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COUNTRY CASE STUDY SUBMITTED BY THE ARAB REPUBLIC OF EGYPT*

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UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

Investment, research and development and interaction among economic agents in technological capacity-building

A case study of Egypt*

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Introduction and Executive Summary

At its Eighth Session, the United Nations Conference on Trade and Development adopted a text entitled "A New Partnership for Development : the Cartagena Commitment", pursuant to which the Trade and Development Board established an Ad Hoc Working Group on Interrelationship between Investment and Technology Transfer. The purpose of this forum was to examine, using case studies and experts reports, the role played by different actors, including private firms, national and foreign, and governments in the creation and dissemination of technology, including ivestment in R and D and the utilization and commercialization of R and D results. It was also intended to consider the impact of contemporary technological change and new technologies as well as the emerging world legal environment and open market on investment decisions and production patterns, trade competitiveness and national capacities for innovation and adaptation.

In pursuing its studies, the Ad Hoc Working Group's main focus was to be on those multiple issues which, by addressing in the most candid manner, are likely to promote international consensus on principles and strategies for policy action at the national and international levels to enhance the development prospects of all countries, particularly those of developing countries. A key function of these studies, therefore, in addition to the exchange of experiences, is to help in drawing

appropriate lessons for the formulation and implementation of policies at the national and international levels for international economic cooperation, and in prescribing some alternative policy options to enable the developing countries to participate in the new highly competitive world economic environment.

The present report on a case study of Egypt is meant to be a contribution to the global effort, served by UNCTAD, which was guided by the general terms of reference laid down for country case studies and the Ad Hoc Working Group itself. The study drew extensively upon knowledge available on the situation in Egypt's R and D establishment and the level of utilization and commercialization of publicly-funded R and D results, as well as upon facts and data of immediate relevance to the profound changes in the country's economy currently taking place.

The report opens with Chapter I which is devoted to a brief discussion of Egypt's National Technology Policy (NTP). This was a drive sponsored chiefly by the Academy of Scientific Research and Technology (ASRT) and to which many professionals and experts contributed during the early 1980s, at a time when the last years bearing the stamp of the closed economy period (1956 - 1974) were drawing to a close. Understandably, the NTP contained elements which expressed support for viable import-substituting industrialization while advocating the use of the momentum thus created to embark upon an active export-oriented

industrialization phase.

The R and D community, much dissatisfied by the marginalization until then of its role in the national economy and by the fact that much (if not most) of the technological needs of the economy are met from foreign sources through purely commercial transactions, was the driving force behind the NTP studies. The major orientations of the NTP addressed the R and D community itself with proposals for enhancing its performance; the question of transfer of foreign technology and the need to maximize its benefits while reducing the effects of restrictive practices; and the critical area of advanced sciences and technologies and the need to prepare the nation to share in their events.

With the adoption of a liberalized economy policy, initially with some resistance but now with wide acclamation, the promise of economic recovery in Egypt is beginning to have positive manifestations. There have been applied a number of rigorous structural reform and corrective measures during the middle and late 1980s, all steering the economy in the direction of liberalization and openness to private sector and foreign investment while drastically reducing protectionist measures. This being a considerable turn in the direction of prevailing policies, the NTP clearly is no longer tenable with its early 1980s orientations. The ASRT is currently considering the introduction of several changes in the NTP while preserving its

basic purpose as a conceptual framework for national action in the areas of science and technology.

Chief among the structural and legislative changes introduced in support of the new liberalization drive are the Investment Law and the New Industrial Zones and Urban Communities Law which both created unprecedented incentives for private-sector and foreign investors, including multinational corporations, to initiate production activities in Egypt. The former Law provides guarantees for equal treatment for national and foreign investors as well as lucrative tax, ownership and financial incentives. The latter Law provides for, and has actually resulted in, the creation of extensive new industrial zones with excellent infrastructural facilities for attracting investors, both local and foreign.

Another series of supportive measures are to be found in the high quality technical education and training which specifically address the newly created industries specially those located in the new industrial zones.

Chapter II is concerned with the creation, transfer and assimilation of technology. It opens with a consideration of the ASRT, being the central government-run and financed agency responsible for the conception, coordination and finance of a large number of R and D projects. Thereafter, a detailed description is given for the technological activities in three major public-sector companies, including those founded on in-

house and external R and D, and collaboration with local and foreign enterprises. These are the Aluminum Company of Egypt, Egyptian Sugar and Distilleries Company, and El-Nasr Pharmaceutical Chemicals Company. The activities of the first two companies included several noteworthy contributions in the fields of capital equipment and new or adapted products and processes.

In another section of this Chapter, a discussion is given of the private sector and its potential role in the transfer and development of technology. Emphasis in this section is laid on the current trends resulting from the open-door economy policy and liberalization of trade. Ample evidence exists that a lot continues to be desired in the area of utilization of the national R and D resources by the local entrepreneurs. Some views are also expressed on a selection of possible areas of action where the private sector is expected to contribute to the realization of goals of the present liberalization policy. These include the aspect of learning as a valued fruit resulting from associations with modern technologies brought into the country through cooperation with foreign business partners and the role of R and D in helping local entrepreneurs to upgrade their performance and acquire certain innovative capabilities. The discussion also addresses the uneasy question of the impact of technology, specially capital- and knowledge-intensive technology, on labour. This is a critical area of concern particularly for Egypt.

The Chapter also explores the issue of foreign direct investment and its role in the transfer and dissemination of technology, through the citation of two examples involving major multinational companies. While it is clear that their science-based activities were predominantly in the nature of field testing of their products for demonstration purposes and within the frame of extension service, they embraced significant elements of training and environmental consciousness. At the same time, it is difficult to trace in these activities genuine effort or original research aimed at the development of new products or processes.

Views are also expressed on the possible areas of action for encouraging foreign direct investment participation in Egypt's economy. One of these is the pursuance of policy lines, and implementation of the requisite actions, aimed at forging strategic technological partnerships with some foreign firms, including multinational corporations, for the creation of export-oriented leader industries. This, as experience has shown in many situations, is a key approach for acquiring competitiveness and entry into world market besides affording invaluable training opportunities. The potential of local R and D extending tangible services to these activities is also explored.

Chapter III is concerned with general conclusions and recommendations for furthering the development of endogenous

technological capacities in Egypt. It recapitulates the salient issues highlighted in previous discussion and emphasizes the questions of : stability and consistency of macro-economic conditions, requirements for foreign direct investment and licensing as vehicles for transfer of technology and the role of government assistance in this regard, capital goods, competitiveness as a means and a target in technological development, pro-export strategy, intellectual property rights, and utilization of R and D inputs (funding, selectivity of projects, the learning aspect attached to these projects and to interaction with foreign partners).

CHAPTER I

THE NATIONAL TECHNOLOGY POLICY OF EGYPT

A. MAIN FEATURES OF THE NATIONAL TECHNOLOGY POLICY IN EGYPT

1. The need for a National Technology Policy

A draft of the National Technology Policy (NTP) document was produced in 1984 following a period of intensive preparation which lasted four years. The conditions which prompted the formulation of the NTP and its implementation have probably much in common with the conditions which have prevailed, and continue to prevail, in many developing countries.

For several years the Egyptian economy has been experiencing complex difficulties. For the most part these were the result of the accumulation of various conditions during the past 40 years and their symptoms included exuberant indebtedness, high rate of inflation, and severely distorted balance of payments. The difficulties were compounded by a high-rated increase of population and the non-existence of vast natural resources endowment in the country. Under these conditions technology was unanimously considered to be the most viable area of action to help the nation in making major strides in the implementation of its programmes for overall socio-economic development.

There is a general consensus that the problems of the Egyptian economy must be directly connected with the condition of inadequate production and productivity attributable to technological under-development which, in turn, was perniciously connected with the state of technological dependence. There were of course several exogenously-determined factors which aggravated this condition. A common implication of this condition was the marked stagnation in the state of several manufacturing industries at a level of import substitution which did not advance considerably beyond the point of departure. What has been missed in those industries were the opportunities for technological intensification through vertical deepening and the production of progressively increasing ranges of their inputs and intermediary products.

Among the major roots of this problem is the fact that the national R&D potential, despite its size and diversity, has a relatively marginal role in meeting the technological needs of the national economy, and that these needs were met predominantly from foreign sources through purely commercial transactions. It can be noted that on several occasions conglomerates of these technology-embodying inputs were supplied in packaged form for the implementation of turnkey projects. This has inevitably contributed to the state of technological marginalization of the local R&D.

These conditions have stimulated the science and technology community to act resolutely and en masse in the direction leading to the formulation of the NTP.

2. Objectives of the National Technology Policy

While upholding and encouraging free-enterprise economy and preserving the basic orientation of the open-door economy policy, the NTP had the distinct objective of providing a conceptual framework for promoting overall technological change and, more specifically, enhancing a balanced import-substituting and export-oriented industrialization. For this reason the State is considered to have a pivotal role to play in guiding the processes of technology generation and importation, and the operations of trade and production, in the direction that results in higher levels of technological development and competitiveness, and for this purpose the State has to mobilize a whole array of measures which might have strong legislative elements.

Evidently, any import-substitution industrialization would be self-defeating if it develops a voracious appetite for, or perpetuated dependence upon, imported capital goods, intermediate products and process know-how, and thus fails to achieve the more advanced stage of vertically deeper industrialization. The same argument is true for export-oriented industrialization.

