RTI

EGYPTIAN DEVELOPMENT AND THE POTENTIAL ROLE OF SCIENCE AND TECHNOLOGY

UNITED STATES OF AMERICA

Volume I

A Report Prepared for
The United States Agency for International Development
June 1976
(Contract AID/Afr-C-1144)

RESEARCH TRIANGLE PARK, NORTH CAROLINA 27709

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PREFACE

The Arab Republic of Egypt and the United States Agency for International Development (U.S. AID) have been exploring the possibility of the United States providing assistance to the scientific and technological community of Egypt. As a means of examining this possibility in greater detail, U.S. AID requested the Research Triangle Institute (RTI), under an existing contract for short-term consulting, to send a team of individuals to Egypt to assess the feasibility of the program under consideration, and to formulate such recommendations as may be appropriate.

Members of the team are listed below. In addition, Mr. George R. Herbert, President, RTI, accompanied the team for the first ten days of its assignment. The report of the observations and recommendations of the team consists of two volumes. Tables of contents for both volumes are included in each.

The team very much appreciates the excellent cooperation of Egyptian officials in the many organizations, institutions and agencies visited, particularly those of the Academy of Scientific Research and Technology and the National Research Center.

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VOLUME I
TABLE OF CONTENTS

		Page
	PREFACE	iii
	LIST OF FIGURES	vi
	LIST OF TABLES	vii
I.	INTRODUCTION	1
	Assignment and Terms of Reference	1
	Organization of Report	2
II.	DEVELOPMENT STRATEGY AND SCIENTIFIC AND TECHNOLOGICAL RESOURCES	5
	The Intended Prime Beneficiaries of Development	5
	Major Elements of the Strategy of Development	6
	Scientific and Technological Resources Available	10
	Organization and Functions of the Academy	11
	Examples of Major Research Institutions	15
III.	THE UTILITY OF RESEARCH RESULTS TO INTERMEDIATE AND FINAL USERS	17
	The Community of Research Users	17
	The Utility of Research Results	22
	The Significance of Research and Development Planning	28
IV.	THE INFLUENCE OF THE ACADEMY AND RELATED INSTITUTIONS	39
	Research Management and the Role of the Academy	39
	The National Research Center	56
	Observations Regarding Equipment	60
V.	RECOMMENDATIONS FOR ASSISTANCE	67
	A Joint Egyptian-United States Program in Science and Technology	67
	Assistance to the Academy of Scientific Research and Technology	71
	Assistance for the National Research Center	83
	Cairo University and Public Sector Projects	89
	ANNEXES	95

LIST OF FIGURES

Figure		Page
1	Diagram of the Relationship of the Academy of Scientific Research and Technology to the Major Organizations of Government and to Other Organizations	12
2	The Organizational Structure of the Academy of Scientific Research and Technology and Links with Other Organizations	14
3	Hypothetical Illustration of the Research and Development Continuum in Relation to "Final" Users of Research	18
4	Schematic Diagram Illustrating Links Between National Goals and National Needs Through Research and Development Programs, Program Elements, Program Subelements and Projects	27
5	Schematic Illustration of Research Goal, Plan, Programs, Program Elements, Program Subelements and Projects	30
6	Hypothetical Illustration of the Role of the Academy of Scientific Research and Technology in Formulating Research and Development Plans and Programs	34
7	Hypothetical Illustration of Managerial Links Between the Academy and NRC through the Academy Program Monitor and the NRC Program Manager	35
8	Hypothetical Illustration of the Relationship Between the Academy and Organizations that Perform Research and Development	37
9	Illustration of Reserve Fund Contributions and Use in Relation to Academy Research Support Budget	76

LIST OF TABLES

Table		Page
1	Number of Active Scientists in Egypt With Doctoral and Master of Science Degrees in 1972.	10
2	Number of Egyptians Receiving Bachelor's Degrees, 1965-1973.	11
3	Hypothetical Projections of Academy Research Funding, Egyptian Government Support to the Academy for This Purpose, Deficit and Reserve Fund	77

EGYPTIAN DEVELOPMENT AND THE POTENTIAL ROLE OF SCIENCE AND TECHNOLOGY

I. INTRODUCTION

As a general proposition, the development of a society depends to a considerable measure upon the capacity of the scientific and technological community of that society. Resource availability, commitments and beliefs of the people, and the nature and extent of external influences are also important. But without the scientific and technical capacity to transform physical, biological and organizational phenomena, the change implied by development usually remains latent, or at best sluggish and unimaginative.

Egypt as a society is committed to development, and Egypt has created over the past 25 years an impressive scientific and technological community, as represented by numbers of trained people and institutions. It seems, however, that this community has been upon the periphery of the prevailing development process.

Such change as is taking place seems to occur as a consequence of decisions within the ministries of central government, at the governorate, district and local levels of government, and through limited individual entrepreneurial activity in urban and rural communities. The technology upon which such change is based is largely imported technology. By comparison, the Egyptian scientific and technological community has not been drawn effectively into the process, and development appears to be slow, cumbersome and sometimes ill adapted to the people and to the particular conditions of Egypt.

Assignment and Terms of Reference

Egyptian leaders have perceived the potential role that the scientific and technological community can play in the development of Egypt. The gap between this potential and the extant peripheral status is also

recognized. Steps are being taken to close this gap, to move this community into the center of the action. In recognition of the multiple demands upon Egyptian resources, coupled with unfamiliarity with processes by which scientists and technologists can become initimately and effectively involved, assistance in this endeavor has been requested of the U.S. Agency for International Development (U.S. AID). Discussions have taken place and a "Project Identification Document" (PID) prepared (reproduced in Volume II of this report). The PID summarizes these discussions and presents a tentative outline of possible types of assistance.

In view of this background, U.S. AID has engaged the authors of this report as a consultant team to accomplish the following:

1. To assess the potential role of the Egyptian scientific and technological community in the development of Egypt.
2. To examine the tentative scope and nature of U.S. AID assistance to this scientific and technological community as perceived by Egyptian and U.S. AID representatives.
3. On the basis of this assessment and examination, draw conclusions and recommendations regarding:
   a. The types of assistance that might properly be provided.
   b. The magnitude and duration of this assistance.
   c. Institutional relationships appropriate for such assistance.
   d. Such other aspects as may be identified within the time available.

Organization of Report

The report consists of two volumes. The first volume summarizes such observations, assessments, conclusions, and recommendations as the team has been able to accomplish within a three-week period. The second volume contains several documents assembled by the Academy of Scientific Research and Technology, the National Research Center, U.S. AID, and other organizations. Additional information of interest is also included (see Table of Contents).

The documents assembled and the support and cooperation provided the team have been invaluable. Without such assistance, accomplishment of our mission would have been impossible. Our expression of appreciation is therefore sincerely extended to our Egyptian colleagues and to representatives of U.S. AID.

II. DEVELOPMENT STRATEGY AND SCIENTIFIC AND TECHNOLOGICAL RESOURCES

The PID takes note of a problem which Egypt shares, in common, with all developing societies, namely, a high population growth rate. The predominance of desert areas, largely uninhabitable, results in this population being concentrated along the Nile and in the Delta. More than 36 million people now live under conditions of rural congestion and urban crowding exceeding the density of most heavily populated areas of the world. Under prevailing conditions of population growth and, until recently, deteriorating ability to cope with unemployment, budget deficits, rising costs of social services and other complexities, the need for increased productivity has become obvious. This, in turn, has led to acute concern with agriculture and industry, and with transport systems, investment processes, trade relationships, capital/labor ratios, and other aspects of development. These considerations have led to recognition of technological innovation as being of prime importance.

The problem, as set forth by the PID and as expressed in Chapter I above, is thus how to utilize the Egyptian scientific and technological community to the fullest extent possible in achieving the type and degree of technological innovation required. Before addressing this problem directly, however, we summarize briefly in this chapter the nature and scope of Egyptian development as we have come to perceive it. Scientific and technological resources are then reviewed.

The Intended Prime Beneficiaries of Development

President Anwar Sadat, in the "October Statement" of 1974, has clearly indicated that all citizens should benefit equitably from development. The concern is with more than just economic development--i.e., with food, clothing, shelter and other material goods. Public Law 52, enacted in 1975, provides for change in political status of individual citizens through a system of elected councils ranging from the smallest hamlet, through villages, districts, governorates, and the national

legislature. The Organization for the Reconstruction and Development of Egyptian Villages (ORDEV) is devoted to improving the social, economic, and political status of the rural people of Egypt. A similar effort is reported to be under consideration for urban communities. The magnitude of the task is apparent: President Sadat, in a recent decree (March 1976) appointing a new cabinet under Prime Minister Mamdouh Salem, asserted that the cabinet is expected to introduce austerity measures and far reaching changes to improve the economic situation of the country.

Major Elements of the Strategy of Development

A development plan for 1976 has been published. The five-year development plan for 1976-80 is to be released soon, perhaps in May. A longrun plan (15-20 years) is also under preparation and is to be completed within a year.

The five-year plan will be discussed in draft form by various councils and groups for several weeks following release. Final adoption is then expected in October 1976.

Based upon discussions with several individuals involved in or familiar with preparation of these plans, the team has derived the following understanding of the major elements of the emerging development strategy for 1976-80:

1. Balance of Payments and Population/Resource Considerations.

Debt obligations accrued in the past, plus current strong import demand in relation to export receipts, have an overriding influence upon planning for the immediate future. Egypt realizes that nations, like other organizations and individuals, must remain financially solvent if they are to continue to manage their own economic affairs. The balance of payments problem, however, is related to the population/resource ratio in that population is at once a major source of demand for imports, particularly food. Population growth also generates perhaps the most abundant factor of production, labor. Egypt has not discovered or developed natural resources-- e.g.,oil--in such

quantities that their export sales can match the demand for imports. Hence, the strategy for development over the next five years will include elements such as the following:

a. Conserve capital, especially "foreign exchange" capital, and plan for the intensified use of labor in new development projects.

b. Develop new products for export and, in doing so, concentrate upon labor-intensive processes of production.

c. Make more effective and efficient use of capital goods, raw materials, and labor--installed capacity as well as new construction. Seek to keep the rate of improvement in production in excess of the rate of increase in wages as a means of helping to control inflation and thereby improving the international competitive position of Egypt as well.

d. Develop domestic substitutes for consumer goods purchased abroad.

e. In seeking ways to increase production, give careful attention to those fields of activity in which Egypt has a comparative advantage.

f. As a means of enhancing the role of local government in the development process, and also to minimize inequalities in regional development, give serious consideration to intermediate technology. Less sophisticated techniques may prove more feasible at the local level.

Technological considerations dominate throughout these elements of strategy. Labor-intensive, as opposed to capital-intensive, techniques are needed. Examination of the resources and peculiar conditions of Egypt, in relation to Egyptian needs and world markets, is encourged--not through the eyes of those who have devised techniques appropriate for other countries, but through Egyptian eyes.

2. The Longrun Strategy.

Beyond these immediate balance-of-payments pressures, Egyptian development strategy calls for even more direct confrontation with the hard realities of development that have been underestimated, or overlooked, by most societies. Until population growth is actually brought under control, at a level consistent with the aspirations of Egyptian people, the optimum utilization of a growing labor force will remain of central concern. Here again, the challenge lies in concentrating the power of science upon fundamental needs and in introducing technical and organizational changes consistent with the unique requirements of Egypt. Considerations which affect the longrun strategy include the following:

a. Population is expected to double by the year 2000; present momentum will carry growth to between 70 to 80 million people, almost regardless of control measures adopted. Encroachment upon the limited areas of productive land must be stopped. This means vertical expansion ("high rise") of settlements within existing village, towns and cities, and horizontal expansion in desert areas.

b. The challenge is to design structures utilizing labor-intensive methods of construction, raw materials in abundant supply in Egypt and consistent with economic, social and cultural standards that will come to prevail. It is anticipated that by the year 2000, horizontal expansion in what are now primarily desert areas will occur as a means of accommodating perhaps 30 percent of the population. This will entail the creation of a "new industrial/economic map" of Egypt. Mineral deposits, the Quatara depression and other resources of the desert must form the economic basis for such change.

3. Technology Adapted to Egyptian Needs.

The organization and operation of agriculture on presently cultivated areas should be reexamined. Many rural villages are becoming

net importers under emerging techniques, rather than net exporters, especially when account is taken of machinery being introduced. Such substitution of equipment for labor represents, in several instances at least, adoption of foreign technology without examination of the consequences in terms of trade balances and the problem of providing employment for a rapidly growing population.[1/] This illustrates the danger Egypt now faces on both the agricultural and industrial fronts--i.e., the risk of becoming locked into the framework of the wrong technology simply because construction, production, design, organization (the gamut of economic development activity appropriate for other countries) is being copied rather than carefully adapted to the peculiarities of Egyptian conditions.

Economic aspects of development comprise only part of the picture. To meet the challenge of the remainder of this century, the cultural issues must be faced as well. For example, it seems improbable that Egypt can continue the present system of extensive higher education, nor with the provision of employment, within government, to all university graduates regardless of whether they contribute productively to the needs of society. Change in the structure of society, and in the techniques by which tasks are accomplished, appear neither to be keeping pace nor in accord with change in the numbers of people and their qualifications to perform tasks consistent with needs and resources.

The framework within which planning for the future of Egypt must take place is therefore social, political, and cultural in nature, as well as economic and technical. Technological innovation must encompass organizational as well as technical change. The scientific and technological community, social science as well as physical and biological, has much to contribute. In fact the challenge of the

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[1/] Further evidence of the complexities or rural development is contained in Jones B. Mayfield, Local Institutions and Egyptian Rural Development (Ithica: Center for International Studies, Cornell University, 1974).

future cannot be met without the contributions of this total community.[1/] But the question is how?--how to capture the imagination of those who comprise this community and cause them to formulate and implement bold programs of research and development consistent with national needs? It is in answering such questions as these that Egyptian leaders are seeking assistance from U.S. AID.

Scientific and Technological Resources Available

The Academy of Scientific Research and Technology (henceforth identified as the Academy) has been engaged recently in an assessment of scientific and technological resources available in Egypt. A publication summarizing the findings will be issued soon. Meanwhile, Table 1 provides an indication of the nature of the evidence tabulated through 1972.

TABLE 1

NUMBER OF ACTIVE SCIENTISTS IN EGYPT WITH DOCTORAL AND MASTER OF SCIENCE DEGREES IN 1972

Field of Study	Doctoral	Master of Science	Total
Engineering	804	483	1,287
Medicine	1,658	213	1,871
Agriculture	1,170	1,279	2,449
Basic Science	1,440	1,221	2,661
Social Science	2,027	897	2,924
TOTAL	7,099	4,093	11,192

Source: Academy of Scientific Research and Technology.

[1/] The importance of science and technology to development has been a recurring theme in Egyptian planning. Prior to the plans now being formulated, President Sadat, in presenting a Programme of National Action (Cairo: Ministry of Information, 1971), called for the creation of "a State consecrating all that modern science has achieved for the benefit of society."(p.26) He continues by asserting that "more than any other nation we have no hope but in modern science."(p.32).

Although not yet available by category, the Academy estimates that the number of Egyptians holding doctoral and master of science degrees from Egyptian and foreign universities, and currently active in Egypt, reached a total of 18,000 in 1975.

Whereas holders of advanced degrees comprise the reservoir of potential leadership for the scientific and technological community, holders of bachelor's degrees are essential to the performance of many functions by this community and to the functions of the many other types of entities of a developing society. Table 2 presents the number of recipients of such degrees by category for the period 1965-1973.

TABLE 2

NUMBER OF EGYPTIANS RECEIVING
BACHELOR'S DEGREES, 1965-1973

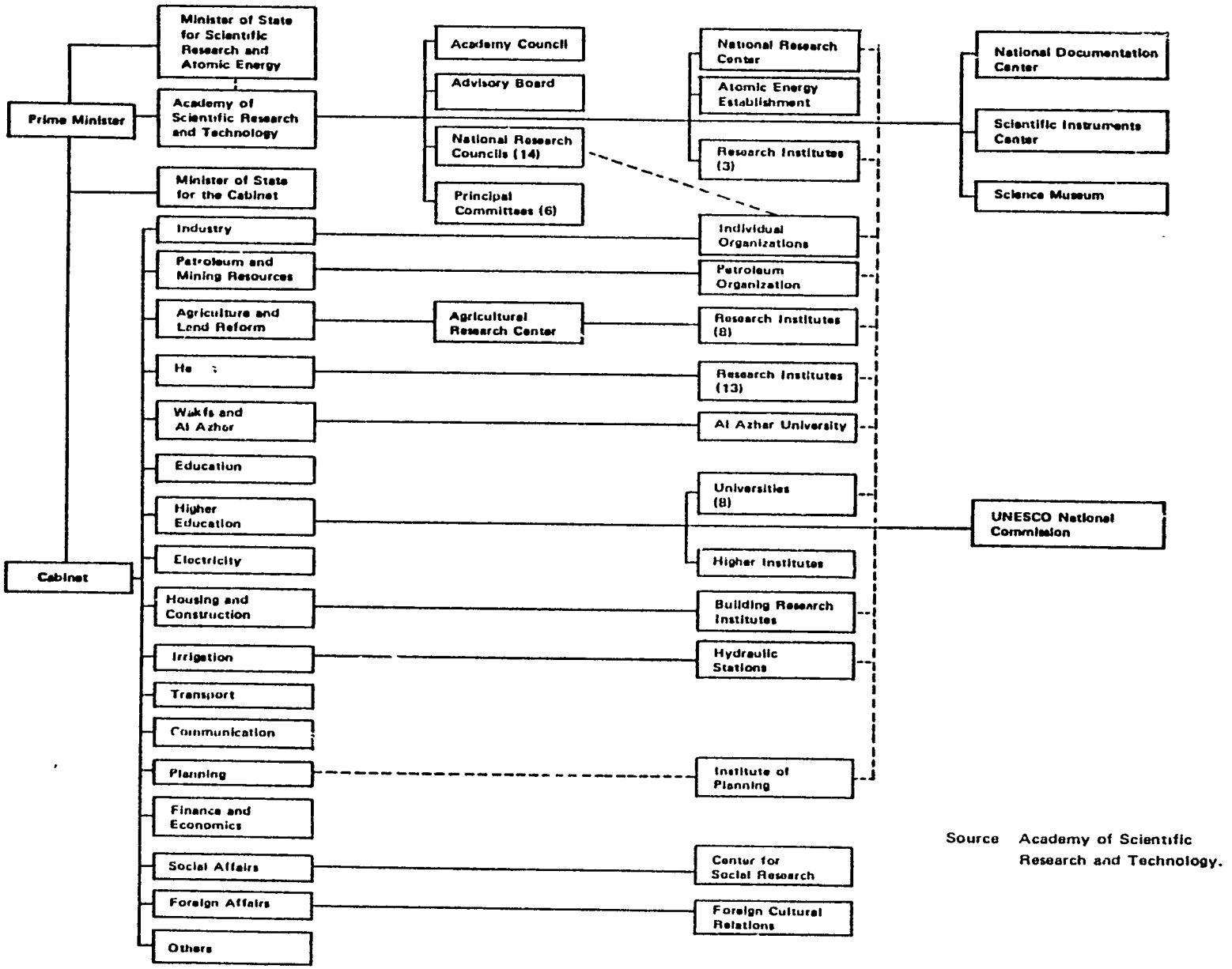
Field of Study	Number of Recipients
Natural Science	20,202
Engineering	27,238
Medicine/Health	28,819
Agriculture	25,481
Humanities/Social Science	106,069
TOTAL	207,809

Source: Academy of Scientific Research and Technology.

