Final Overview Report for Project on Improving the Science and Technology Policy and Management in Egypt

A Project Conducted under the Auspices of the Egyptian Ministry for Scientific Research and Funded by the World Bank

February 1997

*** A World Bank-IDF Funded Project, WB28836**

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Executive Summary

A Project on "Improving the Science & Technology Policy and Management in Egypt" was undertaken by the Ministry of Scientific Research (MOSR) with the aid of a World Bank Grant. The Project's ultimate goal was to formulate a national policy and strategic framework for creating a more effective S&T system to help accelerate the nation's socio-economic development. Participants in the project included many Egyptian experts from the R&D community, industry, and government, as well as a number of international consultants.

A diagnostic evaluation revealed key strengths and weaknesses in the Egyptian S&T system. The latter included inefficient management structure, inadequate resources, weak links between R&D institutions and industry, ineffective and non-motivating funding policy, and relative isolation of S&T institutions from the national socio-economic development activities. Remedies for these areas of weakness have been suggested.

A principal recommendation of this work urges Egypt to adopt an explicit, formal S&T policy. A proposal for such a policy was formulated comprising a national goal, a set of specific objectives, and nine strategic action areas. The policy's national goal is, *"To strengthen the scientific and technological capabilities of Egypt and to mobilize them towards the support of the socio-economic development of the country, and its gradual transformation, within a rapidly changing global economy, into an industrialized economy by the year 2017."* The nine strategic action areas include:

1. **Strengthening the S&T management structure.**
2. **Upgrading resources and improving their allocation process.**
3. **Increasing the effectiveness and efficiency of R&D institutes.**
4. **Supporting innovation, competitiveness and marketing as a basis for an export strategy.**
5. **Accelerating technology transfer.**
6. **Nurturing essential as well as advanced technologies.**
7. **Integrating S&T into the fabric of Egyptian life.**
8. **Harmonizing the legal environment.**
9. **Enhancing international collaboration.**

A series of measures was identified for each strategic action area. Some of these measures are directed toward producing effects in the immediate future, whereas others will produce effects in the medium- and long-term outlooks.

A number of key operational elements was also developed to accelerate the policy's implementation. These operational elements included:

1. **Establishment of a national S&T data base.**
2. **Formulation of strategic plans for revitalization of R&D institutes affiliated with MOSR.**
3. **Completion of insight surveys on nine Egyptian prospective export industries.**
4. **Formulation of national strategic plans for selected technology sectors (electronics, informatics, marine, and pharmaceutical technologies).**
5. **Preparation of proposals for well-defined, specific priority projects.**

<u>Recommendations</u>

The following are the major recommendations resulting from the project.

1. ***Immediate action by the Egyptian government to formalize the S&T policy proposed in the study and to integrate it with the national plan for socio-economic development.***

2. ***Immediate action by the MOSR to implement the many strategic action elements of the S&T policy.*** **Task forces, with representation of the private sector, should be formed with each task force responsible for developing an implementation plan in one of the strategic action areas of the S&T policy (e.g. a legal reform task force to prepare proposed law changes for submission to the Legislative Assembly). These task forces should be coordinated through a steering committee headed by the Minister.**

3. ***Immediate action is encouraged to carry out a feasibility study for establishing a "National S&T Fund" at a level corresponding to about 0.25 - 0.5% of the Egyptian government's budget.*** **The purpose of this fund is to sponsor priority technology-oriented projects using a competitive bidding process and to contract research for well-specified deliverables. In awarding these contracts, preference should be given to teams that integrate the capabilities of R&D institutes, industry, and universities. The contribution of the private sector and the aid of foreign donors and international organizations (e.g. the World Bank) should be sought in establishing this "National S&T Fund." Strategic R&D plans that evolved from this Project would constitute a viable initial base in this regard.**

4. ***Immediate action by the R&D institutes to implement the revitalization plans agreed upon during this study.*** **Among the important actions are: a) transforming most of the industrial research institutes into technology centers capable of serving the national needs, accelerating technology transfer, and enhancing local technology development; b) diversifying the sources of funding, particularly through technical service and research contracts with industry and other private and public organizations; and c) opening the relatively closed bureaucratic management and operating system, by reforming staff-hiring practices, by providing incentives and rewards for productivity and innovation, and by encouraging interaction with clients and other S&T institutions.**

5. ***Immediate action by MOSR which will result in near-term success models for transforming two or three R&D institutes into technology centers.*** **Good candidates for such near-term success models are:**

   A) **<u>A Pilot Project in Technology Development and Investment in the Electronics Sector</u>**
   This project involves converting the Electronics Research Institute (ERI) into a mini-ITDI (Industrial Technology Development Institute) for the purpose of piloting the concept of incubating technologies for spin-off companies in electronics, software, energy conversion, and microwave devices.

   B) **<u>A Pilot Project in Technology Development and Investment in the Textile Sector</u>**
   This project involves establishing a mini-ITDI to enhance technology and process development, design, and modern marketing techniques to serve the critical textile and garment sector. The nucleus for this project should be NRC's textile division.

   The plans for transforming these institutes should include goals of becoming a "dominantly private operation" and launching some priority projects as joint ventures with local industry within five years. The aid of foreign donors in initiating the near-term success models for transformation should be sought.

6. ***Immediate action to initiate a project to systematically, effectively, and efficiently utilize the expertise of Egyptian expatriates.*** **Based on the experience of newly industrialized nations, this project must be given high priority, since it will benefit all other projects. The many excellent suggestions proposed in this study, especially in the International Consultants' Report (September 1995), provide a solid framework for initiating the project. In particular, assistance from foreign donors should be sought to establish a "Distinguished Egyptian Expatriate Fellowship Program" which seeks to attract renowned Egyptian expatriates in selected critical areas of expertise to spend one to three years in Egypt on specific priority projects.**

7. ***Action to increase the role of the private sector in supporting and implementing S&T programs.***

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1. Introduction

Since late 1993, Dr. Venice Gouda, the Minister of State for Scientific Research has undertaken a full-fledged endeavor to improve the Science and Technology Policy and Management, particularly in that part of the S&T system affiliated directly to the Minister. Through several contacts with World Bank staff, an IDF Grant of US$ 360000 was received to support these activities. A project was started in August 1994 and was completed in December 1996.

The Project's ultimate goal was to formulate a national policy and a strategic plan for creating a more effective S&T system that can better serve the national goals of producing technological transformation and accelerated socio-economic development.

Participants included a multidisciplinary team of senior experts from the Egyptian R&D community, industry and government, as well as a number of international consultants. The study followed a careful methodology that assured wide participation by all institutions and sectors which would be affected by changes in the S&T system. A list of the key study participants is given in Appendix A.