3. Areas of action of the National Technology Policy

In summary, the NTP contrives to concretely produce complementary and mutually reinforcing effects in the following fields of action:

(a) Stimulation of the national technological capabilities to increase their inputs, while encouraging demand for these inputs, vis-à-vis inputs from foreign sources, both qualitatively and quantitatively, through strengthening of the local innovative-adaptive-productive capacities and co-ordinating their contributions. For this purpose, the NTP prescribes specific actions for strengthening the national R&D institutional infrastructure in the areas of capacity building and the requisite physical facilities, and emphasizes the importance of providing adequate financial resources. It also highlights the actions needed to orient the main bulk of R&D activities towards technology generation goals, including the supportive legislative changes which need to be introduced. Another category of activities concerns the support required for leader-sector technologies which include, in the fore-front, the capital goods sector, among others.

(b) Maximizing the benefits of foreign technological inputs through prescribed orientations and actions for applying fair terms and conditions in transfer of technology contracts and for assuring the socio-economically favourable effects they are required to produce. These orientations and actions are conceived within the context of the overall objective of maintaining a dynamic balance between these inputs and those contributed from indigenous sources (including the R&D establishment), particularly with regard to the needs of production in terms of embodied and disembodied technology.

(c) Preparation of the society for the inevitability of receiving and having to interact positively with the advanced technologies. The NTP prescribes specific action areas as well as general orientations. These include the need for capacity building in selected areas of frontier sciences and technologies, and the creation of a state of active popular appreciation of science and technology at large.

The NTP, additionally, placed clear emphasis on two issues of major importance. These are the issues of political support and early unpackaging of technology.

a) Political support

In the course of the deliberations over the NTP, especially at the stage of drawing conclusions, it has been generally recognized that the policy should receive support at the highest levels of political and social authority. The patronizing role of the political authority in many countries is known for having been instrumental, in fact crucial, in removing many obstacles, mobilizing resources, and enlisting co-operation of all the parties envolved.

b) Early unpackaging of technology

At the conceptual level as well as operationally, the process - in effect involving an early unpackaging of a needed technology - translates itself into a "make-or-buy" type of decision-making which would be guided by a distinct, but level-headed, bias towards indigenization of technology. Ideally the responsibility for its implementation filters down to all actors involved in the processes of technology acquisition, both through generation and importation channels. This responsibility may also be exercised at the levels of the sectoral planning authorities and production units.

Success in this process would be expected to have far-reaching effects, particularly in moving the place and role of national R&D towards the centre and enabling it to have an increasing share in technological decision-making and in efforts for fostering technological self-reliance. When successfully implemented, the result of early unpackaging of technology amounts to creating almost instantaneously serious and sizeable demand for the contributions of the R&D community. The result, additionally, would be the foundation of a rewarding working relationship of mutual respect and inter-dependence between the national R&D establishment and the major activities of the national economy sectors.

B. RECENT DEVELOPMENTS RELEVANT TO TECHNOLOGICAL CAPACITY-BUILDING

1. Economic recovery in Egypt and transfer of technology

After years with a closed economy system and high governmental intervention, with strong protectionist attitudes, policies and policy measures, Egypt now seeks to achieve economic reform. Among the many new policy measures adopted and currently actively implemented, there are several legislative and organizational instrumentalities which all seek to introduce comprehensive macro-economic changes and major structural

adjustments. The objective is to steer the predominant orientation of the country's economy towards liberalization and create a new climate favourable to competitive business.

Corrective measures currently being implemented within the reform have both direct and indirect impact on the status of technology transfer, development, adaptation and diffusion. They have already produced important structural changes and greatly influenced the decisions made by many national and foreign investors which, in turn, have significant technological implications. Within the context of the present study of particular relevance are the new Investment Law and the newly created industrial zones and urban communities. These instruments are beginning to have wide-spread effects since they proved to be highly effective for attracting local entrepreneurs and foreign investors, including multinational corporations to utilize the opportunities thereby afforded.

a) Investment Law No. 230 of 1989

Egypt has promulgated this comprehensive law to repeal the old investment law, No. 43 of 1974, which proved its inadequacy for the new directions. The Law covers investments by both local and foreign investors. Two distinct regimes for investment are specified in the Law : a- inland investment projects, and b- free

zones investment projects. The Law provides for a package of several guarantees and incentives, the importance of which derives from the fact that they represent considerable departure from previous practices and involve far-reaching support for the liberalization drive. On account of their significance, a synopsis of the more relevant provisions of these are listed below 1/.

- Private capital of any nationality may participate independently or jointly with other nationalities in any investment field under the Law.
- All investment projects are considered private sector projects and, therefore, not subject to laws and regulations governing the public sector and its employees.
- All investment projects enjoy the exemptions granted by the Law equally regardless of the nationality or domicile of the owners.
- All projects established under the Law have the right to acquire land and real estate property as required for the business or its expansion.
- Free-zones' projects have the right to operate on behalf of other projects and vice versa. Inland projects are accorded the same privilege with approval of the General Authority for Investment.

- Products manufactured by the projects implemented under the Law are exempt from price controls and profit ceilings.
- The Law stipulates safeguards for private investment including guarantees against nationalization, confiscation, custody, or sequestration of project assets and funds.
- Projects are entitled to open foreign currency accounts in Egypt, retain their foreign exchange earnings, benefit from all banking and monetary facilities available, import their needs and export their products without being required to register with the Registry of Importers or Exporters, repatriate all or part of their net profits at the highest declared rate of exchange, re-export invested funds in case of liquidation or dissolution of the project, etc.
- Inland investment projects are entitled to a tax exemption of 5 years duration; the exemption includes industrial and commercial profits and dividends, and may be extended for a further period or periods not exceeding 5 years. Project expansions may also enjoy a 5-years tax exemption.
- Projects established in the new urban communities, industrial zones and remote areas are tax-exempt for a period of 10 years.

- All capital assets (equipment, machinery, supplies and means of transport, with exception of passenger cars) required for pursuing the licensed activity of projects within the free zones are exempt from customs duties and taxes.

b) New Industrial Zones and Urban Communities

The creation of new urban communities (subject to Law No. 59 of 1979) including ones which incorporate new industrial zones, has been a development with two-pronged effects: a- to alleviate the acute (also chronic) problems associated with overpopulation in the old urban areas (chiefly concentrated in the Nile Valley and Delta), and b- to establish an environment conducive to the creation of new industry-based businesses. Clearly this has been conceived to complement and reinforce the investment promotion legislation.

The core of the new urban-industrialization programme are 17 new cities and towns. Modern concepts in city planning were applied and liberal use of land permitted the creation of a healthy balance between all components of human environment, also with much allowance for future expansions.

It is anticipated that the new urban community areas will be populated by about 6 million people when completed. Most of

the new cities are planned to have suitably located industrial zones, provided with a full range of modern infrastructural facilities and utilities. After about 12 years from the start of the programme, economic activities have actually started in the majority of them including operational industry in seven of them.

It is estimated that the currently producing factories occupy land of about 11.4 million sq. meters total area, utilize capital investments totalling no less than LE. 3,750 million (one LE being equivalent to US$ 3.33, 1993), provide work opportunities for more than 68,400 persons earning annually at least LE 114 million in wages, and produce goods (excluding services) worth at least LE 4,280 million annually 2/. The distribution of these figures according to the various manufacturing categories is shown in the adjoining table.

Table

Basic Statistics on Operational Industries in 7 New Urban Communities

Total of Wages LE Million	No. of Workers	Annual LE Million	Invested LE Million	Land Area (000 sq.m.)	No. of Factories	Manufacturing Category
11.5	5940	692	462	2,973	112	Food Industries
5.4	11,150	135	142	583	63	Wood Products & Metal Furnitures
7.9	5,470	331	299	569	94	Plastics Industries
7.0	2,670	134	147	574	42	Paper Industries
24.6	11,370	752	627	1,253	118	Spinning and Weaving
13.2	7,030	385	322	825	78	Electrical and Engineering Industries
8.0	3,780	185	167	447	59	Metal and Mechanical Industries
8.9	7,110	431	382	1,606	110	Building Materials
11.9	6,110	465	426	1,040	95	Chemicals and Pharmaceuticals
15.5	7,820	768	613	1,516	171	Miscellaneous Industries
114.3	68,450	4,280	3,750	11,400	942	Totals

Source: Ref. No. 1/ 2/

Industrial plants currently under construction occupy land plots of total 4.57 million sq. meters area, utilize capital investment totalling about LE 1,280 million, and are expected to yield output of products worth about LE 2,600 million annually, to employ about 35,700 workers and pay wages of about LE 57.5 million annually 2/.

In addition to these new urban-industrialization programmes, there are separate programmes for the creation of agricultural settlements in the new land reclamation areas. Of particular interest to investors, local and foreign alike, is the mushrooming industry of creating touristic villages and holiday resorts, especially along the Red Sea and the Peninsula of Sinai coasts.

The Investment Law No. 230/1989 provides for special incentives and guarantees to investments in industries and businesses created in the new urban communities, industrial zones and remote areas additional to those awarded under the Law to other inland activities anywhere in the country. Most important is the exemption from taxes for a period of ten years, instead of 5 years for other areas. The exemption includes profits realized by the projects' industrial and commercial activities as well as dividends yielded by such projects. Exemption commences from the first fiscal year following the start of production or engaging

in the activity, as appropriate. Moreover, the period of exemption may be extended, when so warranted by considerations of public interest, for an additional period of five years.