Volume II of this report contains a descriptive summary of the number of universities, research centers, institutes, agencies, and other types of research and development entities to which the Academy is related through special research councils and other organizational arrangements.

Organization and Functions of the Academy

In Figure 1 a schematic summary is presented of the relationship of the Academy to the principal organs of government. In brief summary form, the functions of the Academy are:

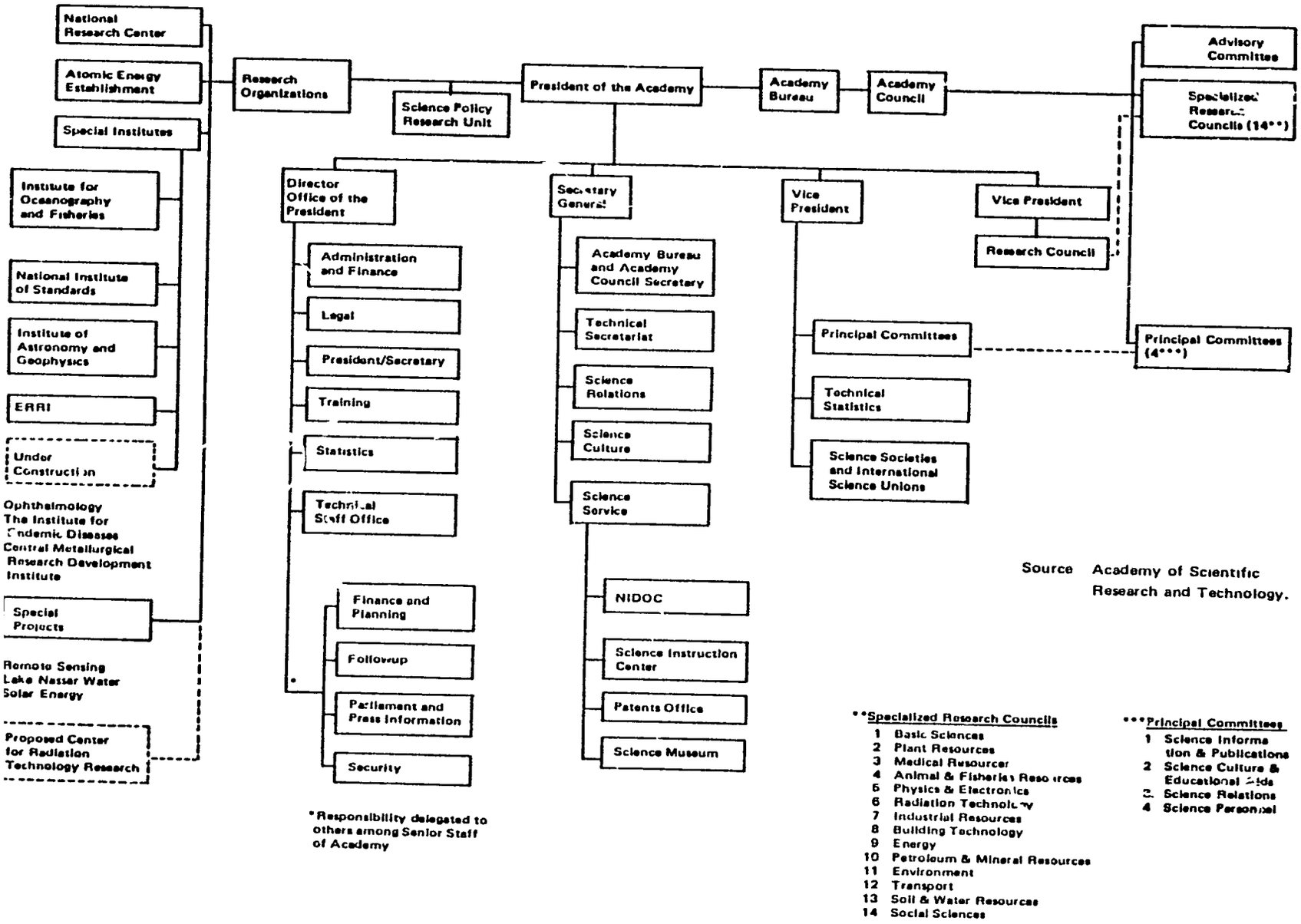


Source Academy of Scientific Research and Technology.

Figure 1. Diagram of the Relationship of the Academy of Scientific Research and Technology to the Major Organizations of Government and to Other Organizations.

1. To support scientific research and the application of modern technology in all fields included in the program of economic and social development.
2. To formulate policies which insure the linking, at a national level, of the scientific and technological organizations with the principal trends of the scientific and technological research needed to serve the national development plans.
3. To formulate and coordinate research projects related to the national proble , financing them and following their execution.
4. To coordinate the major research projects affecting the national economic and social plans and which are executed in the various institutes and departments.
5. To participate in the study of the scientific and technological aspects of the major development projects and, when necessary, to recommend establishment of new research institutes.
6. To encourage basic research as a means of building up research personnel resources and of supporting research schools working in modern fields of science.
7. To disseminate information concerning the possibilities of internationally known modern technologies being used in Egypt.
8. To participate in the development of science curricula, in the organization of incentives to scientific workers, and in the organization of scientific publishing and the popularization of science.
9. To support scientific societies and encourage the holding of scientific conferences, and the development of international relations in science.

The internal organization of the Academy, and its links to various research centers, institutes, councils, advisory committees, and other organizational units, are summarized in Figure 2. The composition of



Source Academy of Scientific Research and Technology.

*Responsibility delegated to others among Senior Staff of Academy

**Specialized Research Councils
1 Basic Sciences
2 Plant Resources
3 Medical Resources
4 Animal & Fisheries Resources
5 Physics & Electronics
6 Radiation Technology
7 Industrial Resources
8 Building Technology
9 Energy
10 Petroleum & Mineral Resources
11 Environment
12 Transport
13 Soil & Water Resources
14 Social Sciences

***Principal Committees
1 Science Information & Publications
2 Science Culture & Educational Aids
3 Science Relations
4 Science Personnel

Figure 2. The Organizational Structure of the Academy of Scientific Research and Technology and Links with Other Organizations.

the various councils and the committees is given in Volume II. Information is provided also regarding existing and planned research organs, and their linkages with the Academy.

Examples of Major Research Institutions

In addition to the Academy, the PID considers the potential role of the National Research Center and Cairo University. Other institutions are also important; these two are discussed for illustrative and perhaps other reasons. We therefore present summary information regarding both.

1. The National Research Center.

NRC is a large, natural science-oriented, Government-supported research institution located in Cairo. Its staff, comprising some 1500 professionals, is housed in extensive laboratory and office spaces near the center of the city.

Research at NRC has been basic and academic in nature, determined by and closely related to interests of the senior professional staff in pursuit of their individual research interests.

Administratively, NRC reports to the President of the Egyptian Academy of Scientific Research and Technology (but is not a component of the Academy). It receives its primary funding through Government auspices, for which several higher authorities including the Academy's President, the Office of the Prime Minister, Finance Minister, and others to lesser degree have responsibility.

The efficiency and productivity of NRC activities are not assessable in the short period of three weeks. However, observation combined with opinion and information from various sources--including management principals of NRC itself--indicate that signficant improvement is needed in the national relevance of NRC research.

Fortunately, this need for research thrusts directed more toward national development goals has been recognized by NRC management, and higher authorities, and is being attacked by the conscious adoption of new operational philosophies intended to develop and apply this resource more directly, massively and appropriately to solution of priority problems.

As will be described subsequently, to attain this goal will require much better identification of national development priorities and consequent action related to: (1) the managerial and technical development of the staff, (2) user community needs and interactions, and (3) provision of significant new material resources.

The NRC management, under the leadership of its director, seems committed to these objectives and expresses hope that enabling assistance may be provided.

2. Cairo University.

Founded in 1907, Cairo University is one of the eight major universities in Egypt. With approximately 3,000 faculty members and more than 65,000 students it plays a significant teaching and research role. Instruction is offered in Arts, Law, Medicine, Science, Economics, and Political Science, Commerce, Engineering, Dentistry, Pharmacy, Agriculture, and Dar al-Alam.

III. THE UTILITY OF RESEARCH RESULTS TO INTERMEDIATE AND FINAL USERS

In this section we seek to set the stage for appraisal of the potential of the Academy and associated institutions and agencies for meeting the challenge of Egyptian development. To do so, it is necessary to characterize the community of potential research users, to stress the necessity for research results of high utility, and to outline how research may be structured to meet the needs of Egypt.

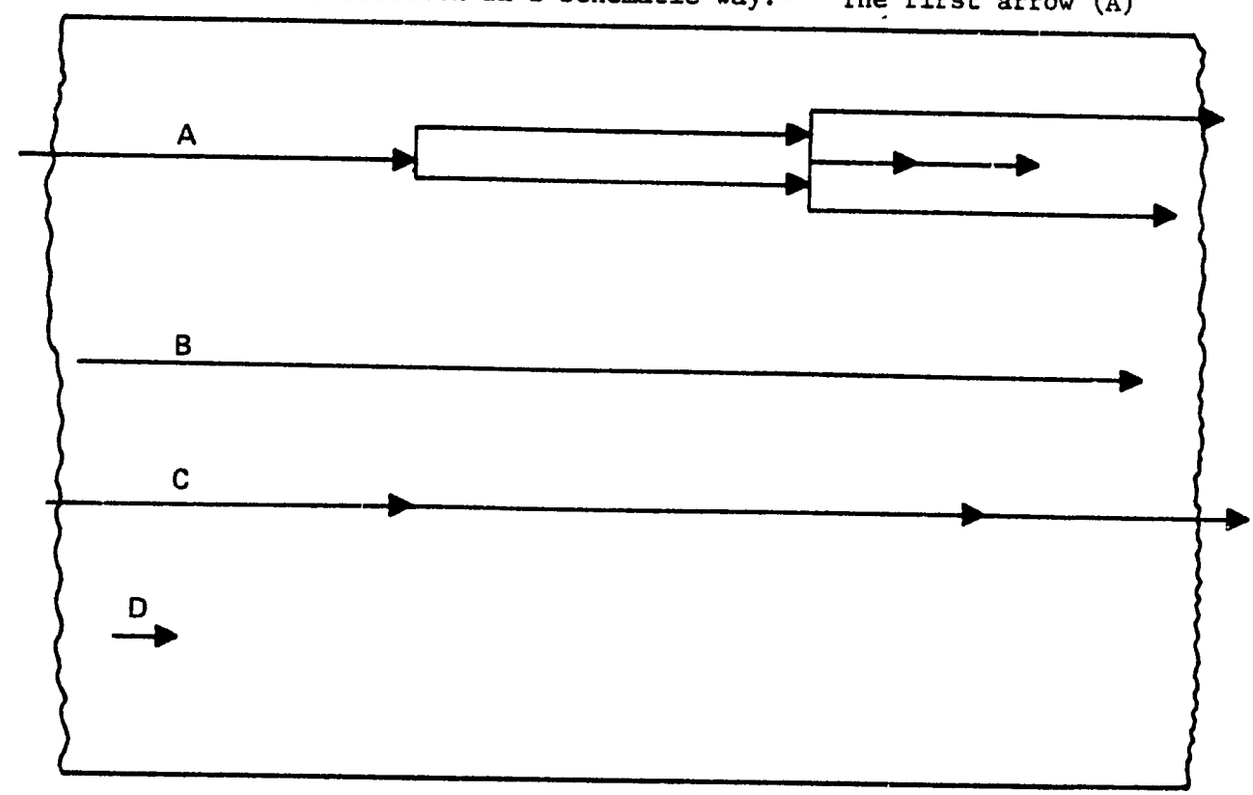
The Community of Research Users

1. Initial, Intermediate and Final Users.

For analytical purposes, the individuals and organizations that use, or otherwise benefit, from the results of research may be divided into three groups: (1) those in research who interact with each other in identifying problems and in designing research programs and projects (initial users of prior knowledge who create new knowledge), (2) those who adopt the new knowledge, develop it further and put it to work (intermediate users), and (3) those whose lives are subsequently affected by the impact of the new knowledge (final users). All three groups must be considered in planning research. Chemists and engineers (initial users) of the National Research Center (NRC) have developed a new process for making sand bricks, for example, that will be of direct benefit to the brick manufacturers (intermediate users), but ultimately a broad section of the population should benefit from the availability of a new and inexpensive building material (final users).[1/]

[1/] Within each group additional users or beneficiaries can be identified. In addition to brick manufacturers, those who produce brick ingredients to mix with sand may benefit. Building contractors may also benefit if construction becomes cheaper and more construction results. The "final users of buildings" include small wholesale and retail merchants, organizations that use buildings in manufacturing and storing products, and families that enjoy the benefits of more and better housing.

Figure 3 illustrates possible relationships between the "doers" and the "users" of research in a schematic way.[1/] The first arrow (A)



Origin of Research | Exploratory, Assessment or Conference Stage | Theoretical and Empirical Research Application Stage | Prototype Development or Further Application Stage | "Final" Users of Research Results

Figure 3. Hypothetical Illustration of the Research and Development Continuum in Relation to "Final" Users of Research.

1/Figure 3 and associated discussion are adapted from Quentin W. Lindsey and Judith T. Lessler, Utilization of RANN Research Results: The Programs and Its Effects--A Survey of the Research Applied to National Needs Programs of the National Science Foundation (Research Triangle Park: Research Triangle Institute, March 1976), pp. 8-10. The "torn ends" of Figure 3 signify that we are dealing with a continuum in that there is no real finite beginning to the research and development process, nor is there a real and finite end. Moreover, the impression of "linearity" that Figure 3 may convey is false. The research and development process does not, with neat precision, begin with a basic research idea, move then to the applied research or development stage, then to prototype, and on inevitably to the final user. The process is often synaptic in nature, with time lags, discontinuities, delays, unexpected complementary linkages between two projects, disappointing "dead-ends," and so on. Despite these drawbacks, perhaps Figure 3 does convey the notion that there is a process of research and development that can be harnessed to a degree in order to enhance the well-being of the people of Egypt.

beginning on the left illustrates a first-stage formulation or assessment (by initial users of prior knowledge) that led to two subsequent projects which, in turn, provide the basis for, say, prototype development (by intermediate users). Three different prototypes are illustrated as having been developed and tested in the next stage. The final arrow-point of each line signifies that results have reached "final users" or "consumers." Thus, "intermediate users" of prior work emerge in the continuum between the origin and "final" users of results. Some of these may be additional research and development organizations, some commercial producers, and some wholesalers or retailers.

The second arrow (B) beginning on the left illustrates a single project that culminates directly in "final" user adoption of results. There are no intermediate users in this instance. A single organization carries the effort from the beginning to final use by, say, consumers. Internally, however, the organization may carry the work through several comparable stages. An example (admittedly not realistic) would be for NRC to carry the sand brick development on through the manufacture of bricks and thence to the construction of buildings for people to use. Normally, organizational specialization intervenes and such a process is divided among several "sequential" users before the final user is reached.

The third arrow (C) illustrates a case in which an exploratory assessment or conference led to a single research and development project that resulted in effects that quickly reached final users. For example, a particular disease may have for the first time, struck a crop produced by farmers in a given area of the Nile valley. An effective treatment may have been established by prior research. The small exploratory assessment then (1) identifies the disease, (2) prescribes the treatment needed, and (3) plans the steps to take by farmers (and perhaps an associated cooperative) in obtaining materials and treating the crop for the disease. Thus, only two stages of effort are needed beyond the assessment in order to reach final users--one stage by farmers and the cooperative, and the next by distributors of the farmers' products.

A research project may be initiated and terminated at any stage of the research process. For example, the Academy may provide financial support for an initial exploratory assessment or conference and each of the subsequent projects thereafter to insure "final" use. Or alternatively, Academy support may have continued through to prototype development, with other government agencies, or semiprivate or private organizations, assuming all or part of the cost thereafter.

The Academy may support an exploratory portion activity, as illustrated by arrow (C), and then stop because from that point on the work is clearly the responsibility of other organizations. In some cases, such as the last arrow (D) illustrates, the Academy may fund an exploratory assessment or conference to determine whether a suggested need or problem is indeed national in significance and subject to solution by the application of research. The conclusion may be reached that the problem is not of national importance, or for other reasons that further research should not be supported by the Academy. If so, as arrow (D) illustrates, the effort may be terminated. The primary user of results then becomes the Academy itself. The decision to stop or to take a different approach is the primary outcome. Thus, the exploratory project or conference also can function as an important Academy "management tool."

2. Intermediate User Subcategories.

Within the category of "intermediate users," three different types may be distinguished for purposes of orienting research and development policy toward their needs.

a. The Commercial Users.

These users consist of those organizations that may be willing to finance a research project on a contractual basis. An organization perceives the potential utility of results in meeting its needs and accordingly will pay for the research if it is cost-effective from the organization's point of view. Typically the research is intended to solve problems such as those encountered in production. The potential user is seeking to improve

his product(s), change the raw material input, develop new products, or overcome managerial problems. The critical characteristics are that the problem exists with the user and that the user normally pays for the research.

b. The Potential-Investor Users.

These users respond to economic opportunities identified by research. The research is generally undertaken as a speculative venture proceeding on the assumption that, if successful, a potential investor will use the results. The Academy, for example, may support the preliminary development of new products from under-utilized natural resources. When promising opportunities are discovered, the results are released to investors. In Egypt, these investors may be government agencies, industries in the public sector, or emerging private organizations. In some cases, a royalty payment may be assessed. The distinguishing characteristic of the potential-investor user is that the research problem does not originate with him. He enters the picture only after a solution is in sight.

c. The Public-Domain Users.

These users consist of those individuals and organizations that use knowledge developed deliberately for placement in the public domain. Most agricultural research is intended for this purpose; results are typically distributed free of charge to farmers. In many cases extension services are created to help convey the information to the potential user. By contrast with research aimed toward the potential investor, public domain research usually has a particular potential user group in mind before the research begins, and the problems or needs of this group are identified as a means of guiding or structuring the work to be done. The rationale for such research is usually that the number of

potential users is large and the economic size of each is small in relation to the cost of research needed. No single user can afford the cost. Hence it is in the public interest for government to finance important projects and to make the results freely available to all.

The Utility of Research Results

In utilizing research results, the decisions of intermediate and final users are affected, in some identifiable way and within some reasonable period of time, by the results. The research may deal with tangible, prototype hardware, or with intangible issues such as implementation of government policy. In the first instance, utilization may mean that an industrial organization decides to produce the hardware on a mass basis. In the second, utilization may mean that a government agency decides to alter its present course of action to conform with a change in policy.

The impact of utilization upon organizational entities of society may be positive, negative, or neutral. For example, use of a new labor-saving machine in a factory may have a positive effect upon net income to the organization operating the factory. Since it displaces labor, however, those factory workers who must seek other employment will construe utilization to be negative.