The Project output included:

1) **formulation of a new and effective S&T Policy with specific goals, objectives, and strategies;**

2) **Action Plans for institutional reform and upgrade of the capabilities of the R&D institutes and their coupling with industry; and**

3) **identification of specific priority projects.**

The purpose of this document is to briefly summarize the results of the study. Several detailed reports were produced in the course of the study. A list of the principal reports is provided in Appendix B. The present document is intended as a concise, self-contained account of the study.

2. Methodology and Participants

The study was supervised by Prof. Dr. Venice K. Gouda, the Minister of State for Scientific Research (MOSR) and was managed by Prof. Dr. Mohamed Mokhtar El-Halwagi, the First Undersecretary of MOSR. The national effort was led by a team of 23 persons that included national consultants with a high-level of expertise in S&T management, as well as a selected number of directors and senior managers of the R&D institutes affiliated with MOSR. The team also included a well-known economist and a highly recognized authority on business management.

Key input to the study was provided by a team of international consultants which visited Egypt in September 1995 and included well-recognized experts from industry, academia and R&D organizations from the US, France, and Colombia. The team of international consultants was headed by an Egyptian expatriate with internationally recognized expertise in S&T management, technical planning and advanced technology. The names of these consultants also appear in Appendix A. The extensive documents prepared by the international consultants are noted in the list of references in Appendix B (see, for example, reference 14).

Two consulting firms, the Danish Technological Institute and Battelle Memorial Institute (US) contributed to developing action plans for the textile and the electronics and informatics sectors.

Considerable support and advice were received from many members of the World Bank staff, especially Jacques Baudouy, David Steel, Stephen Heyneman, Badr Kamel, and Roushdy Saeid.

The study was conducted in three phases, which are briefly summarized below.

Phase 0: Lessons Learned and Diagnostic Study

In this phase, the effort focused on three activities:

1) **acquiring knowledge and study of the experiences of S&T systems in developed countries, economies in transition, and newly industrialized countries;**

2) **performing a diagnostic study of the Egyptian S&T situation; and**

3) **evaluating individual R&D institutes.**

The first activity involved: a) a study tour taken by the Minister and some of her senior advisors to France, OECD, Hungary, Singapore and Malaysia; b) input from national consultants, Egyptian expatriates, and other international experts; and c)

review of previous studies and relevant reports on S&T experience in Egypt and worldwide.

The second activity focused on performing a descriptive, analytic and diagnostic study of the overall Egyptian S&T situation. Primary areas of weakness and strength, as well as key issues, were identified (references 2, 3, and 6).

The third activity involved detailed assessment of the capabilities and performance of each of the thirteen R&D institutes affiliated with MOSR. This assessment is part of references 17 - 31.

Phase I: S&T Policy

The extensive activities of Phase 0 led to a better understanding of Egyptian S&T strengths and weaknesses. This, combined with lessons learned from successful global experiences, led to identification of important changes to be made and to a clearer vision of the characteristics of the desired S&T system.

A S&T policy framework was formulated and widely disseminated for extensive discussions. Through these national deliberations and international consultations, the national vision for a S&T policy was articulated in terms of a national goal, a set of specific objectives, and a strategy consisting of nine action areas.

Phase II: Operational Elements of Future Action Plan

This phase focused on identifying key elements of the action plan necessary to put the S&T policy into operation. A full implementation plan is beyond the scope of this study. However, the efforts in this phase were deemed necessary in order to facilitate a speedy transition from policy formulation to implementation.

The activities in this phase resulted in the following:

1. **Establishment of a National S&T Data Base.**
2. **Strategic plans for revitalization of the R&D institutes affiliated to MOSR.**
3. **Models for innovation and competitiveness in candidate export industries.**
4. **Strategic plans for selected priority technology sectors.**

(The output of this phase is documented in reference 1 and parts of 15 - 32.)

A final study workshop was held in Cairo from December 21-22, 1996. It was attended by several Cabinet Ministers, senior members of the R&D community, industry and business leaders, and a number of international consultants. The workshop provided an opportunity for further refinement of the project output and for further mobilization of efforts toward the critical implementation phase that must follow the conclusion of the project.

3. Overview of the Egyptian S&T System

Detailed accounts of the characteristics and statistics of the Egyptian Science & Technology System and its institutions are given in references 2, 3 and 6. Also, detailed descriptions of the functions and capabilities of the R&D institutes affiliated to MOSR are given in the individual institutes' reports (references 17-31).

3.1 General Structure of the System

The system includes institutions with both deliberation and implementation functions.

3.1.1 Institutions with Deliberation Functions

- **Four National Advisory Councils: Affiliated to the Presidency of the Republic with an assignment to study selected topics of public interest. One of these is the council for Education, Scientific Research and Technology.**

- **The Academy of Scientific Research and Technology (ASRT): One of its major functions is to deliberate through 13 specialized councils (more information about ASRT will be presented later).**

- **Government Ministries: Most government ministries administer both deliberative, as well as specialized executive functions.**

- **Ministry of Scientific Research (MOSR): The Minister is responsible before the cabinet and parliament for matters related to S&T Policy and issues which cut across various sectors and disciplines. The minister is also responsible for the institutions affiliated to MOSR.**

3.2 Institutions with Implementation Functions

Institutions with implementation functions may be departments, laboratories or large multidisciplinary centers. They can be categorized into: a) governmental; b) public sector; c) private sector; and d) non-governmental organizations. Because of their large number (318) and broad range, they are classified according to sector of performance (Table 1).

TABLE 1. CLASSIFICATION OF S&T INSTITUTIONS ACCORDING TO SECTOR OF PERFORMANCE

SECTOR OF PERFORMANCE	NO.	%
• Higher education sector	223	70.0
• Productive sector	51	16.0
• General services	44	14.0
TOTAL	318	100.0

A) Governmental Institutions

These institutions may be divided into three subgroups: 1) universities; 2) institutions affiliated to the Ministry of Scientific Research (MOSR); and 3) institutions affiliated to other ministries. There are 13 governmental universities, of which 12 are affiliated to the Ministry of Education. Presently, there are 14 S&T institutions affiliated to the Ministry of Scientific Research, which are listed in Table 2. ASRT in turn has 13 institutions, which are listed in Table 3. Many other ministries have their own S&T institutions. Prominent among these are the institutions belonging to the Ministries of Agriculture and Land Reclamation (MALR), Public Works and Water Resources (PWWR), Industry and Mineral Wealth, Electricity and Energy, and Health. A list of S&T institutions affiliated to Ministries other than MOSR is given in Table 4.

