat and clean although not airconditioned. The climate is dry and temperatures moderate so the absence of airconditioning has not been a problem. The most serious problem identified by the IHA computer people was the inaccuracy of input data received from throughout the country for equipment inventory and maintenance applications.

The computer, an IBM 360/20, is used by the Ministry of Finance for payroll, income and expenditure accounting, and

customs and trade statistics. The latter accounts for over one-third of the work done. Computer utilization averages about 130 hours per month. The lack of civil service recognition of ADP and low salary levels have caused serious difficulties with high turnover. There is no use made of the computer for economic planning. This 360/20 is the only tape-oriented system in Addis Ababa. The manager expressed concern over lack of backup but the IBM representative stated that there has been no problem. A very high number of hours are required for sort routines. IBM has advised a change to System 3.

The only computer installation that Burroughs has in Addis Ababa is at the Ethiopian Airlines. It is a B2501 with 30K memory, 20 million bytes of disks storage, card reader, 3 - 800 bpi tape drives, and an 860 lpm printer. It is used primarily for accounting applications and is used about 150 hours per month. It replaced an IBM 1440. Training has been provided free and a systems analyst was on site for one year. He is to return for a full-time assignment. A customer engineer will also be available fulltime. Mr. Soodeen, the Burroughs representative, expressed concern that the decision-makers are turning to System 3 to replace the 360/20's. He was offering service bureau assistance on the 2501, leasing time back from the Airlines. He expressed problems in educating middle management. In his opinion there are only six

competent systems analysts in Addis Ababa. That, in his opinion represents the total capability. He is bringing in the systems analysts and intends to try to establish training courses in analysis and COBOL programming.

Dr. Ademola Banjo, Head of the Science and Technology Section of the UN Economic Commission for Africa, divided the use of computers in Africa into two areas: specific application orientation and the economic and social development planning per se. The latter was divided into specific development planning such as communications or agriculture and total economic planning of an entire country's activities. Dr. Banjo stated that computers were not being used in Africa in this latter area at all and in very isolated cases in specific sector activity. Computer use in Africa is almost totally confined to specific applications such as statistical processing, accounting and limited scientific or engineering applications. He is well aware of the computer potential in planning but feels that very few areas are in a position to use them in such a way. He feels that such use must be in a research sense at this point and probably centered in a University. He feels that Nigeria is probably in the best position to begin such a program. He expressed the need of the country's planners for some guide to use to assist in evaluating the manufacturer's proposals for hardware. He discussed the expense of computers and the problem that a

country like Ethiopia has in priorities for resources. This makes it even more critical that improvement be made in the current utilization--paritcularly within the government.

UGANDA

Interviews:

Government:

Mr. Boronga, Head, Ugandan Government Computer Center, Ministry of Finance

Education:

Prof. Donald Mann, Department of Mathematics, University of Makerere

Uganda Development Corporation:

A. H. Catterall, Finance and Accounts Division

Manufacturers Representatives:

IBM World Trade Corporation -

N. Asinjo, Uganda Manager

Burroughs Machines Ltd. -

T. Emmerson, Uganda Manager

International Computers Ltd. -

V. J. Stilwell, Uganda Manager

Summary of visit:

Mr. Nick Asinjo, Manager of IBM's activities in Kampala, identified three computers in Uganda. An IBM 360/30 in the Ministry of Finance, an ICL 1901A at Makerere University and an ICL 1902A at the Uganda Electricity Board. In addition, there is a terminal at the East African Railways in Kampala linked to an ICL 1904E and 1905E at Nairobi, Kenya. This is used for wagon control.

There are import restrictions and controls that affect business in Uganda. In some cases up to 100% deposit is required for import items--this does not apply to IBM because it is importing equipment they themselves own. Licenses are required for imports. There are duty charges that can be as much as 6 to 8 times the monthly rental of equipment, and 10% of the purchase price. The Government itself is, of course, not subject to such duty or restrictions

Mr. Asinjo gave some of the background to the governments' computer activity. It was installed in the last half of 1967. It was originally to serve the Makerere University and the Government. The University wanted it installed there, but the government insisted it be in Ministry of Finance. The University then acquired its own computer. ICL provided the 1901A with 8K core (now 16K) and it now costs £5,000/year. It is used less than 100 hours per month. It is located in the Mathematics Department. It first had two disk drives and has recently added four tape units. It is used for certain research, e.g., preventive medicine. There are inadequate numbers of systems analysts and programmers to provide support to potential users.

The Uganda Electric Board's 1902A is used only for administration and business applications such as billing. It was installed in December 1971 and was a sole-source procurement. There is a full-time ICL man at the

installation, a data processing manager, one programmer and one programmer-trainee.

The Ministry of Finance operations is under the Minister, Mr. Wakahweya, and the Secretary to the Treasury, Mr. Geria. Mr. Boronga is the data processing manager. There had existed a committee to consider computers in government headed by Mr. Wakahweya when he was Secretary to the Treasury. Presumably, little was done with a report submitted. A committee has recently existed headed by the Chief of Organization and Methods in the Ministry of Planning to develop recommendations for computer support within the government.

At the present time there is no national policy regarding computer utilization and no national plan.

Mr. Asinjo identified the following applications on the 360/30: payroll, social security (programs written by IBM), loan accounts to corporations in the tea and tobacco business, population statistics and census, and currently preparing for an agricultural census.

IBM provides courses for government programmers as required. Short courses on such topics as disk organization are also given.

RPG and COBOL languages are used on the 360/30 with FORTRAN used to a limited degree for technical applications. There is a "ranching scheme" being supported by the government computer. The East African Community is the sponsor of the

total project and numerous banks have put up the money It involves breeding, veterinarian medicine, etc. It is only now in the planning stage as far as computer support is concerned.

General supporting functions are believed by Mr. Asinjo to be adequate. Power is reasonably reliable and spare parts are no problem for IBM.

The training of people was identified by Mr. Asinjo as a major difficulty. In aptitude tests given to a broad cross-section of applicants for programming--about 80% got "D" or less. There has been some improvement recently but only slightly. The difficulty seems to be in the basic educational background.

Mr. Asinjo sees no problem related to unemployment. It has never risen as an issue in his experience.

He identified orientation of senior managers as the major single need. He referred to work done by the International Management Development Institute, Inc. of Wilton, Connecticut. This firm has conducted a management course for senior managers in East Africa. Mr. Asinjo considered it excellent and suggested that a part of such a course could include some time on computers as an approach to this educational need.

He emphasized that shortages of foreign exchange were the essential consideration in the acquisition of computer

support in Uganda and not continued hardware or software service.

Mr. Donald Mann, Professor of Mathematics at the University of Makerere, confirmed the fact that the University has one ICL 1901A with 16K of core. It is used in education and scientific applications. General computer orientation and high-level language programming were taught recently to 174 students (second year) in commerce and economic statistics. In addition, a more rigorous course was given to 90 students in the physical sciences. Data processing or computer sciences is not taught as a degree program. Mr. Mann made a strong point that it was an open-shop operation and that students and faculty were free to come and use the computer at any time. There is one senior individual who manages the operations for the Math Department, but no other staff.

The computer is available to secondary schools and some now run simple programs written by their students.

The University has contacted all local scientific organizations and offered the computer for support. Some are using it but on a limited basis. Water development planning is being done on the computer as a part of the United Nations Hydromat Program. Forestry planning is also being supported by the University computer.

In Mr. Mann's opinion, the main problem in effective computer use by planners and those involved in economic and social development is the absence of at least a single civil servant with personal knowledge and enthusiasim concerning the potential of the computer and coupled with enough policy power to direct the government in this area.

The Uganda Government Computer Center, headed by Mr. Boronga, has an IBM 360/30 with 32K of core, six disk drives, four tape drives, card reader, paper tape reader, and line printer. It was installed in August 1967 with 16K core. There are no plans to change hardware but a doubling of core is anticipated. The government charges $70 per hour for computer time to external users and there are plans to increase this charge to $100. Utilization is now about 200 hours per month. The operating system is DOS and most programs are written in RPG and COBOL. There are eight programmers on the staff with authorization for 15. Mr. Boronga is striving for positions for a chief systems analyst and a chief programmer. Mr. Boronga presented staffing, salary, training, and management as principal problems. There is no training program and one is needed for systems analysts and programmers. The civil service pay begins at -800 per year, next step is £1,026, and next is £1,494 and up. Mr. Boronga believes strongly that more training should be on-the-job than in the classroom-with trainees working along side of senior programmers.

In reviewing the major problems, Mr. Boronga expressed the following opinions:

1. His managers are understanding and present no problems.

2. More assistance is needed in developing and selling new applications.

3. Power, maintenance and related supporting systems are not a problem.

4. The local manufacturers are understaffed in Kampala and training is not adequate.

5. He needs systems analysis support.

6. There is a serious shortage of technical literature and very little technical communication or exchange takes place in the East African community of computer professionals.

Mr. A. H. Catterall of the Finance and Accounts Division of the Uganda Development Corporation explained that no use of the computer is being made by any part of UDC. Mr. Catterall has tried to interest management in PERT as a tool, but can get no support. The work of this Corporation represents a major area where computer impact could be significant in administrative support, project control, and economic planning.

Mr. V. J. Stilwell, manager of ICL in Kampala, expressed strong opinion that the staffs involved in the computer activities in government are seriously deficient in technical knowledge and capability. He also expressed concern that the

government was not yet ready from a conceptual or structural standpoint for the changes that would result from the use of the computer as an assist to management. Mr. Stilwell is providing computer support to a wide group of customers through the use of the ICL computers at the Electricity Board and at the University of Makerere. He has only one systems analyst/programmer and cannot keep up with the demands. It is very likely that a full computer service center may emerge.

Mr. Tony Emmerson, the local manager of Burroughs, identified the Burroughs L series equipment as being the firms target for marketing in Uganda. He does not feel that they are ready to spend the money for anything more--largely due to the lack of trained personnel and Burroughs is not prepared to do total operations for a customer yet. They have considered the service center approach with rental to a major customer and operations by Burroughs. It may come later. The L series has been very successful in Uganda. He feels that the best hope for more effective use of the computer is through the students coming out of the University and moving into management positions.