In considering the impact of research in Egypt upon final users, it is important to note also that the results of research may have a wide or narrow effect. Penicillin, for example, is nearly universal in its potential benefit to the population, but the impact of a solution to the bilharzia problem would be concentrated in the agricultural labor force--the segment of the population most exposed to this particular infection. The composition of the final user community depends, therefore, upon the nature of the research. To some extent this may be anticipated in advance, as in the case of projects concentrating upon bilharzia.

1. The Importance of Utility to Users.

Research designed to facilitate the development of Egypt differs significantly from research that is not expected to have immediate utility. The difference lies in the fact that research for development purposes must influence decisions. On the premise that users will act in their own self-interest, the key to utilization is therefore the utility of research results in relation to the needs of the user community. And these needs must be keyed to national development goals.

Consider, for example, the commercial user as defined above. This potential user must be motivated and able, first, to define his needs with sufficient clarity that the researcher has a clear perception of the problem to be solved, and, second, he must be motivated to use results when they emerge. Many Egyptian production units are publicly owned and sheltered from competition. These and other factors tend to weaken managerial incentives to increase productivity, improve product quality and develop new products.[1/] The incentive to use research services in factories is often further hampered by the nature of production equipment. It tends to be either very old, in which case management's main responsibility is to keep it running, or it was purchased in recent years on a turn-key basis with all major follow-up service provided by the equipment supplier. Moreover, commercial users are often not accustomed to using research services. They have had little experience in identifying and describing problems in a manner which will enable the researcher to work on them. Furthermore, researchers have had little experience in helping customers formulate their problems. There tends to be a gap in communication between the potential user and the researcher.

Turning next to the potential-investor users, utilization depends primarily on the potential of results in relation to costs and benefits.

[1/] Public ownership does not automatically imply inefficiency and lack of managerial incentives. Rewards and penalties that result in efficient, effective and equitable performance can be built into public sector enterprise as well as private, but steps to do so must be taken deliberately.

If a new product or process cannot be expected to result in benefits exceeding costs, it is not likely to be utilized. Cost-benefit relationships apply whether we are referring to a government agency as investor (e.g., the costs and benefits of alternative ways of moving fish from Lake Nasser to Cairo), to a public-sector industry (e.g., labor-intensive vs. capital-intensive machines for a textile plant), or a private investor (e.g., a potential private manufacturer of small-scale agricultural equipment). A sample assessment by team members of current unsponsored research conducted by several research centers and institutes of Egypt suggests that some of it may not hold significant economic promise.

Public domain users typically weigh the utility of research results in terms of potential benefits and costs, plus compatibility with cultural life style. This latter factor generally includes elements of risk aversion and an inclination to maintain established social relationships. Newly developed agronomic practices, for example, may encounter acceptance problems if their adoption requires giving up cultivation of secondary crops which traditionally provide back-up insurance against failure of the primary crop. The new practices may also encounter cultural resistance if they require small land owners to give up splintered ancestral holdings in order to aggregate land to take advantage of economies of scale. Current research projects (reflecting past practices) tend to be organized along disciplinary lines, and hence have not given systematic consideration to some of the broader issues. Recent developments in both the Academy for Scientific Research and Technology and the National Research Center, however, are aimed at broadening the scope of problem definition.

2. <u>The Necessity for Interaction</u>

If utility to the user is a key to the adoption of research results, then interaction between research workers and potential users is necessary for two reasons: (1) the researcher and the potential user must reach a mutual understanding of the problem, what is required by way of solution, and the possible effect of solution upon subsequent decisions; and (2) the potential user must be in a position to learn of

the results of research as they emerge (to assume that he will read and understand results when published in a scholarly journal is not good enough).[1/]

A number of commercial users in Egypt have the capability to define problems, work with a research organization, and use the resulting research output. They have within their organizations well developed planning units that are charged with identifying problems and opportunities and developing programs to deal with them. More typically, however, team members observed that the professional staffs of production units are fully occupied with day-to-day operational problems, and cannot direct any significant effort toward matters which might involve the use of external research services. As a result, they cannot easily link themselves with output points of the research system.

Public-domain users are not normally expected to take the initiative in defining their problems with research workers. The agricultural extension service and government units concerned with small-scale industry are usually expected to convey results of research to such users, and to communicate emerging problems back to research and development organizations. Potential-investor users must be persuaded regarding the utility of research results before they will invest, and this persuasive effort is best begun in the formative stage of a project and continued through to the end.

The team observed, however, that there are many functional gaps between research and development organizations and potential users--whether they be commercial, potential-investor, or public-domain users. Many cases exist where, for example, commercial users have the capability of identifying their needs and using results, but interaction

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[1/] Lindsey and Lessler, Op. Cit., pp. 46-56. Utilization of research results was found to be much higher if there are various forms of two-way communication (meetings, letters, telephone conversations) between the researcher and the potential users, from the formative stage of the project through to completion. Similar conclusions were reached by Gary Fromm, William L. Hamilton and Diane E. Hamilton, Federally Supported Mathematical Models: Survey and Analysis, (Cambridge: Abt Associates, Inc., 1974).

between the "doer" and the "user" is limited. When this occurs, the research organization makes little or no contribution and the problems of the user persist.

The scene is beginning to change, however, and a market for research services shows signs of emerging. NCR, for example, has recently (early 1976) established an Office of Sponsor Relations and Marketing which will seek to identify potential commercial users and encourage them to contract with NRC for research work. NRC reports that the program of this new office is progressing well, but that users typically do not yet have confidence in the utility of contract research, and are hesitant to spend the full amount necessary for NRC to solve their problems.

3. Relation to National Needs or Goals

Whereas research results must have utility to potential users--and utility is enhanced if interaction occurs among inital, intermediate and final users--there remains the question of utility to society in general. Are research resources being used to focus upon critically important national needs or problems, or are they being diverted to support the self-interest objectives of a select few at the expense of the rest of society? Or are the resources being expended on projects which have not met the test of national priorities?

The test, in answering these questions, lies in relating the research plans, programs and projects to the national goals and plans of Egypt. These goals and plans, in turn, must identify the national needs or problems in such a way that research may be structured and guided accordingly. Figure 4 illustrates this point in a simplistic fashion.[1/] National goals (such as discussed in Chapter II above) are at the core of the effort. These are developed within the ministries and departments of Government, but should be established through discussions with the research and development community and with those concerned with all elements of Egyptian society, particularly those with problems or needs of national consequence.

[1/] Figure 4 is also adapted from Lindsey and Lessler, Op. Cit., pp. 11-13.

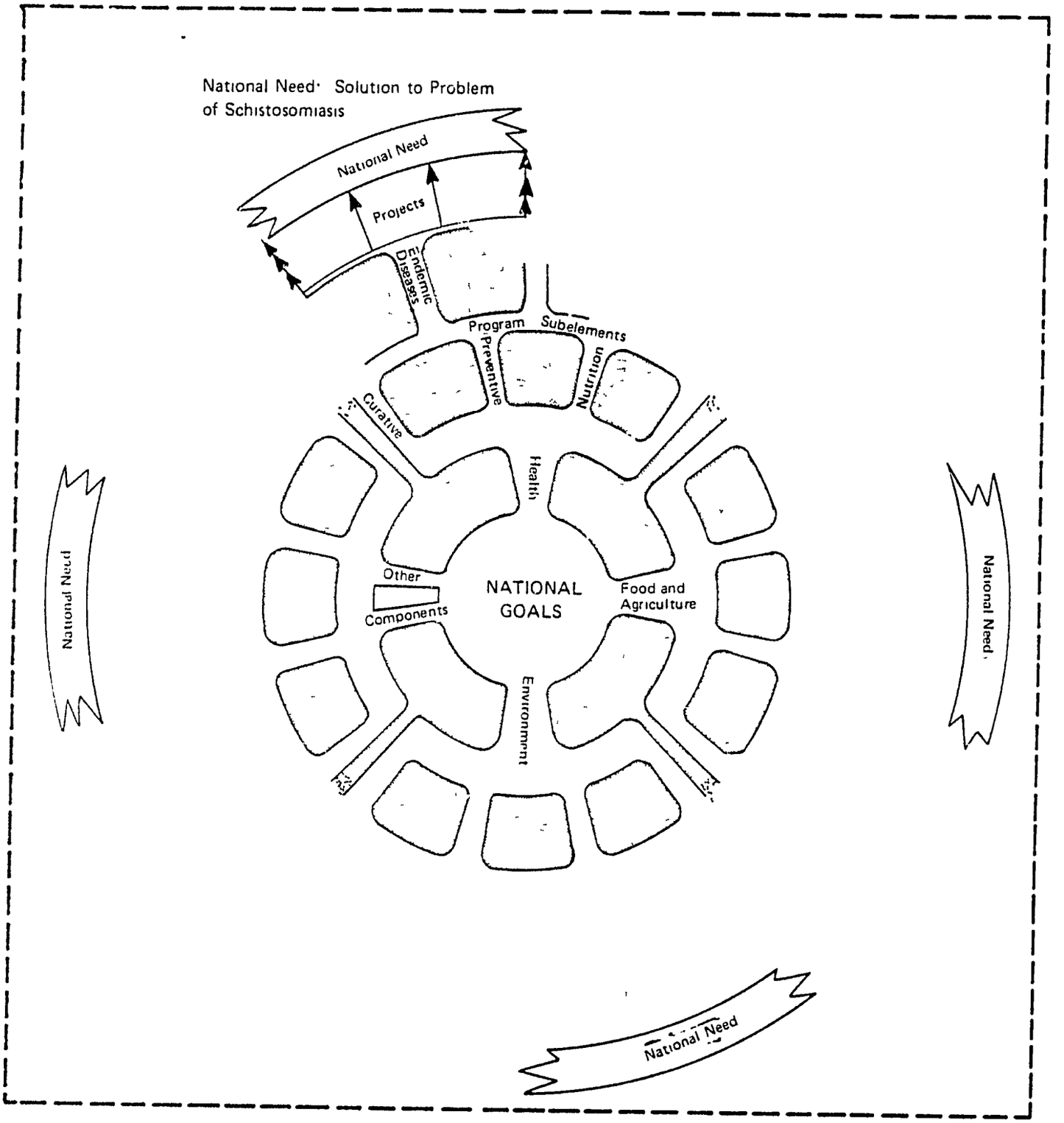

Figure 4. Schematic Diagram Illustrating Links Between National Goals and National Needs Through Research and Development Programs, Program Elements, Program Subelements and Projects.

National goals, of course, are then translated into action plans for various government ministries, departments and agencies, including plans for public and private sector enterprise, for education, for regional and local development and so on. These action plans are not illustrated in the diagram. Instead, lines of research and development that parallel or complement the action plans are presented in schematic fashion. For example, if a national goal of Egypt were "to improve the health of all citizens," the research and development plans might be divided into such program elements as research dealing with curative medicine, research concentrating upon preventive health care, research pertaining to nutrition, and so on. A program subelement might consist of research dealing with serious endemic diseases. Solution of the problem of schistosomiasis, endemic to Egypt, has been identified as an important national need. Thus, if Figure 4 may be construed as at all indicative of national needs-oriented research in Egypt,[1/] the arrows pointing to the schistosomiasis problem represent a structuring of sequential projects (comparable to elements of Figure 3 above) intended to lead to curative and/or preventive measures in dealing with this debilitating disease. These results would then be utilized by additional intermediate users such as public health clinics. Final users would be the people of Egypt who either have, or are subject to, schistosomiasis infection.

The Significance of Research and Development Planning

It should be evident from the foregoing sections that research and development must be linked closely to national goals and planning, and that research results must have utility to the community of users, ranging from initial to final users. Research and development itself, however, must be planned as Figure 4 implies; otherwise it risks becoming simply a conglomerate of projects the utility of which may be

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[1/] Figure 4 is not intended to represent national goals or research programs of Egypt. Such terms as are used are only illustrative.

questionable. Certainly Egypt, in striving to bring the scientific and technological community into the center of development action, must give careful attention to such planning.

1. The Importance of Goals

Research and development planning is meaningful only if it is directed toward a goal or set of goals. Often development goals are expressed in terms of what is expected to happen to the final users of research results: the health of all citizens is to be improved, for example, or income per capita is to be increased and/or the distribution altered. In planning research, these general goals need to be translated into the particular problems that must be solved or needs that must be met in order to make attainment of such goals possible. This usually results in identifying the needs or actions to be taken by intermediate users as well as final users--e.g., what the health clinic or the sanitation engineer must do to solve a health problem, or what a manufacturer must do to increase production without raising the cost per unit of product. Thus, in identifying the goals for research and development it is sometimes necessary to work backward from the general goals of development to the particular needs or problems inhibiting development.

If stated goals are inadequate or incomplete for research and development planning, the planners must pull together a "perceived" set of goals, based on statements of leaders, actions of legislative bodies, decisions of the courts, or other evidence such as statistically valid public opinion surveys--plus their knowledge of problems inhibiting attainment of perceived goals. The list of pertinent goals for research, stated and perceived, must be agreed upon by appropriate levels of authority in order to legitimize and provide support for plans developed to fulfill the goals.

2. Research Planning, Programs, and Projects.

Once the goals are identified, plans can be formulated to meet them through a series of time-phased programs. In complex national research plans, each program usually must be subdivided into program elements. In a five-year plan, the projects which should have priority in the first and second years can usually be stated and defined with

fair precision. The projects for the third, fourth, and fifth years of the program are stated in general terms at the start of the program, if at all, but become more refined and concise as time moves closer to them. Thus a research plan is made up of a collection of time-phased programs, each of which consists of an aggregate of program elements. The elements may be further divided into subelements and thence projects and subprojects, as shown in Figure 4. But to illustrate the research design in greater detail, Figure 5 is presented.

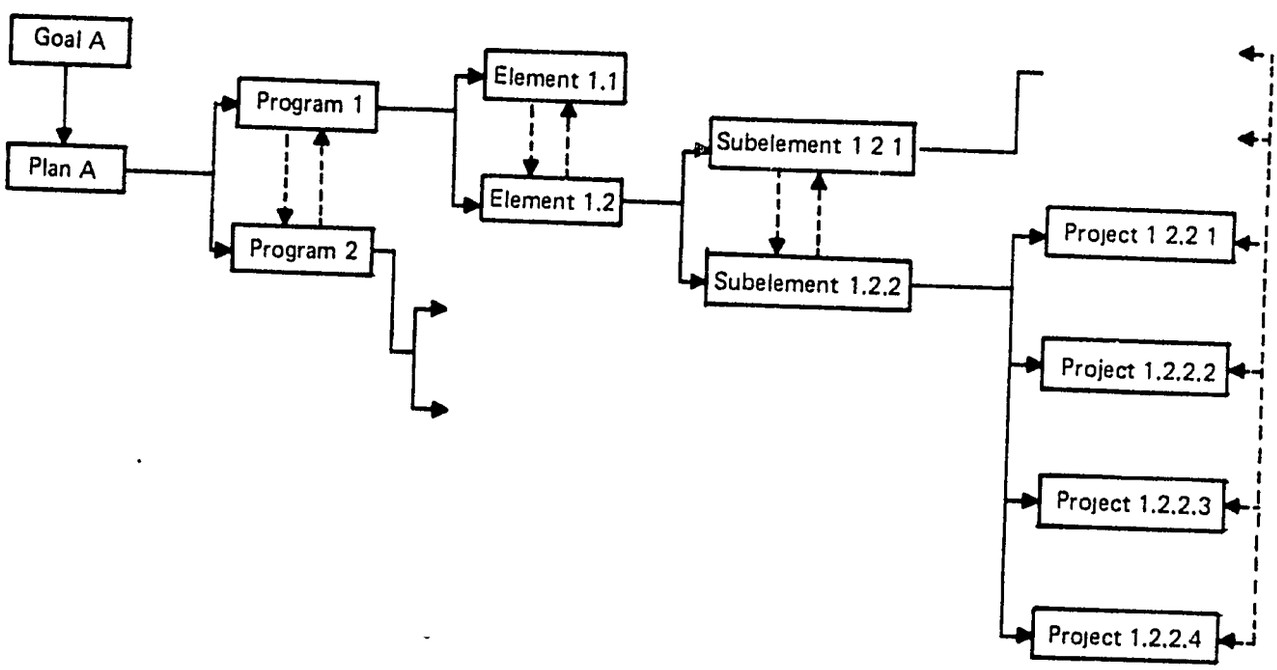

Figure 5. Schematic Illustration of Research Goal, Plan, Programs, Program Elements, Program Subelements and Projects.

To relate Figure 5 to an expressed Egyptian goal, it is reported that President Sadat has publicly stated a goal of "Increased agricultural production to achieve self-sufficiency in food, except for

wheat, by 1980." In this diagram, the plan might consist of two research programs, one concerned with food production and distribution, and the other with domestic food consumption and food imports and exports. The production and distribution program might consist of two elements: (1) crops and (2) livestock, poultry and fish. Each subelement of crop production and distribution may represent a crop that is or may be produced in Egypt. Projects associated with each crop may then concentrate upon key problems in producing and distributing that crop--e.g., genetics (development of new varities); land, water and crop nutrient relationships; labor, mechanization and consolidation of land holdings; storage and marketing; etc.

Although not illustrated, the food consumption and import-export program might consist of the elements domestic consumption requirements and export-import relationships. Consumption subelements might be (1) nutrition requirements and (2) consumer preferences, income and food price relationships. Projects under these subelements would be designed to explore the desirability of nutritionally adequate diets at lowest cost to consumers, but entailing changes in consumption patterns, versus nutritionally adequate diets costing more and requiring less change in consumption patterns.

Obviously, components of such a plan of research and development are interrelated. The dotted lines are intended to so indicate. For example, interaction between crop and livestock production and consumption patterns must be taken into account. Whether adequate protein diets are to be provided by cereal grains and fish, or by less grain and fish, but more livestock (with more grain fed to livestock) would be one of the questions to be answered.

3. Research and Development Structure vs. Government Structure.

A complex issue arises in relating research and development plans to the action plans of a government: the structure of government seldom corresponds to the design or structure of the research program. In the above example, agricultural experiment stations are under the jurisduction of the Ministry of Agriculture. However, other organizational elements, in or associated with other ministries and departments,

are concerned with transportation, industrial processing of food, elements of nutrition, export-import regulations, etc., and are potential participants in and users of the results of the research plan as outlined. Since interaction between research workers and potential users of results is essential from the formative stage through full execution of the plan, several serious organizational problems must be overcome in making full use of the scientific and technological community in achieving the developmental goals of Egypt. A comprehensive research and development program usually cuts across several administrative boundaries. A hypothetical illustration of the role of the Academy in this connection will perhaps serve to illustrate the point.

Ideally, development plans for Egypt must include not only action plans for government ministries and departments, but also plans for research and development that these units may be conducting plus comparable plans for research institutions. The plans should reflect input from Government (Cabinet and Ministries), from the recipients or intended users, from relevant segments of scientific and technological community, and anticipated budget factors.