TABLE 2. INSTITUTIONS AFFILIATED TO MOSR

NAME OF INSTITUTION	NAME OF INSTITUTION
• Academy of Scientific Research and Technology (ASRT) • The Supreme Council for Research Centers and Institutes (SCRCI) • The National Research Center (NRC) • The National Authority for Remote Sensing and Space Sciences • Mubarak City for Scientific Research and Technological Applications • National Research Institute of Astronomy and Geophysics (NRIAG) • The National Institute of Oceanography and Fisheries (NIOF) • The National Institute for Standards (NIS)	• The Egyptian Petroleum Research Institute (EPRI) • The Central Metallurgical Research and Development Institute (CMRDI) • Theodore Bilharz Research Institute (TBRI) • Electronics Research Institute (ERI) • Research Institute of Ophthalmology (RIO) • The Technical and Technological Consulting Studies and Research Fund (TTCSRF)

TABLE 3. INSTITUTIONS BELONGING TO THE ACADEMY OF SCIENTIFIC RESEARCH AND TECHNOLOGY

S &T INSTITUTION	S &T INSTITUTION
• National Network for Technology Development • National Information and Documentation Center • The Egyptian National Scientific and Technological Network • Executive Office for Environmental Information	• Statistics on Science and Technology Department • Patent Office • Innovation and Invention Development Organ • Scientific Instruments Center • The Science Museum • The Regional Development Centers • Sinai Rehabilitation Research and Development Organ

TABLE 4. S&T INSTITUTIONS AFFILIATED TO MINISTRIES (OTHER THAN MOSR)

S&T INSTITUTION	MINISTRY OF
• Agricultural Research Center (ARC)	• Agricultural and Land Reclamation
• Water Research Center • Surveying Department	• Public Work and Water Resources
• Organization for Geological Surveys • Egyptian Standardization Organization • Egyptian Organization for Industrialization	• Industry and Mineral Wealth
• Agency for Nuclear Materials • Atomic Energy Establishment • Egyptian Renewable Energy Development Organization (EREDO)	• Electricity and Energy
• General Organization for Housing, Building and Civil Planning Research • The Center for Telecommunications Research • Transport Research Institute	• Housing, Infrastructure and New Settlements • Transport and Telecommunications
• Organization for Educational Hospitals	• Health and Population
• Military Medical Academy • Nasser Military Academy • Technical Military College	• Defense and Military Production
• The National Center for Social and Criminological Research	• Social Affairs and Insurance
• Center for Industrial Safety	• Labor and Employment
• National Institute of Planning	• Planning
• Police Academy	• Interior
• Center for Education Research	• Education
• Egyptian Environmental Affairs Agency	• Environmental Affairs
• The Cabinet Information and Decision Support Center (IDSC)	• The Cabinet
• Regional Information Technology and Software Engineering Center (RITSEC)	

B) Public Sector R&D Institutions

Presently, these institutions are attached to holding companies which own the public sector companies (Table 5). In addition, a few R&D units operate within some large production companies (e.g. sugar, pharmaceuticals).

TABLE 5. S&T INSTITUTIONS AFFILIATED TO MINISTRY OF PUBLIC ENTERPRISE

S&T INSTITUTION	HOLDING COMPANY FOR
Tibbin Institute for Metallurgical Studies	Metallurgical Industries
Textile Research and Development Center	Spinning, Weaving and Clothes
Electronic Industries R&D Center	
Engineering and Industrial Design Development Center	Engineering Industries
Fertilizer Development Center	
Plastic Development Center	Chemical Industries

C) Private Sector R&D

A few units are emerging, especially in agriculture. Some industrial firms are in the process of establishing small R&D units.

D) Non-Governmental Institutions

114 non-government organizations are active, mostly as units of professional associations and S&T societies.

3.3 Objectives and Resources of Egyptian S&T

3.3.1 Objectives

In Egypt, objectives related to S&T in general, and R&D in particular have been, with limited exceptions, laid down by the researchers themselves. The role of the high decision-making level in the government has been usually restricted to the allocation of financial resources, hence the name "resources policy." Adoption of

such a policy for decades has tremendously weakened the majority of R&D institutions, particularly in that the meager financial resources given to them have barely sustained their existence.

3.3.2 Resources

The Egyptian S&T institutes have been provided with human, financial, material, and informational resources.

A) Human Resources

During the last decades, there have been steady increases in the numbers of personnel engaged in S&T activities. Presently, there are 114,137 persons performing these activities, among which are 49,582 scientists (43.5%), 17,150 technicians (15%), and 47,405 auxiliary personnel (41.5%). The distribution of scientists and engineers among the three sectors of performance follows this order: higher education (71.3%), production sector (16.3%) and general services (12%), as shown in Table 6. Major problems facing S&T personnel include poor remuneration and rewards, over employment (especially in the area of auxiliary personnel), improperly trained personnel in many specializations, and a low percentage of scientists and engineers involved in R&D in the productive sector.

TABLE 6. HUMAN RESOURCES IN S&T ACTIVITIES

SECTOR OF PERFORMANCE	HIGHER EDUCATION		PRODUCTION SECTOR		GENERAL SERVICES		TOTAL		PER MILLION
Categories of Personnel	No.	%	No.	%	No.	%	No.	%	
Scientists	37475	32.8	5674	5.0	6433	5.7	49582	43.5	901
Technicians	10095	8.8	4584	4.0	2507	2.2	17150	15.0	312
Auxiliary	33786	29.6	9342	7.3	5277	4.6	47405	41.5	862
Total	81356	71.3	18564	16.3	14217	12.5	114137	100.0	2075

***Categorization according to academic qualifications shows:**

Ph.D.	**21083**	**31.5%**
M.Sc.	**12527**	**18.7%**
B.Sc.	**15972**	**23.9%**
Technical	**17150**	**25.7%**

B) Financial Resources

Statistics on national R&D expenditure are, as yet, unreliable and available data differ according to their source. On the average, the figure is of the order of about 0.4% of the GDP. Public funds are provided to S&T institutions by two ministries: Ministry of Finance (running expenses), and Ministry of Planning (investment funds). The only example of an intermediate funding organization is the ASRT, which receives its funds from the Ministry of Planning and uses them for the support of research projects contracted to R&D institutions nationwide. Foreign-sourced funds constitute an important component of the R&D resources, especially in the ministries of agriculture, health, and ASRT.

C) Material Resources: The S&T Infrastructure

During the last decades, Egypt has allocated the investments it could afford for the construction, installation and launching of its S&T institutions. With regard to S&T equipment (apparatus and instruments), the main difficulties encountered are high prices and rapid obsolescence, lack of domestic production of S&T instruments, and problems of repair, maintenance and spare parts.

D) Information Resources

Many efforts have been undertaken by different ministries to establish S&T information and documentation facilities. Despite these efforts, there is a general feeling among S&T performers and end-user communities that there is an urgent need to strengthen and coordinate these efforts in the context of a national information and documentation policy.

3.4 Egypt and International Cooperation in Science and Technology

Egypt, being aware of the advantages of international cooperation in S&T, has attempted to tap all available international resources in this respect. Toward this end, it has established and assigned several governmental structures to undertake this responsibility. However, more local coordination is needed.