TURKEY

Interviews:

Government

Zeki Avralioglu, President of the State Institute of Statistics

Atalay Coskunoglu, Director General, Highway Department

Ca it Safa Basaran, Director of the Computer Center, Highway Department

Shadi Ginerik, Under Secretary for Social Planning, State Planning Organization

Education:

Middle East Technical University -

Bulent Epir, Associate Professor and Head, Department of Computer Sciences

Erol Arkun, Assistant Professor

Ismet Gungor, Assistant Professor

Tunler Uney, System Programmer

Hacettepe University -

Aydin Koksal, Director of the Computer Center

Istanbul University -

Haydar Furgac, Head of Mathematics and Statistics Department, Economics Faculty

Manufacturers Representatives:

IBM World Trade Corporation -

Robert Niedermayer, Manager (Ankara)

Turgut Oguz, Deputy General Manager (Turkey)

Acar Bumin, Marketing Manager, Government and Universities

Miray Tekelioglu, Marketing Manager, Private Firms

Burroughs -

Nezih Divitci, Manager (Ankara)

Private Firms -

Mensucat Santral, T.A.S. (Textile Industries)
Mehmet Basar, Data Processing Manager

Akbank, T.A.S. (Major Turkish Bank)

Aydin Sidal, Assistant General Manager

Tahsin Ertuzun, ADP Consultant

Summary of visit:

There are over 80 computers in Turkey with almost three-quarters being IBM equipment, about one-fifth are UNIVAC machines and the remainder either Burroughs or NCR. An inventory of all computer facilities was prepared in 1971. It presents rather complete information about the hardware and applications of each installation. The majority of the computers in Turkey are small, i.e., in the IBM 360/20 or UNIVAC 1004 or 1050 class. The largest IBM computer at the time of the inventory was a 360/40, the largest Burroughs was a 3500 and the largest UNIVAC was a 9400.

It has been estimated that there are about 250 professionals engaged in some aspect of computer activity in Turkey with a nucleus of about 50 who have substantial university training. It is significant that all of the computer

installations are run by Turkish nationals. A survey of personnel needs has revealed that there is a shortage of over 100 systems analysts and about 75 programmers. By 1980 it has been estimated that there will be an additional 100 small computers, 54 medium-size computers and five large computers. This growth will require an additional 1350 key personnel. Thus, the education and training need is significant.

Visits were made to the two universities in Ankara involved with computer activities and computer education. At the Middle East Technical University (METU) all aspects of computer usage in Turkey were discussed as well as the educational programs at METU. There is no national policy concerning computer technology and its application. The need for such a policy has been discussed in the government but no significant action has been taken except in the area of procurement. A regulation has been passed that requires any government body seeking the acquisition of a computer to obtain the approval of the State Planning Organization. Due to the lack of technical capability in the SPO, METU has been asked to review the requests and to recommend action to the SPO. Five requests have been reviewed to date by METU--two were excellent and recommended for approval, but the remaining three were poorly prepared and returned for additional work. This review role is not one METU wishes to retain. It has placed them in the middle between the computer manufacturers and the

requesting government office and it is felt that this role may jeopardize the principal mission--that of computer education.

The METU staff estimated that over 80% of all computer resources are going into business applications and educational functions. The State Planning Organization makes limited use of the METU IBM 360/40 for economic modelling and planning. The opinion was expressed that there was lack of understanding at top management levels of the impact that computer technology could have on economic and social development. It was suggested that a seminar for senior Turkish managers might be a useful step toward improved utilization. It was emphasized that this should be within Turkey and not a regional effort with other countries.

The problems associated with supporting systems were discussed with the METU staff. The impact of computer technology on employment was discussed; it was the opinion that the threat of unemployment due to the use of computers was not an obstacle to its extended use and presented no significant problem. The only government regulation mentioned as an obstacle to computer use was the import duty on hardware. The supporting systems such as power, air conditioning, etc., do not present significant problems in Turkey. It is necessary to install voltage regulators to insure steady power. The

problems associated with physical installation have been generally left up to the computer manufacturers to resolve.

The METU staff includes four assistant professors in the computer sciences department and three full-time instructors. The staff is supported by assistance from the Mathematics Department and the Electrical Engineering Department. To date, there has been no separate computer sciences degree program but a masters program is planned for the fall of 1972. Thirty students are expected to enroll. The IBM 360/40 at METU is used primarily to support other departments of the University and the courses taught in programming, etc., are oriented toward teaching students in all departments how to effectively use the computer as a tool in their areas of activity.

Education and training was underscored as the number one problem to more effective computer utilization. It is particularly needed at the senior manager and systems analyst level. It was further emphasized that the computer hardware in Turkey is generally underutilized; many installations are getting less than 100 hours per month on their computers. It was the opinion of the METU staff that the present communications system in Turkey is not reliable enough to support data transmission and, thus, permit widespread timesharing and remote terminal usage.

There has recently been established a Turkish Information Processing Society. The objectives include effective communication among professionals (the Society has begun publication of a journal), communication of computer potentials to management, and sponsorship of education and training. It is believed that this Society has great potential to serve as a very effective force in improving computer utilization in Turkey.

The head of the computer activity at Hacettepe University, Mr. Aydin Koksal, is the president of the Turkish Information Processing Society. He expressed particular concern for the more effective development of computer applications on the existing computer hardware within Turkey. He was critical of the manufacturers that they did not do more to assist in the development of further applications following original installation of hardware. The training of programmers and systems analysts within the users organizations has not been adequate and the users are, therefore, very heavily dependent upon the manufacturers. Mr. Koksal discussed the problems due to the absence of instruction in systems techniques, management sciences and management information systems. He described the computer activities at Hacettepe which have been entirely in support of the other departments of the University. A doctors degree program in computer sciences is to start next year and will have about six students. The University has a Burroughs 3500 with several cathode ray tube

erminals used for direct access to a time-sharing
ystem.

The President of the State Institute for Statistics, Mr. Zeki Avralioglu, described the history of the development of computer use in his Institute and of his plans for the future. The Institute purchased an IBM 1005 card processor in 1964 but immediately began planning for a larger system. An IBM 407 was acquired to support the processing of construction permits. There remained the need for computer support for foreign trade statistics, industrial census, population census, and customs activities and a UNIVAC 9400 was purchased in 1968. This hardware was not working until September 1971. There have been serious hardware and software problems. He has embarked on a program to train both an electrical and mechanical engineer (sending both to the U.S. to be trained on UNIVAC hardware) and has also sent two systems analysts to the U.S. to obtain masters degrees. The programmers available are junior and lack experience; eight have been trained through AID support.

The UNIVAC 9400 is the largest UNIVAC equipment in Turkey and two disk units were added in June. It has a 65K memory and this is planned to be increased. The present jobs that the Institute for Statistics run on the equipment are periodic in nature and the computer is not

fully utilized. The President of the Institute would like this facility to serve as the central computer processor for the Turkish government and he would also like to be able to sell services to others. A recent committee charged with reorganization of the government included in its report the recommendation that government computer services be centralized. This report has not been put into effect but the State Planning Organization has taken over the responsibility for central acquisition. In addition, a bill has been drafted for the Turkish Congress permitting the Institute to charge private firms for computer services. There has been no further action on this bill.

The Turkish Highway Department is making very effective use of an IBM 652 computer. It was acquired in 1960 primarily for support in accounting activities. It has now been extended to support highway and bridge design, equipment inventory and maintenance, spare parts control, traffic analysis, general highway development planning, materials research and personnel support. There are a total of about 160 applications programs with over 60% of the time used for commercial or business type applications and the remaining for engineering applications. The computer staff has 40 people and operates only one shift plus overtime. The majority of the applications programs have been written by the staff. The Highway Department has about 40,000 employees

distributed throughout Turkey and, thus, is faced with major managerial problems. It was evident that they are making effective use of the IBM 652 capabilities.

Plans have been made to upgrade the IBM 652 to a greater capability. Very detailed analyses have been made resulting in a complete feasibility study outlining the total computer needs. Their plans include a central processor with 256K storage, four 100 million byte disk units, a controller capable of supporting 31 terminals, remote terminals hardwired for use in the central office, and the capability for paper tape input as received over telex lines from remote stations. They do not believe that the present communications facilities will adequately support data transmission nor do they have the personnel trained to undertake a networking operation with timesharing. The local Burroughs manager, Mr. Nezih Divitci (it should be noted that in Turkey Burroughs is a part of the Koc firm, a very large holding corporation) identified education as the major problem in improving computer use in Turkey. The principal background for those in the computer business is engineering and there has been a strong tendency for them to be too "exotic" in their use of the computer. There is a serious lack of trained systems analysts, information processing specialists, and programmers. He complained rather bitterly about the requirement for government organizations to obtain the State

Planning Organization's approval to acquire a computer and its lack of competence to make the necessary reviews. The use of the Middle East Technical University as an advisory body has slowed the process severely and no action is being taken on many procurement requests.

The Burroughs manager stated that his firm has a staff of 45 people in EDP in Turkey; about 12 are programmers and analysts, 10 sales personnel and 10 maintenance engineers. Of the over 80 computers in Turkey, only three are Burroughs and they all are 3500's. The manager claimed that these three machines had 60% of the disk storage available in Turkey, 40% of the memory capacity, and 30% of the total dollar value. (These figures have not been verified but it is true that the three Burroughs installations are some of the largest and most sophisticated in the country.) The manager stated that in his opinion the average life of a system in Turkey was about eight years and that purchase of equipment was, therefore, looked upon favorably. He indicated that his main sales thrust in the near future would be in the Burroughs 1700 line.

The use of computers in Turkey was discussed at length with Dr. Kenneth Neff who is a professor of economics from Michigan State University and a consultant for AID to the National Educational Research and Planning Project which is under the Planning, Research and Coordination Office of the Ministry of Education. This office has an IBM 1620

which was originally purchased by AID for the Bureau of Tests and Measurements in the Ministry of Education. This project has sent 19 people to Michigan State for advanced degrees--five of which are specializing in some type of systems training. The IBM 1620 is used in support of the development of educational programs by those being trained. One of the principal applications is the processing of examinations of all types.