The Egyptian Academy of Scientific Research and Technology is the existing body at the highest level of the Egyptian government which has the understanding, competence and desire to undertake the job of integrating research and development planning into national planning. The directives we have seen (Volume II) confirm the intent of the Egyptian government that the Academy is to play this role. Statements made to us during our stay in Egypt have further confirmed this view. The Academy already has in its infrastructure (Specialized Research Councils and Subject Committees) the start of an apparatus which could be directed toward better national research and development planning.

How should this role of the Academy relate in general to the responsibilities of other organizations having research and development interests and capabilities? Since it will probably be some time before the Academy can introduce research and development planning into the initial stages of national planning, the Academy must start with plans

already in existence or being developed. Starting at this stage perhaps has an advantage, since it permits the Academy to gain experience in the broader aspects of such planning, and to gain confidence and a reputation which will make its services sought at all levels. The introduction of national research and development planning into the initial phases of national planning may be a new concept in some of the ministries and top level councils, and may tend to be resisted since its potential for helping them has not yet been demonstrated and may not be readily understood.

In starting to develop a research and development plan related to a sector of an existing national plan (Figure 6, block 1), the Academy would, with the goals of that sector firmly in mind, obtain needed input from the potential initial, intermediate and final users, and from the results of related foreign research. From these and other inputs, the gaps and barriers which will hinder completion of the plan will be identified. The Academy would then prepare the related research and development plan (2), consisting of a series of time phased programs (2a).

The next step (3) is to consult with all organizations which can perform the need research and development. This important part of the process will (and should) result in some modification of the plan. After proper consideration, a decision would be made to assign the responsibility for the conduct of a program (4) to one or more of these organizations.

As an example, suppose Program C is to be assigned to NRC (5). NRC would be given such guidance as seems necessary and asked to prepare a proposal ("request for proposal") to the Academy for doing the work, including identifiable projects, staffing and budgets, planned subcontracting, time phasing, equipment needs, etc.--in short, a management plan for doing the program. The proposal (6) would be submitted to the Academy and, after discussions, changes and negotiations, would result in a contract (7) from the Academy to NRC.

In what might be called the second phase (Figure 7), NRC (1) designates a program manager, with a team to assist if needed, to guide

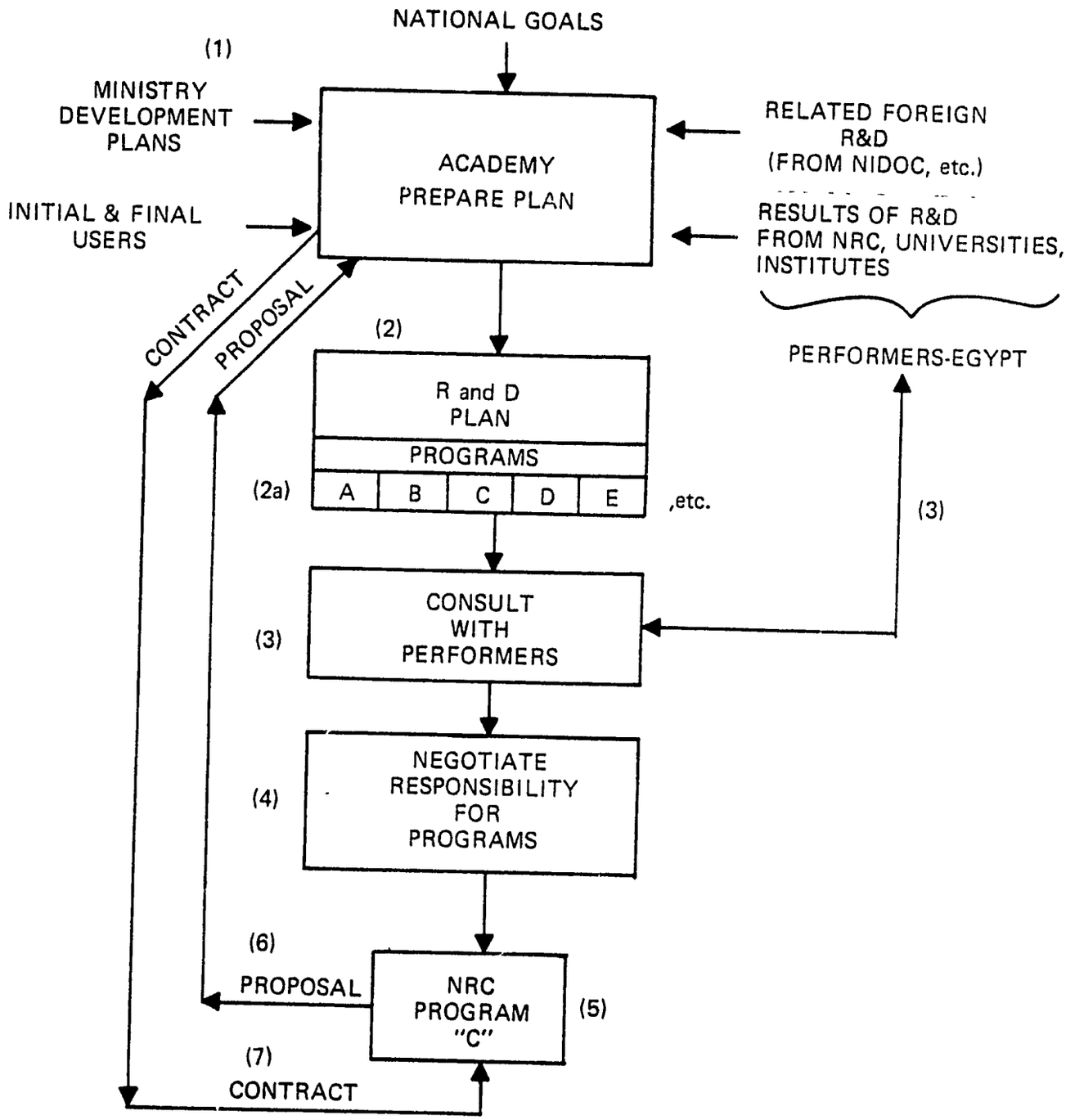

Figure 6. Hypothetical Illustration of the Role of the Academy of Scientific Research and Technology in Formulating Research and Development Plans and Programs.

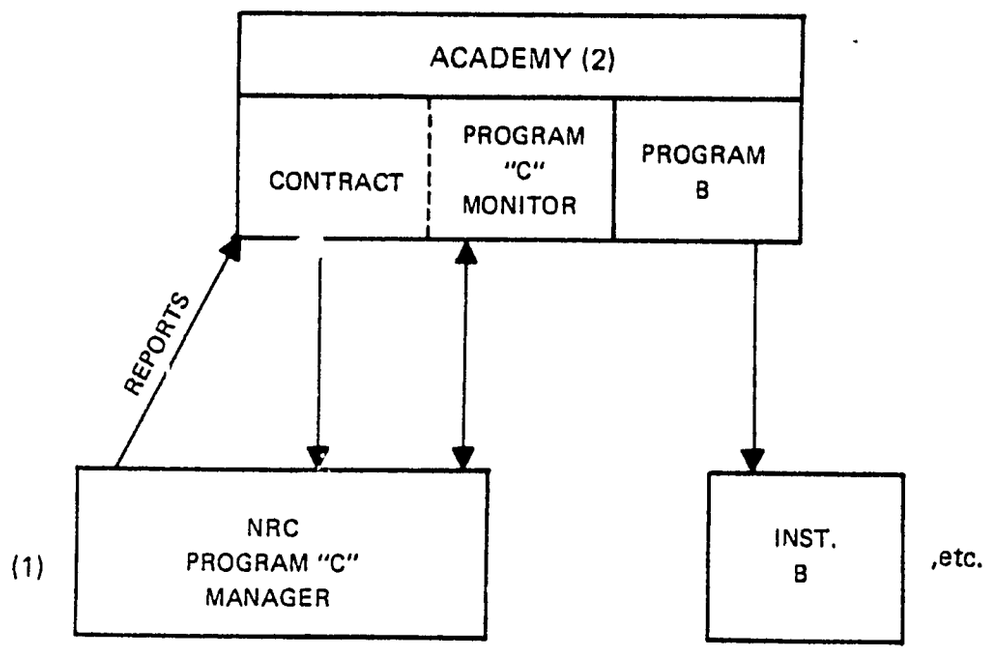

Figure 7. Hypothetical Illustration of Managerial Links between the Academy and NRC through the Academy Program Monitor and the NRC Program Manager.

the execution of the program in accordance with the approved plan. The Academy (2), through the use of a program monitor or coordinator, maintains a continuing follow-up with NRC to assess progress against the proposal, to give whatever assistance is needed, but not to direct the work. That is the responsibility of NRC (or whatever organization is selected for the assignment).

Both of these, the program manager (1) or team for the performing organization (NRC in this example) and the program monitor (2) or coordinator for the Academy, have been found to be essential to the success of large, multi-disciplinary, multi-participant programs in

various countries. A phase three (equally important, and which should overlap in phase one and which certainly should be underway during phase two) consists of contact with potential users, such as interested and involved agencies and groups, to whom dissemination of results will be made. Also a feedback procedure should be initiated to provide information from potential users to evaluate the utility of results to them.

The relationship between the Academy and the organization which will perform the research and development called for under the program is depicted in a general way in Figure 8. The Academy (1) produces problem-oriented research and development plans (strategies) and programs, by analyzing national goals, plans, etc., as outlined previously. The Academy (2), through contracts or otherwise, assigns responsibility for the conduct of the largest possible segments of the programs to the performers of mission-oriented programs of research and development. The Academy avoids breaking down the programs into small projects. As described earlier, that should be left to the performers, subject to approval of their proposals by the Academy. The performer (3) (NRC in this example) subcontracts as required.

The Academy monitors and coordinates through its program monitor (4), evaluates the program, and supports dissemination and utilization of the results. The main points are that the Academy (1) operates at the level of government policy and is involved in the broader aspects of national research and development planning, evaluation, etc. The operational aspects are left to the performers (2), such as NRC, with the performance being monitored (4) by the Academy.

This description of the role of the Academy as the designer of larger scale national research and development plans is not to be interpreted that the Academy would control all of Egyptian research and development. Its main role should be, through intelligent and integrated planning, to establish a framework or rubric within which on-going or proposed projects can be fitted or assessed. The performing organizations, the "doers," should be strongly encouraged to continue to seek support for the work they are doing or want to do, from whatever source possible. The Academy plans would provide guidance for the "doers," and

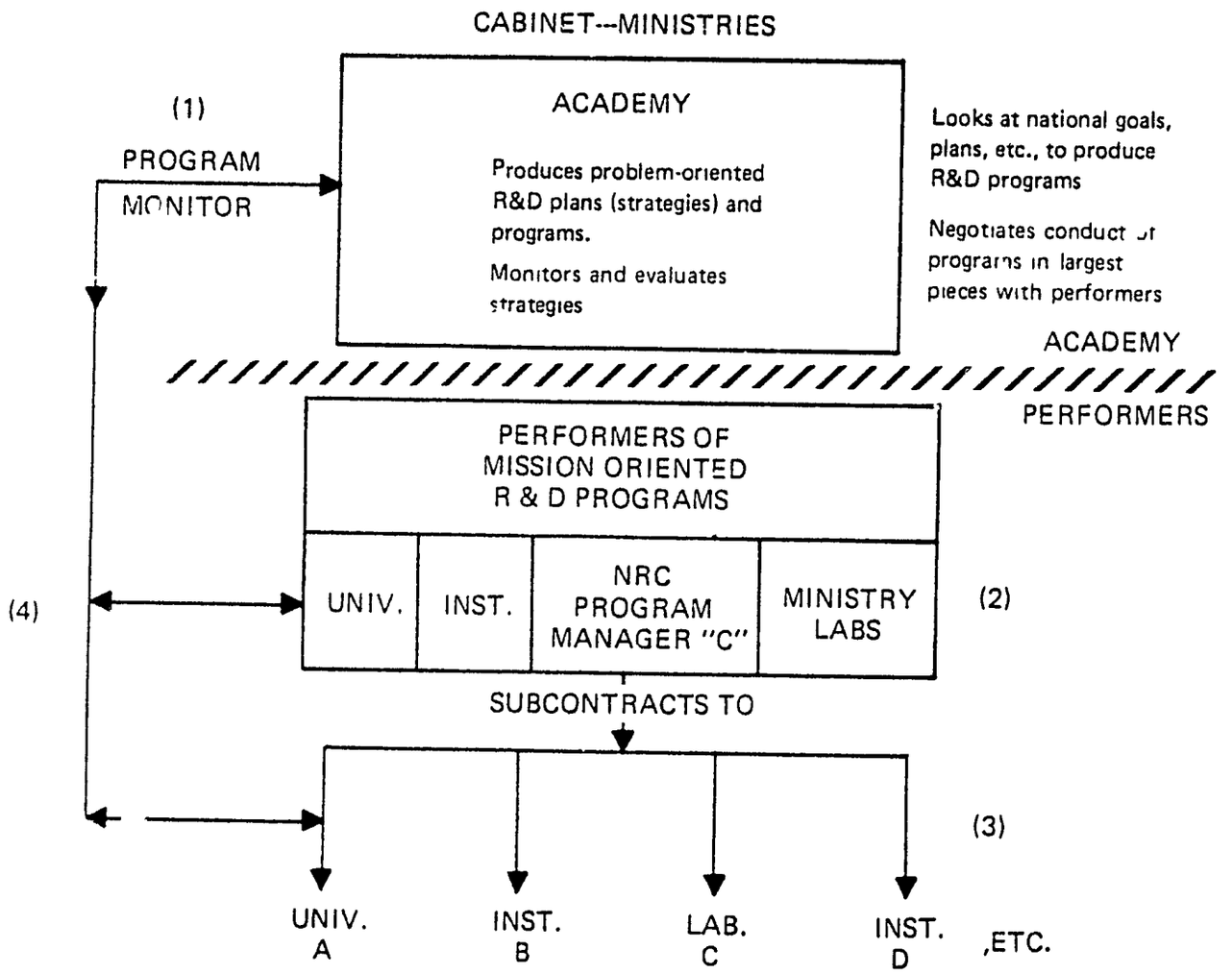

Figure 8. Hypothetical Illustration of the Relationship between the Academy and Organizations that Perform Research and Development.

the Academy should, through carefully designed incentives, encourage research consistent with the goals enunciated in the Academy's research and development plans. Attempts by the Academy to direct programs by requiring prior approval of all research and development would stifle creativity, introduce delays and become counterproductive.

If the Academy fulfills its role of research and development planning and guidance in a statesman-like manner, and refrains from intruding into the operational aspects of research and development, it can give a degree of stability and direction which will be of lasting value to the development programs for the physical and social welfare of Egypt.

The dividing line between research and development appropriate for planning, organization and support by the Academy and that which should continue within the domain of other organizations and agencies (particularly ministries and departments), is often difficult to identify. Normally, however, the choice hinges upon the magnitude and interdisciplinary complexity of the need or problem. If it intersects the responsibilities and disciplinary or subject matter orientations of several components of Government, and is of national significance, then the Academy is likely to have a role to play.

IV. THE INFLUENCE OF THE ACADEMY AND RELATED INSTITUTIONS

The role of the Academy as a catalyst in supporting research and development in relation to national needs is, in the view of the team, conceptually sound. The alternative of orienting the scientific and technological community toward applied research by administrative fiat has not been feasible as reported by past experience.[1/] Based upon our observations of various elements of this community, support appears to be growing for the approach taken. Nothing is being forced upon research workers in the universities, laboratories, research centers, institutes and agencies. If they desire financial support from the Academy, however, then they must comply with the orientation prescribed.

Being closely related to central government decision-making, as Figure 1 of Chapter II illustrates, the Academy is in a strategically opportune position to influence decisions of the development process. Yet the Academy is not a "line agency" such as a ministry and, consequently, is better able to maintain continuity in performing the catalytic functions of research and development essential to all elements of government.

Given this catalytic mode of operation, questions yet to be answered are: How much influence is the Academy, and the research and development activities it supports, having upon Egyptian development? Can this influence be enhanced? If so, what changes should be made to accomplish this?

Research Management and the Role of The Academy

As perceived by the team, whereas the emerging orientation of the Academy and related institutions is sound, strategically important national needs of Egypt are not yet being met in any significant way by Academy-funded research. It is, of course, much too soon to expect

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[1/] The question arose in several discussions with leaders of the research community. Team members were told that past arrangements in which prior manifestations of the Academy were ministerial had not functioned effectively.

sweeping results. Several projects--e.g., the schistosomiasis work--appear directed toward important national problems or needs. Insufficient time was available, however, for the team to review all projects critically to determine how well they were planned and how well they are being executed. But in scanning the lists of projects, and in reviewing the more detailed descriptions of some, we are left with the impression that more attention could be given to structuring interrelated projects into programs of research consistent with research plans that, in turn, are consistent with the plans and activities of ministries, departments, and agencies.

To put the latter point another way, dialogue at the ministerial level is taking place between the Academy and the Government, but interaction between Academy administrators, potential program managers of research projects, and the people with the problems or needs is too limited. There is evidence that development planning by government agencies, technology planning by public-sector enterprises and an emerging private sector, and science planning by the Academy and its councils and committees are taking place in somewhat separate compartments at the "operating" levels. Our discussions with Academy and research council leadership, and with ministers in Government, revealed a clear grasp of major problems or development needs of Egypt--e.g., the need for more and better food, for overcoming critically important health problems, for labor-intensive rather than capital-intensive industry, for a new "industrial/economic map" of Egypt, and so on.

As we probed, however, to determine how programs of research are formulated, how certain projects are managed in relation to each other, and how and whether potential users of research results were involved in the formulation and execution of projects, too little communication seemed to be taking place.

The research councils and subject committees of the Academy are intended to comprise the arena within which research and development planning is integrated with Egyptian development planning. We believe

the councils and committees are serving a highly useful purpose as forums within which the general issues of development planning, science planning, and technology planning can take place. They also comprise the medium within which concurrence can be obtained for basic changes in the general orientation of the scientific and technological community. But formulation of explicit research and development plans and programs in the manner, and to the degree, outlined in Chapter III requires full-time involvement of a small core of professional program developers and coordinators functioning within the Academy. Such individuals would be responsible for achieving the needed interaction at the operating level between the Academy and the "doers" and "users" of research.

Administrators of the Academy research support program are aware of this lack of interaction and are exploring ways to overcome the difficulty. The appropriate Vice-President already has begun to seek assistance in project follow-up and in the performance of other needed functions. We suggest the following steps be taken, however, to enhance the effort:

1. Program Monitors or Coordinators.

For the Academy to provide support and guidance to research and development programs in the manner outlined in Chapter III, the staff functions now performed should be extended to include vigorous program development and coordination activity. For brevity, we will identify such staff people as "program monitors."[1/]

Program monitors are the professional people who perform the catalytic function of formulating the major Academy research plans and programs, interacting, in the process, with appropriate individuals concerned with national development plans. (They do not, in other words, sit down and design a program limited to their individual perspectives). A program monitor works with potential program managers (the individuals who will actually guide the conduct of research and development) in

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[1/] The choice of terms is unimportant. Understanding the functions to be performed, however, is of vital importance. See the glossary in the appendix of Volume I for a brief definition of terms.

formulating the elements, subelements, and projects of program activity. In formulating these details, potential users of results must also be consulted.