3.5 Transfer of Technology

In the execution of its huge industrialization schemes and other large development projects, Egypt has depended principally on foreign technology, essentially in the form of turn-key and other packaged types. In the sixties and seventies, most

imported technologies came from the former Soviet Union and other Eastern bloc countries. The picture changed in the eighties and nineties when most technology imports came from Western countries.

To encourage foreign technology inflow, the government of Egypt adopted a laissez-faire policy towards technology imports and has not issued any laws or established any institutional infrastructure for monitoring or regulating foreign technology. Prior to this study, S&T institutions did not play a significant role in influencing technology transfer. There were no major attempts by S&T institutions to evaluate, understand, absorb, recommend, adopt, adapt and diffuse foreign technology.

3.6 Strengths and Weaknesses of the S&T System

The strengths and weaknesses of the Egyptian S&T system have been identified. Since the focus of the study is to seek improvement, the weaknesses are described in more detail.

3.6.1 Strengths

1. **Tremendous human resources with a large number of highly educated and specialized personnel.**

2. **Presence of a considerable number of R&D institutions in various specializations and disciplines.**

3. **Many shining examples of success, particularly in agricultural research and in some of the well focused industrial R&D.**

4. **Long-time tradition in S&T.**

5. **Governmental commitment towards S&T institutions.**

3.6.2 Weaknesses

This study sought to suggest remedies in areas of serious weakness. Despite the many shining examples of success achieved by the Egyptian S&T system, it failed to become a scientific and technological power which could induce an effective transfer of technology and know-how from advanced nations and, in turn, create a solid national technological base; both of which are necessary foundations for successful socio-economic development.

It must be noted that during the past two years, many positive changes have taken place in response to the many important recommendations that evolved from the study. Below is a summary of the common set of problems that were identified in the study.

1. **Lack of an Explicit National S&T Policy**

   A Science & Technology Policy usually consists of a clear goal, specific objectives, and a well-defined strategy. Such a policy is necessary to define a plan of action, the roles of various R&D institutions, and priorities of R&D. One of the key outputs of this work is a proposal for a new effective S&T policy with a clear goal, specific objectives and action-oriented strategies.

2. **Inefficient and Complex Organizational Structure, Causing Conflicts Rather than Promoting Harmony**

   Generally, an efficient system has clear lines of direction and responsibilities in a top-down line management and has a well-defined matrix of interactions. The decision-making process and the overall management structure for the Egyptian S&T system are complex, and in some cases, they are not even defined.

   The nature of the overall management system led to conflict, impeded action and a lack of coordination. Previous attempts to remedy these fundamental flaws in the system were limited to creating a myriad of "coordinating committees" which consumed too much effort without considerably improving the situation.

3. **Financial Resources Seriously Limited**

   Financial expenditures on R&D are very modest. While no accurate data exist, the total expenditure on R&D, excluding universities, appears to be about 0.4% of the Gross Domestic Product (GDP), with 70% - 80% of the budget devoted to salaries. This compares to 2% - 3% of GDP spent on R&D in industrialized nations. Therefore, Egyptian R&D activities suffer greatly from severe under financing.

   Most of the scientific and technological equipment, instruments, and other hardware tools of R&D are obsolete. Although other software and information tools (libraries, computers, data bases, etc.) of R&D have improved recently, they are still critically deficient.

   Researchers are generally underpaid, and there appear to be no strong financial incentives encouraging researchers to excel.

4. **Deficient Physical and Information Resources**

Physical resources (installation, equipment, scientific instruments, computers, libraries) in most R&D institutions are deficient. Much of the equipment is either far behind the state-of-the-art or obsolete. Some institutions constructed mostly with foreign funds have better equipment, but local capabilities for repair and maintenance remain severely limited.

The information and documentation system has undergone major improvement recently, but availability of and access to information (particularly via computer networks) is still seriously deficient. The information resources and management system (books, periodicals, computerized links among organizations and to the outside world, basic scientific and technological data bases, data on ongoing and planned projects, etc.) need major improvement.

5. **"Laissez Faire" Funding Policy and Selection of Research Topics Left to Individual Researchers**

Government funding, which is the major source of funding, is provided to R&D institutions on a "resource basis" (primarily to pay salaries of existing employees). Therefore, the funding implicit policy is a continuation of existing research. Prior to this study, national priorities, missions, or projects were not identified and individual researchers selected their own research topics.

6. **Most R&D Institutions Function as Academic Units rather than as Technology Centers**

Most Egyptian R&D institutions are functioning in a manner that replicates universities by placing emphasis on "academia" rather than functioning as national laboratories or technology centers. A primary mission for a young researcher is to prepare a Master or a Ph.D. thesis. Senior researchers (professors) spend much time supervising thesis research. The research topics generally tend to be of the same type or similar to those found in universities with a heavy emphasis on basic sciences and paper studies. The applied research, much needed for the nation's technological transformation and industrialization, is not given the priority it deserves.

7. **75% of the Researchers are in Universities**

The higher education sector has 70% of all S&T institutions and 75% of all scientists and engineers in Egypt. Hence, scientists and engineers in the production and general services sectors represent only about one quarter of the national R&D resources. This is in sharp contrast to the case in advanced nations where R&D capabilities in specialized institutions (government, public, and private) are much larger than in universities. A nation aspiring for rapid

technological transformation and industrialization must focus a greater part of its R&D resources on institutes in the production and general services sector.

8. **Only 15.7% of S&T Personnel are in Engineering and Technology**

   There are 114,137 persons engaged in S&T activities. The distribution of researchers is as follows: natural sciences (22.8%), engineering and technology (15.7%), medical sciences (22.8%), agricultural sciences (14.7%), and social and human sciences (24%). The percentage of persons in engineering and technology needs to be increased, particularly during the stage of producing technological transformation. A related issue is the need for technicians to be better trained and to acquire advanced skills, particularly in repair and maintenance of equipment.

9. **Foreign Funds not Well Coordinated**

   There is little coordination of foreign funds. Usually, these funds are directed to certain projects of different ministries and/or institutions in the frame of multilateral or bilateral S&T cooperation agreements. Foreign funds are presently substantial and can be coordinated to maximize the benefits to Egypt in areas of technology transfer, as is necessary for a major transformation in the national technological and industrialized base.

10. **Weak Links Between R&D Institutions and Industry**

    Prior to this study, most R&D institutions had not established a strong provider-client relationship with industry and had not focused their activities on what is most important to industry. The institutional reform initiated as part of this study emphasized improving the links between industry and R&D institutions.