Dr. Neff stated that there is a severe shortage of systems analysts and programmers and felt that this is certainly one of the major obstacles to more effective computer utilization. He also emphasized the great disparity between salaries paid to government employees and to those in private industry. A systems analyst in industry can get from three to five times the pay that his counterpart in government service will receive. In addition, there is little opportunity in the government service for recognition or significant advancement for those in the computer field.

The use of the computer in education planning was discussed. There is a need to build data bases concerning teachers and facilities as input for the planning work. The major obstacles to the effort are the problems associated with data collection, input preparation and file updating.

Dr. Neff emphasized the problems associated with adequate education and training. He visualizes the project work in the Ministry of Education leading to the development of an institute similar to the U.S. Department of Agriculture graduate school.

The use of computers in national planning and the need for a national policy in the field of computer technology were discussed with Mr. Shadi Cinerik the Under Secretary for Social Planning in the State Planning Office. This office is making limited use of the IBM 360/40 at the Middle East Technical University for general planning. Those planning officers on the SPO staff with background and experience in the use of computers use the 360/40 for their own individual work developing economic models for limited analysis. There is no central program, however, utilizing the computer for national economic and social planning. The impression was left that very little was being done to use the computer in such areas.

Mr. Cinerik expressed appreciation of the importance of computer technology to Turkey's development but very little is being done to provide for its effective use from a national standpoint. The only action taken to date on a national level has been the establishment of the requirement for all government and quasi-government organizations to obtain approval of the State Planning Organization prior to the acquisition of computer hardware.

The impression was left that there is no plan to take further action in the SPO related to a national policy for computer technology nor are there any steps being taken to strengthen the staff.

The deputy general manager of IBM in Turkey and the marketing managers for private firms and for government and the universities cited three major problem areas in the use of computers: 1) concepts--the computer is either regarded as an accounting machine or an electronic brain; 2) personnel--lack of adequate education and training as well as extremely low salaries in the government for ADP personnel; and 3) procedures for obtaining computers and services--these are either non-existent, contradictory or unrealistic for implementation. In addition, the frequent changes in senior government managers have made it difficult to impart the necessary background and understanding to lead to effective use of the computer. There is a serious gap in understanding and communication between those Turkish managers sent abroad for training and those who have not had that opportunity. The former need to be restrained in their enthusiasm over computer support and the latter need to be encouraged. There have been management sciences seminars given in Turkey sponsored by the Turkish Management Association but the most is not made of the opportunity to introduce computer technology as a part of this instruction.

In the discussions with IBM personnel, the following points were made concerning barriers to effective use of computer technology in Turkey:

1. Government personnel regulations--no shift work permitted, low pay, no civil service structure for those in ADP, lack of trained people.

2. Supporting facilities--unreliable voltage levels in power supply.

3. Government regulations--48% customs duty on wholesale price of imported computer.

4. Communications--local lines of poor quality; long distance lines of adequate quality but cost for leasing prohibitive. (IBM has given seminars to the Post, Telephone and Telegraph personnel concerning data transmission.)

5. Managers--inadequate understanding of management science and significance of computers.

IBM has 135 employees in Turkey and about 60 computers installed. They believe their support activity to be reasonably responsive although spare parts are difficult to clear through customs and long delays are encountered.

The three areas that the IBM management believes require priority attention to improve the use of computers are improved education, lowered customs duties, and more effective use of teleprocessing.

The Mensucat Santral, a major textile firm, is making use of computer technology. The firm has about 3,200 employees

in all phases of textile manufacturing and has an IBM 360/20 with a computer staff of about 20 people. The computer is run for one shift a day and totals about 150 hours per month. Applications include accounting, billing, payroll, budget, stock control, and various types of statistical analysis of production, including cost analysis. The ADP manager for the firm had worked for IBM for 15 years. He also operates a service bureau providing support for 15 separate companies. This activity covers about one-third of his operating budget. The data processing staff is self sufficient and capable of accomplishing all necessary systems analysis and programming. Upgrading of hardware is planned within a year and the long range plans include teleprocessing capabilities. The management supports gradual growth with in-house talent and experimentation on a small scale in new areas.

Mr. Mehmet Baser, the data processing manager at Mensucat Santral, expressed the opinion that Turkey's major obstacle to effective use of computers was the lack of understanding by senior management of their capabilities. He did not feel this was a problem in his firm but was generally true throughout Turkey.

The AKBank, a major bank in Turkey with 300 branches throughout the country, began using IBM unit record equipment in 1963, added an IBM 1401 in 1965, changed to an IBM 360/30 in 1967 and added an IBM 360/25 in 1971. The assistant general manager

described the wide variety of applications supported on the computer and these include all phases of the banking activity. The bank has not been satisfied with the IBM support and is reluctant to upgrade to a single larger computer because of their dependence on the 360/25 to backup the 360/30. They have experienced lengthy down-time due to hardware problems and delays in obtaining spare parts. The bank does not depend on IBM for programming support but has an in-house staff capable of maintaining the applications programs and developing newer ones. Their ADP staff numbers about 75 out of a total staff of 5,000 people. They pay about $17,000 per month for their computer hardware. One of the deterrents to the expanded use of computers in the banking business is its highly competitive nature and the difficulty presented in cooperating with others in the banking business. When discussing the future expansion of computers in the Akbank, the emphasis was on teleprocessing. The wide geographic coverage of the bank's branches would make the use of a teleprocessing network a very attractive alternative if the communications facilities can support data transmission. This appears to be at least five years away at this time.

The majority of the interview time with Professor Haydar Furgac at Istanbul University was spent discussing the processing of Turkey's equivalent of the college board examinations. This is done with the support of an

IBM 1620 with 20K of core and two disk drives. This activity lasts for about two months each year and is the principal activity on the computer. The university has over 30,000 students and the 1620 cannot begin to serve the needs. However, even the 1620 is used for only about 100 to 120 hours per month. The University has very few competent programmers or operators. The Mathematics Department cannot obtain adequate computer support much less the other departments of the University. No University administrative activities are supported by the computer. An active computer support program is urgently needed by Istanbul University. There is little hope of effective use of computer technology throughout Turkey's government and business if the students do not become used to using it as a tool during their education. Istanbul University has requested upgrading the hardware through the State Planning Organization but no action had been taken for the past six months.

BRAZIL

Interviews:

Government:

Isaac Kerstgnetsky, President, Institute of Geography and Statistics (IBGE)

Jose Dion de Melo Teles, Director-President, Servico Federal de Processamento de Dados (SERPRO), Ministry of Finance

Sergio Filippi Sambiase, Director, Department of Development, SERPRO

Ronaldo Panoyotis Contopoulos, Director, Department of Operations, SERPRO

Ricardo Saur, Executive Secretary, Federal Coordinating Commission for Electronic Data Processing (CAPRE), Ministry of Planning

Education:

Prof. Celso de Renna e Souza, Coordinator--Program of Engineering and Systems, Federal University of Rio de Janeiro (COPRE/UFRJ)

Prof. Carlos Jose Pereira de Lucena, Head of Graduate Department in Computer Sciences at the Catholic University of Rio de Janeiro

Prof. Larry Kerschberg, Ph.D., faculty of Computer Sciences at the Catholic University

Prof. Helio Vieira, Digital Systems Laboratory, Politechnic School, University of Sao Paulo

Dr. James G. Rudolph, Eectronic Research Laboratory, Hewlett-Packard (on loan to the University of Sao Paulo)

Manufacturers Representatives:

IBM World Trade Corporation -

Antonio Carlos Rego Gil, Sales Manager, Data Processing

Burroughs Electronics Ltd. -

Henry Eicher, President

George Herz, Sales Manager

Honeywell-Bull -

Francois de Lauzon, Development Manager

Empresa de Sistemos de Computadores, Ltd.
(representing Siemens)

J. A. Vencovsky, Manager

Miscellaneous:

Raulino C. Oliverira, President, SUCESU in Guanabara (Brazilian Computer Users Association)

Ronald J. Eckmann, Vice-President, SUCESU in Guanabara

Luiz Guinle, Director of Education and Training for Datamec (computer service center)

Samuel Konishi, President, National SUCESU (Brazilian Computer Users Association)

Summary of visit:

There are now (August 1972) an estimated 800 to 850 computers in Brazil, not including minicomputers. There is no complete inventory and the number is growing rapidly; i.e., at the rate of about 25% to 30% per year and is expected to continue at this pace for the next five years. The computers currently in use have been estimated to have the following approximate distribution by size of equipment (ACM Sao Paulo chapter estimates):

2nd generation	20%
3rd generation (small size)[1]	40%
3rd generation (medium size)[2]	35%
3rd generation (large size)[3]	5%

NOTE: 1. IBM System 3; 360/20; etc.

2. IBM 360/25-40; B-2500/3500; UNIVAC 9300/9400; etc.

3. IBM 360/50-65; 370/155-165; Burroughs 6700; etc.

There are eleven manufacturers dealing with computer sales and leasing, as follows: IBM, Burroughs, UNIVAC, Honeywell-Bull NCR, Siemens, AEG-Telefunken, CII, Hewlett-Packard, DEC, and Phillips. IBM has about 65% of the market by numbers and 75% by value, followed by Burroughs with about 15%, both by numbers and value; UNIVAC with about 9% in both categories and Honeywell-Bull with 8% by numbers and 2% by value. The equipment is distributed by field of activity about as follows: industry--35%; government and public service--25%; finances--23%; and commerce in general--17%.

The following information represents examples of computer use in Brazil. Their use is so widespread that it was not possible to collect data on all installations.