2. Education - training supportive measures

The drive for economy liberalization of the past few years revealed the fact that there was serious shortage of qualified and suitably trained personnel who could take the newly created industries to levels of competitiveness. Apart from the Government's conventional general education and vocational training programmes, the entrepreneurs and foreign industrialists investing in Egypt felt the need for a new breed of professionals, technology practitioners and technicians through the creation of a number of new training institutions and programmes. Thus, the Higher Technological Institute in the Tenth-of-Ramadan City represents a concept of technological education, quite new in Egypt, which capitalizes on the interface with industries and a built-in feedback mechanism. The Institute is a non-governmental and owned by the nonprofit Foundation for Development of New Communities. Its departments and curricula are all directed to study and training in disciplines related to production technology, particularly as relevant to the newly created industries and new and information-intensive technologies. There is distinct bias towards hands-on training in production facilities.

The Production Management Programme, implemented in the City through collaboration between the Carl Duisberg Gesellschaft of Germany and the Higher Technological Institute, is an example of a unique practice-oriented know-how transfer programme for top managers and production managers of the private sector industry in Egypt. The German-Arab Chamber of Commerce, Cairo, and the Association of Investors in the Tenth-of-Ramadan City also cooperate in the programme, supported by Germany aimed at assisting the private industry to increase its overall production efficiency by acquiring modern practical knowledge while using advanced problem solving techniques. After the programme is completed, qualified trainers/consultants would be available at the Higher Technological Institute to render continuing support to private industrial enterprises through training of their management staff and offering consultancy services to help in solving production problems 3/.

Other examples of bilateral and multilateral schemes of cooperation exist which aim at improving the quality of technical training in the country.

CHAPTER II

INTERACTION AMONG ECONOMIC AGENTS IN THE CREATION, TRANSFER AND ASSIMILATION OF TECHNOLOGY IN EGYPT

This Chapter is devoted to a descriptive-analytical presentation on the various issues related to R and D in Egypt and the factors that influence its performance. The discussion is based on the citation of actual cases where R and D are carried out and/or where R and D results are utilized.

A. DOMESTIC R AND D AND THE COMMERCIALIZATION OF ITS RESULTS

1. Coordination and Planning: The Academy of Scientific Research and Technology

The overwhelming majority of R and D in Egypt is carried out in governmental or public sector establishments. Because of the situation of closed economy and nationalization of the major industries and businesses during the 1960's, the effects of which extended well into the 1970's and part of the 1980's, no significant private sector R and D activity was on record. Nowdays, apart from the specialized research units affiliated to

technical ministries, and also apart from the traditional university-type research, there exists an independent system of central research which interacts actively with other research institutions and users of R and D results in the country. This is the Academy of Scientific Research and Technology (ASRT) and a cluster of nine centrally located R and D institutes and centres directly supported from central budgetary resources. The Patents Office and related facilities are also affiliated to the ASRT.

The Minister of State for Scientific Research represents and speaks for the entire centralized R and D activity before the Cabinet of Ministers. The officiated R and D institutions include: The National Research Centre (NRC), National Oceanography and Fisheries Institute, National Metrology and Standards Institute, National Astronomy and Geophysics Institute, Egyptian Petroleum Research Institute, Central Metallurgical Research and Development Institute (CMRDI), Theodore Bilharz Research Institute, Remote Sensing Centre, and National Information and Documentation Center. The ASRT terms of reference and organizational structure correspond to its central location and role. Of particular importance is the existence of 13 specialized research councils 4/, acting as central deliberative bodies which have in their memberships senior representatives of ministries, R and D institutions, universities, production facilities, private sector establishments,

nongovernmental organizations, etc. It is these councils which consider national needs that can be served by R and D contributions, and therefore propose/approve specific R and D projects and monitor the progress of their activities, the delivery of their accomplished results and their actual utilization, and the policies which govern the entire process. These councils, therefore, are the principal ASRT forums through which direct interaction, exchange of views, identification of needs and possible approach modalities, in addition to decision-making, occur between generators of science and technology knowledge and users of such knowledge. Among the significant policy guidelines adopted by these councils which continue to be implemented are the following 5/:

a) The subject of investigation should, to the extent possible, be demand-oriented, i.e. respond to a real need expressed by a production/service facility and carry the promise of producing results with sufficient economic return.

b) Priority in the selection process is given to those projects which are co-financed with the potential user establishment or the production/service establishment which proposes the project.

c) The principal modality for implementation of the R and D project is based on a contractual commitment following competition between eligible institutions and their demonstrated capacity to carry out the project to fruition while liaising with

beneficiary institutions.

d) Monitoring the R and D activities and regular evaluation of the progress achieved determine whether financing of the project should be continued or, if required, supplemented with additional funds.

2. Selected cases of domestic R and D activities

Below is given an illustrative description of a few cases of Egyptian industrial enterprises which actively interacted with, and utilized results of local R and D. The cases have been selected so as to illustrate also the potential of in-house R and D capabilities of the enterprises in solving production problems and/or expansion of industrial activities and deepening of the manufacturing processes. The examples quoted also reflect cases of large industrial enterprises which, faced with the challenges of a national economy liberalization, found it necessary to evolve their policies and practices in order to be able to cope with the changing economic environment.

Aluminium Company of Egypt (Egyptalum)

Egyptalum is a major company which underwent remarkable economic growth and technological development in a strategic industry that was initially founded on straight-forward transfer

of foreign technology. Growth and development have been the fruit of the maintenance of a balanced mix of import and local manufacture of equipment, transfer of foreign and local generation of know-how, and cooperation with both foreign suppliers and local R and D establishments for the acquisition of complete production systems. Perceived within the frame of a learning process, the balance was clearly dynamic and evolved into a scheme for enhancing the Company's technological capabilities through progressively increasing the share of local contributions in any given product or process.

Egypt has no substantial proven bauxite deposits. Nevertheless as a result of the advances realized at Egyptalum, the country has now an acquired comparative advantage of technological character in the aluminium industry which compensated for the absence of a key natural resource. The case is discussed to illustrate a modality for interaction and interdependence between various economic factors, both internal and external.

The basic aluminium extraction process and equipment were supplied during the early 1970's by the then-USSR, but in actual implementation the detailed unpackaging of the technology occurred. Thus a strong element of training was incorporated from the outset and, over the years, three levels of training

institutes were created to provide specialized labour. The company was responsible for the design and installation of all complementary civil, electrical and mechanical facilities and equipment. The increase in production from an initial 33,000 tons/year (1975-1976) to the full design capacity of 166,000 tons/year (reached in 1983) occurred in phases and was accompanied by progressively increased level of self-reliance through learning and enhanced absorptive capacity. Further increase to 181,000 tons/year output, which significantly exceeded world average in equivalent plants, was achieved (1984) as a result of improvements in operation conditions, automation and computer-control of the electrolytic cells and optimized management of overall work parameters of the original process.

Development of the Electrolytic Cells

To go beyond the above mentioned level of output, and to reach the ambitious set target of 240,000 tons/year, it was necessary to depart from the original 'Soderberg' electrolytic cell technology, utilizing self-baked anodes. Decision was made in favour of the more advanced pre-baked anode technology requiring a number of radical changes, amounting to re-designing of the entire cell system and unit construction. Instead of opting for an import of the new system and its installation on turnkey basis, the Company - having already upgraded its own R

and D and engineering capabilities and having created working links with other research establishments inside and outside the country - decided to go through the more challenging experience of developing the requisite know-how. This led to embarking on the major development programme in the Company's history. The 8 - year long preparatory studies were in part supported by USAID programme of assistance and implemented through collaboration with Cairo University Faculty of Engineering.

But before shifting to the pre-baked anode production technology with heavy capital investment involved, it was necessary to test the new regime under actual working conditions. For this purpose full size operational prototype cells were designed and constructed through tripartite cooperation involving Egyptalum, Cairo University and VAMI Institute of Petersburg; the latter partner had previously provided the design and know-how of the old plant. In all, nine electrolytic cells were designed on the basis of contributions from this consortium and built in the Company's workshops. This was a situation which provided an opportunity for early unpackaging of technology, requiring decisions to be made on the optimal sourcing (local and foreign) of all materials, components, machinery subsystems, auxiliary equipment, etc., as needed for building a complete system for the electrolytic extraction of aluminium. The majority of hardware were found to be capable of being produced locally and only the

highly sensitive and specialized components had to be imported. As a result of continuous test-running for 3 years, the new production system, yielding some 1500 kg of metal/cell day, was expected to be evaluated towards the end of 1993, before finally selecting the requirements of full scale commercial production, utilizing the new technology, aiming at an annual output of 240,000 tons. Improving the operating conditions will also result in the increase of production efficiency and more rational use of resources and energy. The learning experience gained in the process, considered separately, is invaluable.

Development of the Foundries

This was an area in which Egyptalum's own R and D and engineering facilities collaborated closely with local research institutions and foreign parties. The developments chiefly concerned various types of furnaces and other equipment used in the post-extraction processing. They utilized original R and D results and reverse engineering, and were complemented by the know-how supplied by foreign companies. This was another opportunity for learning which greatly enhanced the Company's technological capabilities.

The original 20 holding furnaces which the Company started with were all of USSR manufacture, 16 tons capacity each and

designed for operation in stationary mode. Development in this area, leading to increase of holding capacity to 25 tons per furnace and change to a tilting mode of operation, was based on two new modern furnaces purchased from a Swiss firm after the introduction of several novel features which gave rise to all the furnaces currently in use. The improvements also resulted in substantial reduction in power consumption and reduction in capital cost. Further advance to more sophisticated holding furnaces of 45 tons capacity of the tilting type is now targeted.