11. **Technology Transfer Follows Laissez-Faire Policy with No Significant Role for the S&T Institutions**

    To encourage foreign technology inflows, the government of Egypt adopted a laissez-faire policy towards technology imports and has not issued any laws or established any institutional infrastructure for monitoring or regulating foreign technology. Currently, foreign technology imports approximate "turn-key" type packages. S&T institutions have not provided the leadership necessary to assist in developing effective policies and schemes for maximizing the benefits of technology transfer. Efforts to understand, absorb, adapt and diffuse foreign technology were seriously limited. No strong attempts were made to introduce reverse engineering or to use foreign technology imports as a base for creating national technology.

4. S&T Policy Proposal

One of the Project's primary recommendations urges Egypt to adopt an explicit, formal S&T policy. A proposal for a S&T policy was formulated and widely disseminated and discussed among various R&D, industry, government, business, and investment sectors in Egypt. An agreed on S&T policy proposal has emerged from the study, the highlights of which are presented in this chapter.

4.1 Needs and Requirements for S&T Policy

Need for a S&T Policy

An explicit S&T policy framework is urgently needed for the following reasons:

- **To mobilize the existing uncoordinated S&T capabilities towards effectively serving the national development needs of Egypt.**
- **To upgrade technological capacity to respond quickly to windows of opportunity that the fast-changing, new globalized economy offers.**
- **To concentrate scarce resources in clearly targeted objectives.**
- **To revitalize and restructure governmental S&T superstructures and infrastructures, and to establish new necessary facilities.**
- **To create capabilities and an environment conducive to acquiring, diffusing, and improving foreign technology, as well as developing local technology.**
- **To create mechanisms for technology assessment for sustainable development with an emphasis on environmental considerations.**

Requirements for an Effective S&T Policy

It is not sufficient to formulate a S&T policy. For such a policy to be effective, strong political will and political commitment at the highest level is necessary. The intention is to submit this policy framework and strategy to the Cabinet of Ministers for approval and, finally, to the President for winning sustained support for the entire cause of S&T development in Egypt as a national priority.

Furthermore, in order to make the S&T policy more effective, it is proposed that the following steps be undertaken by the Cabinet:

- **Development of a clear vision of the socio-economic development of Egypt for the next 20 years.**

- **An effective integration of S&T policy with other socio-economic policies such as economic, educational, industrial, agricultural and health. If these policies are not clearly defined, their formulation becomes an essential requirement.**

- **An assurance that the greater part of the Egyptian people is actively involved and adhering to the major thrust of the proposed S&T policy. Furthermore, the fruits of development need to be shared among the different classes of society.**

Need to Work with Different Time Horizons

The policy orientations have the central purpose of serving major agreed-upon strategic objectives. Some elements of the proposed S&T policy framework are directed towards producing effects in the immediate future in order to quickly mobilize S&T capabilities to address pressing needs. Other framework elements will produce effects in the medium- and long-term outlooks.

4.2 Structure of the Proposed S&T Policy Framework

The S&T policy framework presented in this document integrates some ideas that have been sounded in previous proposals in addition to new ideas inspired by: 1) the rapidly evolving globalized economy; and 2) the successful economic reform currently underway in Egypt.

The policy proposal covers the following three parts:

- **A general goal that provides a sense of purpose.**

- **Specific objectives that provide a more operational framework for action.**

- **Strategic Action Areas that constitute the key elements of an integrated strategy aimed at developing S&T capabilities in Egypt. A series of policy measures and policy options are identified and briefly discussed under each Strategic Action Area.**

Some elements of an action plan have been proposed. However, a serious implementation plan must immediately follow the approval of the S&T policy.

4.3 S&T Policy Proposal

Goal

"To strengthen the scientific and technological capabilities of Egypt and to mobilize them towards the support of the socio-economic development of the country, and its gradual transformation, within a rapidly changing global economy, into an industrialized economy by the year 2017."

Objectives

To reach this goal, the following specific objectives must be achieved:

a) **Applying S&T to the solution of urgent national socio-economic problems in the production and services sectors.**
b) **Strengthening the technological capabilities of the country to increase its capacity to compete successfully in international markets, particularly in high value-added products. Furthermore, all efforts will be undertaken to find a niche in the global market of high technology products to be manufactured and exported by Egypt.**
c) **Increasing the effectiveness of R&D activities as carried out by the universities and institutes affiliated to the different ministries, particularly those affiliated to the Ministry of Scientific Research. Special emphasis should be given to industrial research institutes and their transformation into technology development centers.**
d) **Encouraging the application of advanced technology in the production and services sectors and promoting the role of R&D therein.**
e) **Forming and utilizing partnership agreements between Egypt and other nations and transnational corporations for enhancement of S&T cooperation that mutually reinforces economic cooperation.**
f) **Preserving the environment as a vital component of all sustainable development efforts.**

Integrated Strategy for the Development of S&T

The S&T development strategy comprises nine strategic action areas that must interact together to achieve an effective integrated plan. It must be emphasized that S&T development is a very complex and a multi-faceted dynamic process that involves the strengthening and creation of different capacities that are highly interrelated. Furthermore, it cuts across the activities of most ministries and government departments, the public and private sectors, and all those involved in the socio-economic development of the country, both national and foreign.

Thus the strategy proposed here is based on the interrelated factors or strategic action areas that must be addressed and implemented in an integrated way by those in the government, production and service sectors (public and private), scientists and technologists, as well as other end-users of the S&T results. These strategic action areas define the scope and main dimensions of the S&T Policy.

First Strategic Action Area:
Strengthening the S&T Management Structure

To strengthen the S&T management structure, the following is needed:

a) ***Evaluating the different S&T functional levels responsible for decision-making and implementation.*** **Examples include ministries-affiliate research institutes, the Academy of Scientific Research and Technology, universities, independent research institutes, public and private sector firms involved in technology transfer, and other organizations.**

b) ***Undertaking a reform and restructuring process based on these evaluations to improve the functions of the aforementioned levels in policy formulation and implementation.*** **This requires developing appropriate methodologies for the identification of S&T needs, for resource allocation for these activities, for retraining of human resources (e.g. in planning and program evaluation technologies) and for the creation of a data base and an information system that facilitates the monitoring and analysis of ongoing scientific and technological development. A time schedule to program this reform needs to be established.**

c) ***Upgrading the present S&T statistics facility through the use of internationally agreed upon methods to compile statistics, and strengthening its infrastructure in terms of personnel, equipment, and operational means.*** **Material resources for this facility will be provided either through local or foreign aid.**

d) ***Establishing a clear and transparent budgetary document that presents the detailed financial requirements for implementing the S&T Policy.*** **Coordination of the whole S&T budget, including budgets of all ministries related to S&T, will be the responsibility of the Cabinet. At the end of each fiscal year a document will be produced showing how the initial budget has been implemented.**

e) ***Establishing an inventory, on a yearly basis, listing the activities of different institutions involved in S&T in Egypt.*** **It is important that each document contains clear data regarding resources, budgets, man-power, projects, foreign contracts, results, and other key input and output information.**

f) ***Ensuring the equitable geographical distribution of R&D institutions to optimally serve local governments according to their specific needs.***

Second Strategic Action Area:
Upgrading Resources and Improving Allocation Procedures

To operate properly, the Egyptian national S&T system will be provided with sufficient human, financial, material (infrastructure and equipment) and informational resources on a timely schedule and with the appropriate mix. The government will maintain an efficient organization to deploy these resources with a distribution that best enables the achievement of the specific objectives of this policy.