1. Government -

a. Federal

(1) The Federal Government's largest single data processing service, SERPRO (Servico Federal de

Processamento de Dados), was originally intended to serve all elements of the Federal Government, but, although it claims to serve some 100 customers outside of the Ministry of Finance in which it is located, it devotes the great majority of the time for that ministry. Support to the income tax activity is its major single project. SERPRO has a total of 22 computers (19 are IBM and three are Burroughs) located in eleven different centers in Brazil. The SERPRO growth has been very rapid. The first computer was installed in January 1968. In 1969 there were 470,000 forms processed in the income tax system and this number has risen to 8 million in 1972. SERPRO has two 370/145's in operation and expects to install a 370/165, two more 370/145's, three 370/135's, and two Burroughs 3500/3700's. SERPRO has the largest data processing facilities in Latin America with over 5,000 employees and a 1972 budget of $35 million. Over 50% of its efforts are in the area of data preparation and input. However, work is accomplished on research projects related to hardware and systems software. There is also "developmental" research in the applications design and programming area.

(2) The Institute Brasileiro de Informatic (IBI) was founded in 1971 as a part of the Brazilian Institute of Geography and Statistics (IBGE) of the Ministry of Planning. It is somewhat a counterpart of SERPRO but serves only the IBGE. This Institute (IBGE) is one of the three major elements of the

Ministry of Planning; the others being the Development Bank and an Institute of Planning. The IBGE has about 5,000 employees and about 75 are in IBI (the data processing shop). In an interview with the president of IBGE, he cited the link between the mass of statistics collected and tabulated and the use of these statistics in planning as the most significant task facing his organization. He feels that this is the important area for computer technology and discussed modeling and its importance not only in decision-making but in the identification of statistics to be collected and processed. He emphasized the need to more effectively use the computer as a tool to assist in research connected with the planning function and to enhance the offices' analysis capabilities. There is a major need for effective staff development--he identified this as the most significant single requirement. In this regard, he emphasized the need for a staff with practical capabilities to meet the specific requirements of the Institute. The IBI operates an IBM 370/155 and included among its projects are the processing of the demographic and economic census and the elaboration of a large data base of socio-economic data.

(3) The Ministry of Planning has estimated that the data processing expenditures of the public administration will be about $125 million from 1972 to 1974. Considering the importance of this area, the Federal Government created a coordination committee for data processing activities in April 1972. The committee is known as CAPRE--Comissao de Coordenacao

Actividades de Processamento Eletronico. It is an inter-ministerial commission chaired by the Secretary General of the Planning Ministry (currently Sr. Flanzer). The executive secretary in charge of day-to-day operations is Mr. Ricardo Saur, formerly with Petrogras. The membership of the commission consists of representatives of the following: the Armed Forces General Staff; the Finance Ministry, the Development Bank (BNDE); SERPRO; IBI; and the Office of Administrative Reform. CAPRE's main purposes are to rationalize the governmental data processing investments and to uprgade the productivity of its data processing equipment. It's functional responsibilities have been set forth as (a) maintain detailed records of equipment and software employed in Brazil in both public and private sectors; (b) provide advice concerning procurement of equipment for Federal agencies; (c) coordinate technical training programs; and (d) propose financial policies especially with respect to Federal financing of activity in the private sector.

In interviewing Sr. Saur, he emphasized that the main thrust of the work of the Commission was not to restrict computer activity but to assist in the use of computer technology. In discussing the responsibilities of CAPRE, he stressed the need for assurance that hardware being acquired is really needed and that all supporting systems have been adequately planned for in advance. In the educational area,

Sr. Saur feels strongly that advanced computer science education is being taken care of and that practical training for immediate strengthening of user's capabilities is necessary. He discussed the plans in Brazil to create a capability to manufacture computer hardware, stating that the emphasis will be in the minicomputer field and possibly selected peripheral equipment. It is anticipated that there will be an agreement reached for cooperation with a foreign firm--he mentioned Fujitsu, DEC, Varian, H-P, and CII as possibilities. He believes, as do others in Brazil, that such an industry is needed so that Brazil is not dependent completely on imports and to provide employment for a core of highly-trained engineers to develop in the country.

Sr. Saur expressed particular interest in the area of U.S. Federal laws, organizations and mechanics for the direction of the use of computer technology. He also discussed the need for planning and action in Brazil in the area of standardization.

b. State & Municipal

(1) The various state governments of Brazil have data processing capabilities and are rapidly expanding. For example, Sao Paulo has an organization called PRODESP with an IBM 360/65 and employing about 70 systems analysts and programmers. In addition, the state

of Rio Grande de Sul is currently investing about $3.5 million to expand its data processing equipment.

(2) Similar work is underway in the municipal governments around Brazil with that on the state level. The data processing center, for example, for Sao Paulo has a 370/155 and a very active support program. This data is only a small sample of what is taking place and no direct contacts were made in these areas.

2. Universities -

There are a wide variety of activities at a series of Brazilian universities both in direct computer support to university administration, research and educational programs in many departments as well as in computer science programs from the undergraduate through graduate courses. Some of the leading universities in computer technology are the Pontifica Universidade Catolica do Rio de Janeiro (Catholic University of Rio), the Universidada Federal do Rio de Janeiro (UFRJ), the Universidade de Sao Paulo (USP), and the Universidade Federal do Rio Grande do Sul (UFRGS). It is not possible to cover the University activities in this report; reference is made to the work of the U.S. National Academy of Sciences and their sponsored work team that has prepared reports on computer science education in the universities. A brief summary is as follows:

Catholic University of Rio de Janeiro

Since 1967, the Department of Informatics has been offering an active master of science program in computer science. There are currently about 90 students enrolled in different stages of this program. At the end of 1971, about 25 master degrees were granted. The program is expected to produce about 30 graduates per year once it has stabilized. The present faculty has 26 members of which 10 have doctoral degrees. The Department has access to the University Computing Center with its IBM 370/165, IBM 7044 and IBM 1130. The staff of the Computing Center of about 20 work part-time for the Department of Informatics. The Catholic University is also starting a Ph.D. program in computer science. The first students attending the program will graduate in 1974. It is expected that the program will produce about 15 graduates per year by 1978.

b. University of Sao Paulo

The Department of Applied Mathematics of USP has a program leading to a Bachelor of Science in computer science which is presently in its second year. The first class (30 students) will graduate in 1974. The Department is also planning a Master of Science program to be offered in 1973. Presently, the students interested in computer science have to take their Master of Science either in mathematics or in electrical engineering. A number of graduate courses in computer science have been offered since 1968.

Also at the University of Sao Paulo there is the Digital Systems Laboratory in the Escola Politechnica. In this lab there has been the project to construct a micro-computer (4^k bytes of memory) which was designed in 1971 by graduate students. This project is a part of the drive to establish a computer hardware industry in Brazil. It is believed by some as essential to provide employment for engineers trained in the design fields and that Brazil needs to have a cadre of such trained people. The work is being supported by the Ford Foundation through the presence of Dr. J. G. Rudolph from Hewlett-Packard. He will be on the faculty for one year.

c. Federal University of Rio de Janeiro

The Coordenacao de Programas de Pos-graduccao in Engenharin (COPPE) offers a masters in systems engineering with emphasis on computer science. The program has 65 graduate students, half of whom are on a full-time basis. There are six Ph.D.'s and 12 M.Sc's in the program and the full-time faculty will reach 32 by 1973.

d. Every major Brazilian university offers some introductory undergraduate course in computer programming. In addition, several Brazilian universities are helping to meet the country's growing needs in the area of EDP training by offering extension courses.

Research Centers -

The Institute of Atomic Energy in Sao Paulo has an IBM 1620 and will install an IBM 370/155 in the near future.

b. The National Institute of Space Planning has a Burroughs 6700.

The Brazilian Center of Fiscal Planning has an IBM 370/145.

4. The Other major users of computers include public utilities, financial institutions, manufacturing firms and data service centers. No attempt is made in this report to list all computer centers; in fact, there is no complete inventory available.

It has been estimated by the ACM chapter in Sao Paulo that there are a total of 11,200 people in the ADP activity distributed as follows: systems analysts--3,500; programmers--4,000; computer operators--3,700. Such figures have been increasing by 25 to 30% per year and are expected to continue growing at this rate. Thus, the availability of qualified personnel in adequate numbers is a critical problem. The Rio Symposium on Computer Education held in August of 1972 was devoted to all aspects of this issue. There appear to be adequate efforts in the development of computer sciences education at the university level. This is not to say that a satisfactory level has been reached but that the need has been recognized and programs are underway to meet the need. There

appears to be a need for more attention to vocational type training--development of programmers, operators, etc., who do not necessarily have a university background.

The computer manufacturers' representatives (Burroughs, IBM, Honeywell-Bull, and Siemens) all emphasized the problems concerning human resources, training, education, etc. Each expressed the opinion that education and training were the principal problems. There seemed to be agreement that the lack of adequate systems analysis and design was the major area of deficiency. There has been a straight transfer of applications from unit record equipment to computers and then to upgraded hardware without any attempt to examine the entire function from a systems standpoint and then develop the optimum application system placing the computer in this new context. The president of Burroughs made a particular point of this and believes that much of their success in Brazil is due to insistence for systems analysis, etc., prior to hardware installation. Burroughs has made its major penetration in the world market in Brazil--about 160 systems using Burroughs equipment are in operation.

Because of the shortage of qualified people, salaries are very high. This has caused serious problems, creating friction with other employees in the same firm and also contributing to a high turnover rate in the computer field with high mobility.

The subject of regional training was discussed with the manufacturers's representatives and IBM, in particular, feels that this approach is not very realistic in Latin America. It is felt that significant cooperative efforts among the countries was highly unlikely. The opinion was also expressed that cooperation between countries at similar levels of development (rather than developed to developing countries) was not realistic.

There appeared to be general agreement among the manufacturers that the need for standardization efforts is great. The Burroughs president was especially hopeful that the CAPRE (government coordinating computer commission) would make significant progress in this area.

Computer societies and organizations began in Brazil in 1961 with the founding in Rio of ABRACE (Associacao Brasileira de Computadores Electronicol). It has never expanded, however, much beyond Rio and is not very active today. ABRACE was the Brazilian IFIP representative until December 1971; there is no representative from Brazil at this time.