Parallel development was achieved in the Company's homogenizing furnaces, used in the heat treatment of formed aluminium products, the original version of which was imported from the USSR. Using modifications introduced by in-house R and D and engineering, enabled an increase in the furnace production capacity from 30 tons to 50 tons/day, in addition to reduction of power consumption. The furnace charging system was also radically modified as a result of collaboration with a major Swiss firm which proposed the basic engineering. Egyptalum developed the detailed engineering, then built the components and fully assembled the system in its workshops.

Starting with only one wire treatment furnace, supplied by an international British-based company, and by a combination of

original R and D and reverse engineering within Egyptalum and in collaboration with a Cairo University research team, it was possible to build a far more advanced furnace. The new product incorporated a programmable logic control feature which greatly improved the performance over the original British version. Similar developments were realized in the wire casting machine.

Another R and D-based development resulted from a multilateral project for the design and installation of an automatic control capability to upgrade the casting operations which utilize molten metal from the holding furnaces. The project was supported by the USAID - Academy of Scientific Research and Technology (ASRT) Science and Technology Cooperation Programme, and implemented through contributions from Cairo University Faculty of Engineering and Egyptalum. The design of all requisite hardware and software items as well as their production - partly through subcontracting - was accomplished locally as a result of the project with highly satisfying results achieved.

Computerization of the Coke Calcination Process

Calcined coke is a key input material used in making the anode paste, essential in the electrolytic extraction of aluminium. Egyptalum has its own calciner which utilizes 'green' petroleum coke as starting material. Although the calciner plant's potential capacity is 150,000 tons/year, the actual needs

of Egyptalum are only 75,000 tons/year. A USAID - ASRT - sponsored project was, therefore, implemented with the objective of utilizing the plant's full production capacity by introduction of a computer-based control system.

The project, now almost completed, involved collaboration of a Cairo University research team with Egyptalum's R and D and Engineering Center. The new multi-variable, micro-processor-based control system enables full monitoring of all operations and reactions in the calciner, and hence optimized performance in all stages of the process. The result is highly improved overall efficiency and productivity, including: reduction in wastages and in energy consumption, upgrading of the quality of product to international standards (also reflecting on the performance of the aluminum electrolytic cells), reduction to a minimum of polluting particles released with effluent gases, prolongation of the life of refractory materials used, enabling the early detection of faults and their location and also creating a capacity to use blends of 'green' coke received from different sources to obtain calcined coke of uniform and requisite specifications. The project was also a valuable opportunity for personnel to receive working exposure to, and gain experience in the advanced technology of micro-processor-based systems used in the control of large chemical processes, including their design, installation and use.

Safaga Seaport Calcined Coke Facility

Directly related to the previous project is the Company's decision to create a full-scale receiving, storage, transfer and ship-loading facility in the Red Sea Port of Safaga. The facility was designed to constitute a complete system for handling at least all the Company's surplus production of calcined coke. The entire system and individual components were conceived with the help of the computer-aided design capability in the Company's R and D and Engineering Center and completely built in its capital equipment workshops. The system is considered to be one of the most advanced engineering accomplishments in Egypt in recent years.

Capital Equipment Design and Manufacture

This capability in Egyptalum was acquired progressively with time to become now the second most important asset and cash earner for the Company. A resultant of a prolonged learning process involving hands-on training and acquisition of expertise through transfer of technology operations and direct association with foreign experts, this in-house capability was greatly enhanced by the possession of the latest equipment and software in the Company's R and D Engineering Center. During the past 12 years, it has been a persistent policy of the Company to attain

a competitive ability in the field of design, construction, and on-site installation of capital equipment. This capability embraced a broad spectrum of activities ranging from the production of special alloys to the manufacturing of complete production units and industrial systems.

For these wide-ranging activities, the Company frequently resorted to basic engineering and in fewer cases detailed engineering as provided by foreign owners of technology, and at times to reverse engineering methods, but in most cases original research and design were used in order to elaborate the requisite production technology. An important resource that the Company constantly utilized was local research institutions in the universities and R and D facilities of specialized establishments, such as the Central Metallurgical Research and Development Institute (CMRDI). Conscious of the critical importance of quality control in today's highly competitive world, the Company also created a well-equipped quality control facility for testing materials and products.

The Company's capital equipment activities extended well outside the sphere of aluminium production to serve many industries in Egypt in the supply of standard and customized parts and complete equipment, in a wide range of alloys and metals, which were all previously imported. Among the

particularly important capital products are the rolls used for drawing metal sheets. This line of manufacturing and the mastery of roll technology in general were a direct fruit of collaboration with the CMRDI. The Company is now able to produce commercial supplies of high precision ductile iron rolls, clear chill rolls, indefinite chill rolls, among other types which are used by almost all steel producers in Egypt. Examples of other capital equipment include complete melting and heat treatment furnace assemblies, casting machines, metal filters, air filters, special gears and gearboxes, material handling equipment, crucibles, storage tanks, charging machines, etc.

Another significant example of collaborative R and D in the field of capital equipment concerns the developments in an electromagnetic casting (EMC) machine for aluminium alloys. The requisite studies, including mathematical modeling, were carried out in collaboration with Cairo and Helwan Universities. Currently, the Company is in the phase of manufacturing the new EMC machine which will be put to test prior to commercial use in the very near future; only the measuring instruments will be imported.

A recent and important development has been for the Company to enter into a collaboration arrangement with a major foreign company, Mechatherm International Ltd of the United Kingdom.

Accordingly, Egyptalum acts as a subcontractor responsible for the manufacture and supply of capital equipment on the basis of detailed engineering designs and some specialized items to be supplied by the foreign partner.

R and D for Production of Key Input Materials

In a more advanced stage in Egyptalum's development, it was decided to achieve a higher level of competence in the manufacture of aluminium through securing reliable and sustainable sources of supply for at least some of the input materials. A number of R and D-based projects were conceived for this purpose and include the following examples.

a) Metallurgical Alumina: To achieve ready access to both bauxite and high grade (metallurgical) alumina, it had been planned to develop a capacity for the local production of alumina, utilizing either local or imported ore. A preliminary study, carried out by Egytalic (an Italian - Egyptian joint venture), was completed on the economics of an industry for producing 500,000 tons/year of alumina utilizing local or imported bauxite or a blend from different sources. Laboratory-level R and D studies followed by pilot scale investigations were conducted to gain familiarity with the conventional Bayer process for production of alumina from bauxite, using ore imported from

different foreign sources. This was another production-oriented research supported by the USAID - ASRT Science and Technology Cooperation Programme, which was implemented in close collaboration with CMRDI.

b) Aluminium Fluoride: The electrolytic cells at Egyptalum require a supply of aluminium fluoride amounting to approximately 6000 tons/year, all of which is imported. An R and D project was, therefore, initiated which aims at the utilization of waste fluosilicic acid, discarded in the local fertilizers industry. The project was also supported by the USAID - ASRT Science and Technology Cooperation Programme and implemented by the CMRDI in close collaboration with the Company's R and D and Engineering Centre. When completed, the project will provide the information necessary for the installation of an experimental production plant which will be followed by further up-scaling to the targeted level of 5000 tons/year commercial production. The project covers aspects of techno-economic evaluation and environmental impact.

c) Cryolite: This is another important ingredient of the raw materials mixed with alumina in the electrolytic cells. Being another important input, it was necessary to optimize its utilization. The Company's R and D undertook a successful research for the treatment of cryolite as recovered from spent materials with the objective of reducing the sulphate and carbon

contents to the permissible limits. The product is now comparable in specifications to imported cryolite.

d) Production of Alum: A new spin-off industry was considered for the production of aluminium sulphate (alum) by utilization of aluminium dross resulting from the manufacture of the metal, and estimated to be in the order of 1000 tons/year. On account of its attractively high aluminium oxide content, the dross was subjected to an in-depth R and D investigation for processing to yield alum. The results pointed to the techno-economic feasibility of the developed process know-how and, as a result, a pilot plant was designed, manufactured and installed, by the Company's in-house efforts, for testing the process. The new plant, fully designed and manufactured in the Company's capital equipment workshops, was to be ready for operation during 1993.

Egyptian Sugar and Distilleries Company

Société des sucreries et de distillerie d'Egypte (SSDE) is one of the oldest industries in Egypt, with experience in the production and refining of sugar of more than 100 years. The Company owns and operates plants in 18 different locations, of which 16 are in Upper Egypt, all along the river Nile. The chief concern of the Company is the production of sugar traditionally

from sugarcane and, additionally in recent years, from sugarbeet. Over the years, several satellite industries came into existence, including capital equipment manufacturing. The extensive diversification of the Company's activities has largely been the result more of the acquisition of technological capabilities than of the use of investment capital. The manner in which these capabilities developed, and the factors which helped and interacted in the process, are discussed below.

Training

Because of the spread of its production facilities, SSDE had ready access to the education and training resources of the Upper Egypt universities. General and customized training programmes were developed and implemented on-site in the production facilities under supervision of university staff. Most of these training activities took place under contractual arrangements with Assuit University. This University had also assisted in the creation of a Sugar Technology Institute within one of the Company's production plants, but administered as an outreach facility of the University.

Other contractual training activities are implemented in collaboration with Cairo and Ain-Shams Universities in the areas of design and engineering of equipment with the use of advanced

techniques, maintenance and repair of equipment, and computerized control of production operation. The Company's scientists and engineers are also given opportunities to receive training overseas in specialized institutes as well as in industrial establishments, particularly those which have transfer-of-technology transactions with SSDE.