Once a program of research is initiated or "contracted for," the program monitor follows or "monitors" the work of the program manager as the program unfolds. Principles implying high standards of research and development performance must govern this relationship. For example, if the program is going astray, the program monitor needs to call attention to this fact, but he must be constructive and assist the program manager in overcoming difficulties as they arise. Consistent with the Academy's supportive, catalytic role, the program monitor neither directs nor conducts the research. But he does insure that the guiding principles of national need-oriented research prevail, that the work of the program manager is facilitated rather than hindered, and that there is continuing communication with the identified user community as a means of keeping the program on target. Only if the program manager violates these principles, or goes completely astray for some reason, would the program monitor recommend cut-off of funds or other appropriate corrective action.

Program monitor qualifications will vary with the nature and scope of the programs for which they are responsible. A program concerned, for example, with transport and communications issues may require an individual with an engineering orientation; whereas, a food and nutrition program will likely require some form of agricultural orientation. An appreciation for and, in some program categories, training in social sciences will also be necessary. Several general qualifications may be set forth, however, that apply to some extent to all program categories:

a. Highly trained in a scientific field, but also "broad-gauged" enough to be familiar with and interested in several other fields. This ability to deal with several fields may be enhanced by further training and/or experience in research and development type activity.

b. Diplomatic, friendly, understanding and, when the need arises, persuasive in dealing with professional colleagues, with leaders in ministries, departments and agencies, with

industrial and agricultural organizations, and with ordinary rural and urban people who often are most affected by national problems.

c. Dedicated, orderly, tireless, and capable of maintaining commitment to program goals over a period of years, for the problems will often seem insurmountable and the rewards for dedication nonexistent.

2. Program Managers, Project Directors and Subproject Leaders.

The role of the program manager has been defined to some extent in differentiating him from the program monitor within the Academy. The program manager functions outside the Academy structure. He directs, is responsible for, and otherwise is in charge of a total program or program element of research the Academy is supporting. As mentioned in Chapter III, a program element may be subdivided further into projects and subprojects. A convenient term to differentiate the program manager's role from that of the individual in charge of a project is "Project Director." If a project is further divided, the term "Subproject Leader" may be used. These terms in no sense convey a hierarchy of scientific ability or expertise; they refer to the decision-making structure--the system of research and development management--essential to guiding the unfolding of a longrun program of interrelated activities through to the stated goal. A scientist of international reputation may be in charge of a minute, but critically important, subproject. The program manager or project director provides him with the support he needs and insures that results emerge in time to relate properly to the next stage. Neither the program manager nor the project director directs the specific work of the scientist in the execution of his subtask; nor does the scientist extend his authority beyond his subtask to influence unnecessarily the execution of the entire program.

3. Formulating Programs and Requests for Proposals.

The research programs of the Academy are, of course, executed largely by universities, research centers, and institutes through contractual relationships. Although such relationships already exist,

vigorous effort by program monitors in formulating the Academy program will require a more precise articulation of requests for proposals than has occurred in the past. To the extent that the Academy is successful in visualizing the structure of each program element, the requests for proposals from universities, research centers, and institutes should reflect this vision. The logic of this admonition is obvious: if one states with clarity and logic what is wanted, the more likely the proposals will be consistent with requests.

Several choices must be made, however, in issuing requests for proposals. First, although the identification of the national need or goal may be clear, the structuring of the program to achieve the goal may remain ill-defined. Thus, a request may be issued for an institution to structure or design a program of research and development to reach the specified goal. Then, if an institution submits an acceptable proposal and does a creditable job of design, the next decision relates to whether:

a. To request a proposal from a single entity, one that will assume responsibility for executing the entire program (an institution, or a task force consisting of representatives of several institutions joining together); or

b. To divide the program into components or stages and request proposals for each part.

If the latter is followed, the Academy is retaining control over how to fit one component to another, or to move from one stage to the next.

Criteria for deciding whether to contract for an entire program, or for separate parts, may depend upon such factors as availability of funds, the capacity and experience of the research and development institutions, and the quality of the proposals. The point is, however, that these decisions govern in large measure how and to what extent the Academy relates in a substantive way to the universities, research centers, institutes, and agencies. It can be assumed that decisions often will be affected by dialogue subsequent to proposal submission. Often discussion

and negotiation will clarify both financial and technical differences, if they exist. The team believes that whenever possible the management of programs and program elements should be delegated to another institution or task force through contractual arrangements.

Formulating research and development programs and requests for proposals is the means by which the gaps between development planning and science and technology planning are bridged. Assuming the Academy is able soon to build a core staff of program monitors, an emerging opportunity may be seized to properly structure a program or program element. Following the release of the draft five-year plan, a seminar is planned (for September) in which those concerned with development and those concerned with science and technology will have the opportunity to interact. We suggest that, in preparing for this seminar, a few small working groups be identified, each consisting of the following types:

a. An individual from planning.

b. An individual with a problem or serious need--e.g., an industrial manager whose plant is functioning at half capacity, or a village leader who is concerned with development of his village, or an individual concerned with how to move fish from Lake Nasser to Cairo.

c. A potential project director of such a project as represented by the problem.

d. A potential program monitor from the Academy.

Each small group could, as a prelude to the seminar, outline how they would organize and execute a program (or program element) of research to deal with the problem.

Similar groups could also be formed to review existing projects and perhaps, where appropriate, suggest ways for linking projects together to form an integrated program of research under a program manager. The proposed projects outlined and the existing projects reviewed could be examined against the background of the draft five-year plan.

Beyond this initial and brief "test run," a more concerted effort should be made to integrate research planning with the development plans of Government agencies. The key to this integration lies, it is here suggested, in further structuring of the Academy research and development program in relation to critically important national needs--particularly in the sense of carrying the effort through to the prime beneficiaries, the people of Egypt. The Academy research and development plan may consist of three or four major programs, as illustrated in Figure 4 above, each of which is directed toward a need reflecting or consistent with a basic developmental goal.

To identify a major program, the potential program monitors of the Academy might take steps such as the following:[1/]

a. Initiate a dialogue with ministries and departments of Government concerned with an important developmental goal, with university leaders, with industrial leaders, and with ordinary rural and urban people, all for the purpose of achieving a first approximation of the major program characteristics--i.e., to trace through conceptually the sequential chain of potential users such as illustrated by one of the lines of Figure 3. The point is to make contact with:

   1) Those in a position (the "initial" users) though research and development, to do something about the problems blocking achievement of the goal.

   2) Individuals who may be "intermediate users" of research results and who need to take action that will contribute to goal attainment.

   3) Selected numbers of those who will be the prime beneficiaries ("final users") of the results of

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[1/] The Academy may assemble individuals on a consultant basis, or a small team on a contractual basis, to assist program monitors do their work in taking any of these steps, drawing upon people from research centers, institutions, communities, etc. We do not mean by this suggestion that all individuals contacted and engaged in dialogue should become consultants to the Academy. We refer simply to direct assistance that may be needed by monitors in doing this work.

research and development. For example, rural or urban people usually have supprisingly acute comprehension of unemployment problems, food production difficulties, etc. They also have useful things to say that are sometimes overlooked.

The time taken to make this review should be limited to perhaps one month, for it cannot be exhaustive.

b. Assess what has been done, or is being done, in the way of research and development that may be related to, or contribute to resolution of, the problems or needs tentatively identified as inhibiting attainment of the development goal. Much of this work may be accomplished through contacts with appropriate people from the research and development community. But it must be organized, guided, and consolidated by the concerned program monitor. This step is sometimes construed as a "state-of-the-art" review. Again, it should be done as quickly as possible, concentrating upon Egyptian sources of information and readily available foreign sources. Often the best way to insure that this review is done quickly and efficiently is to contract with an individual (or a small team) from the research community.

c. Based upon the work of steps (a) and (b) the program monitor, on a first approximation basis, should identify the major program components and visualize insofar as possible the structure of research and development essential to meeting the national goal, building upon what is already known. In taking this step, further dialogue with contacts made in steps (a) and (b) should be pursued to the extent that time permits. One of the purposes of dialogue at this juncture is to insure complementarity with other programs, avoiding duplication and competition. To supplement the efforts of the program monitor and those working directly with him, a small team of foreign consultants may be called in to participate, especially to identify any

work accomplished in other countries that may have been overlooked and to assist in visualizing further work to be done. The time required for step (c) should again be limited, recognizing that perfection cannot be achieved. Perhaps another month to six weeks is a reasonable period. In taking this step, and just as account is taken of past research, related current program and project support by the Academy should be integrated to the extent possible with the new program.

In no way should this more "integrated" design of the structure of the Academy program of support be regarded as an abandonment of present project support. The primary word of caution is to limit the "new" structure to what can be implemented effectively, rather than to attempt to encompass all possible pursuits. Later, as this system of "management of research by objectives" is perfected, a broader coverage may be developed.

d. Present the results of step (c) to the Academy Council for review, suggestions, amendments as necessary, and approval. In this presentation, it must be made clear to the Council that, whereas the program elements, subelements, and projects are identified with reasonable assurance, more detailed structuring of some (perhaps each) will be pursued further as a request for proposals is issued and contract negotiations carried out. An assumption underlying this suggested step is that, because the program as structured may cut across several research council jurisdictions, it should go to the Academy Council for review and approval first. The appropriate Special Research Councils may then use the program as the overall guide for their subsequent decisions. If it is found that some change in special council organization and/or composition is required in order to better facilitate council functions in relation to program plans, then appropriate action may be taken.

Notice that we have not suggested, even in this "second cut" at structuring a program of research, that the Academy move immediately to formulate its total, or overall, research and development plan in relation to the Five-Year Plan, and to encompass all major programs. A plan that includes all Academy activity should be formulated, but we believe it should be done after some experience is gained in structuring a particular program. Thus, while this structuring of a particular program is underway, program monitors, working with the President, Vice-Presidents, Secretary General, and other Academy officials can be identifying other key program areas that the Academy should support, and outline plans for developing them. Constraints upon Academy resources, availability of research organizations to execute such programs, and the experience of program monitors are among the factors to consider in deciding how rapidly additional programs should be developed.

4. The Need for Explicit Longrun Operating Principles and Plans.

Whereas the Academy is clearly in a strategic position to guide, by catalytic influence, the role of the scientific and technological community, it nevertheless appears vulnerable to shortrun budget swings caused by fluctuation in total demands upon the national budget. For example, research and development is in many countries regarded as something that can be "cut back this year" because of some shortrun emergency of great importance. Egypt is not likely to be an exception. The Academy may be subjected, also, to self-interest pressures for luxury equipment, or other less-than-important-national-need-desires, particularly as the budget for research support becomes larger. Thus a longrun funding program to cushion against shortrun fluctuations and a set of principles whereby requests for support may be judged in relation to national needs seems essential.

5. The Importance of Credibility.

The Academy is concerned with the question of "how far to go" in supporting the chain of events from initial users, through intermediate users, to final users of research results. It is a thoroughly legitimate concern; resources can easily be dissipated by extending the effort too far or too rapidly. On the other hand, important contributions can easily

"die on the vine" if they are not carried through to the point where benefits become obvious, to the point at which the catalytic influence has caused action to take place and to continue after Academy support terminates.

No hard-and-fast rules exist by which all programs and projects may be judged. But it is important that the Academy establish its credibility as an institution that can contribute vigorously and effectively in dealing with problems, the solution of which are of critical importance to the development of Egypt. In the absence of hard-and-fast rules, a few guidelines may prove useful:

a. Be certain that every program and project funded by the Academy under the new principles is indeed of critical importance to the development of Egypt, especially in terms of the prime beneficiaries, the people of Egypt. Be as selective as possible in identifying the strategic "point of entry" in the research and development process and, whenever there is reasonable evidence that emerging results have utility, continue effort until intended users themselves assume the initiative.

b. Involve potential users in formulating and executing programs and projects whenever possible. This helps identify the strategic points of entry and the opportune time for withdrawal. It also provides the basis for two-way liaison between users and program managers or project directors. Representatives of existing associations of potential users may be invited to help plan programs and projects and to follow their execution. In addition, with Academy encouragement, a "Research Associates" program could be established by NRC, and later by other research organizations. Potential research customers would be invited to join, perhaps for a nominal sum. Membership in the program would entitle the Associate to receive periodic summaries--written in Arabic and in layman's language--of current research results and their potential significance for Associates. Annual meetings of Associates could be held during which promising new research activities would be discussed, and

Associates would have an opportunity to meet informally with researchers and give their views as to what should be done. Associates would be entitled to call upon the research unit for a modest amount of diagnostic problem identification service. The objective of the "Research Associates" program would be to establish and maintain an ongoing exchange of information between the research and user communities. To the extent that there is an intervening third party institution, such as the Government Organization for Industrialization, it should also be included in the program.

Still another way of establishing two-way liaison would be through a modest manpower exchange program. Selected professionals from intermediate-user institutions could be sent to work in the research organizations, and researchers would work for agreed upon periods in the user organizations. The objective would be to familiarize the staff of each type of organization with the problems and interests of the other. The exchanged professionals would be expected to assume regular responsibilities in their temporary assignments. They would stay in these assignments for a long enough period (perhaps six months to a year) to become thoroughly familiar with their new professional environment. There already exists precedent for this program: textile firms, for example, have sent professionals to NRC for brief periods. This type of activity should be expanded to cover movement in both directions, and to cover a broad range of potential research users.

c. Restrict the scope of Academy-supported research to levels not much greater than present levels for another year or so until clear evidence of success begins to emerge. Sheer number of programs and projects will not be nearly as effective in establishing credibility as will a few projects

of high demonstrated utility. The needs of the potential user community are far in excess of the present level of problem-solving activity, but the links between the "doers" of research and the "users" of results must be built carefully and effectively. Until results become of obvious value to users, churning out results that remain unused, for whatever reason, would be meaningless. As will be elaborated further below, once the process of meeting needs or solving problems catches on--and if guided properly it will--it must be financially and administratively possible to expand and extend efforts with expansion and extension of demand. The Academy must become known as an organization that can support and facilitate the solution of tough problems. It cannot become known as simply another bureaucracy that lumbers from one budget year to the next, supporting weak and marginally useful research with what funds it can pry out of the central treasury.

6. Opportunities for the Social Sciences.

The team observed that some industrial plants are operating at far less than full capacity (Helwan iron and steel factory, for example, produced less than half its rated capacity in 1975), that policy decisions of government are implemented slowly, that agricultural production is considerably less than "known technology" would permit, and so on. It is not unusual to find problems of this nature in both developed and developing countries. The point being made here, is that not all research and development supported by the Academy needs to begin with the assumption that new techniques are required. Improved management, elimination of organizational bottlenecks, and enhancement of work incentives are all appropriate research and development objectives.

The list of projects supported by the Academy is strongly oriented toward physical and biological sciences, with engineering and other applied aspects included. Social science-oriented research projects, although under consideration by the Special Research Council for Social Science, have not yet been supported.

There are institutes, departments, and centers (whether functioning independently or within universities) that are capable of pursuing social science-oriented research and development programs and projects--e.g., the National Institute for Management Development and the Institute for Arab Research and Studies. The team recommends that the Academy seriously consider supporting a program of research and development which has a goal of improving some aspects of the efficiency and effectiveness of existing institutions, agencies, and public-sector enterprise. If viewed only as an initial experiment, a well-conceived and well-designed program in this area could demonstrate the potential contributions of the social sciences to national development.

The use of performance criteria--such as efficiency, effectiveness, equity, and responsiveness to citizen needs--has implications for the internal organization and operation, as well as for the external impact of institutions upon society. For example, some evidence was observed, and comments received, that performance of the scientific and technological community is handicapped by organizational shortcomings such as the following:

a. The purpose, mission, or objective of the organization, and particularly of subunits with which individuals are directly associated, often remains ill-defined. Despite willingness and desire to contribute to Egyptian development, individuals still need the incentive of a clearly perceived objective that is unquestionably related to that development.

b. The system by which performance is judged appears not to differentiate adequately between "good performance" and "bad performance"--i.e., between vigorous performance related to development and inadequate, or nondevelopment-related performance. Rewards and penalties seem not to be based on performance, and a consequent effect on morale can be assumed, leading to discouragement of individuals who might otherwise perform well. A universal problem resulting from predominant peer orientation of groups within organizations becomes that of preserving average or less-than-average performance.

c. Funds for supplies and equipment (also equipment maintenance) needed in research, for operating facilities, and for other research activities have been so limited that efficient and effective operation has been impossible in many instances. This contributes further to the morale problem.

If criteria such as the four suggested above were adopted, research and development pursuits related to improving the implementation of development plans would be directed to more than simply enhancing operational efficiency. For example, fulfillment of the equity criterion is sought through the Government commitment to full employment and social justice. But as a respected leader of Egyptian planning noted, the commitment has been made without adequate resources and organizational capacity. To illustrate, an agency may employ more individuals than justified by its given mission and existing equipment and other resources. Employees are compensated whether they perform or not. Indeed, highly effective performance by all is impossible because of organizational and resource constraints. Work efficiency, organizational effectiveness, responsiveness to citizen needs, and equity thus are interrelated.

The team knows of no easy solutions. Adoption of a complete "laissez faire" approach would likely subject the Egyptian society to forms of both foreign and domestic exploitation that were prevalent a quarter-century ago.[1/] A few cases are reported of research and development activity in which research programs have been organized with an appropriate balance

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[1/] President Sadat, in October Working Paper, 1974, pp. 10-13, called attention to the accomplishments of the Revolution of July 1952, emphasizing freedom from foreign influence and social emancipation of broad masses of Egyptian people. There are expressed desires to improve the performance of the economy through far-reaching changes, (Cf. President Sadat's decree appointing a new cabinet, March 1976). But even now, considerable income disparity exists. It is reported that in 1973, 2,000 Egyptian families had incomes of more than $80,000 each that year, while more than 90,000 families earned less than $120 (New York Times, November 7, 1975). A dense and growing population coupled with severely limited resources provide an ideal climate for exploitation of the many by the few. Hence, many fundamental problems face Egypt, and the social sciences have much to contribute to the development effort.

between staff and resources, with a clear mission consistent with organizational capacity, and with incentives and disincentives designed to stimulate good performance by all. There may be comparable examples in government and in industry. The seriousness with which the Government views such matters, however, is demonstrated by the recent appointment of a "Minister of State for the Cabinet" whose responsibilities include follow-up of Cabinet decisions to insure implementation of developmental policies.

As a means of launching a program of research in the social science category, the team suggests as a high priority item for future programs for the Academy:

a. A brief but vigorous exploratory assessment study funded by the Academy to (1) outline the scope and depth of the national need for improved implementation of developmental policies and programs, (2) prescribe the goal of a program of research and development in this area, (3) identify the obstacles or problems to be overcome, and (4) specify the major elements of the program to be launched. A small working group, headed by an Egyptian from one of the appropriate institutes could work with a program monitor of the Academy. Foreign consultants could be used if necessary. Close liaison with the office of the Minister of State for the Cabinet should be maintained throughout.

b. Assemble, under Academy auspices, a group of key Egyptian leaders to review the results of the exploratory study and reach agreement on initial lines of research and development to pursue. Full coordination of the program with appropriate Government officials should be assured.

c. Issue a request for proposals and, following receipt and negotiation, initiate a program of research in this area.