Another organization--SUCESU (Sociedate dos Usuarios Computadores e Equipametos Subsidiarios)--was founded in Rio in September 1965. It is an organization for users, manufacturers, and suppliers, currently with about 400 organizational members. (There are no individual members but this is being considered.) In June 1969, SUCESU became a national organization and regional chapters have been

established in Sao Paulo, Minas Gerais, Rio Grande de Sul, Parana, Pernambuco, Bahia and Brasilia in addition to Rio. The national organization holds a data processing convention each year, considered to be the most important for the Brazilian computing community. SUCESU provides an opportunity for users of similar equipment and applications to meet and exchange information. It also provides for the translation of selected literature, conducts various industry-wide surveys, represents the users in meetings with Government officials, etc. During detailed discussions of the organization's structure and operations with its national president and the president of the Rio chapter, they indicated a strong interest in standards activities. They have already begun discussions on this subject with the Brazilian standards organization.

There are several data service centers operating in Brazil. Both IBM and Burroughs are running such activities. In addition, there is an independent center known as Datamec who operates six B-3500's, two B-500's, one B-200 and one IBM 360/30. I met with the head of Datamec's training activity who provided the following information. The center began as a part of the Ducal Company, a large clothing manufacturer, in 1963. It began to sell services outside of this firm and then became independent with Ducal as a client. The principal application areas deal with finance and banking. The largest single account is the lottery system in Brazil.

1968, the firm decided to enter the field of computer education. Their courses cover the full scope of activity from orientation to programmer training. They have about 500 students in any given month in some phase of the training. Many of the instructors are part-time and consideration is being given to move into the consulting field. The total Datamec has about 450 employees, including over 80 keypunchers in Rio.

COLOMBIA

Interviews:

Government

Alvaro Velasquez, Chief, National Department of Statistics (DANE) and Head of Commission de Normas (Federal Commission for Computer Policy)

Alvaro Pachon Munoz, Director General of Data Processing, DANE

Alfredo Solarte, Chief, Systems Division, Department of National Planning

Alfonso Perez Gama, Electronic and Systems Engineer, Systems Division, Department of National Planning

Alfonso Espitia, Systems Division, Department of National Planning

Education:

Rafael Ulloa, Director, Center for Engineering Calculations, National University, Bogota

Jorge Villalobos, Center for Engineering Calculations, National University, Bogota

Heberto Pachon, Director, Computer Center, University of the Andes, Bogota

Manufacturers Representatives:

Enrique Rugeles Amaya, Sales Manager, IBM, Brazil

Louis M. Arnel, Manager, Burroughs of Brazil

Miscellaneous:

Ernesto Rojas Morales, President, Colombian Association of Electronic Calculation

Fernando Corral Maldonado, Vice President for Finance, Bavaria (Brewery)

Guillermo Osuna Sanz, Chief of Data Processing, Bavaria

Summmary of visit:

Colombia has over 80 computers and about three-fourths of the total applications are in the business or general commercial area. About 70% are IBM, 16% Burroughs, 8% NCR, and 5% UNIVAC. Almost one-half are rented and one-fourth are purchased; the remainder are a part of an educational plan or have been locally assembled.

The government has recognized the significance of computers to this country's economic development and has established a commission to direct its use in government--with the chairman reporting to the President of Colombia. Dr. Alvaro Velasquez, the Chief of DANE (the governmental statistical office), is also head of this commission. He provided the following general information concerning the commission. It was established in 1968 with the principal objective of achieving higher hardware utilization and efficiency within the national government. It has not been active, however, until very recently. The commission is planning to place priority on the tasks of 1) review of justification for computer hardware by government organizations (they must all be sent to the commission for overview); 2) acceptance of the responsibility for actual hardware selection for all parts of the government; and 3) direction of the program of

inancing and details of acquisition of hardware. He also expressed considerable interest in standards and considers this work to be within the scope of the commission. The Commission is composed of representatives of the major departments of government and is supported by a staff of 5-6 people who work full-time in this area. It is intended to extend the authority of the commission to state and municipal governments.

Dr. Velasquez feels that education is the most critical problem in the effective use of computers in Colombia. The universities are not able to support the demand. DANE does its own training and operates an IBM 360/50 complex with plans for a 370/145 to be installed in January 1973. IBM 2780's are used for remote job entry from other cities in the country via microwave links. The center has both an IBM 2701 and 2703 communications controllers and the system operates under IBM OS (operating system). The DANE computer activity is the largest in the Colombian government and one of the largest in the country.

The Chief of the Systems Division of the National Planning Department and his staff provided information on the work of their department. The planning responsibility in this department is not for national computer use--that is the role of the commission--but it is in the areas of economic and social planning. For example, a main project is the preparation of the Public Investment Plan which is a part of the National

Development Plan. The System Division uses statistics taken from DANE and prepares economic models for execution on an IBM 1130. From all evidence, this modelling is rather simplistic but it is significant that such a program is being conducted. The principal problem in effective computer use, in the opinion of this system division staff, is one of human resources. There is a serious shortage of people with adequate training. They also cited the low government salaries as a major difficulty.

A major point was made concerning the lack of technical literature and manuals--when such are available, they are usually in English. Also, the lack of standards was cited as a significant problem causing much duplication and blocking exchange of data and programs.

There are two universities in Bogota with computer centers and educational programs; i.e., the Universidad Nacional and the Universidad de los Andes. The Universidad Nacional is a government-supported school with over 13,000 students. It has had a history of unrest and classes only began again in August after being closed for about six months. Its equipment is an IBM 1620 with associated peripherals. It was installed in 1967 and is supported by a staff of 13 people, including four programmers. The computer is used in three areas of activity, i.e., administrative--40%; teaching--30%; and research--30%. Engineering students are all given introductory

courses and some FORTRAN programming. They also receive a semester of numerical analysis and statistical methods and some take a course or two in operations research. Very little use is made of the computer by the other colleges of the University. In fact, there is a major controversy over the placement of the computer center organizationally in the university and it appears that the Dean of Engineering will retain the center.

The future plans of the center were discussed in some detail and its intention to upgrade to an IBM 360/44, including six 2260 cathode ray tube terminals, etc. They also intend to acquire an EAI 580 analog computer. There was also interest expressed by this staff in the need for computer-related standards activity.

The main theme of the director of the computer center at Los Andes was the desirability of providing centralized computer support for those universities in geographic proximity with each other. He used the State network in Wisconsin with the center in Madison as an example. He worked with UNIVAC in Chicago for 14 years before returning to Colombia.

Los Andes has an IBM 360/44 with 128K core and three 2311 disk drives. It was purchased for about $700,000. This center is also under the Dean of Engineering. The director expressed a strong need for a standards program. The director does not believe that the threat of unemployment

due to computers is a significant factor in Colombia. He commented that this was not a country of high technology and fear of computers does not exist simply because most people have no knowledge of them. He believes, however, that it is management's responsibility to see that computers are used to do tasks not otherwise possible--not principally as labor-saving devices.

IBM Colombia employs 450 people and all but about 20 are Colombian. The company contributes significantly to the country's economic activity. It operates a large typewriter assembly plan, for example, and is the largest corporate tax payer in the country. Its exports to other Latin American countries assist substantially in the foreign exchange balance.

The major problem in the computer business is the lack of available foreign exchange and high taxes, etc., associated with bringing a computer into Colombia. Duties, transportation, etc., total 84% of the purchase price. It is also very difficult to arrange financing.

The human resources--quantity and quality--are also a problem. The IBM representative feels that this can only really be met through increasing university-level programs and thus moving graduates into the ADP field. IBM is supporting visiting professors to teach teachers at various universities. He feels that the major contribution can be made in this area. He had had experience with all levels of training and

education and feels the greatest success is through universities. IBM is donating a computer to the Ministry of Education for use in secondary school programs. The National University will assist in this work.

The IBM manager feels that teleprocessing will be a partial answer to the foreign exchange problem--but will be slow in coming. IBM has tested both Telex and telephone lines--the former are not adequate but phone lines are of acceptable quality. Discussions are now going on which the government concerning charges. There is a difficulty in that city phone companies report to mayors so there is a political/organizational problem. The IBM representative indicated that the Colombian GNP per capita is about $305 and that this coupled with the high attrition rate as students move from primary to secondary schools and to universities are very serious problems making the use of high technology very difficult. He was high in his praise of the University of the Andes.

IBM's computers imported into Colombia generally come from Japan and sometimes Canada. He discussed concern over the use of the second-hand computers. They are usually in poor condition, old machines, difficult for IBM to service and keep running. Also, they usually do not have the capacity to really be of significant support to the user.

Dr. Arnal of Burroughs described his problems in competing with IBM for government business. Burroughs has only been in Colombia for about three years while IBM has been in the country since 1938. Burroughs does have about 15% of the market in numbers with most equipment being the B-3500. Most of its customers are in the financial business in one aspect or another.

Dr. Arnal also has had a difficult time in doing business with the universities. A more active role is planned with the educational community--including possible financial support for various educational programs.

Dr. Arnal discussed at length, the issue of education at the university level. He complained about the present stress on engineering as opposed to computer education in business, economics, etc. He pointed out the absence of management training and education in the area of management information. He stated he could hire all the engineers he needed for $350 per month, but that industry needed people of high quality in management science and information.

Dr. Arnal also discussed the economics of marketing in Colombia referring to the 84% charges on top of the selling price. However, he feels that adequate resources are available (in government, particularly where they are exempt from 60% of these charges) and it is not a major obstacle in his marketing efforts. The discussion included comments on the importance and benefit to Colombia of competition in computer marketing.

Dr. Morales, the President of the "users" group in Colombia, described its activities. This group has only personal members--not organizational members. It is more a professional society than user's group in the usual sense. The principal objective is the improvement of communication among those engaged in computer use and education. The group sponsors a Congress--held every other year--where technical papers are presented and problems of mutual concern are discussed. In addition, the association prepares a technical newsletter, however, due to inadequate funds, it is infrequently issued and is not very significant by their own admission. The association also has committees for action in specific areas, i.e., education, ethics, teleprocessing, etc. These committees sponsor special study sessions in an attempt to assist in communications and transfer of technical knowledge.