Process Technologies

Although the basic technologies for the current standard production have been obtained as a result of transfer of technology arrangements, original contributions by SSDE have affected nearly all technologies in terms of equipment design and capacity, layout and coordination, monitoring and control, as well as overall performance. As a result of experience with the original equipment and processes and the innovations introduced, SSDE is considered now as having fully mastered the process technologies involved in the manufacture of several products. This mastery created within the Company a capability for rendering professional consultancy service and competence for contracting in Egypt and abroad in the respective areas.

Process Developments

With time, SSDE accumulated experience in the management of its process technologies in actual implementation and acquired a capability for introducing important innovations. These were more than mere adaptations to suit local conditions; at times they upgraded the basic technology and multiplied its benefits or increased its environmental soundness. Some of these innovations were the result of shopfloor developments and adaptations, but most of them, especially during the past two decades, were the product of systematic R and D contributions within the framework of a Company policy for intensification of its activities and development of its acquired technologies.

Research and Development

In this area, SSDE has created a range of fully equipped and adequately staffed R and D laboratories, and acquired a complete cane sugar pilot plant which is capable of simulating process conditions and testing any alterations.

In recent years, it became a regular practice of SSDE to solicit R and D-based contributions from the local scientific research community and to accept proposals for research cooperation. In both cases, the Company bears part or all of the

incurred expenses and the activities are implemented under a contractual arrangement with close follow-up by joint supervisory committees. Most of these R and D studies are short-term and concern specific problems which the Company encounters. At least 29 such projects are related to plant components and issues of design and engineering, work optimization, modernization and rehabilitation of equipment, etc., and therefore mostly are carried out in cooperation with the engineering faculties of the universities. No less than 20 other R and D projects, proposed by research workers, are process-related in areas of potential interest to SSED. Although it is too early for an evaluation of these activities, mostly conducted at the National Research Centre and some universities, it is evident that the Company has already started to make use of the results.

Capital Equipment

The site of this activity is SSDE's Hawamdia Equipment Factory (HEF) which has extensive R and D, design and engineering, quality testing and control, and manufacturing capabilities. To an extent based on reverse engineering, but largely based on living experience and original developments and designs, the capital equipment produced at HEF range from small parts to completely assembled standard unit operation equipment and machinery. As a result of accumulated experience and self-

confidence, SSDE now has the capability to undertake the design, construction and installation of complete production plants in industrial projects, including the requisite front-end studies, techno-economic evaluations, process selection and basic and detailed engineering. It was the result of the Company's reaction to the pressures of competition, inside and outside Egypt, and the pressing needs of the national economy.

In addition to the Company's own efforts, the assistance obtained through bilateral and multi-lateral arrangements was instrumental in upgrading their design and process engineering capabilities which now extended to the development of international activities. This occurred through the Company's assigning of manufacturing and marketing of its technological innovations to foreign companies. Another facet of the newly acquired international operations capability, is contracting for the design, engineering, construction and installation of complete production projects. Examples of these include sugar plants, alcohol distillation unit, plant for urea-enzyme treatment of soy bean cake, vegetable oil refinery, etc, for several countries in the Middle East region and Africa.

El-Nasr Pharmaceutical Chemicals Company

The Company, established during the middle 1960's, is the major producer of synthetic pharmaceutical chemicals in Egypt. El-Nasr Company has facilities and multi-purpose equipment capable of producing a large variety of pharmaceutical chemicals. At the start of its activity, the Company utilized know-how supplied by USSR for the production of a small number of chemicals. Later, in view of the necessity to modernize its processes and to expand and diversify production range in order to be able to compete at least in the domestic market, a number of transfer of technology agreements were concluded with a few foreign companies for the production of more pharmaceutical chemicals.

Taking into account that pharmaceutical chemicals industry is highly research-intensive, the Company took major steps to reinforce its in- house R and D capabilities and modernize its quality control facilities. At the same time, the Company entered into a number of cooperation agreements with local research institutions with a view of developing techno-economically feasible processes suitable for commercial application in the production of several chemicals. This was part of a general trend for import-substitution industrialization. It was also seen as an important element of technological self-

reliance which complements the common practice of obtaining licensed know-how from foreign companies.

As a result of contributions from various local sources, mainly the Company's own R and D facilities, the Company is now able to have a product mix which reflects a much higher content of locally-generated know-how than during the 1970's and 1980's.

3. The Private Sector and its Potential Role in the Transfer and Development of Technology

a) Current Trends

Under the "Infitah" (Arabic for the open-door economy policy and liberalization of trade), the private sector was revived and its activities progressively regained importance. This was part of the major reforms which took place, including the reversal of several economic trends, many of which were in compliance with the recommendations of the World Bank and the IMF. At present (1993) the volume of total private investment grew to a level of no less than 50% of that of total investment - with a persistent upward trend - of which about two thirds is due to local investments. As a result and quite visibly, there has been higher investment efficiency and better use of available resources.

Industrial public sector's contribution also dropped to about 60% of the gross industrial product, and is currently confined to certain key, mostly heavy industries such as petroleum, aluminium, iron and steel, sugar, basic chemicals, and textiles. Gross government expenditure now shrank to 20-25% of the GNP after it reached the mark of 45-50% during the managed economy years.

Most of the economy sectors are now liberally open to private investors with important incentives awarded to entrepreneurs, Egyptian and foreign alike, as provided under Investment Law No. 230/1989 and New industrial Zones and Urban Communities Law No. 59/1979 (discussed in some detail above). Much of the local markets needs were satisfied through import trade, liberalization of which resulted in lifting of nearly all restrictions and general lowering of the tariffs.

The process of technology acquisition presents a case with certain paradoxical features. Before 1974, nearly all technology was either imported, mostly from the then-USSR and Eastern Europe, or already a few decades old. It was generally both import substitution-oriented and noncompetitive by world standards. Heavy protectionist measures were a necessity for the local market and virtual absence of Egyptian goods in international markets was another consequence. During most of

those years there existed very little demand for the science-based, technology-related contributions of the local research establishment, including the universities and full-time R and D institutions, despite its existence as a sizeable resource. This occurred also despite the fact that the strong interventionist role of the government could have extended - as it did in several other developing countries - to the surposeful utilization of the national R and D base as a safe and useful instrumentality for transformation of the import-substituting industrialization to higher levels of industrialization and perhaps also to a viable and sustained export-oriented industrialization.

However, most of the requests for cooperation addressed to R and D institutions were in the area of analysis and quality control tests. This trend persists until today. The under-utilization of the national R and D potential, bordering on a state of marginalization, was a deplorable situation which was the subject of close diagnostic examinations by the scientific community at large. It was also an important factor that contributed to diversion of the researchers' attention to self-oriented and thesis-type activities.

With the opening of the economy during the late 1970s, and encouraged by the resulting prospects, there have been some active interactions and demand for local R and D services. It

must be recognized, however, that in most cases the overtures for cooperation were made by the R and D personnel through proposals and advances by motivated individuals or teams of research, and much less as a result of demand perceived by the enterprises and entrepreneurs. The above-cited examples of end-users refer predominantly to public-sector, State-owned enterprises, the chief executives of most of which are members of the ASRT's research councils and committees. It is doublful that there have been on record important cases of private sector enterprises which requested sustained or large-scale inputs from the national R and D establishment.

The apparent failure of the private sector in Egypt to solicit sizeable R and D contributions is neither inherent nor an old phenomenon. It has been experienced only during the closed-economy years because the sector was virtually non-existent. Since the "Infitah" and perhaps until the present time the emerging enterprises saw more immediate benefits and quicker return in the time-tested and field-proven imported technologies and services offered by foreign suppliers. There is every reason, however, to expect important changes after stabilization of the liberalization policy is attained and after confidence is gained among the interacting economic agents within the country. Indeed, the potential of R and D is becoming well recognized by the private sector. One example is the case of Memphis Chemical

Company, Cairo, which owed its very existence and prosperity to the commercialization of a number of locally generated R and D results.

b) Future Trends

Because of many similarities in the nature of their operations, private sector and FDI in Egypt - much as elsewhere- require quite similar environments for their healthy functioning and growth. In fact, the "Infitah" atmosphere and all the legal changes that came with it provided for equal treatments and incentives for FDI and national private sector projects. It is not difficult, however, to see the possibility for a degree of division of labour based on areas of competence and nature of expected contributions. The following are some views on a selection of possible areas of action where the private sector is expected to contribute further to the realization of goals of the present liberalization policy.

1- The Learning Aspect

The fact that Egypt now aspires to join the newly industrialized countries has many connotations. A prima facie realization is that all pursuits for the desired technological growth would have to focus on the creation of an efficient imitative technological capability in the country as a target to

be maintained for at least the period of life of one generation.[1] Such attainment could only be the fruit of a profoundly conceived learning process which necessarily results from extensive associations with prime sources of knowledge and expertise. The realization of such associations could be accomplished through various modes of technology transfer and FDI, but most importantly through strategic technological alliances.

The atmosphere of fierce worldwide competition has become the driving force behind the forging of technological alliances and partnerships between firms in the industrial world. The giant industrial conglomerates must be seen as powerful agents of technological progress and as sources of the knowledge necessary for the learning process. What remains to be critically considered for Egypt, therfore, should be the terms under which learning is to be accomplished and the imitation capabilities are to be build.

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[1] Imitation in the present context, a term used in the full benevolent sense, refers to firms which follow rather than lead technologically but interact actively with the leaders. By extension, the term may also be used to refer to societies which are predominantly imitative.

While FDI would probably be a principal channel for the transfer of the requisite technological knowledge and expertise, the private sector in Egypt would most likely be the recipient and interacting partner particularly due to the fact that the bulk of required financial resources are being increasingly provided by the national private sector.