7. Support Services.

Due to limited time, the team was unable to explore the support services of the Academy in depth. These include, as Figure 2 above indicates, a documentation center, patents office, collection and dissemination of statistics regarding scientists in Egypt, technical support to

the various councils and committees, and so on. As a rough measure of the proportion of Academy staff involved, nearly 60 staff members are providing technical services to the Specialized Research Councils and Subject Committees, whereas employees of the Academy total nearly 600.

Any review of institutions from the perspective of effectiveness, efficiency, equity, and responsiveness in implementing development objectives should include the Academy as well. Meanwhile, as a first step in strengthening the Academy role, the team recommends immediate action to establish and fill program monitor positions. A minimum of six should be recruited initially, perhaps 15 to 20 within a year.

A program of in-service training, plus short training periods abroad, should be initiated for program monitors. Initial one-year appointments would enable both the individual and the Academy to determine whether the person and the role are mutually compatible. Such positions do not always appeal to even highly qualified individuals, and provision should be made for termination of the arrangement without embarrassment to either the individual or the Academy.

It also is suggested that the accounting procedure by which the Academy keeps track of support provided other institutions include internal Academy costs of the programs and projects as well as the direct funding to the performing institution. Also, estimates should be made of research institution contributions. As the program grows, it will become necessary to compare some projects on the basis of total costs and total expected benefits. Such an accounting procedure would be helpful in this regard.

The National Research Center

As a consequence of intensive study, the management of NRC concluded some months ago that it was necessary to redirect the primary efforts of the Center toward the accomplishment of research and development much more responsive to Egyptian national needs. To meet national development goals midst the diverse contemporary forces impinging on the country, NRC management recognized that it is imperative that the nation's scientific and

technical resources be directed toward solutions of systematically identified problems of high priority.

In keeping with the new national needs-oriented objectives of NRC, its research and development programs are to be increasing by directed toward accomplishing tasks that are defined by these needs. Thus, the direction of programs will be away from individualized, isolated, and academic programs toward those that are interrelated and mission-oriented. This is a prime goal of NRC management. As a result, the nature of administrative problems will alter, reflecting the new requirements for policy formulation and planning which must assume prominent roles if the programs of the Center are to be responsive to the new orientation. NRC intends, within five years, to achieve a 70:30 ratio of applied research to basic research, versus the present 10:90 ratio. Consequently, enhanced ability in the formulation of policies and plans is required.

Study and adaptation of contemporary organization systems for maximizing the efficiency of multidisciplinary, mission-oriented research and development programs is a perceived need.

Increasing administrative complexity, deriving from new research approaches and programs, calls for development and implementation of new management control systems. This is especially needed as greatly expanded research and development services to user-communities come into being and NRC organizational entities become progressively more interactive and mutually engaged.

New policies and plans, organizational structures, and management control systems, will contribute to the requirements for effective and timely evaluations of performance at all organizational levels. Consequently, NRC must look to the utilization of improved evaluative methods.

Recognizing that the traditional individualized, academic, basic research has become deeply embedded in the organization and will yield only slowly to new imperatives, it is accepted that the process of change will be evolutionary rather than revolutionary. Even so, the process will require careful administrative action to minimize negative impact on morale, while at the same time moving significantly toward the new objectives.

In addition, there are significant equipment disparities at the Center, which will progressively inhibit implementation of new research and development initiatives unless substantially removed. It probably is not possible to move effectively toward the new goals without substantial new equipment acquisitions and refurbishing of existing items. Although it would be desirable to link all such acquisitions directly to specific new projects related to national goals, it is recognized that provision of equipment items to reinforce the basic capability are required simply to enable performance of standard research and development functions.

The NRC Director has identified three initial priority groups of equipment needs, illustrative details of which are given in the appendix of Volume II:

a. Equipment to enable performance of the usual tests of various natural and man-made materials and products. This is an important service to industry which is presently not available in Egypt; it also will bring NRC staff into working relationship with potential sponsors of research and development.

b. Pilot plant equipment, the specific need for which will be identified as research and development programs meeting the new objectives are formulated--probably during the initial year or so of a U.S. AID assistance program.

c. Equipment to facilitate new research management and support functions, such as information storage and retrieval systems, which would be facilitated by such items as microfiche readers, a multi-purpose (i.e., science and business) computer, audio-visual aids, etc.

It would be desirable to provide various of these items of equipment early-on in a support program and can be justified by the variety of demonstrated needs.

As a consequence of its historic pattern of inner-directed basic research, NRC has not developed an adequate knowledge either of its potential user communities nor of those methods and means by which contract

research organizations normally develop and maintain these relationships. Only recently has a formal program been organized with sponsor development as its objective. This activity would benefit from information, methods, and material support from an external source having experience in the marketing of contract research and development services.

Egypt experienced a hiatus of several years duration during which customary sources of information and documentation were cut off. Consequently, even as the world volume of scientific and technical literature was increasing exponentially, the country had inadequate access to it. This has created an information deficit at NRC which seriously impedes execution of its primary mission in performing research and development functions. Although it is not presently possible to definitively describe priorities in this fundamental resource, it is clear that appreciably expanded information services are needed. These should include not simply access to various archives and data sources but also importantly, an institutional resource in the United States which can provide a functional interface between NRC and the U.S. information and documentation sources.

As one of its new areas of research and development activity, NRC has determined that the identification, acquisition, and adaptation of appropriate technology for Egypt should have high priority. As a prime source of such technology and of knowledge of how it may be acquired and adapted, the United States may serve a notably useful role in assisting this new NRC program. Consequently, assistance is needed from the United States in establishing and maintaining a program including these three functions.

A corollary of this activity should be the development at NRC of a technoeconomic analysis capability which would define, systematically, new technology needs resulting from national development plans and programs. The precise nature of this capability remains to be defined. The techno-economic function, however, is viewed to be of basic importance in two other aspects:

a. It will serve as a bridge and interpreter between the scientific and technological expertise of NRC and its user communities (broadly defined), relating and evaluating the Center's

technologic outputs in terms of the needs of users from an economic as well as a technical standpoint.

b. It will, through extensive knowledge of user objectives, programs, and needs, provide to the scientific and technologic components of NRC reasoned concepts of research and development needs to be met by these units.

Most user communities have both perceived and latent needs for techno-economic analyses as the means by which decisions may be reached which properly integrate technological and economic factors.

From a broad perspective of national needs, the techno-economic organization can define mission-oriented, multidisciplinary research and development opportunities which often elude the individual discipline-centered research units. Cooperating with the research and development marketing function described earlier, a techno-economic analysis unit could enable NRC to interact more effectively with user communities and to optimize its provision of research and development services.

With its changed directions and operating philosophy, NRC has created new requirements for strengthening and up-dating its technical and management capabilities. Both theoretical and applied staff education programs should be used to bring the human resources of the Center to a performance level commensurate with the requirements imposed by the new organizational directions.

Observations Regarding Equipment

Research equipment--in the research centers, the universities, and in public sector enterprises--has been held to be a serious bottleneck in the pursuit of research and development activity in Egypt.[1/] Therefore, one member of the team gave special attention to equipment condition and needs.

1. Classification of Equipment.

Equipment can be broken down conveniently into three categories,

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[1/] Cf. Gilbert B. Devey, Instrument Requirements for the National Research Center and the Scientific Instruments Center. (Washington and Cairo: National Science Foundation, September 1974). Summary in Vol. II.

viz:

a. Scientific Instruments.

These include major equipments such as spectrometers of various kinds, electron and other microscopes, X-ray equipment down to pH meters and other bench-top instruments.

b. Testing Equipment.

This includes standard measuring instruments such as tensile testers, impact resistance, and hardness meters, etc. In addition, and most importantly, it includes an array of specialized testing equipment for specific industries. Typical industries would be glass and ceramics, plastics, textiles, paints and surface coatings, and leather.

c. Pilot Plant.

This includes both standard items such as distillation columns, filter presses, spray dryers, grinders, evaporators, etc. and specialized pilot plants for industries such as petrochemical, fermentation, food processing, and many others.

This section will cover an estimate of the present status of the available equipment in Egypt, the facilities available for maintenance and repair, and ordering procedures. Suggestions where U.S. AID funds could best be utilized to further the objectives outlined in other sections of the report are included in a later chapter.

2. Status of Equipment.

Research and development equipment is characteristically located in Egypt in:

The National Research Center,
The Universities,
The Institutes, and
in Industrial plants.

Most of the observations included in this report are concerned with the National Research Center although some "spot" studies were made of the other types of locations.

a. National Research Center.

A detailed study was made of the following departments: glass and ceramics, metals, textiles, polymers and pigments, pulp and paper, and the pilot plant.

Except for the metals department, all equipment was of earlier than 1964 vintage. Some were very old pieces. In general, the equipment was in working condition but at a rather low level of efficiency. In many cases, good work has been, and is being, carried out under rather unfavorable conditions. Many laboratories were found to lack major items which normally are considered essential. The pulp and paper department, for example, had no suitable beaker and lacked most standard paper-testing instruments. The textile department needs liquid ammonia cotton-treating equipment, steam treating equipment, nonwoven fabric equipment such as a punching machine, and some transfer-printing equipment. The polymer department, as just one example of its equipment deficiency, had no normal polymer characterization equipment. The metals department had some very fine new Swiss foundry sand equipment and also metallography, all provided by UNIDO. However, this whole department will move to Helwan as the new Iron and Steel Institute.

The pilot plant equipment was rather old, and certainly inadequate, for the new role of NRC. Some items, such as fermentation plant, were in good condition but mixed up with all kinds of other plants. The space appears adequate but some reorganization into separated specific areas is clearly needed. This is recognized by both Professor Saada and Professor Haruni who suggested, however, somewhat different areas. Typical areas would be fertilizers, pharmaceuticals, building materials, and leather and tanning.

To summarize, although there are a number of new pieces of equipment, the majority of items at NRC are rather old

(pre-1964), and there is a desperate need for an infusion of good new equipment, essentially "across the board." This brief summary report is in full accord with the National Science Foundation Report noted above. The referenced report also contains some excellent recommendations with respect to alleviating the situation and ways in which U.S. help could be utilized.

b. The Universities.

Visits were made to the two largest of the eight universities, The University of Alexandria and Cairo University. In Alexandria the department of textile technology and the chemical engineering department were visited. In both cases the equipment was quite antiquated. However, some textile testing equipment and spinning and weaving machinery were in full use and appeared to be working well. As far as could be judged on a short visit, the chemical engineering department was in much worse shape, with virtually no pilot plant or modern equipment of any kind.

At Cairo University, the departments of chemistry and chemical engineering were visited. The chemistry department had some good, rather modern, spectrometers, conductivity bridges and other electrochemical equipment. Again, however, considerable modernization is clearly called for. For example, no equipment whatsoever was to be found in the polymer chemistry section. The chemical engineering department had very poor overall equipment with, however, some good X-ray radiography and ultrasonic equipment, a new atomic absorption spectrometer and good microscopy. It did not appear, however, to be much used at the present time.

There was a very large East German pilot plant assembly including filter, evaporators, dryers and so on, all about twenty years old. This gift equipment, although well intentioned, was too large for university use and had apparently never been used.

It could conceivedly be utilized at NRC and should perhaps be looked at in this regard. No other equipment of note was found. Both universities had reasonably good computer facilities at their computation centers.

c. The Institutes.

No special visits were made, but it was gleaned that in general they do, or will have, rather good new equipment donated from various sources. Undoubtedly, however, large, rather vital, pieces are still needed; for example, the Petroleum Institute still needs an engine-testing station and pilot plant facilities.

d. Industrial Plants.

Visits were made to the Helwan Iron and Steel Works, The Kima Fertilizer Plant, and the Misr Beida Dyers Company. The plants were all modern, well equipped, and appeared to have adequate testing and evaluation mechines. Except for the Misr Beida Company, no true research and development function was carried out. The latter did have a small development group and laboratory.

3. Maintenance and Repair of Equipment.

Although undoubtedly small repairs to equipment are performed in individual laboratories, all major repair and maintenance work is carried out in the Scientific Instrument Center. This is a large operation with a staff of 300 and reports directly to the President of the Academy. It is divided into five sections: glassblowing, electrical, electronics, optical, and mechanics. In addition to repair and maintenance, it builds specialized items, tests and checks instruments, and also has a training function. It is a very busy and well-utilized facility with more than 3000 major repairs per year. Again, it lacks modern equipment--modern glassblowing and diagnostic electronic equipment being examples. It also needs capabilities in fiber optics, micro-optics, digital device work, and integrated circuitry. A survey should be made of the most pressing needs. This, again, is all in full accord with the National Science Foundation

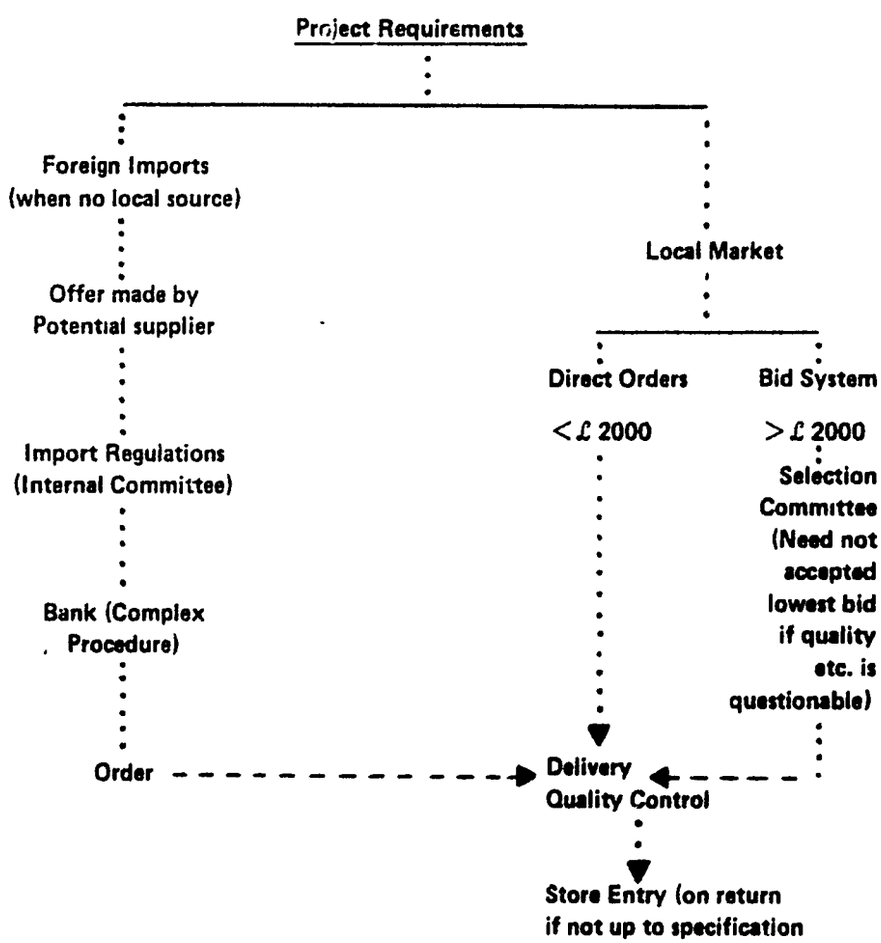
Report referred to previously. Good recommendations are to be found in that report for modernizing the Scientific Instrument Center. There appears to be something of a morale problem as the result of the opportunity for good technicians to easily find more lucrative jobs elsewhere in Egypt and in the other Arab countries.

In general, spare parts are ordered by the individual laboratories.

4. Ordering Procedures at NRC.

The ordering of all equipment at NRC is part of the responsibility of Professor Hassan Kamel, Head of the Ceramics Laboratory.

The flow sheet for ordering is as follows:



With foreign imports the bottlenecks are the banking-currency procedures, the receiving and clearing at Alexandria, and subsequent shipping to Cairo. In general, the procedures appeared to be working smoothly, but with rather heavy delays at the two points mentioned. An average time between order and delivery is apparently three months at the present time, although much variation occurs.

V. RECOMMENDATIONS FOR ASSISTANCE

A Joint Egyptian-United States Program in Science and Technology

In view of the foregoing examination of the potential of the Egyptian scientific and technological community, it is hereby recommended that a joint Egyptian-United States program in science and technology be established. Although the primary orientation of recommended programs is with the Academy, as will become evident in subsequent sections, assistance to NRC and other institutions is contemplated as well.

1. Goals.

   a. To enhance the Academy's catalytic role in enabling the Egyptian scientific and technological community to realize its full potential in contributing to the development of Egypt.

   b. To provide a basis for scientists and technologists from the United States and other countries to assist in the pursuit of developmental objectives of Egypt; and, as the current requirement of meeting Egyptian national needs of crisis proportions is overcome, for Egyptian scientists and technologists to cooperate in similar research and development activities in the United States and in other countries.

   c. To place the relationships on the common plane of commitment to excellence, integrity, and service to humanity that characterizes scientific pursuits of the highest order, regardless of national background.

2. The Catalytic Role of the Academy.

The above goals reflect the role that the Academy is seeking to play in relation to scientific and technological pursuits in Egypt. Correct understanding of this role is of critical importance in defining the organizational arrangements appropriate for any joint endeavor. In brief, the Academy's role is catalytic and supportive rather than administrative, as discussed in preceding chapters. The Academy occupies a central position in relation both to other elements of the scientific

and technological community and to the users of the results of research and development. This, however, is not an administrative relationship. No element of the community is required to maintain any substantive relationship with the Academy if it chooses not to do so. If an element desires financial support from the Academy, however, support is provided according to Academy procedures (see Volume II for details regarding Academy organization, procedure, and relationships with other elements of the scientific and technological community).

3. A National Academy of Sciences Relationship.

The authors of this report are, of course, in no position to commit the U.S. National Academy of Sciences (NAS) to any involvement with the Academy of Scientific Research and Technology. This would require direct exploration with the U.S. National Academy. To provide a basis for exploration consistent with the goals expressed above, however, the following suggestions are presented:

a. Joint Review Committee.[1/]

In subsequent sections, details of the organization, operation, and funding of a joint Egyptian-United States program are presented. Day-to-day management of such affairs must be left to Egyptian and American representatives functioning on a full-time basis; but, to provide for periodic review of the program, it is suggested that a "Joint Review Committee" be appointed, consisting perhaps of three Egyptians appointed by the Egyptian Academy, three Americans by the U.S. National Academy, and three from other countries selected by the two Academies. The chairmanship should perhaps rotate between Egyptian and American representatives.

b. Functions of the Joint Review Committee.

Among the general functions of the Joint Review Committee, the following are visualized:

[1/] The title given to this group is suggestive only. A more suitable title might be devised if it is decided to establish such a unit.

1) Meet once each year in Egypt to review accomplishments of the preceding year and plans for the coming year.
2) Provide suggestions to the Academy for such improvement in program direction as may appear useful.
3) As now conceived, the Joint Review Committee would be advisory only. Its influence would depend upon its vision, understanding, and powers of persuasion consistent with the goals of the joint relationship.

The team recommends that provision be made by U.S. AID for exploration of a joint Academy of Scientific Research and Technology/ National Academy of Sciences working relationship. This effort should take place early in the first year of the program of assistance supported by U.S. AID.