Dr. Morales feels that the principal requirement to support more effective use of computer technology is wider educational programs in the universities. He discussed the dominance of computer education by the engineering colleges and the need for its extension to other programs such as economics, business administration, etc.

e discussed the need for work in the area of standards and feels that this is very important. Dr. Morales was formerly the head of DANE and was instrumental in the establishment of the Federal Commission for Computer Technology--now

headed by the present chief of DANE--Dr. Alvaro Velasquez. Dr. Morales expressed the opinion that the senior government officials were aware of the potential of computers in development but that current "political considerations" have delayed more effective action. The value of the proper use of accurate statistical data in both economic and social planning was emphasized by Dr. Morales.

In discussing human resources, he commented that the vocational type training programs have assisted in meeting the needs for low-level programmers. There are several such commercial operations in Colombia. But he stressed the need for higher level systems analysts who could develop the applications that will have most meaning and impact on development

The Vice President for finance and data processing manager of Bavaria, one of the largest industrial organizations in Colombia, explained that firm's use of computers. As might be expected, their outlook on the use of computer technology and its problems is different than those in government or the universities. Bavaria is a very large brewery and also has a wide range of other commercial activities that it directs. They began use of computers with an IBM 650 in 1961, changed to an IBM 1410 and then to an IBM 360/40 (purchased) in about 1969. They have gradually put more applications on the computer and are now planning for an

integrated management information system tied to subsystems for finance, accounting, budgeting, inventory, etc. The computer is not yet used in the production process but it is being considered for a new plant under construction. Of the 16 staff members at the computer center, five are university graduates. Bavaria has had considerable success in training their own employees in ADP. This has been done with some help from IBM, but largely on their own. The Vice President considers the computer to be absolutely essential to the company's effective operation. They are looking forward to eventual expansion to an IBM 370 and plan to use teleprocessing to link their many activities throughout Colombia. Bavarian officials feel that the unemployment issue could be troublesome if not properly handled. They have shown to the unions that the computer actually supplies them with more complete and accurate data with which to protect their interests. They have also shown that those few people displaced by the computer have been given opportunities for better paying jobs. This campaign has been very successful.

KOREA

Interviews:

Government:

Hyong Sup Choi, Minister of Science and Technology

Hyung-Ki Kim, Director, Bureau of Technical Cooperation, MOST

Sun Kil Kim, Director, Bureau of Program Development and Promotion, MOST

Man Yong Lee, Director, Information Management Directorate, MOST

Dong Chul Kim, Assistant to the Director Information Management Directorate, MOST

Kil Yeong Song, Director, National Computer Center, MOST

Kyung Soo Kim, National Computer Center, MOST

Sun Rae Choi, Director, Bureau of Statistics, Economic Planning Board

Chan Wui, Chief, Data Processing Division, Bureau of Statistics, Economic Planning Board

Pil Bong Han, Chief of EDPS Operation, Data Processing Division, Bureau of Statistics, Economic Planning Board

Commercial/Industrial Users:

Korean National Railways -

Cha Hyun Mun, Administrative Official, EDPS

Jin Hwan Cho, Manager, EDPS Office

Kyung Rak Nam, Chief, System Analyst Section, Data Processing Center

Korea Banks Computer Center -

D. C. Kim, Secretary General

Hak Kyn Yang, Staff Member

Korea Electric Company -

Jae Min Oh, Chief of Computer Center

Sung Won Jang, Computer Center Staff

Korea Computer Center -

Won Yun Kang, System Analyst

Hyung Soon Kim, System Analyst

Manufacturers Representatives:

IBM, Korea -

G. C. Rasmussen, General Manager

UNIVAC Division, Sperry Rand, Ltd. -

Peter Main, General Manager

Control Data Korea, Inc. -

P. R. Min, General Manager, Marketing Division

Sun Ha Kim, Sales Manager

Korean Institute of Science and Technology -

Ki Soo Sung, Manager, EDP Department

Summary of visit:

There were a total of 34 computers in Korea as of October 1972. The growth has been rapid with the first computer installed in the Bureau of Statistics of the Economic Planning Board in 1967. By the end of 1970 there were 19 computers in operation and by October 1972 31 different

organizations had a total of 34 computer installations. The Koreans have classified four of the computers as large, as medium size and 12 as small computers. This classification has apparently been made primarily by core capacity with a CDC-3300 and UNIVAC-1106 and 9400 classed as large,an IBM 360/40 and 25 and UNIVAC-9300 as medium, and an IBM 1130 and FACOM 230-10 and 230-15 as small. Of the 34 computers currently in operation, 12 are IBM, nine are UNIVAC, six are FACOM, four are CDC, and three are NCR. The applications are typical for a developing country with 10 computers located in universities, five used in government administration and statistics, four in banking and insurance, four in accounting and business applications, four in data centers, three in engineering and scientific work, two in defense and two in public corporation administration. About two-thirds of the computers have been acquired on a rental basis.

The 31 organizations operating computers have reported a total of 627 people working in some phase of the activity. The total includes 46 managers, 68 systems analysts, 455 programmers and 58 operators. There is no report of the number of people involved in data preparation and input. Interviews with representative computer users revealed problems and difficulties in effective operation similar to those experienced by the other LDC's visited. There is a shortage of adequately trained staff. The education and

training programs have not been able to meet the needs of the rapid growth in computer installations. There is evidence too many people have been trained as programmers through the short vocational-level training courses while there are severe shortages of systems analysts, systems level programmers and experienced installation managers. There is a critical need for senior managers and policy makers to more fully understand the potentials of computer assistance as well as the problems associated with its use. There is no national plan for education and training in this field and, therefore, there is inadequate balance in the present educational efforts among the various specialities, e.g., programmers, systems analysts, managers, and maintenance engineers. The significance of manpower planning is recognized by the Korean Government as demonstrated by the Third Five-Year Manpower Development Plan, 1972-1976 but this planning has not been extended down to the level of this particular field of computer science and technology.

The shortage of adequately trained managers has resulted in the acquisition of computer systems without the basic planning usually necessary for successful operations. There is evidence that some computers were acquired for the prestige factor with no analysis made as to its actual application. Some computers were purchased without adequate technical services necessary for the development and operation

of applications. In many installations, functional activities were put on the computer with no recognition of the impact this would have on the total functional systems operation or of the need for a thorough systems analysis permitting a new conceptual orientation and approach. There is a lack of systemization in traditional manual methods of data handling and changes are difficult because they involve not only the procedure itself but changes in the basic system of operations as well as patterns of human behavior in work performance.

There are serious economic problems impeding the further use of computer support in Korea. Foreign exchange is in critically short supply and computer hardware requires large expenditures for rent or purchase from foreign suppliers. The Government now requires all computer imports to be approved through a government committee. In a survey reported on by the Korean Institute for Science and Technology, most computer users consider the long-run organizational efficiency through procedural reform as the objective of computerization. This requires financial investment over a long period before the economic advantages are realized. In addition, the extremely high interest rate (over 20% in most cases) is a major obstacle to long-range planning and investment such as required in computerization. These economic difficulties are undoutedly largely responsible for the fact that few computer

installations are in private business firms and the majority of the computers in Korea are in schools, government, quasi-governmental public service firms, and data service centers which are non-profit.

This emphasis on problems should not leave the impression that there have been no successful computer applications in Korea. The Korean Electric Company went through an extensive planning period prior to the acquisition of a computer in July of 1971. The firm has an IBM 360/40 which is used to support the billing of customers, internal accounting, inventory control, engineering design, and service expansion planning. In a firm of 12,000 employees, 74 are in the computer center. It is of particular interest to note that the Electric Company acquired most of its ADP staff through additional training for those already in its employ. The company utilizes the computer close to 400 hours per month.

Other organizations that have achieved some success in computerization include the Korean Banks Computer Center (which provides a central service for 13 banks), the Korean Foreign Exchange Bank, the Korean Airlines, the Korean National Railroad and the Union Steel Corporation.

The Korean Government's use of computers has followed the typical pattern of early applications in statistics, such as census, and later extension into support of the taxation

function, budgeting activities, limited economic planning, and scientific research. The Government has experienced serious difficulty in maintaining competent personnel for its various computer activities. The pay is as much as 50% under the private sector for similar jobs. Thus, as has been the pattern in many LDC's, the government has a high turnover in its ADP staffs, training new employees only to lose the better ones to private organizations.

The planning and development of programs for effective use of computer technology in the Korean Government, and in the economy in general, is the responsibility of the Ministry of Science and Technology (MOST). In an interview with Mr. Hyong Sup Choi, Minister of MOST, he discussed the importance of computer technology to Korean development and some of the principal problems. He is very much aware of the potential of the computer but expressed concern over the high rate of growth of hardware accompanied by a generally low utilization rate. The Minister described the Government EDP Committee that includes among its responsibilities the approval authority for all new hardware acquisitions in Korea. There prevails an attitude in MOST that there should be a moritorium on computer imports until more effective use is made of existing hardware.

Special mention should be made of the Korean Institute for Science and Technology and its role in computer technology. KIST was established in 1966 as an integrated applied research

organization supported by both the government of Korea and the United States to contribute to the development of Korean industries. It is a non-profit independent corporation that has been assured autonomy of operation and the maintenance of financial stability supported by the Government. KIST has an ADP staff of 100 people and is equipped with a CDC-3300. The KIST Computer Center is certainly a major center of excellence in the computer field. It is operating, however, as a service center for many users and this role will hamper its effectiveness as a center of development activities and applied research.

In summary, there has been steady progress in the use of computers in Korea since its introduction in 1967. The potential of computer technology is recognized by a limited number of government officials and business managers but the lack of technical skills, financial resources and appropriate systems development may delay its effective use. There exist Government estimates that there will be over 150 computers in Korea by 1976 inspite of these problems.