1. Development of Human Resources

a) Coordination between S&T policy and educational policy will be made. With regard to scientists and engineers, the quality of education will be raised since any qualitative deterioration in the educational system will cause a real threat to the S&T system.

b) Development of S&T manpower will ensure an adequate supply of scientists and engineers to meet the demand for them in various sectors of the national economy. The percentage of persons specializing in engineering and technology disciplines will be increased specifically to assist in Egypt's technological transformation. A related issue is to increase the number of well-trained technicians with advanced skills, particularly in repair and maintenance of equipment.

c) A long-term plan will be adopted to change the present distribution pattern of scientists and engineers. (The universities presently have 75% of their total.) The aim is to progressively increase the number of S&T personnel in productive sectors to reach about 60% by the year 2017.

d) The government will also improve the status and working conditions of scientists and engineers involved in S&T development.

e) The government will support extensive S&T training schemes, including continuing training for enhancing performance in all research and application fields.

f) The government will strengthen the programs for utilization of Egyptian expatriates as an effective mechanism for the supply of world-class expertise.

g) An ambitious program of study missions abroad in selected S&T fields of high importance, including the priority areas of advanced and emerging technologies, will be promoted.

2. Financial Resources

a) **The government intends to increase the national R&D expenditure to reach 0.8% of the Gross National Product (GNP) by the year 2000, and then gradually raise the expenditure to reach 2% by the year 2017.**

b) **The sources of R&D funding will be diversified to include funds from the private sector and foreign resources in addition to public (government) funds.**

c) **A new National S&T Fund for priority projects will be established at a level corresponding to about 0.25-0.5% of the total national budget (in addition to existing allocations for S&T). This national S&T fund will sponsor priority projects using a competitive bidding process and contract research for well-specified deliverables and milestone schedules. Awarding these contracts should give preference to integrated teams of industry, R&D institutes, and universities.**

d) **Other funding mechanisms will be established to support R&D and innovation projects at the enterprise level.**

e) **Tax incentives will be provided to increase private sector investment in R&D.**

3. Material Resources: The S&T Infrastructure

The government will take the necessary steps to create infrastructural units, supply equipment, and establish information facilities as needed for the national S&T system. Furthermore, S&T organizations will be given the flexibility to also upgrade their material capabilities through funds generated from the private sectors and research contracts.

Third Strategic Action Area:
Increasing the Effectiveness and Efficiency of R&D Institutes

The government realizes that universities and R&D institutes affiliated to the different ministries are a national asset. Their effectiveness must be continuously improved as an integral and key element of the socio-economic development of the country.

Thorough evaluation of the present conditions and activities of R&D institutions will be undertaken, and remedial measures will be taken by the concerned authorities both at the national level and individually for each institute.

Special attention will be devoted to industrial research institutes and their revitalization, taking into consideration the local economic changes and the

experiences of other developing countries. In this regard, the following policies will be adopted:

a) ***Transformation of the institutes into technology centers capable of serving the national need of strengthening technological capabilities.*** **The focus of their activities will be on: (1) providing technical services aimed at solving immediate and urgent problems of production; (2) accelerating technology transfer from advanced nations through understanding, absorption, adaptation and diffusion to local firms; (3) facilitating technology transfer to local companies and institutions in all stages of negotiations, installation, operation, maintenance, and upgrade; (4) enhancing local technology development by introducing some innovations which may be known elsewhere; and (5) performing conventional R&D to create new knowledge and technology.**

b) ***Evaluation of the possibility of transforming the present model of public research institutes to a joint venture between the public and private sector, and deciding the organizational options needed to achieve that goal.***

c) ***Evolution in the funding strategy of these institutes from one based on an annual budget fully funded by the State, to one based on the following directions:***

- **Assurance of government support for a core budget, which represents only 50% of the total annual budget, with the remaining 50% to be generated through contract research or other funding mechanisms.**

- **Two main sources can be used by R&D institutes in mobilizing additional resources: i) the National S&T Fund managed by the government, (see second strategic action area); and ii) through improving their technology marketing capacity to generate additional funds.**

- **In order to facilitate contract research and the sale of technological services, the government, in addition to the creation of the new National S&T Fund, will establish a credit line for private enterprises. These lines of credit are to be used by the enterprises to finance joint projects with the R&D institutes.**

d) ***Adoption of a series of measures aimed at opening the relatively closed bureaucratic systems that characterize the Egyptian R&D institutes with the intent of facilitating their interaction with the production sectors.*** **Such changes include:**

- **Reduction of emphasis on academic graduate training programs in R&D institutes together with a change in the recruitment practices that are closely linked to them, in order to avoid the in-breeding phenomenon in these institutes.**

- **Deregulation and debureaucratization of the environment in which R&D institutes operate so that they can function in a more efficient way.**

- **Reduction of the rigid employment law constraints under which R&D institutes currently operate. This will facilitate mobility of manpower resources and create a promotion system that rewards performance rather than seniority.**

- **Encouragement and facilitation of the exchange of staff between R&D institutes and production units, as a means of strengthening the links between the two sides.**

e) ***Establishment of marketing units in the R&D institutes operated by marketing and business specialists.***

Fourth Strategic Action Area:
Supporting Innovation, Competitiveness & Marketing as a Basis for an Export Strategy

The government will strive to support firms directly in promoting and facilitating innovation processes and technological change at the enterprise level by undertaking the following measures:

- **Developing programs aimed at strengthening the technology management capacity of enterprises (e.g. strategic planning, knowledge of export markets, training of manpower).**

- **Establishing credit or funding mechanisms aimed at supporting technology development and innovation projects at the level of the firm.**

- **Establishing a national innovation system through promoting systematic linkages among the key actors of technological development (enterprises, R&D institutes, universities, engineering and consulting firms, suppliers of equipment and of technology, investors, etc.).**

- **Initiating a program for technical support to small and medium sized enterprises because of their importance in leading new technology-intensive initiatives in addition to their role in traditional sectors.**

- **Providing full support to the local standards and quality control and assurance systems. The government will gradually shift its activities to focus more on the regulatory function while encouraging private enterprises to assume the functions of testing and certification.**

- **Removing legal, financial and other obstacles that hamper direct investment.**

