3 Scientific Communities in Egypt: Emergence and Effectiveness

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Egypt is the largest and most populous Arab country. Its strategic location and natural wealth have endowed it with a special position throughout history. The high level of creativity of Egyptians, beginning with the Pharaonic period, is attested to by their invention of the major components of modern civilization. The powerful influence of Egyptian, Phoenician and Mesopotamian civilizations on Europe was transmitted through Greece (Bernai, 1987). After the fifth century BC, Egypt was subjected to a series of foreign invasions: Greek, Roman and, finally, Arab. The Arab period, beginning in the seventh century AD, integrated Egypt into the nascent Arab-Islamic civilization, of which it became an integral part and to which it made significant contributions. The Arab-Islamic civilization established the foundations of modern S&T in three directions: *(a)* it underlined the necessity for a solid empirical base, *(b)* it introduced the mathematization of scientific knowledge, first accomplished in the field of optics by Hasan bin al-Haytham, and (c) it demonstrated the harmonious relationship between science and technology. In addition to these three achievements, the Arabs brought about an enormous expansion of all the known fields of S&T—from mathematics and medical science to geology—and sponsored the free diffusion of scientific knowledge across political and cultural frontiers.

After developing vigorously for five hundred years, however, Arab civilization began to decline as a result of the confluence of a number of internal and external factors. Although considerable socio-economic development occurred subsequently in various parts of the Arab world, yet, Arab S&T continued to decline. Beginning in 1498, with the entry into the invasions by European powers, which eventually took hold and initiated a period of European colonization.

There are considerable volumes of publications on the development and status of education and science in the Arab world during the last two hundred years. Much of this literature is of a descriptive nature and a great deal remains to be investigated before a critical understanding of the formation of the modern Arab world is achieved. Despite the decline of its scientific and technological capabilities, the Arab world was not a *tabula rasa*, ready to be fertilized by European science; furthermore, science was not transferred through colonial scientists or through the 'benevolence' of colonial policies.

This paper is mainly concerned with the present state of S&T in Egypt, with special emphasis on some aspects of the effectiveness of its scientific communities. The paper will first provide brief background information and then set the subject in a regional context.

Science and Technology: From 1800 to 1947

Napoleon Bonaparte conquered Egypt in 1798 in a bid to secure a direct route to India. He was accompanied by a scientific mission. Europeans maintained a slender research base in Egypt for a long time. The output of the scientific team that accompanied Napoleon provided Egypt and European governments with valuable and seminal information throughout the nineteenth century. The utilization of this information was often disastrous for Egypt. A notable example is the construction of the Suez Canal. The British, for whom India was the cornerstone of their empire, could not tolerate their rivals, the French, straddling the shortest route to India. British policy throughout the nineteenth century was dedicated to the preservation of the Ottoman Empire in its weak condition in order to prevent any European power from gaining influence there. Admiral Nelson was therefore despatched to remove France from Egypt, which he did.

Shortly afterwards, Muhammad Ali, a senior Albanian officer in the Ottoman army, saw a golden opportunity for establishing his personal control over Egypt. Through a succession of moves, he placed himself in control of Egypt and became the Viceroy of the Porte. Muhammad Ali quickly grasped the importance of technology. He set himself the task of establishing a powerful army, schools to train military manpower, military industries, a medical school to train doctors for the army, and the development of the agricultural sector to generate the revenue to sustain his power. He also attempted to develop the textile industry by monopolizing the means of production and subjecting traditional producers of textiles to heavy fines. In order to achieve his objectives, Muhammad Ali sponsored a substantial number of Egyptians to study abroad (mostly in France) and imported much larger numbers of European army officers and instructors to staff schools and the army, and to plan and manage physical investments in Egypt. He contracted with a number of European firms to establish industrial firms to process agricultural output: cotton, sugar, indigo and other products. He also employed a large number of foreign doctors, technicians and engineers to establish a medical school, and to plan and execute large-scale engineering works to expand irrigation and water storage capacities.