2- Role of R and D

Much of the interest of private sector investors under the "Infitah" has been directed to obtaining ready-to-use know-how and other technological ingredients from foreign sources rather than using the local R and D resources for furnishing the same inputs.

In fact several private sector manufacturing industries (such as in the areas of carpets, ceramic tiling, drugs and electrical and lighting fixtures) are known to have been successful as a result of being highly competitive and thereby achieving entry into world industry. They are all located in the new industrial zones and have utilized the incentives provided under the "Infitah" legislations, while applying imported technology as know-how and capital equipment and maintaining close working links with major manufacturers in the industrial countries. None of them as yet, however, has similar links with local R and D.

The question that should be raised, therefore, is whether Egypt could afford to depend exclusively on foreign technological inputs (or allow this dependence to continue indefinitely) under conditions where Egypt's best bet is to enter into associations with technological leaders for building up competent imitative technological capabilities which involve profound learning from the leaders. The cost of missing the learning opportunities afforded by interaction with these leaders in an increasingly competitive world economy could be very high.

It is a fact that the transition from an imitative capability to an innovative capacity has never occurred in real world without using R and D as the engine of the transition. The private sector in Egypt should be persuaded that longer-term allies can be found in the national R and D establishement. To achieve and maintain a competitive edge, the firms must depend for the supply of innovations on alliances with technology suppliers and on viable working associations with local progressive R and D facilities.

Several examples of successful R and D interaction with production, including commercialization of results, are known. The required change should not aim merely at duplicating these examples, but introducing important structural and policy changes with widespread effects. There may also be a need for certain

legislative measures for creating/stimulating demand for the services of this important national resource. There is here an important role for the government to play through the prudent application of selective forms of intervention to enhance interactive R and D-industry relations which could be far more useful than merely providing indiscriminate protection to industry. The role envisaged for ience-based activities related to the new technologies of the leaders being introduced into the country.

3- Technology and Employment

The problem of unemployment is acute in Egypt, affecting no less than 15% of existing work force in addition to large numbers of graduates who yearly enter into the labour market. This has become a chief concern of the government and is behind the call for initiation of labour-intensive projects. However, there is probably no techno-economic option, with socio-political connotation, that can serve the cause of export-oriented economic growth in Egypt better than the adoption of technology-intensive

industries, even if this implies the use of lesser labour per unit of value added. Despite the abundance of relatively cheap labour, as a distinct comparative advantage, most of the private sector entrepreneurs under the "Infitah" have opted for the most advanced production methods as an effective tool for capturing a niche in domestic and international markets. The same entrepreneurs are aware that success in this endeavour opens new vistas for deepening of their manufacturing operations (by backward integration), diversification of their production lines, progress to more advanced even if more expensive technologies, and creation of new production facilities. All these facets only mean more opportunities for gainful employment and the elevation of the quality of the labour needed.

Again government has a distinct role to play in supporting, without unduly intervening, the drive for acquisition and utilization of advanced technology, including through FDI.. Similarly encouragement of banks to make available soft loans with favourable terms to facilitate such acquisitions and to provide risk capital for entry into new fields of technology-intensive production and high technology ventures is increasingly becoming a necessity.

4- Incentives

The most important incentives that need to be addressed in the present context are those which help production in the country achieve levels of competitiveness for export worthiness. Such incentives must be linked to quality requirements and compliance to the most rigorous of foreign specifications, and ultimately to actual exportation successes. A particularly sensitive set of incentives relates to the utilization of the local R and D capabilities in supplying some of the technological needs of production enterprises.

While prudently applying stimulative measures to promote the national private sector, the government should also consider protection of local manufacturers against unfair trade practices, such as dumping and unwarranted foreign export subsidies, as well as entry of counterfeit products. The experiences of other countries should be helpful in identifying the measures - including, for example, the enactment of anti-trust laws and legislations counteracting unfair trade practices - which are most suitable for at least the current phase of Egypt's economic transformation.

5 The National Technology Policy

Under present conditions the National Technology Policy (NTP) should be a manifesto for action in the science and

technology fields and, as appropriate, have both mandatory and voluntary elements. More specifically, it should contain indicators for the two channels of generation and importation (transfer) of technology, and thereby furnish an environment for the healthy functioning of the R and D establishment and the harmonious operation of the private sector and foreign direct investment, among other economic agents, all for an assured and sustained technological, and hence economic growth of the country. The areas of action, just outlined above and also those listed below are only some of the important areas on which the NTP needs to pronounce itself explicitly.

B. FOREIGN DIRECT INVESTMENT AND TECHNOLOGY TRANSFER

1. Selected cases of the transfer and dissemination of technology by foreign partners

Ciba-Geigy in Egypt

The activities of Ciba-Geigy (CG) - a major chemical Swiss-based multinational corporation - in Egypt have included important R and D-related contributions which originated both from the parent Company's home laboratories in Basel and from its research facilities located in Egypt. Activities in the latter facilities are mainly concerned with the optimized field

application of the chemicals as well as with their environmental soundness and safety.

The following is a brief descriptive-analytical account of CG's chief R and D - related activities in Egypt.

Kaha Agricultural Research Station

Created in 1974, as a joint venture between Egypt's Ministry of Agriculture and Land Reclamation and the Company, the Station played an important role in the transfer of technology to both agricultural extension servicemen and farmers. Since the Station is part of CG's worldwide agricultural field research stations, considerable know-how and technology from the entire network activities and varied experiences were used in providing the Stations' services, including the provision of specialized training-education opportunities to Egyptian technicians, engineers and farmers. It is to be noted, however, that no evidence is available on the existence of any joint research with local R and D institutions for the development of new agricultural chemicals or the improvement of production procedures of existing chemicals.

Regional Locust Research Center

This is a specialized research facility aimed at the development of new control measures against various species of

locusts and grasshoppers. The activities, conducted in close collaboration with the Ministry of Agriculture and the UN-FAO, include: studies on the two most harmful species and their breeding patterns; testing and screening of chemicals and new biological and natural agents on the insects, and training of local professionals on the test methodologies and their interpretations.

Computerized Integrated Post Management Database

A project, nick-named 'Sphinx Project', was initiated in 1989 as a collaborative interdisciplinary R and D programme between Egypt's Ministry of Agriculture and Land Reclamation, the Plant Protection Division of CG-Basel and some academic institutions, specifically to establish a comprehensive database for the projected Integrated Pest Management (IPM) approach in the production of cotton. Its aim is to develop an action-oriented, Egypt-specific, computerized cotton expert system to assist decision makers, advisors and extension workers. The system is designed to allow accurate decisions with respect to pest control timing and the proper pesticides and their correct amounts as related to other agricultural criteria and practices, and in coordination with other control measures 6/.

Technical Advisory Offices (TAO)

CG has two TAOs in Egypt: one for plant protection-related activities and one for CG's industrial products (dyestuffs, polymers, pigments, additives, etc). The two offices, naturally have promotional activities, but additionally render services to users of the CG chemicals, such as provision of professional advice and technical support to users and hands-on training to practitioners in the trade on aspects of safe handling, storage and transportation of the chemicals.

Bayer Research Station in Egypt

The Bayer Research Station is concentrating on field research and extension services related to crop protection, but bases its activities mainly on the use of pest-control chemicals which have been developed by the R and D facilities of the parent company. The Station's principal activities concern inter alia. the following: (i) cooperation with the Ministry of Agriculture's R and D institutions in the implementation of some projects of mutual interest; (ii) introduction of latest research methodologies to local practitioners and research personnel involved in controlled laboratory-cum-field experimentation; (iii) training of agricultural pest control specialists on latest techniques for field work, including modern equipment used and methods for evaluation of the effectiveness of new pesticides;

(iv) delivery of similar training service to citizens of neighbouring Arab and African countries through collaboration with the International Agricultural Centre, Cairo; and (v) delivery of extension services through field demonstration on the use and safe handling of modern pesticides, including principles and practices of 'integrated pest management'.

The Station's chief activities at present time center around a methodology for pest control applied through seed dressing with a new insecticide.

2. Foreign Direct Investment and its Potential Role in Technology Transfer

a) Current Trends

The above coverage was limited to two foreign, multinational corporations which were selected because their activities and products are intrinsically science-intensive and highly R and D-dependent, and their business in Egypt is supported by some research or research-related activities. There are, of course, many other examples of foreign companies which have direct investment in Egypt in other areas of manufacturing but visibly without significant R and D-related, Egypt-located activities.

The ventures of nearly all these companies were initiated only in recent years attracted by the "Infitah". Their activities are to be found in a vast diversity of production fields. The bulk of the foreign investment came within joint venture arrangements. These involved substantial capital transfers and, more importantly, the transfer of proprietary know-how and equipment and the equally important modern management and marketing methodologies along with many renowned brand names and front-line products. Although the foreign partner in a number of cases held majority equity share he was rarely the exclusive owner of the business.

A general observation in the majority of cases is that the contributions of multinational corporations, and foreign direct investment (FDI) in general, towards technological capacity building in Egypt occurred mainly at the levels of technology dissemination and utilization. The R and D-related activities of technology transferring companies, as illustrated above, were predominantly of technology adaptation character and hardly operated at the level or for the purpose of technology creation. These activities had also the objective of field testing of the products for demonstration purposes, within the frame of a comprehensive extension service which also has strong elements of training and environmental consciousness. It is equally true that it is very difficult to find genuine science-based activity

carried out or sponsored by a foreign private investor which is primarily directed towards original research and aiming at the generation or development of new products or processes.