- **Redressing weaknesses of the patent system, particularly by strengthening enforcement mechanisms.**

- **Providing tax incentives for private sector investment in R&D and technological services.**

- **Providing training programs to enterprises in modern global marketing techniques.**

Fifth Strategic Action Area:
Accelerating Technology Transfer

In its national drive towards technological transformation, the government foresees the vital opportunities available through liberal transfer of foreign technology within equitable and mutually rewarding transactions. In order to realize more effective, more beneficial and faster technology transfer, the following measures will be undertaken:

- **In all transfers the latest in manufacturing processes and equipment will be preferred and used together with the most modern industrial management and marketing techniques.**

- **The government will not only issue action-oriented, fair and reasonably balanced guidelines for use by Egyptian importers in negotiating and concluding transfer of technology transactions but will also monitor their implementation. Another set of guidelines will be established for use by foreign suppliers of technology to optimize their transfer operations.**

- **Some of the international agreements for economic cooperation should involve joint investment ventures aimed at technology transfer to Egypt and training of Egyptian scientists and engineers in modern technologies.**

- **Industrial research institutes will be encouraged to play a major role in accelerating and facilitating effective technology transfer through: a) understanding, adaptation and diffusion; and b) providing assistance to local firms during all stages of technology transfer.**

- **Vertical and horizontal transfer of local technologies developed in local R&D institutes will be encouraged.**

- **It is also recognized that Egyptian expatriates represent a critical source of know-how that can be effectively utilized in technology transfer. Effective mechanisms for such utilization will be developed.**

Sixth Strategic Action Area:
Nurturing Advanced Technology

In addition to nurturing currently essential technologies such as electronics, textiles, pharmaceuticals and chemicals, the government intends also to accord high priority to advanced and emerging technologies which are expected to shape the economy and lifestyles in the 21st century. Such technologies include:

- **Biotechnology and genetic engineering.**
- **New and Renewable Energy.**
- **Informatics.**
- **Micro-electronics.**
- **New and advanced materials.**
- **Clean, environmentally favorable technologies.**
- **Nanotechnology.**
- **Others, such as marine, desert, environmental and advanced manufacturing technologies.**

It is therefore highly pertinent to explore the socio-economic impact of these technologies in the medium- and long-term, as well as in the short-term, in areas of education, R&D, and particularly export-oriented production. There is a dire need for Egypt to acquire a competitive edge in selection of these technologies and to make the relevant informed decisions in the very near future.

Seventh Strategic Action Area:
Enhancing International Cooperation

A predominant trend in Egypt's strategy for socio-economic transformation will be the creation of viable S&T-based cooperation with the industrial and newly industrialized countries. To achieve this objective, the government will support the following:

- **Inclusion of S&T cooperation as an important component in the major Egyptian-foreign strategic partnerships with advanced and newly industrialized countries, especially in areas of frontier sciences and advanced technology.**

- **Focused attention on the specialized training of Egyptian scientists and technologists in these countries.**

Eighth Strategic Action Area:
Integrating S&T into the Fabric of Egyptian Life

The success of a S&T-based development policy requires the support of significant segments of the population. New value systems need to be established for this purpose, which would complement, not eliminate, traditional values and help in mobilizing energies and resources. To achieve this, there is a need to address the country's population with the following message:

- **The long-term progress, even survival, of the nation now depends primarily on its capacity to maintain a global economic competitiveness which is characteristic of the new world order.**

- **Sustaining this competitiveness is the only way to ensure better living conditions for the population and to reduce social tensions and environmental problems.**

- **The change of individual attitudes is a key to success. This will require continuous effort by all governmental, public and private sectors at all levels (managers, workers, bureaucrats, consumers, etc.) to change the negative attitudes which presently prevail and cause the low output of work. This change in attitudes will be supported by a long-term and consistent campaign which will first focus on quality, and then promote it in all walks of life by appropriate mobilization of media (TV, newspapers, other media). As a first step, a pilot, small-scale campaign would be implemented.**

The government will take all steps to increase popular appreciation of S&T. This is not only to provide a broad-based foundation and climate conducive to invention, innovation and overall S&T technological advancement, but also to create a popular opinion which supports the S&T policy decisions. For this purpose, a national program for the popularization of S&T will be launched by the government. Contributions by the public and private sector production and service sectors, scientific and technological associations and societies, as well as instruments of the media, will be ensured. Different modalities and mechanisms for implementation of this program, especially those used successfully in other countries, will be applied after adaptation to the local conditions.

Ninth Strategic Action Area:
Harmonizing the Legal Environment

The government, guided by signals of global economic change and by the necessity to conform with the new global environment, realized that the whole gamut of legislative instruments which govern or influence the economic policies (in particular, those related to competitiveness, exports and macroeconomic policies), as well as those which govern or influence the R&D establishments, need to be

reviewed and amended as appropriate. The present S&T policy framework will concentrate on the urgently needed legislative reforms directly affecting the performance of S&T in Egypt such as:

a) ***The laws, presidential decrees, and by-laws governing the function and performance of R&D institutes.***

b) ***The existing legislative instruments for protection of intellectual property rights (patents, trademarks and copyrights) affecting the behavior of technology suppliers and technology developers.*** **The existence of strong patents, trademarks, and copyright protection systems, and the prompt enforcement of the relevant laws, will improve Egypt's access to the best available foreign technology and will encourage innovation within the country as well as provide an important attraction for foreign investment and joint ventures.**

5. Revitalization of the R&D Institutes

As discussed earlier in chapter 3, the early diagnostic study included evaluation of the R&D institutes which revealed that: 1) in many cases, institutes operated without statements of vision and mission; 2) the link with industry was weak and there was no consistent effort to identify client needs; 3) the resources were insufficient and available resources were not oriented to serve any sound goals; 4) the managerial skills were inadequate; 5) there were no effective plans for human resource development; and 6) in many cases, the income from research contracts was very small, and the number of R&D projects was low.

This evaluation led to a second phase of the study that focused on revitalization of the R&D institutes affiliated with MOSR. The R&D institutes developed their own revitalization plans with input from national and international consultants (see references 14 and 32, for example). For the institutes to develop their *own* revitalization plans was an excellent strategy for two reasons. First, it allowed faster implementation of the study recommendations through a "bottom up" process to supplement the "top down" reform process undertaken by the government (e.g. formulating a S&T policy, instituting legal reform). Second, it allowed all members of the institute, from staff researchers to managers, to interact, deliberate, and set goals and objectives for their own institutes. This process has a concomitant "change of mindset" that is more effective than any written document.