REPUBLIC OF CHINA

Interviews:

Government:

K. T. Li, Minister of Finance

Mr. Wang, Vice Minister of Finance

J. K. Loh, Director, Data Processing Center, Ministry of Finance

Kevin Liao, System Analyst, Chief of Systems and Programming Division, Data Processing Center, Ministry of Finance

Jen Fong Hsin, Chief of Computer Division, Data Processing Center, Ministry of Finance

Tai-Ying Liu, Deputy Director General, Department of Customs, Ministry of Finance

Ming Che Chang, Vice Chairman, National Science Council

Jih-Chen Ma, Senior Research Member, Division of Engineering, National Science Council

Mr. Chang, National Science Council

H. T. Chou, Director General, Budgets, Accounts and Statistics, Executive Yuan

K. C. Lee, Chief of EDP Center, DGBAS, Executive Yuan

Y. S. Tsiang, Minister of Education

Hien-Chee Fang, Director General of Telecommunications, Ministry of Communications

P. H. Kong, Director, Telecommunications Laboratories, Ministry of Communications

Chin-Son Sun, Director, Technical Cooperation Department, Council for International Economic Cooperation and Development (CIECD)

William C. W. Lin, Deputy Director, Technical Cooperation Department, CIECD

W. H. Liu, Senior Specialist, Economic Planning Group, CIECD

Education:

Tamkang College, Tamsui -

Chien Lih, Dean of Studies, Dean of Graduate School

I-ming Shen, Dean, Engineering School, Director, Computation Center

Louis R. Y. Chow, Associate Professor and Chairman, Department of Computer Science

National Chiao Tung University, Hsin Chu -

Hao-Chun Liu, President

Chu-I Chang, Dean of Studies and Director of Institute of Electronics

Chi-Change Lee, Chief, Electronic Computer Center

Chao-Chih Yang, Chairman, Department of Control Engineering and Computer Science

Manufacturer's Representatives:

IBM, Taiwan -

W. M. Whitmyer, General Manager

Control Data Far East, Inc. -

William J. Gucker, Consultant

Miscellaneous:

Chinese Society of EDP -

Kenneth K. L. Fan, Secretary-General

Erh Lin, Chairman, Academic Committee

China Data Processing Center -
Howell S. C. Chou, President

Summary of visit:

There were 44 computers in the ROC in October 1972. Of these, almost three-fourths are IBM equipment followed by CDC with eight installations. UNIVAC, NCR, FACOM and NEAC are represented by from 1 to 3 computers. The majority of the computers are in the size range of the IBM 360/20 to 30 with a substantial number of IBM 1130's. There are three CDC 3300's and one CYBER 70 series computer. Upgrading is planned for several installations and first acquisitions are being made by some organizations so that it is difficult to be current in presenting statistics concerning hardware. The China Air Lines has recently installed a UNIVAC 9400 system and the Bank of Taiwan is in the process of installing an IBM 370/135.

The first computer, an IBM 650, was installed at the National Chiao Tung University in 1962 and replaced in 1964 with an IBM 1620. In 1965 the Taiwan Sugar Corporation was the first to use data processing for industrial management with the installation of an IBM 1440. The China Data Processing Center grew from its early creation (with support from AID) as a part of the Council for International Economic Cooperation and Development to be an independent service center and was

one of the first to install a third generation computer (IBM 360/30) in 1967. It since has added a UNIVAC 9400.

The early computer users were educational institutions and public enterprises. By the end of 1967 about half of the computers were in colleges and over one-third in public enterprises. After 1968 the economic structure of Taiwan began to change with industrialization growing rapidly. The need for data processing also grew rapidly and its course of development shifted toward industry, transportation and public administration. Projects to apply computers to activities of banking, insurance, railways, telecommunications, airlines, petroleum and electric industries are in progress and the expansion is expected to be rapid.

There are major problems, however, confronting those attempting to improve the present utilization of computers and direct the further development of their use. These problems were highlighted in discussions with representatives of the ROC's National Science Council. It is their belief that there has been over enthusiasm for computers accompanied by much effort to train routine programmers. The result has been the pattern of the development of the usual business-oriented applications such as billing, accounting, etc., accompanied by excessive use of the computer as a printing machine. The absence of adequately trained system

analysts has been a major obstacle to the development o other applications. The opinion was voiced that although many managers express an appreciation of the potential of computers few have the necessary understanding to direct the development of their use. A major effort is needed to better inform the senior managers and to develop the capability to design effective system applications.

Other problems highlighted by various individuals interviewed include the shortage of well-qualified computer center managers, the shortage of qualified professionals in all areas of computer science and technology, the particular lack of competencies in computer hardware technology, the difficulties in the processing of the Chinese language by computers, and the lack of a strong centralized capability in the government for policy-making concerning computers. These are fundamentally the same problems identified in many of the other LDC's.

The review of the ROC Government involvement with computer technology was enhanced by the opportunity to meet with the Ministers of Education and Finance. These men are fully aware of the potential of effective computer support to the economic and social development and growth of the Republic if not of all of the problems to be encountered. The need was discussed with the Minister of Education for a balanced educational program with priorities set for resource allocation

from vocational programming training through graduate programs in computer sciences. There does not appear to be a staff adequately trained to develop such a governmental program for computer education. There are individuals in Taiwan with the necessary knowledge and background but government has not either seen fit to hire the necessary competence or cannot because of an inadequate salary structure. Without such centralized planning, there will continue to be independent educational programs being developed and offered, and each may be valuable but without adequate planning of the national need nor relationship to each other. The Minister of Education showed great interest in the subject, provided time for an extensive discussion, and went to great effort to arrange interviews with individuals known to him to be knowledgeable in computers and influential in this sphere of activities in Taiwan.

The meeting with the Minister of Finance was followed by detailed discussions with his director of data processing. Tax administration is the principal application on the CDC-3300 computer operated by Finance. Over 7 million documents are submitted by the taxpayers and about 90% of this data is entered into the computer by optical character readers. Limited use is made of key-to-tape machines.

The center operates three shifts per day and seven days per week. There are 33 programmers and systems analysts included

in a total staff of 73. Return communications with the tax payers represents a major problem because of the difficulties in printing Chinese characters with a computer. Currently, all of the return mail is manually addressed. Research work on Chinese character printers is being sponsored by the National Science Council.

Planning has been underway for some time for the data processing center of the Ministry of Finance to support the needs of the Department of Customs. The early phase of this planning was performed by a consultant who recommended the replacement of the CDC 3300 with two 3170's and teleprocessing with links to the three customs offices. This system has finally been ordered by the Ministry.

As a result of the realization and concern of senior government officials, an Ad Hoc Committee on Electronic Data Processing of the Executive Yuan was established in 1968. Dr. Bruce Billings, the principal U.S. scientific advisor in Taiwan, was instrumental in this development. (Dr. Ruth Davis, present director of the Institute for Computer Sciences and Technology, served as a consultant to the ROC Government in the national planning for an effective computer capability.) The committee was created at the deputy ministerial level. As a result of the committee's efforts a centralized data center was established under the Director General for Budgets, Accounts and Statistics (DGBAS). The assigned ADP responsibilities of this center include the

review of application systems from all parts of the Government, the review and approval of requests for ADP equipment throughout the Government, general guidance in the development of government ADP systems, planning and review of ADP personnel requirements and training, and the operation of a processing center for census activities and general government administration. The original concept has been for this center to serve as the centralized data processing center for the Government. This has not been successful and for a variety of reasons other governmental organizations have been permitted to acquire computers and establish ADP centers. In addition, much of the government's data processing is being performed by external facilities such as the China Data Processing Center.

The DGBAS computer center presently operates an IBM 360/40 and there are plans to upgrade the hardware to an IBM 370/145. Remote job entry is supported by the Center with links to the Highway Construction Bureau, the Telecommunications Directorate and its Laboratory, and the National Chiao Tung University. The center has a staff of 82 including 33 programmers and analysts.

Two universities were visited in the ROC; the Tamkang College of Arts and Sciences and the National Chiao Tung University. The Tamkang College has a total enrollment of about 12,000 students with campuses at Tamsui and in downtown Taipei. Considerable time was spent discussing the programs

of the Department of Computer Science and the Graduate Institute of Management Sciences. Computer courses are offered at all levels from an introduction to computing through computer design, automata theory and simulation theory. The computer center and department are a part of the Engineering School. The computer center for the College has an IBM 1130 and is planning to install an IBM 370/135 in the coming year.

The National Chiao Tung University is a very unusual institution. It was founded in Shanghai in 1896 and then reestablished in Hsinchu, Taiwan in 1958. It now is comprised of a College of Engineering that includes an Institute of Electronics and four under graduate departments of electrophysics, electronic engineering, control engineering and communications engineering. A graduate program began in 1968 and a department of management science was established in 1971.

As previously mentioned, this university had the first computer installation in Taiwan--an IBM 650 installed in 1962 and replaced by a 1620 in 1964. An IBM 2770 has been installed recently and provides access to the Executive Yuan IBM 360/40 for remote job entry. The University has elaborate laboratory facilities for both training and research. A complete description of facilities and courses is available at NBS. The capabilities of the University will be significant in the country's continuing efforts to

make effective use of computer technology.

Due to the emphasis currently being placed on teleprocessing by the planners in Taiwan, a visit was made to the Telecommunications Laboratory of the Directorate General of Telecommunications, Ministry of Communications. The Laboratory, located near Chungli, about 45 kilometers southwest of Taipei, has six major divisions, i.e., Radio Physics, Transmission, Switching, Electronic Devices, Satellite Communications, and the Computer Division. The latter was established in 1971 and is responsible for the development of programs for administration and engineering purposes for the various organizations under the Ministry of Communications. Study projects also include data transmission below 4800 bits per second, teleprocessing, and Chinese character input/output devices. There is a close link between the study programs at the laboratory and the research at the National Chiao Tung University.

Discussions were held with officials of the Council for International Economic Cooperation and Development concerning the use of computers for economic planning. Since 1963, the CIECD has been the central economic planning agency in the ROC. The outline of computer utilization for economic development includes aggregate model building, compilation of input-output tables, research on regional distribution of crops with a special equilibrium model, traffic models, long range forecasting model for government revenues and expenditures, aggregate demand and supply models,

and an economic forecasting model. This list may convey the impression that computer support to the economic planning is firmly established and well advanced. Such is not yet the case but, as indicated by the list, there are extensive efforts being made to improve the planning and enhance development through increasing sophisticated analysis requiring expanding computer support. There have been recent contracts with external consultants to improve the total planning process.