Apart from the afore-mentioned profit-seeking activities, there are several science-based R and D-oriented contributions from foreign parties which involve substantial investments. Most of these are conceived and implemented in collaboration with agencies and institutions of foreign governments, usually under bilateral arrangements, and are directed to serve public-sector institutions and private enterprises alike. The most notable of such programmes is the US-Agency for International Development (USAID) techno-scientific programme in Egypt which is implemented in the form of several projects in collaboration, inter alia, with the Ministry of Agriculture, Ministry of Industry and the ASRT. The latter institution is responsible for management of the Science and Technology Cooperation Project which is essentially an end-user-oriented research development and engineering (RD and E) activity.

The project also delivers complementary services, such as preliminary techno-economic feasibility studies requisite for initiating the projected research, supportive science and technology information and management training, input material and final product quality control, etc. The programme exhibits

distinct tendency to assist private sector small- and medium-sized enterprises. For most of the sub-projects selected for support, the requisite expenditure is provided through cost-sharing between the USAID, the beneficiary enterprise and the Government. This formula has proven its value in assuring the commitment of the enterprise to actually benefit from the delivered RD and E results.

Seen in its entirety, the current strong drive for privatization and opening to foreign investment has been the centre of a widespread reform to halt the deteriorating state of the national economy, and was meant to be an Egypt-specific response to the recommendations of the World Bank and the IMF.

It is a fact that since the "Infitah" became a concrete reality, FDI played crucial, sometimes turning-point roles in some areas of the production and the services sectors, and the results are now tangibly felt in all quarters.

At the same time, in the manufacturing industry sector, the situation with respect to the role of FDI, and foreign involvement in general, is as yet inconclusive and more time needs to elapse before valid evaluations can be made. However, a predominant feature of this involvement appears to be its orientation towards production of consumer goods for use in the

local market. Many of the manufacturing approaches were limited to assembling operations with limited technological value-added. This was a facet of the consequences of opening of the economy after many years of isolation and highly protected import-substituting industrialization, which itself didn't have very ambitious goals.

A general character of several of these investments has been their tendency to favour quick-return ventures which utilized the ready-to-use and the tested-and-proven technologies (which rarely were the latest) imported from the industrial countries. This in effect meant the shrinking of the already modest demand for the contributions of local R and D to even lower levels.

However, judged by prospects rather than by hitherto achieved results, FDI may prove to be the vehicle through which larger-scale transfer of technology is stimulated, particularly in those cases where the transfer through licence agreements or direct purchase of technology is, for any reason, difficult. This is borne out by the experiences of several of the newly industrialized countries (NICs).

b) Future Trends

The following are some views on the possible areas of action which are likely to favorably affect future trends of FDI in

Egypt. While some of them reflect personal perceptions, others are already the subject of attention by the government.

Encouragement of FDI Participation

For attracting massive FDI flows and optimizing their impact, there will be a need for changing some aspects of the finance policy and project approval procedures, providing novel incentive modalities, and adopting an encouraging stand with respect to the intellectual property protection system. In general, there is a need for a comparative and in-depth study of the impact of selected measures for interaction with the outside world through, inter alia, modes of transfer of technology, FDI and strategic technological alliances.

FDI and Competitiveness

A central goal of industrialization under the present liberalization drive is for Egypt's economy to acquire sufficient export capabilities through which to achieve entry into world industry. Clearly, competitiveness must be a pivotal attribute and a sine qua non for such pursuit. Transfer of technology through FDI flows and foreign substantive participation can be seen as a realistic channel for attaining such competitiveness.

A whole array of measures may be prescribed to reinforce those actually being implemented. It is believed that among these, the most important are the approaches which are designed to achieve the forging of strategic technological alliances with major foreign industrial concerns for the creation of Egypt-based, export-oriented leader industries and entry into high technology fields of production. This approach should be explicitly enunciated in a national technology policy document as a matter of general consensus and commitment by all government formations.

R and D and FDI

The existence of a viable R and D capability is among important prerequisites for attracting FDI. Even with a predominant orientation towards domestic market, FDI in Egypt should be persuaded that the potential of local R and D services extends much beyond solving immediate production problems to the level of expanding or improving the products' marketability locally and in other countries of the region. With time and facing challenging situations, local R and D may also produce results of important innovative character. The active participation of the local R and D institutions is sure to prove to be mutually beneficial to all sides of interaction.

Training

Training is usually necessary for attracting FDI, but can also be a highly valued outcome of its practices. In most cases such training will be highly specific and directed to serve predominantly the industries engaging the FDI. At the same time, together with R and D efforts, training assures a more thorough and deeper absorption of the technological knowledge transferred via FDI and thereby contributes to a genuine technological growth of the society. Extensive assistance from foreign sources, received mostly under bilateral arrangements, was highly useful in the design of advanced programmes which addressed diverse manufacturing techniques as well as requirements of quality assurance as necessary for achieving a level of competitiveness (see Chapter I, B-2).

An important trend, that may well be adopted in this respect, is to assure that foreign investors should incorporate elements of as intensive training as possible in their transferred technology packages and provide, for this purpose, some suitable incentives.

The Need for Advanced Technology

There is a marked tendency in several FDI-based and local private sector industries to use relatively advanced technologies

with low-labour intensity features. This is a healthy development in Egypt's industries which should be encouraged.

It seems that only production perfected through the application of sophisticated technologies will be competitive and have a chance to penetrate foreign markets. The government may, therefore, be well advised to spread awarencess about the importance of advanced technologies and methods of production and consider ways and means for encouraging their extensive introduction, while utilizing the advantage of less costlier labour.

Small- and Medium-Sized Enterprises

The vast majority of the industrial firms that were created as a result of joint ventures with foreign capital or private sector activities are small- and medium-sized enterprises. All these industries came into being to benefit from the incentives made available under the laws of the "Infitah". The majority of these were established in the new industrial zones. The current governement trend is to create more industrial cities and preserve the privileges now awarded.

It could also be noted that in many cases the foreign investors are small- and medium-sized enterprises. This is another healthy symptom which should be encouraged. At the same

time, it is important to invite MNCs and advanced technology firms to consider investing in Egypt, particularly within a formula of a long-term strategic alliance.

Intensification of Industries

A large number of the "Infitah" industrial activities, including most of the joint ventures involving FDI, were relatively shallow and based on the assembling of components much of which were imported. After the elapse of a sufficient learning time, it appears important for these industries, to remain viable, to deepen their manufacturing operations by backward integration. With the support of existing incentives, including optimal effective rate of protection and supplies from upstream industries at favourable prices, the local manufacturing intensity and competitiveness can be considerably augmented.

In this context, every encouragement should be given to R. and D efforts aimed at improving both products and processes, even if these originally are innovations of foreign firms.

Environmental Soundness

Egypt has been plagued in the past by the transfer of a number of environment polluting technologies. Environmental soundness is a central concern of decision-makers today. A highly authoritative environment affairs machinery has been created and

attached directly to the Cabinet of Ministers. It is permanently represented in the General Authority for Investment (GAI), which is the government arm responsible for the enforcement of Investment Law No. 230/1989, and has the responsibility of examining the environmental aspects of any project submitted for approval by the GAI. All foreign investors are advised about the requirements for environment protection and disposal of hazardous materials, and their established facilities are subject to periodic inspection.

CHAPTER III

GENERAL CONCLUSIONS AND RECOMMENDATIONS FOR FURTHERING THE DEVELOPMENT OF ENDOGENOUS TECHNOLOGICAL CAPACITIES IN EGYPT

A. MACRO-ECONOMIC CONSIDERATIONS

1. General policy actions

Conscious about the crucial importance of liberalization of the national economy, the Government of Egypt adopted in 1986 a comprehensive plan for economic reform and restructuring. The implementation programme was anticipated to attain substantial targets and was based on the premise that the pattern of interventions (or cessation of past interventions) can be changed so as to pay closer attention to market signals.

The policy measures applied since then produced tangible results for regaining macro-economic balance. Particularly notable is a package of measures aimed at reducing national budget deficit which succeeded in lowering the deficit to only 7.3% of GDP in 1992, as compared to 22% in 1988. Among other measures were stabilization of the rate of exchange of the

Egyptian pound, streamlining and harmonization of banking operations, liberalization of interest rates, creation of a market for treasury bills, implementation of fundamental reforms in the government administrative system, and introduction of social measures for alleviating the pressures created by the total reform on the low-income groups of the population.

Clearly these measures have implicit technology connotations. Another group of measures - supported by appropriate legislation - was specifically designed to impact on the decision-making of all enterprises, both private and public, and national and foreign investors, and have explicit technological implications. These include: (i) encouragement of private sector participation; restructuring of the public sector, particularly through privatization; (iii) creation of new urban communities and industrial cities; (iv) liberalization of foreign trade; and (v) liberalization of prices.

2. Comments and lines for future action

a) Stability and Consistency of Macro-economic Conditions

The past experiences indicate that unstable macro-economic conditions and contradictory policy actions stifle investment and no technology strategy could be seriously pursued. The conclusion, therefore, is that long-term consistency in macro-

economic policy and economic-technology strategy reassures firms that the rules of the game will not suddenly change. However, a determined, well-publicized, and sustained effort by the government begins to positively affect investor behavior even before stability is achieved 7/. The results, already visible in Egypt, appear to be assuring that important benefits will be reaped in the near- to medium-term, if no major distortions occur in world trade and technology market.

b) Requirements for Foreign Direct Investment as a Vehicle for Transfer of Technology

The most important requirement for attracting foreign direct investment - involving substantial transfer of technology - is a stable macro-economic environment. Additionally, the availability of the following prerequisites determines the attractiveness of a country to foreign investors: (i) physical infrastructure, including roads, ports and telecommunication facilities; (ii) skilled technical manpower; (iii) local support industries to provide basic machinery, parts, material inputs, components and test services, thereby lessening the dependence on imports; (iv) a simplified administration and bureaucracy; and (v) well-focussed, aggressive information dissemination concerning local investment opportunities and advantages 8/.