Through this process, each R&D institute submitted a plan for the next five years. These plans thoroughly covered the following items:

- **Vision**
- **Clients (end-user)**
- **Clients' needs**
- **Mission**
- **Goals**
- **Objectives**
- **Programs**
- **Projects**
- **Material resources:**
  - **Building**
  - **Equipment**
- **Human resources:**
  - **Organization structure**
  - **Training programs**
- **Financial resources:**
  - **Earned income**
  - **Support income**

Each institute's five year plan was presented in a series of meetings attended by the Minister of Scientific Research, members of the Project Advisory Committee, the chairmen of the other institutes, and finally by the clients of each institute. The feedback obtained from each presentation helped to further refine and fine-tune the plans and to gain the client's input, involvement and support. The whole exercise led to some accountability which was previously missing and to a steady progress towards "Best Practices." The reports from MOSR institutes are parts of references 17-32 and are summarized in reference 1.

6. Operational Elements of the S&T Policy

The formulation of a complete action (operational) plan for implementing the S&T policy was beyond the scope of this study. However, a number of operational elements were developed to speed up the transition to the action and implementation plans after the conclusion of the study. The key operational elements developed are as follows:

1. **National S&T Data Base**

   Compiling Arabic and English data bases for the national S&T institutions was begun by establishing a data base for public R&D institutions and private consulting firms. The intention is to complete this data base for all S&T institutions in Egypt and to periodically update the information.

2. **Strategic Plans of MOSR's Institutes**

   As summarized in the previous section, the R&D institutes affiliated with MOSR have developed revitalization and strategic plans for the next five years. Also, as part of these plans, special data bases were initiated for identified priority technological sectors.

3. **Innovation & Competitiveness as a Basis for an Export Strategy**

   Insight surveys on nine Egyptian prospective export industries were conducted. These were chosen from the ten industries identified by the Stanford Research Institute Report for the Ministry of International Cooperation, and encompassed:

   - **Processed foods**
   - **Pharmaceuticals**
   - **Fertilizer industry**
   - **Apparel sector**
   - **Household textiles**
   - **Leather & footwear industries**
   - **Electronic industry**
   - **Automotive components**
   - **Household durables**

   A number of preliminary reports were prepared (see reference 1). They provide a broad introduction to these industries, particularly from the stand-point of growth potential, markets, and technology needs.

In addition, a pilot experiment on industrial audits and reorientation of R&D institutions to RTO's (Research and Technological Organizations) has been conducted with regard to the textile and electronics sectors. The Danish Technological Institute (DTI) was contracted for the Electronics Research Institute and the Textile Division of the National Research Center.

4. **Formulation of National Strategic Plans for Selected Priority Technology Sectors**

These included:

- **Electronics and Informatics.**
- **Marine Technologies.**
- **Pharmaceutical Technology.**

The methodology applied was similar. It commenced with assessing the base line status (Educational, R&D, Industry). Next, options for future strategies were evaluated in light of the national capabilities and anticipated global changes in markets and technologies. A logical strategy was selected, and a national R&D plan was formulated.

The final product embodies identified priority programs and well-defined, specific projects that are summarized in reference 1 and in topical reports. Examples of proposed priority R&D projects are given in Tables 7, 8 and 9 for the areas of electronics, marine and pharmaceutical technologies, respectively.

In addition to the above, other sectors were also addressed, but were outside this project. These included genetic engineering, biotechnology and environmental technologies.

5. **Proposals for National R&D Network and for Technology Oversight Program**

Two other important proposals were formulated as elements in implementing the strategic action areas of the S&T policy.

The first proposal is to establish a National R&D Network that links industrial firms and S&T centers. It is proposed that this Network be undertaken by a private sector company to be formed as a joint project between industrial firms and interested industrial S&T centers (see reference 1 for proposal details). During the final study workshop (Dec. 20-21, 1996), the Federation of Egyptian Industries embraced the proposal and declared its intention to take the lead in initiating and operating the project.

The second proposal is to establish a Technology Foresight Program in Egypt. The objective of the program is technology development planning and technology priority setting in the context of a medium- and long-term perspective (see reference 1).

TABLE 7. EXAMPLES OF PROPOSED PRIORITY R&D PROJECTS
EXAMPLE A: THE AREA OF ELECTRONICS AND INFORMATICS

PROJECT NAME
Establishment of Photovoltic Semiconductor Manufacturing Facility in Egypt
Use of Automated Manufacturing Techniques in Textile Industries
Using Computers in Machine Translation, Education and Management
Using Modern Power Electronics for Development of Control System in Industry
Use of Expert Systems and Multimedia in the Development of Media of Geographic Information Systems (GIS)
Establishing a Custom VLSI Design Center at ERI
Development of Human Resources in the Fields of Electronics, Computers and Informatics
Design and Fabrication of Hybrid Integrated Circuits in the Microwave Range of Frequency
Advanced Communications Systems Based on Modern Digital Signal Processing Techniques (ADCOM/DSP)

TABLE 8. EXAMPLES OF PROPOSED PRIORITY R&D PROJECTS
EXAMPLE B: THE AREA OF MARINE TECHNOLOGIES

PROJECT NAME
Capacity Building in the Field of Marine S&T
Utilization of Fishing Satellite Data for Potential Fishing Zone Forecast Along the Southeastern Mediterranean Waters of Egypt
Oyster and Clam Culture in the Red Sea
Culture of Artemia in Egypt
Isolation and Characterization of Certain Biosubstances from Marine Natural Resources of Expected Broad Spectrum Applications
Toxicity of Salinas (origin, effect and how to control it)`
Biohydrometallurgy and Biosorption of Metals from Marine Resources (Biomineralization and Bioenrichment of Metals)
Synthesis of Some Organo- and Organometallic Compounds as Anti-fouling Agents
Application of New Egyptian Technology to Produce Economic and Low Toxic Marine Plants
Evaluation and Exploitation of Mineral Resources in Marine Environments

TABLE 9. EXAMPLES OF PROPOSED PRIORITY R&D PROJECTS
EXAMPLE C: THE AREA OF PHARMACEUTICAL TECHNOLOGY

PROJECT NAME
Survey & Characterization of Drug Chemical Products
Consolidation of National Drug R&D Establishments
Establishment of a Central Chemicals (Cancer Chemotherapeutic) Facility
Establishment of Advanced Drug Electronic Data Center
Production of Bulk Pharmaceutical Chemicals from Special Raw Materials
Immuno-protective, Anti-pathology and Antifecundity Vaccines
Plant Drug-Discovery Program
Liposomal Products for Drug Delivery and Microemulsions for Parenteral Nutrition

APPENDIX A

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APPENDIX B

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<u>National Strategies and R&D Plans (December 1996)</u>

33. Marine Technologies.

34. Electronics & Informatics.

35. Pharmaceuticals (Drugs).

S&T Data Bases

36. Survey of National S&T Institutions.

37. Sectoral Data Bases (Marine, Informatics & Pharmaceuticals).

Others

38. Status of Nine Industrial Sectors (95).