4. Evaluation Implications.

Under the procedures followed by U.S. AID in providing assistance, periodic evaluation must be made of the results. The team recommends that the details of a joint evaluation process be established during the first year of assistance through discussion with Academy leadership. For example, the evaluation process might include "critical path indicators." If so, agreement to this effect should be reached through discussion, including the indicators to be used and methods of collecting data.

Evaluation could become a useful part of the functions of the Joint Review Committee, provided it is based upon mutual agreement among representatives of the Academy, NRC, other relevant Egyptian agencies, U.S. AID, and the National Academy of Sciences. In addition to the activities of the Review Committee members themselves, a special study team (of perhaps five members selected by the Review Committee) could be assembled prior to each annual meeting in Egypt. This team would be expected to conduct the detailed data collection and analysis essential to the performance of evaluation and other Committee functions.

5. Policy Review.

In preceding chapters, reference was made to the need for additional dialogue between the research community and individuals in government concerned with the formation and implementation of development plans and projects. The intent of such dialogue is to focus the research and development effort upon important national needs in the most effective ways possible. The integration of science policy and development policy occurs through such a process.

The team suggests that Egyptian leadership consider using the Joint Review Committee also as a "sounding board" in relation to policy questions. Critical policy choices may be debated with Committee members each year before making final decisions. For example, major research and development priorities could be formulated tentatively and Committee members asked to comment upon them and to suggest how particular research programs might be structured most effectively in relation thereto.

6. Reserve Fund.

Financial support to the Academy of Scientific Research and Technology to enable it to assist other Egyptian institutions in meeting equipment and other needs will be considered in a subsequent section. Given the necessity for fund management to be related closely to research policies and programs, however, we note at this time that annual meetings of the Joint Review Committee should include examination of the use of the fund. The Committee should also be expected to recommend periodically any changes in reserve fund accumulation and/or use that the members regard as appropriate.

7. Link With Joint Working Groups.

The Joint Working Groups (formed to foster cooperation among comparable organizations in Egypt and the United States), particularly the Science and Technology Group, might find the suggested Joint Review Committee to be a useful way of establishing closer liaison with the Egyptian research community. At any rate, the team views the role of the Review Committee to be complementary to that of the Joint Working Group on Science and Technology (and perhaps others) and recommends that liaison with the Joint Working Group be established if the Committee is created.

Assistance to the Academy of Scientific Research and Technology

In association with the possible NAS involvement reviewed above, several additional forms of technical and financial assistance are recommended in relation to the Academy, as discussed below. Although linked to the Academy, much of this assistance would "flow through" to other institutions of the scientific and technological community, or otherwise be utilized by them.

1. Technical Assistance.

The central importance of the program monitor role as outlined in previous chapters suggests that, to proceed at the pace recommended in giving somewhat greater structure to the program of the Academy, technical assistance will be required.

a. Technical Assistance Team.

Assuming that the Academy assembles from 15 to 20 candidates for program monitor positions, it is recommended that U.S. AID contract for a technical assistance team consisting of three individuals with relevant experience for a minimum of two years to assist in initial program formulation and management. To assure continuity, the cooperating U.S. institution's contract should be subject to extension for a period of five years for reasons given below. To be more explicit as to team qualifications, the following are suggested:

1) Team Leader: Have experience in research and development planning and in conducting and administering contract research over a broad range of problem areas. Preferably, some of this experience would have been in developing countries and include both funding agency and research institution perspectives. Beyond this experience, his qualifications should be similar to those listed above for the Academy program managers. He should be capable of developing such rapport with Egyptians that his expertise would be in great demand, but he should also have both the desire and the

ability to recede to the background as soon as Egyptians have become capable of assuming responsibility for functions he may have performed initially by way of setting an example.

2) Second Member: With respect to qualifications, the second team member should have somewhat comparable experience with contract research and development, but his training should have resulted in concentration in somewhat different fields. For example, if the team leader's experience has been oriented more to industrial research and development, the second member might have an agricultural orientation. Other qualifications are similar, except that fewer years of experience would be acceptable.

3) Third Member: Again, the primary difference in qualifications between the third member and the others relates to primary orientation and length of experience. If the first two are predominantly oriented toward agricultural, engineering, and/or industrial pursuits, the third should have experience predominantly over a broad range of research and development projects that are social service oriented--e.g., education, health, rural village development, or urban development.

b. Short-Term Consultants.

To provide the Academy and institutions that it supports with short-term expertise as needed in formulating and executing research and development programs, it is recommended that, for the first year, provision be made for up to six teams consisting of an average of three technical experts spending an average of six weeks in Egypt per team. The exact composition of each team will be determined as the needs arise. It should be possible to draw members

from the United States or any other country where appropriately qualified individuals may be found.

Initially, it is anticipated that two or three teams will assist in the program formulation procedure as outlined in Chapter III. The remainder will assist in the details of execution, working primarily with such institutions and agencies as may be submitting proposals and receiving contracts.

c. Training in the United States, in Egypt, and Elsewhere. It is not contemplated that regular training outside Egypt explicitly for degree purposes would be appropriate to this proposed technical support for the Academy and the research and development it, in turn, is supporting. However, if a certificate or professional degree is received as incidental to properly designed training--e.g., in developing or updating competence in operating complex types of equipment--this would be acceptable. Various forms of on-the-job training and short-course classroom instruction will prove useful in acquainting Egyptian professionals with recent developments in mission-oriented research, management-by-objectives, and equipment maintenance and operation. It is therefore suggested that provision be made for an average of 10 Egyptians to spend an average of four months each outside Egypt for training purposes each year for a five-year period. For purposes of estimating costs, it is assumed that Washington, D.C., be used as the average travel distance and that per diem rates for Washington be used to estimate subsistence. It should be possible, however, to travel to any appropriate country for such training.

In addition to training in the United States or in other countries, it is further recommended that four workshops

lasting an average of two weeks each be held in Egypt to insure instruction closely related to Egyptian conditions. Academy staff and professional staff of institutions supported by the Academy should attend (15-25 per workshop). Provision should be made to bring instructors to Egypt from the United States or other appropriate countries. Allowance should be made for time required for preparation by instructors--approximately equal to the duration of the workshops.

d. Information Search Capability.

Egyptian scientists need to be provided with the capability of assessing the state-of-the-art relating to a component of program activity, basic documents in relevant fields must be provided, and means to search the literature in other countries should be available. Thus, it is recommended that provision be made for such assistance. Broad-based library support is not intended, and requirements should be rather closely linked to specific research and development programs and projects as they are identified.

2. Funding Academy-Supported Research and Development.

That portion of the Academy budget allocated to support research in the coming fiscal year is reported to be LE 1.9 million. A total of LE 3.5 million has been budgeted for these purposes for the past two years. Thus, the present level of research and development support provided Egyptian institutions through the Academy budget is now running at roughly LE 2.0 million per year. A technical staff of approximately 55 people assists the Vice-President in charge of this component in servicing the needs of the Academy Council, the 14 special research councils, and the subject committees. Senior individuals functioning as program monitors are not yet in place, although serious thought is being given to their selection.

a. The "Reserve-Fund" Requirement.[1/]

The longrun programs of research and development discussed above must be so structured that, while individual shortrun projects within the structure begin to make early and visible--even though incremental--contributions toward solving broad national problems, a sustained effort over ten years or more is assured. The purpose of the sustained effort is two-fold:

1) To have a cumulative effect of striking magnitude over the ten-year period.
2) To firmly establish within the Egyptian society the procedures by which science and technology are used effectively in meeting important national needs.

Given the high-level decision to assist the Egyptian government in achieving developmental objectives, it appears there is adequate justification for U.S. AID to provide sizable amounts of funding to the Academy over the next three to five years. Beyond five years, continued support, while possible, is not assured. The rate of effective expenditure by the Academy in each of the next five years, however, is expected to be considerably less than the possible level of annual U.S. funding support. Thereafter, it will rise to levels exceeding the rate of any U.S. support that may be possible beyond the first five years.

To accommodate these differential rates of funding support and effective expenditure over a ten-year period, and at the same time assure commitment to longrun programs to meet national needs, it is proposed that through bilateral

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[1/] The term "Reserve-Fund" is used here in a general sense without reference to legal or specific procedural aspects as might be implied by such a term in U.S. or Egyptian law. The intent is simply to convey the general notion of accumulating funds for disbursement over a period of time according to agreed-upon principles.

contributions, a "reserve-fund" be created in the first year of U.S. support to the Academy. The concept is illustrated graphically in Figure 9.[1/]

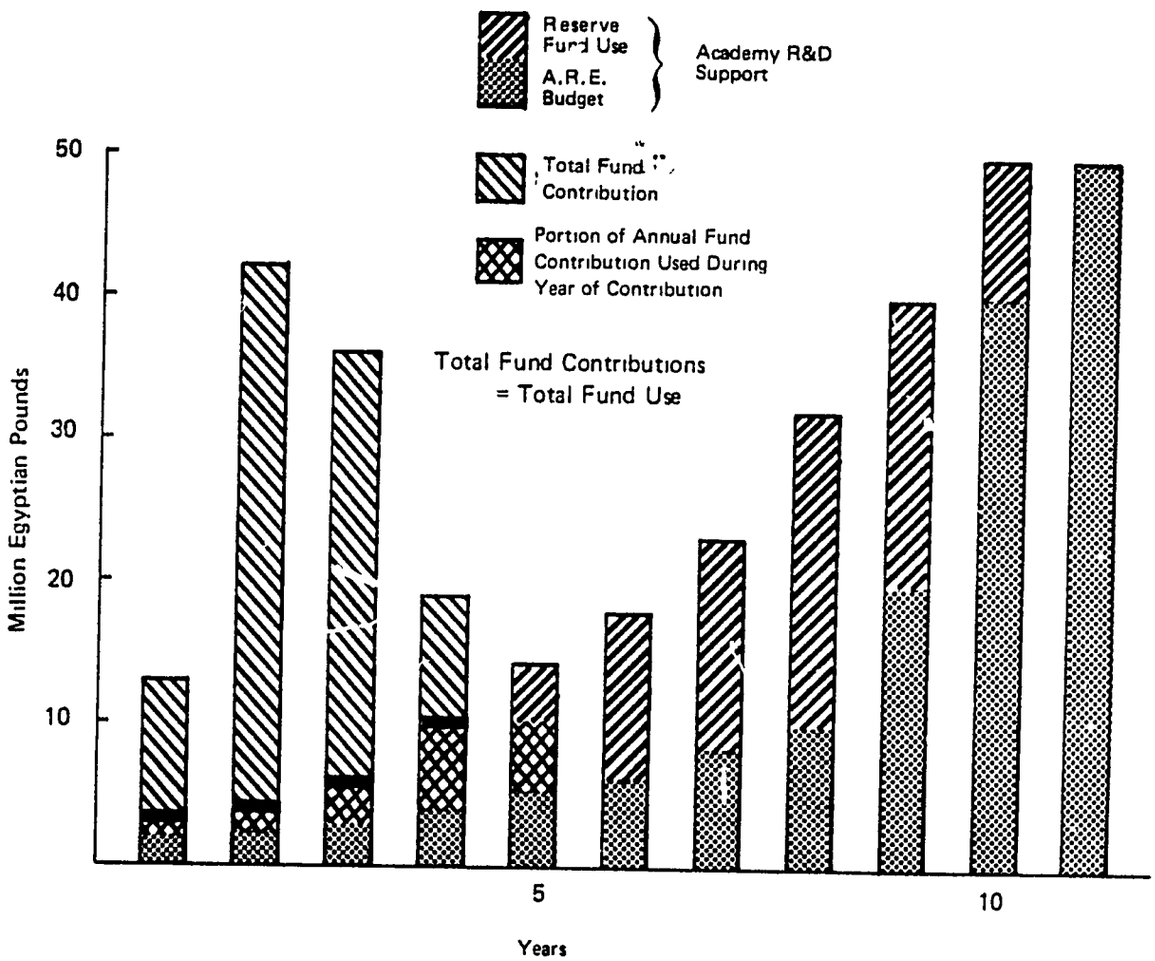

Figure 9. Illustration of Reserve Fund Contributions and Use in Relation to Academy Research Support Budget.

[1/]Note that the "cross-hatched" sections of the columns for each of the first four years indicate that a portion of the contributions to the reserve fund each year is used that year along with A.R.E. budget support. In the fifth year, all contributions (cross-hatched areas) for that year are used plus some of the reserve from prior contributions.

TABLE 3

HYPOTHETICAL PROJECTIONS OF ACADEMY RESEARCH FUNDING, EGYPTIAN GOVERNMENT SUPPORT TO THE ACADEMY FOR THIS PURPOSE, DEFICIT AND RESERVE FUND

YEAR	Academy Research Funding	Egyptian Government Support	Deficit	Reserve Fund
	(Million Egyptian Pounds)			
1	3	2	1	10
2	4	2	2	40
3	6	3	3	30
4	10	4	6	15
5	14	5	9	5
6	18	6	12	-
7	23	8	15	-
8	32	10	22	-
9	40	20	20	-
10	50	40	10	-
11	50	50	0	-
TOTAL	250	150	100	100

Table 3 presents the same information as Figure 9. The research support expenditures of the Academy rises from the present LE 2.0 million per year to a hypothetical level of LE 50.0 million in the tenth year. It is assumed that other demands upon the Egyptian Government over the next five years will make if difficult for the Academy to obtain domestic budget support consistent with the projected research funding, especially the hard currency component. Cumulative expenditures are projected to total LE 200 million over the ten-year period, cumulative government appropriations to total LE 100 million. The deficit is thus LE 100 million. The reserve-fund amount is therefore shown to be the equivalent, or LE 100 million.

If indeed the Academy succeeds in funding productive, problem-oriented research, some benefits should begin to be evident within five years. At the end of ten years, the evidence should be sufficiently persuasive to justify the Government underwriting the entire budget in the eleventh year.

b. Reserve-Fund Creation and Management.

Procedures for establishing and managing the reserve fund must be devised carefully, more carefully than the three-week assignment of this team will permit. It is, therefore, recommended that one of the assignments of the technical assistance team in the first year will be to provide for establishment and management of the fund, utilizing carefully selected consultants for assistance as needed. The following issues are among those to be decided:

1) Portion of the reserve fund to be contributed by U.S. AID in dollars, the portion in PL 480 pounds, and the portion to be provided by the Egyptian Government.

2) The manner in which management of the fund is to be shared.

3) The principles in accordance with which the fund is to be disbursed over time--e.g., is it to be fully exhausted within, say, ten years or treated as an endowment and only revenues from fund investments expended?

Assuming that Figure 9 and Table 3 represent reasonable first approximations of the magnitude of the reserve-fund requirement, it is suggested that provision be made in the first year of assistance for an incremental contribution by both U.S. AID and Egypt. An increment of up to US $3 million by U.S. AID is suggested as a minimum, matched by Egyptian pounds according to whatever

ratio is agreed upon in the first year. Higher amounts are recommended if analysis indicates they are feasible.

As will be indicated below, equipment needs already evident are sufficient to justify a reserve fund contribution of at least three million dollars by U.S. AID in the first year. As the principles of fund establishment and operation are established early in the first year, justification for further contributions must be provided as well. Additional equipment and incentives for outstanding research performance are among the reasons for the fund. Perhaps the most compelling justification will prove to be the ability by the Academy (with U.S. AID support) to commit professional staff and resources to research programs of considerable magnitude for sustained periods consistent with important national needs. Such commitment in accordance with principles of operation that will insure effective results is not now possible. Given the Academy's funding level of approximately LE 2 million, only small and/or shortrun commitments can be made. As comprehensive research programs are formulated in the first and subsequent years, a basis will exist for firm, longrun commitments of considerable magnitude.

c. The Joint Review Committee.

As outlined above, in conjunction with the periodic review of the joint Egyptian-United States program in science and technology, it is suggested that an annual review be made of reserve-fund expenditures in relation to program accomplishments. It is assumed that day-to-day management will be centered in an arrangement involving Academy leadership and the U.S. technical assistance team. But as the proposed Joint Review Committee meets, it should also examine past and projected reserve-fund expenditures in relation to program activity.

3. An Example of Reserve Fund Use.

In the area of equipment it is clear that substantial assistance from U.S. AID is badly needed. In view of the enormous overall needs and the multiple demands of the various research groups, however, it is difficult to focus on the best mechanism. In general the priorities include:

a. Scientific instrumentation.

b. Testing equipment.

c. Pilot plant.

It appears that the most practical and effective way to make such assistance available would be in the form of a large reserve fund as suggested above. Although the reserve fund, as described, would be used for more than just equipment, orders for equipment should be placed against it but geared to one or two large demonstration programs and their constituent projects. Such orders could be monitored by the reserve-fund management. Any large items should also include provision for the training of Egyptian personnel in the United States in the operation, maintenance, and repair of the equipment and in the interpretation of data. The professional level of such "trainees" would depend on the equipment itself. In some cases, both a technician and a researcher might be sent for training.

In addition to these procedures the capabilities of the Scientific Instrument Center (SIC) to maintain and repair the new equipment should be strengthened. New diagnostic or other equipment should be added to SIC on an item-by-item basis as new research equipment is requisitioned and put into use.

Lists of equipment badly needed by the National Research Center are presented as Annexes 10 and 11 to Volume II. Annex 10 consists of basic equipment required for laboratory purposes associated with a variety of need-oriented projects and is divided into high, medium, and low priority ratings. Annex 11 consists of anticipated equipment needs associated with a proposed "more and better food" project. Neither Annex 10 nor 11 is presented as final or definitive of NRC equipment needs. Additions and deletions will be necessary as

these lists are finalized. Nevertheless they do serve as concrete examples, and the cost of such equipment could easily total $2-3 million.

Other research institutions of Egypt are also in need of equipment in addition to NRC, but comparable illustrative lists are not available. When added to the NRC requirements, however, it is estimated that firm equipment requirements of Egyptian laboratories, justifiable in relation to national need-oriented research programs being initiated with Academy support, will total $3 million in the first year. It is for this reason that the team recommends an initial contribution of $3 million by U.S. AID to the Reserve Fund, matched by Egyptians pounds from PL 480 and Egyptian budget sources according to principles agreed upon as the fund in established. (Approximately one-half of the $3 million should be earmarked for NRC needs.) Pounds may be used whenever possible in relation to equipment purchase, but it is anticipated that this portion of the fund will be used for local costs such as research incentive payments and travel.

It is recommended that, in the first year, one of the initial steps that should be undertaken with Academy support and perhaps under NRC leadership is a brief but thorough study of equipment needs by all Egyptian institutions. The study should inventory present equipment, including its location, status, present use, and maintenance and control procedures. Emerging national need-oriented research programs should be identified insofar as possible and related equipment needs specified. Comparisons between inventory information and emerging equipment requirements should then provide guidance regarding what may be accomplished with existing equipment, including needed repairs. Additional equipment required for the year in order to execute projects effectively may then be established on a reasonably firm basis.