Muhammad AH invented the modern turnkey approach to total technological dependence; he believed that this method best fitted his ambitions to secure undisputed control over Egypt (Zahlan and Said Zahlan, 1978). Egyptian manpower, trained in Egypt and in Europe, acquired prescribed technological capabilities successfully; however, the political regime in force was loath to depend on national manpower. In the military fields, the reliance was on Europeans (mainly French), Americans (mainly Confederate army officers after the end of the American Civil War), Albanians, Circassians and others. Egyptians served as low-ranking administrators and officers; they were kept far removed from high-ranking civilian or military positions. The technologically dependent turnkey approach failed to sustain the political and economic development of Egypt: it led Egypt from one economic and political disaster to another. The collapse of the Egyptian economy in the late 1870s led to its occupation by Britain in 1882—an occupation which lasted, effectively, until after the Second World War.

Relevant Educational Development in the Region up to 1947

The establishment of national educational institutions in the Middle East was on a modest scale throughout the nineteenth century. Arab nationals went in increasing (although small) numbers to study in Europe and later in the United States. But the graduates of the new national institutions, as well as those from institutions abroad, were not prepared culturally or professionally for the scientific and technical jobs at hand. During the colonial period, the development of public education had been severely restricted: the largest expansion was through private schools and was on a limited scale due to the low economic activity in the region.

In addition to limited governmental educational programmes, Anglo-Saxon (British and American) Protestant missionaries sought to spread their faith in the region. These missionaries were motivated by a Messianic millenarian movement called the Second Great Awakening which imposed great urgency on those who believed in it. According to this movement, Christ's reign on Earth would begin once the Jews were 'restored to Jerusalem' and converted to Protestantism. Protestant missionaries in the Middle East set out to fulfil their Messianic objectives; they sought to convert the Arab-Jewish communities, where they met with strong resistance. Consequently, the missionaries began to divert their attention to non-Protestant Christian communities in the region. The presence of these missionaries very quickly induced a substantial increase in the activities of French (Roman Catholic) religious and educational institutions. A by-product of this missionary activity was the founding of the Syrian Protestant College (SPC), now the American University of Beirut, in Beirut in 1866. Within a few years, the French Jesuits had founded the College St. Joseph in 1871, also in Beirut.

Maybe the first graduate from SPC to make a mark on scientific thought in the region was Shibli Shummayyil, who after obtaining his degree in medicine from SPC in 1871 spent a year studying in Paris. While in Europe, Shummayyil learnt about Darwin's new theories. Upon his return to the Middle East, he settled in Tanta (Egypt) where he established a medical practice. He devoted much of his spare time to spreading the theory of evolution. Shummayyil started a debate of considerable scale among religious circles and intellectuals in the region. Interestingly, he had a remarkable influence on the American missionaries at the SPC. The views diffused by Shummayyil won over one of these professors, and this conversion to the theory of evolution led to the dismissal of that professor in 1882. As a reaction to the dismissal of a popular instructor, the students went on strike—this was the first student strike in the region in modern times. This was a major upheaval at SPC and for its medical student body.

The diffusion of the science of evolution among American professors at SPC was by an Arab graduate who had learnt the science at source. The SPC was adamant in its fundamentalist approach to science; all the medical students were expelled and most of the foreign faculty of the medical school resigned. The heated debates initiated by Shummayyil did not lead to any proper scientific work relating to the theory of evolution (Ziadat, 1986). The significance of this analysis is that it was Shummayyil who was the conduit of modern science and not the missionaries who stood in opposition. The discussions and public debates on the theory of evolution did not lead to scientific research in this, or any other fields of science. It was not until after the Second World War, when the number of university graduates had reached a sufficiently large size and maturity, that scientific research and the deliberate pursuit of S&T began to take shape.