THAILAND

Interviews:

Government:

Prasidhi Ratanasatien, Chief, Accounting and Statistics Division and Director, Computer Center, Comptroller-General's Department, Ministry of Finance

Rojanakorn Lawvanit, Data Processing Center of Thailand, National Statistical Office

Gordon C. Butler, UN Inter-Regional Advisor on Management Aspects of Computers in Public Service, Advising the Thailand Government

Suthep Tingsabhat, Director, Planning Division, Royal Irrigation Department

Education:

Chulalongkorn University -

Prof. Ittipon Padunchewit, Assoc. Prof. of Computer Science, Director of Computer Science Laboratory

Asian Institute of Technology -

Prof. Tongchat Hongladaromp, Ass't Professor of Structural Engineering, Chairman of Computer Center

Manufacturers Representatives:

IBM, Thailand, Ltd. -

Michael S. Tormey, Managing Director

UNIVAC -

Shuly Koo, Assistant General Manager, Summit Industrial Corporation

Miscellaneous:

Datamat Ltd. -

Manoo Ordeedolchest, Managing Director

Narong Sooppipatt, Systems Manager

Telephone Organization of Thailand

Kiat Siriparp, DP Manager

Esso Standard Thailand Ltd. -

Frank J. Zybura, Computer Center Manager

Electrical Generating Authority of Thailand

Danai Manoparp, ADP Manager

Bangkok Bank -

Vivat Utamote, Computer Manager

UN Economic Commission for Asia and the Far East

K. O. Clark, Chief, Data Processing Section

Summary of visit:

There were 32 computers in Thailand in October 1972. About one-half are used by private enterprises and about 10 in government or government-owned enterprises. Two are in educational institutions, with one at the Asian Institute of Technology and one at Chulalongkorn University. About three-fourths of the computers are IBM equipment. CDC has four or five computers in Thailand and UNIVAC now has three installed. The majority of the computers are in the IBM 360/20 or 30 class although UNIVAC recently installed two 9400's and there are three or four IBM 360/40's.

Three of the government installations were visited--the National Statistical Office, the Comptroller-General in the Ministry of Finance, and the Royal Irrigation Department. The National Statistical Office installed a computer in 1964 and now has an IBM 1401 and 360/40. This equipment is operated over two shifts per day and has a use rate of about 400 hours per month. There are about 35 people on the staff of this computer center. The computer applications include a wide range of statistical processing for the various departments of the Thai government, although it is not legally constituted as the centralized government processing center. The NSO is also charged with the responsibility to act as a supporting center in the development of computer application for government administration. Attempts to provide a central processing service for all requirements of the Thai Government have not been successful and the role of the EDP Committee, established in 1969 in the Ministry of National Development is unclear at the present. It is understood that it was intended that this committee review all requests for computers from government departments but its legal status seems to be in question.

In discussing the operations of the NSO computer center with Mr. Gordon Butler, a UN regional advisor, and members of the staff, it was emphasized that the hiring and retention of

competent employees was the major problem. There is severe competition from the private sector where salaries for comparable jobs often are three times those offered by government. The turnover of personnel in 1971 was almost one-third of the staff. The principal need is for qualified systems analysts. Installation management has also been an area of difficulty; for example, there is need for improvement in the scheduling of jobs on the computer.

The Ministry of Finance installed an IBM 1440 in 1965 and currently operates it for two shifts, reaching about 200 hours per month. The applications are in the area of accounting and budget control. The director of the computer center reported that he was encountering severe hardware troubles on a frequent basis. He is in the process of upgrading the hardware and is in receipt of proposals from CDC, IBM, and UNIVAC. He is strongly in favor of the IBM proposal but there is extensive controversy within the government concerning this procurement. The staff of the center is extremely small with only five programmers and no systems analysts. It is difficult to see how a larger computer could be effectively used without a major increase in quality and quantity of staff. To date, the staff members hired have been college graduates without ADP training and they then have received this training from IBM.

The Royal Irrigation Center has an IBM 1130 with 8K memory. The majority of the applications are in the area of engineering such as hydrology studies, water resource studies, and design problems. There are current efforts to extend its use into administrative areas. It is also used to support the planning activities of the Center. The computer staff is small (less than 30) and the computer is operated for only one shift. Since this is a government organization, it suffers from the low salary scale and inadequate personnel policies for ADP professionals.

Two government-owned agencies, the Telephone Organizations of Thailand (TOT) and the Electrical Generating Authority (EGAT) were visited. The TOT began computer support activities in 1967 and now operates an IBM 360/40 for about two shifts per day, reaching about 300 hours per month. The principal applications are for billing, statistical analysis concerning maintenance in the Bangkok area, personnel, payroll, and accounting. Communications traffic analysis and forecasting are also supported by the computer. In these areas the TOT engineers do their own FORTRAN programming. The other applications are programmed in RPG and PL/1. The low government salary scale is also a problem for the TOT. There have been recent hardware difficulties with excessive down-time. The TOT manager expressed dissatisfaction with the IBM response to these problems.

The Electrical Generating Authority of Thailand (EGAT) installed an IBM 360/30 with 64K memory in 1969. The applications are about half in the commercial area and half in the engineering area. A complete list of applications is available at NBS. The staff totals about 30 and the computer is run about 1-1/2 shifts per day for a total of 200 to 250 hours per month. The staff turnover is less than in the government installations because as a government enterprise pay is somewhat higher although still lower than in the private sector. The computer center relies on IBM for systems and customer engineering support and also for most of the training needed. As in the Telephone Organization, the engineers do their own programming. The computer manager complained of the lack of understanding at the management level of the potentials and problems associated with the computer. He also was experiencing difficulty in communicating with the user departments and in obtaining clear statements of support requirements. In spite of these difficulties, major expansion is planned for computer support.

The Bangkok Bank, Thailand's largest banking organization installed an IBM 360/40 with 178K memory in 1970. The bank has 52 branches and have five on-line terminals with the computer for checking account activities. The line quality varies and the system is frequently inoperable during the rainy season. Other applications include the general ledger,

savings accounts, and mortgage loans. Investigation is currently underway in management information systems. According to the computer center manager, the senior management of the bank has little understanding of the ADP problems. The staff numbers about 40 and the computer is used for over 600 hours a month. The staff turnover is very low and the pay scale and morale are good. The original staff was recruited from within the bank and then given ADP training. New hires are now coming from the University.

Esso Standard Thailand, Limited began computer support in 1968 and now operates an IBM 360/30 with 14K memory for about 450 hours per month. Two shifts are scheduled with a total staff of about 50 people. The Esso computer manager has had extensive experience in managing such activities for Esso and the impact of this experience can be seen in many ways. It is of some significance that this center developed and operated a small on-line billing system for a short time but stopped it because the task could be done more economically through batch processing. An upgrading to an IBM 370/135 is planned for 1974.

An interview was held with the manager of Datamat, Ltd., who has been associated with data processing in Thailand from its early days as an employee of IBM. In 1968, he began Datamat as an independent service company and now operates an IBM 360/22 and a UNIVAC 9300. He provided considerable background concerning

Thailand's experiences in data processing. The patterns of development and problems are typical with those found in other LDC's; i.e., early use in statistical offices of the government, lack of trained personnel, international hardware companies the leading influence, underutilization of equipment, and a trend from smaller equipment to more sophisticated hardware and plans for teleprocessing.

The two educational institutions in Thailand with computers and related courses of instruction are the Asian Institute of Technology and Chulalongkorn University. AIT is entirely a graduate school for civil engineers and has about 200 students from 20 countries of Asia. The IBM 1730 is used almost exclusively for engineering activities and the programming is done by the faculty and students. A particularly significant area of work has been in hydrologic research and analysis. Plans exist to upgrade the hardware to a UNIVAC 1107. The chairman of the computer center has tentative plans to conduct a regional symposium concerning computer support for civil engineering.

An interview was held with Professor Ittipon Padunchewit, the Director of the Computer Science Laboratory and Associate Professor of Computer Science at Chulalongkorn University. He is recognized as one of the senior experts in computer science in Thailand and has also gained some international recognition through his representation of Thailand at international conferences. The IBM 1620 at the University

is used for research, teaching and administration. Courses given include introductory level material, computer mathematics, data processing, systems analysis, programming and special seminars. Professor Ittipon believes that there should be a separate educational institution for computer sciences to serve all the needs of the country and not be hampered by affiliation and requirements of a general educational institution. He has plans for the promotion of such a school.

The UN Economic Commission for Asia and the Far East is located in Bangkok and Mr. Clark is the Chief of the Data Processing Section for ECAFE. He had some observations on the efforts made to use computers in Thailand and transfer of computer technology to the area. He expressed concern that the computer manufacturers have taken advantage of the lack of training and of the organizational structures in Thailand. He gave specific examples of hardware made available through foreign assistance that is being seriously underutilized due to inadequate feasibility planning and training. Mr. Clark discussed the problem of education and the need for easy accessibility of the computer to students in all university departments if computer technology is to be effectively diffused into the commercial, scientific and engineering communities. He emphasized the need for training for managers--both senior management in the possibilities of

computer technology and in ADP managers to realize more effective use of existing installations.

Interviews were held with representatives of both IBM and UNIVAC. IBM has been active in Thailand since the first installation of its computer equipment in 1964 while UNIVAC's offices have been operating for only three years. Both representatives emphasized the deterrent to increased computer use created by the 36% to 38% duty levied against the imports. In Thailand, the government installations are not exempt from this duty as in many countries. Both firms are operating service centers--IBM is directly in the business and UNIVAC operates its installation for its agent, Summit Industrial Corporation and also as a service center. As has been the case in other countries, the hardware manufacturers have played an unusual role because of the lack of trained people and of a general understanding of computers. Some feel that the companies have taken advantage of the customers but the representatives discussed the difficulties of selling when there was this lack of knowledgeable management. They also highlighted the absence of systems analysis capabilities.