4. Manpower Planning and Development.

The question of manpower planning and development is closely related to the discussion of social science opportunities of Chapter IV. In several meetings that the team attended, Egyptian leaders expressed the view that much more comprehensive study is needed in this area. For example, the point was made that even though the number of M.S. and

Ph.D. degree-holders is large in Egypt, there appears to be a shortage of properly trained laboratory technicians. Discussion quickly led to the question of whether technicians simply have not been trained, or whether they find other employment because the salaries and other work-incentives that research institutions are permitted to offer technicians are so low.

In the time available, the team was unable to explore the manpower or labor force question in detail. Clearly the issues relate to more than the problem of matching the supply of various categories of professional and skilled people with the emerging demands associated with developmental activity. Salary and other incentives, educational policies and programs, whether additional types of educational institutions are needed (e.g., technical institutes), etc., are among the elements that must be included in a serious study of manpower planning and development. The team was told that agencies of the United Nations *UNESCO, ILO, etc.) are exploring these issues, perhaps for the purpose of providing assistance. Other sources of assistance may be doing the same. Consequently, the team has no explicit recommendation at this time. In view of the importance of the manpower question, however, it is suggested that, during the first year of U.S. AID support to the Academy, serious study of these issues by appropriate agencies should be encouraged.

5. Supporting Assistance in the United States.

The primary locus of support to the Academy (and thence to other Egyptian research institutions) should be the technical assistance team noted above, located in Cairo. Four types of activity must take place in the United States, however, that will require additional attention. These are:

a. Organizational contacts with the National Academy of Sciences to establish and maintain the Joint Review Committee, assuming such an arrangement is considered feasible.

b. Recruiting team members for short-term assignments in Egypt for research and training purposes.

c. Planning and organizing short-term training for Egyptians in the United States and in other selected countries.

d. Maintaining appropriate liaison with U.S. AID/Washington.

It is therefore recommended that the institution under contract with U.S. AID for technical assistance to the Academy also maintain one full-time professional in the United States to provide the project support and coordination, as listed above. Secretarial assistance should be included, plus provision for travel within the United States and to and from Egypt.

Assistance for the National Research Center[1/]

As a consequence of the needs described in Chapter IV, some recommendations can be offered for the provision of assistance to NRC in its efforts to reconstruct and redirect its resources to be more responsive to the evolving priorities for Egyptian national development.

Consistent with the Project Identification Document, this recommended assistance is projected for a three-year, grant-funded period. However, since many project needs can only be identified as a consequence of continuing interactions between NRC and a cooperating U.S. entity, only the first-year program is set forth here in any detail. Although it may be assumed that many of these activities would be incorporated in subsequent supporting assistance to NRC, it is believed appropriate to detail only the initial project year, with delineation of on-going needs to be accomplished during that time. However, since the larger dimensions of the assistance which NRC needs are perceivable at this time, it can be assumed that programs during the ensuing two years would be quantitatively equivalent to, or larger than, those of the first year. The current uncertainties apply particularly to equipment needs which can only be conjectured at this time, as the illustrative lists of Volume II imply.

[1/] Assistance described in this section consists of that to be provided directly to NRC. In addition, it is intended that NRC may seek additional support through the Academy by submitting proposals entailing use of portions of the Reserve Fund--just as any other research institution may do.

1. Principal Project Elements.

Following, therefore, are principal recommended project elements or functions, which would be provided NRC through the services of a U.S. institution acting under contract to U.S. AID in cooperation with, and support of, NRC.

a. Management Consultation Services.

Acting in the context of a U.S.-style management consulting organization, the contractor would through the Office of the NRC Director, provide general management consultation to NRC in a wide-ranging and continual relationship. The objective would be to assist the Director, and others he may indicate, in all areas of research management, including the primary areas of:

1) Policy development and planning assistance.
2) Organization structure and development.
3) Formulation and implementation of management control systems.
4) Evaluations and evaluation methods.

These activities would be carried out primarily through the resident Program Director and could be expected to include consultation by others, as well as orientation visits by the Director of NRC and management personnel whom he may designate to institutions in the United States where it would be possible to observe and discuss management practices in the research and development environment.

b. Techno-Economic Analysis Capability.

Through both indoctrination activities and participation of U.S. experts in actual research programs in Egypt, assistance would be given in developing competence within NRC for conducting and integrating techno-economic studies in accord with the concept presented in Chapter IV. This would involve, in training programs in both the United States and in Egypt, an inital NRC cadre of five to six individuals.

c. Training Programs.

The U.S. support would provide, in Egypt, training in management subjects for groups of NRC supervisors, utilizing two to four U.S. experts per session. Four two-week sessions are suggested. In addition, training and technical up-dating for ten NRC staff members would be provided in six-week sessions at appropriate sites in the United States.

d. Technical Project Support.

For the development of specific projects, U.S. technical experts would cooperate to complement the efforts of NRC administrators. (Such projects would also receive information and management support under other described programs.)

e. Information and Documentation Services.

The supporting organization would serve as a U.S. coordinator and point of access to information and documentation sources in the United States and elsewhere. It would provide information specialists and technical experts to help insure maximum utility and responsiveness to NRC.

f. Equipment Services.

Support would be provided in the identification, selection, specification, procurement, transport, installation, and servicing of equipment and other material items. To relieve the load on U.S. AID and generally facilitate the program, the U.S. support organization should itself be authorized (contracted) to fulfill these functions under terms of applicable U.S. Government regulations. The support organization would participate with NRC in determining equipment requirements in accord with program objectives and funding schedules.

g. Technology Transfer.

Assistance would be provided in the identification, acquisition, and adaptation of appropriate technology for

application in Egypt, in accord with the organization emphasis assigned this subject by NRC. This would include assistance in assessing the appropriateness of identified technologies through techno-economic analysis. This activity, properly executed, entails relatively intensive and diverse technical assistance and possibly provision of some equipment, scaled to project needs.

h. Demonstration Project.

Early effort would be devoted to assisting NRC in developing a mission-oriented, multidisciplinary project proposal to be submitted for Academy approval and funding. It would incorporate these objectives:

1) Relevance to national needs priorities.
2) Preferably be in the area of food-nutrition, agriculture, rural-urban development, or health.
3) Involve significant participation of at least one other research-oriented institution.

Such a project should involve development of new organizational and technical capabilities within NRC. It might involve significant pilot plant development. It would serve to demonstrate, on a national scale, the efficiency and utility of larger, more comprehensive research and development efforts in pursuit of major national goals. The team believes that the concept of the "more and better food" project, which was discussed as a possible demonstration subject, meets these criteria. This project idea, however, still requires rather extensive development and elaboration. U.S. participation could be helpful in this process.

i. R & D Marketing Program Development.

As an example of activities which would respond to the NRC program development needs described in Chapter IV, the U.S. supporting organization, in addition to consultation, might provide specific assistance in organizing and staging several

user-oriented seminars dealing with the application of technologies of particular relevance to the participants. In environments similar to NRC's, such seminars have proven effective in apprising interested technology users of new developments, while simultaneously developing an awareness of the research institute's interests and capabilities. Techno-economic inputs are valuable in such situations by relating the subject technology to the cost-benefit interests of the user group.

2. Rationale and Method for Assistance.

Generally, the needs and opportunities for the United States to provide technical and material assistance to NRC are compelling. The Center, based on observations of other countries with similar situations and institutions, has unusual potential capabilities that could be central to the process of Egyptian national development. The general level of scientific and managerial competence seems relatively high and is a largely unexploited force that presumably can be brought quickly into a more productive partnership with other domestic forces to make significant contributions toward development goals. However, NRC seems inhibited by three familiar restraints:

a. Lack of managerial comprehension and orientation below the top executive levels.

b. Lack of monetary and physical resources.

c. Lack of access to competent and reliable sources of technical and managerial experience and assistance in advanced technology countries such as the United States.

The central theme of the team's appraisal of NRC is that provision of assistance in these areas of deficiency would result in significant enhancement of Egyptian social and economic progress as a consequence of improved application of science and technology to problems of national development.

Various mechanisms seem possible for the provision of useful assistance and support. Explicit in the Project Implementation Document

is the participation of nongovernmental U.S. organizations in the provision of such support. The team generally concurs in this supposition and offers the following criteria as at least a partial basis for identifying and selecting U.S. private sector organizations for provision of the described supporting services to NRC:

a. Few, if any, organizations of whatever composition can provide, comprehensively, all those services appropriate to NRC's needs. Therefore, an organizztion combining relevant managerial and technical competencies with an ability to identify and incorporate other appropriate resources is necessary.

b. This coordinating organization must have broad-based, diversified experience in the provision of contract research and development services to government and industry.

c. Preferably it should have direct experience with, and knowledge of, the characteristics and problems of research and development institutions in less-developed countries and have been actively engaged in provision of support to, and interaction with, such institutions.

d It should be able to commit knowledgeable and experienced management and technical personnel to the NRC support effort.

e. Ideally, it should have direct experience in the identification, selection, specification, procurement, transport, installation and servicing, under applicable U.S. Government procurement regulations, of research and other equipment and material for utilization by research and development organizations in less-developed countries.

f. It is imperative that the U.S. support organization be acceptable to the Director of the NRC, and other appropriate Egyptian officials.

The U.S. supporting organization would:

a. Establish, mutually with NRC, a support program to provide

the services and material needed to meet the project objectives previously described.

b. Assign a qualified and experienced member of its senior management as Program Director, resident in Cairo, but provide most support by well qualified managerial and technical experts on temporary assignment.

c. Facilitate and acquire the services of such other organizations and individuals as may be needed to accomplish the objectives of the support program.

d. Jointly with NRC, determine equipment and other material needs of the support program, then procure and provide these items.

e. Act diligently and appropriately in assisting NRC to achieve the goals of the support program.

Cairo University and Public Sector Projects

A liaison office with Cairo University is proposed by Massachusetts Institute of Technology for the purpose of providing a link with a major U.S. educational institution in evaluating public sector projects of Egypt.

The overall purpose of the proposed program is to expand institutional capabilities within Egyptian ministries, other government agencies, and research organizations to formulate and implement programs designed to achieve national development objectives. Specific objectives are:

1) To cooperate with ministries and other agencies in expanding their capabilities to perform sector-level planning, project identification and evaluation, and establishment of priorities.

2) To assist the ministries in strengthening their institutional framework through which present and future decision makers are exposed to the latest research findings in the fields of development planning and project evaluation.

3) To help coordinate academic interest in Egypt in cooperating with Egyptian government agencies in organizing and expanding investigations on specific development issues: focusing on

technical and economic issues of technology adaptation, project evaluation, sector level planning, and demographic and manpower studies.

While not a part of its review assignment, the team believes that, if related carefully to the catalytic role of the Academy, this project would serve to demonstrate how the scientific and technological resources of Egyptian universities can be mobilized to deal with specific developmental problems.

The Cairo University/MIT program will provide direct assistance to ministries and agencies on specific projects of current interest to the government. The program will rely on research presently available relating to specific technical areas of Egyptian development planning and project organization. Through a series of case studies and demonstration projects, the program will:

1) Expand the capabilities of ministries to perform sector planning tasks necessary for successful development projects.
2) Establish an institutional framework through which present and future decision makers will be exposed to appropriate research findings.
3) Mobilize academic interest in Egypt in organizing and expanding investigations focused on specific development problems.
4) Illustrate the benefits of technical R & D inputs to specific government projects.

The Cairo University/MIT program will help achieve the overall science and technology goals that the Academy is supporting by:

1) Providing direct technical R & D inputs to development programs and projects. The program will respond to the current need for technical support of ministry-sponsored projects. It represents an intermediate link between the present demand for technical support of development projects and the organization of these activities on a national basis by the Academy of Scientific Research and Technology.

2) Stimulating demand for continued research and development in one of the principal intermediate users--government ministries.
3) Involving one of the principal elements of the Egyptian scientific and technological community--Cairo University--in specific, project level support of government ministries and other agencies.
4) Identifying some of the longer range research and development needs of ministries involved and communicate these needs to the Academy and the NRC.
5) Exposing, through conferences, workshops and seminars, Academy, and NRC, and Cairo University personnel to existing planning methodologies and implementation problems, and illustrate the potential interface between the research community and government ministries.
6) Providing, through the Institute for Technological Planning at Cairo University, an additional link between (a) Academy and NRC-based research and development programs, and (b) the specific project activities of the ministries.

Phasing the Assistance Program

The team is of the firm conviction that the program of assistance should continue for a minimum of five years, with the direct impact of the assistance viewed within the context of ten years. Such a time perspective is both essential and realistic. As observed in Chapter I, Egyptian leaders have perceived the role that the scientific and technological community can play in the development of Egypt. The Academy, NRC, Cairo University, and other institutions are initiating changes leading to fulfillment of this role. Research and development processes, however, require time to formulate and execute properly. It would be misleading to assert that any broad-based impact of the effort will become possible within less than five years; ten years is a more likely period for any striking cumulative effect to become evident.

In our recommendations, reference has been made repeatedly to the "first year." Within the time available, we were able to comprehend and

appreciate the research and development potential of Egyptian institutions. We were also able to identify the steps to take during the first year in providing assistance designed to enhance the realization of this potential. Consequently, the first year should be designated as the first phase of a multi-phased program of assistance. This is the phase in which organizational arrangements for assistance are completed and concrete plans formulated for remaining phases.

We view the Reserve Fund to be an integral part of this phasing, particularly from the standpoint of insuring execution of research and development programs. Few, if any, of these programs can be executed in less than three years; some may take seven to ten years. Usable products will emerge well in advance of completion of each program. For example, knowledge of how to make sand bricks is now a product of an existing research project supported by the Academy. Intermediate users of this knowledge, however, will require more time to translate it into the manufacture of bricks for the benefit of final users. The point is that, for research programs to be carried through to "final payoff," substantial commitments of resources must be made over considerable periods of time. The Reserve Fund is intended to enable the Academy, with U.S. AID support, to make such commitments based upon careful formulation of the programs in relation to development goals.

The team is reluctant to project details of the phasing of the assistance program beyond the first year. If the first year progresses as suggested, the basis for further phasing will be established as the year unfolds. Experience gained can be used to "calibrate" the phases for subsequent years. We recognize that assistance beyond the first year must be based upon detailed plans and specific evidence. Rather than attempt to generate such information at this time, we believe a much preferred procedure is to commit resources to the first year with the expectation to continue. A much more factual foundation for continuation will then be available as the first year draws to a close.

With respect to contractual relationships for the provision of technical assistance to the Academy and NRC, U.S. AID may find it appropriate

to contract for a two-year period, subject to renewal. A one-year contract may not result in the continuity required to sustain the support effort in the most constructive manner.

ANNEXES

TO

VOLUME I

Annex 1

Glossary of Terms

Program Monitor: A professional member of the Academy of Scientific Research and Technology staff who takes the lead in working with government ministries and departments, research institutions, and individuals and agencies with developmental problems in (1) identifying a particular development goal, (2) identifying the problems or obstacles to be overcome through research and development in achieving the goal, and (3) specifying the major elements of a program of research and development to be launched in overcoming the problems.

The program monitor then guides the preparation, for the Academy, of a request for proposals to be submitted by research institutions that believe they are in a position to assume responsibility for the research program contemplated. The monitor then supervises the proposal review, negotiation and contractor selection process. After the contract is issued, this individual then monitors the work of the contractor to insure that it is conducted according to the contractual agreement.

Program Manager: A professional member of the staff of the institution performing the research who has responsibility for managing the research program being supported by Academy funds. He usually is the individual who takes the lead in preparing the proposal submitted to the Academy by the research institution.

Project Director: The senior professional member of the staff of an organization that undertakes a component of the research program that is under the supervision of the program manager. The director is responsible for his organization's element of the program. He may be a member of the same institution as the program manager, or associated with a different institution.

Research Program: A complex, usually large, research undertaking that is designed to carry a research and development process through several stages from an initial idea as to how to solve a problem through to a demonstrated solution. The program is normally subdivided into components as defined below.

Program Element: The first subdivision of a large re earch program. The basis for division is usually determined by the nature or structure of the research required to solve the problem. This subdivision may or may not be used, depending upon the complexity of the program. If it is not used, projects become the first subdivision.

Program Subelement: The second subdivision of a large research program. This division may or may not be used, depending upon the complexity. If it is not used, projects become the next subdivision.

Research Project: Another subdivision of a research program. This is the level where the research actually takes place. Prior levels usually are organizational in nature. A research project deals directly with solution of a component of the overall problem.

Subproject: A subdivision of a research project. Some projects have interrelated parts that can be separated at least in the initial stages of project execution. A subproject is simply a further subdivision of the research activity for the purpose of delegating responsibility for execution.

Initial Users: Those in research who interact with each other (and with people who have or are concerned with problems or needs) in identifying problems and in designing and implementing research programs and projects. They may be identified as the initial users of prior knowledge who create new knowledge--i.e., research results.

Intermediate Users: Those who adopt the new knowledge or research result, develop it further if necessary, and put it to work. They use the knowledge in that their decisions are affected by it. They may be manufacturers, for example, who decide to change a production process based upon knowledge of a new technique developed through research.

Final Users: Those whose lives are subsequently affected by the impact of the new knowledge. The consumer of the product of the manufacturer that adopted the new technique may be construed as a "final user."

Annex 2

Volume II

Table of Contents

		Page
	PREFACE	iii
	LIST OF EXHIBITS	vii
	LIST OF ANNEXES	ix
I.	INTRODUCTION	1
	Assignment and Terms of Reference	1
	Organization of Report	2
II.	THE ACADEMY OF SCIENTIFIC RESEARCH AND TECHNOLOGY	3
	Historical Background	3
	Organization of the Academy	4
	The Research Councils	9
	Research Projects Funded by The Academy	21
	Joint Research Projects	22
	Scientific Agreements With Foreign Countries	22
	Long-term Recommendations of the 1975 Academy Conference	23
III.	THE NATIONAL RESEARCH CENTRE (A.R.E.)	31
	Programs	31
	Projects	33
IV.	OTHER EGYPTIAN SCIENCE AND TECHNOLOGY INSTITUTIONS	43
	Institute of Oceanography and Fisheries	43
	Institute of Astronomy and Geophysics	45
	The Egyptian Petroleum Research Institute	46
	National Institute for Standards (NIS)	48
V.	PROJECT IDENTIFICATION DOCUMENT	51
	Relevancy of the Problem	51
	The Problem	54
	The Project	59
VI.	U.S. NATIONAL SCIENCE FOUNDATION RESEARCH APPLIED TO NATIONAL NEEDS PROGRAM	67
	Eligibility	69

Annex 2

Volume II

Table of Contents (con.)

Page

VI. U.S. NATIONAL SCIENCE FOUNDATION RESEARCH APPLIED TO NATIONAL NEEDS PROGRAM (con.)

Deadlines. 69
Energy 69
Environment. 71
Productivity 75
Exploratory Research and Problem Assessment. 77
Intergovernmental Science Programs 79
Experimental Research and Development Incentives 80

VII. SUMMARY OF NATIONAL SCIENCE FOUNDATION REPORT ON INSTRUMENT REQUIREMENTS. 83

Introduction 83
Applied Research Advisory Board (ARAB) 83
Instrumentation Requirements 85
Cooperative Projects 85

VIII. THE SCIENTIFIC INSTRUMENT CENTER, CAIRO. 87

ANNEXES. 93