The technological ambitions of Egypt require, perhaps at a later stage, that some selectivity be exercised in allowing foreign direct investment. Heavy reliance on such investment does not stifle industrial growth; it may only reduce the indigenous technological content of industrialization 9/.

Licensing as a Vehicle for Transfer of Technology

This has been for long time the preferred modality for the acquisition of technology by public sector and nowdays it remains a preferred form for entrepreneurs. However, licensing arrangements do not always provide access to the most competitive technology. The experience of Egypt makes it possible to make the following observations: (i) it would be a serious misconception to believe that reliance on the licensing of technology, even for the short-term, is a healthy or safe practice; import of foreign technology cannot be a substitute for local development, through R and D, but is complementary to such development; (ii) there is real need for the creation in Egypt of a sophisticated capability to identify and select technologies appropriate for licensing without any encroachment on the freedom of entrepreneurs to make the final decision; (iii) Egypt needs to consider ways and means for incorporating clauses which would encourage maximum utilization and better absorption of the imported technology, including through training10/.

Government Assistance in Transfer of Technology

There exist a variety of information services to help and guide foreign investors on the opportunities available in Egypt and the incentives, exemptions and guarantees provided under the law. These service are centered, mainly at the General Authority for Investment, the Ministry of Industry and the Ministry of Reconstruction, New Settlements and Housing.There does not seem to exist an equally vigorous information service to help local entrepreneurs, and it seems that the government may endeavour to provide explicit support and training to help firms access technology options and acquire, negotiate and master technology 11/.

Capital Goods

The import of capital goods, separately or within turnkey plants, is an important source of foreign technology. For Egypt, judicious selectivity in this area is highly important; reliance on capital goods imports to acquire sophisticated technology is a must.

The government's role is highly desirable for the drastic reduction, or even total elimination, of duties and all non-tariff barriers on the import of capital goods, and for encouraging local firms to subcontract for spare parts.

Competitiveness as a Means and a Target in Technological Development

The major reforms introduced by the Government in recent years have all promoted competition, generally described as 'getting prices right', and clearly set the legal rules of the game. Strong competitive pressures can also have effects in other directions. The possibility that a firm's competitor could underprice or improve a product's quality is a strong incentive to seek technology transfers at higher levels in order to maintain a market share. In certain situations it could also induce firms to seek science-based assistance from Egyptian R and D institutions.

At the same time the question of infant industry protection should be given closer examination. While desireable, even necessary in certain situations, protection at excessive levels or of long duration is likely to lead to technological obsolescence in virtually all industries, given the rapid pace of technical change 7/. Review of competition policies should, therefore, be undertaken from time to time, and with respect to different industries, to determine whether prevailing or proposed infant industry protection is valid or necessary.

Temporary Pro-Export Strategy

The overall orientation of economic reform in Egypt seeks inter alia to achieve a significant level of export capacity. This pro-export bias is necessary to bring about structural change in industrial growth 12/ and can be justified to compensate for the initial set-up costs involved in making a product exportable. Any export incentives under a pro-export policy should be temporary. As experience in other NICs showed, after 3 to 5 years a neutral structure of incentives that does not discriminate between domestic and international sales would be sufficient to sustain the efforts of exporting firms. In application of this policy line, it would be more prudent to use automatic export incentives such as retention rights, tax exemptions, etc..

B. ENHANCING ABSORPTION AND DIFFUSION OF TECHNOLOGY

Whether technology is imported from foreign sources or developed domestically, the level and technical skills of a nation's labour force effectively determine the limits of technology utilization and absorption. A chief concern of any strategy for technological development, therefore, should be to design and implement programmes for technical human resources development. Educators and industrialists alike in Egypt have for long been conscious of this need.

The move for liberalization in Egypt has been accompanied by a conscious drive for upgrading the quality of vocational training and technical education. Some of these efforts received support from bilateral and multilateral cooperation arrangements with foreign parties. For the people already engaged in the work force, there exist short-term options for promoting their technical skills, which should be a primary responsibility of the companies but where the government needs also to be involved. Short-term actions in this domain may include offering government-guaranteed loans to employed people taking classes; letting employers and employees deduct the costs of training and education; providing training through extension services; encouraging repatriation of skilled nationals living abroad; encouraging foreign governments and multinationals to set up special training programmes for local nationals in areas of scarcity; etc.

Among the actions to follow the acquisition of foreign technology is the design of a system for diffusing technology efficiently to other firms in the country 13/. Options available to government to help diffuse technology efficiently can be grouped into three broad areas: (i) to establish/strengthen extension services and other delivery mechanisms to disseminate information; (ii) to support the development of subcontracting system and encourage technology transfer agreements through

incentives; and (iii) to support the development and dissemination of standards, testing and quality assurance systems 14/.

Most of these action areas require the creation or strengthening of specialized institutional arrangements with capable technical staff.

C. THE QUESTION OF INTELLECTUAL PROPERTY RIGHTS

The question of intellectual property rights (IPRs) should be viewed as affecting all future technology-related activities. The direction of the on-going international debate on IPRs, particularly the results of the Uruguay Round negotiations within GATT, should be followed closely and a country-specific position should be reached vis-à-vis every issue of the debate.

The producers of new knowledge argue that IPRs should be effectively protected and strengthened,and new appropriate legal mechanisms created. The technological followers, on the other hand, are concerned that a strict international technology appropriating regime would slow down the diffusion of scientific and technological knowledge which necessarily affects also capacity for technology generation. Another concern is that the more stringent IPRs regime may impede access to the new

technologies. Developing countries consider that the IPRs system should be commensurate with the the development policy and be adaptable to the specific conditions prevailing in each country 15/.

The issues of how to balance the rights of proprietors of technology with the public interest have direct relevance to the Egyptian situation and reflections in Egypt's Patent Law No. 132 enacted in 1949. This Law is applicable until present time but is currently being revised. In particular, this Law provides for compulsory licensing - with adequate compensation to the patent holder - as a prerogative of the Patent Office under specified conditions. Current proposals for amendment of the Law tend to regulate compulsory licensing and other provisions essentially along the lines stipulated in the Agreement on TRIPS.

IPRs and the level of their protection is an area in which Egypt receives signals from the international developments and, as a result, faces a number of challenges and opportunities. While trying to capture a fair share in world trade, Egypt contrives to strike a balance between the privileges granted under IPRs protection and the social cost of such privileges, and also attempts to reduce the possibilities of abusive use of the proprietary rights. The country's right to develop its indigenous technological capacities should constantly be emphasized and defended, including the right of promoting and maintaining

legislation compatible with its development needs. Such legislation should improve the country's access to the best available foreign technology through the channels of foreign direct investment and contracts for the transfer of technology. At the same time, the legislation should encourage innovation within the country while constituting an encouragement for foreign partners and maintaining flexibility in relationships with technology suppliers.

D. UTILIZATION OF RESEARCH AND DEVELOPMENT INPUTS

The present drive in Egypt for an outward orientation of the economy will inevitably result in forging strong links between local enterprises and foreign suppliers of technology. But there is the implicit danger that the local enterprises will, as a result of the general trend, have even less need for the services of local R and D institutions than ever before.

Thus, it seems important to maintain complementarity, even inter- dependence, between the local and exogenous R and D-based contributions. To pursue this policy the following measures would be required:

1- R and D Funding. With only 0.2% of GNP allocated at present for R and D expenditure, Egypt clearly has to cover much more

ground to come closer to the successful industrializers of the developing world. Particularly important is the structure of this expenditure, which requires serious reconsideration to remove existing imbalances between the various elements, such as the ratio of overheads to direct R and D material costs. The Government, which owns and runs the vast majority of R and D establishments, has an explicit role to play in this process within the country technology development strategy.

2- Selectivity. An important prerequisite is that the rational Government intervention called for in the present study should be steered towards selective measures which focus on building up real and lasting technological capabilities. In particular, R and D activities can be an area for selective action. Instead of providing indiscriminately equal support to all activities, attention should be given to those which correspond to priority areas of industrialization and specifically to those industries which depend heavily on the transfer of foreign technology. Any protection provided should be for a limited period and accompanied by export incentives to offset the effects of protection. The chief role of R and D in serving such industries would be to provide the sustained support which prevents their permanent dependency on foreign suppliers.

3- The Learning Aspect. The instrument of protection would be meaningful only if it is geared to the learning period. If the government's support to R and D is selective enough and pointedly aimed at promoting the learning process in specific production activities (even favoring certain industries), then the targeted export competitiveness can be achieved, assured and sustained. In actual practice, the requisite R and D activities should advance to levels which enable the creation of an equivalent technology or an alternative process know-how for manufacturing the same product.

4- Interacting with Foreign Partners. In many cases major firms in industrialized countries and multinational corporations tend to locate their R and D activities in developed countries 9/. For Egypt, however, the chances in this area may be better, given its diversified R and D infrastructure. For this purpose, a high degree of selectivity in awarding government support to the relevant R and D activities would be crucial. Foreign firms are likely to see an important economic advantage in having an R and D-based support located in the country where the technology is planted, particularly in case of those industries which depend on local input materials, or where non-standard measures for preventing pollution are required. In this respect, technological alliances with the concerned multinational corporations would be an appropriate solution.

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