All research work undertaken in the region was part of some European programme. A small number of national engineers began to develop new industries and to participate in consulting and contracting. Some of the work of geological explorations and agricultural development was funded by the Egyptian government and employed competent Egyptian geologists. Until independence, the involvement of nationals in scientific and technical activities was very limited. Medicine, pharmaceutical sciences and agriculture were the leading fields where nationals were actively participating.

The level of activity did not result in the generation of new scientific knowledge; yet, there was wide interest in scientific advances undertaken in Europe. The absence of national institutions and policies to promote scientific work was a major obstacle.

Transition to Independence

The British occupation of Egypt in 1882 reduced the distinction between various ethnic groups and thus had a positive impact on the evolution of social cohesiveness. The economic policies of Muhammad Ali had promoted the emergence of a new class of Egyptian rural and urban notables who accumulated capital from their activities in agricultural production; this new class was to play an important role in the early industrialization of Egypt under the leadership of Muhammad Tal'at Harb and the Bank Misr which he established (Davis, 1983). But the industrialization of Egypt under the Bank Misr did not espouse a radical departure from the prevailing attitudes towards technological dependence. The Bank Misr experiment had many positive aspects, but failed to lead either to a major transformation of the Egyptian economy or to a constructive attitude towards S&T. Thus, both public and private sectors pursued technology policies which were grievously flawed and which did not contribute to the promotion of national scientific and technological communities and institutions.

Surprisingly, Arab political and social analysts have not attributed the disasters inflicted on Egypt to the social, economic and technological policies adopted by Muhammad AH and his successors. On the eve of political independence, planning and project implementation were being carried out by European firms. The political elites who assumed power after independence (circa 1950s) had had no education or experience in S&T. Upon assuming political independence, the different Arab governments, and especially Egypt's, paid only nominal attention to the importance of education and S&T. Education and the establishment of national institutions were given high priority, but the new educational programmes were planned bureaucratically and lacked a creative content. The world of learning and that of development policies and practices (that is, the world of work in a developing society) were moving separately. There was no understanding of the importance of coordination and integration of these two different activities. Thus, the planners of newly independent Egypt had not acquired an understanding of the vital role that science policy plays in bringing about the articulation of disparate socio-economic, educational, and R&D activities.

Independent Egypt

A general belief in the importance of technology and of professionals had taken root in Egypt before independence and before the Second World War. The War years delayed the adoption of suitable actions. Egyptian elites were already considering the establishment of some national organizations in the hope of giving an impetus to institution-building (Sabet, 1969). The Fouad I National Research Council was established just before the Second World War. In 1950, it compiled information on Egyptian scientific manpower and did not find it wanting; there were already considerable numbers of scientists holding PhD degrees from European and American universities. Egypt was ahead of China in the availability of scientific manpower (Zahlan, 1980). The challenge was how to put this scientific manpower to good use.

A military coup in 1952 toppled the regime of Muhammad Ali's dynasty and replaced it with a republican government. The new Egyptian government sought to accelerate social and economic development. New policies were adopted and new institutions were established to implement these new and ambitious policies. The new 'revolutionary' government of Egypt adopted policies that promoted the expansion of education at all levels, industrialization, the establishment of research institutions and a ministry of science. Interestingly, the measures taken by the new government were no less arbitrary than the measures taken by previous Egyptian governments; although scientists were formally consulted, these were no more than gestures, for their recommendations were either vetoed or ignored (Zahlan, 1980).

The new policies did move away, to some extent, from the comprehensive turnkey approach that had prevailed in Egypt. But they did not give adequate attention to institution-building or to the acquisition and accumulation of technology. Government circles only had a limited understanding of the motive force behind scientific work, the relevance of science policies, the importance of innovation and R&D, and the characteristics of a fruitful R&D environment. This did not mean that the Egyptian government did not seek and receive the advice of international organizations in this domain (there were, for example, numerous UNESCO missions to Egypt). The political culture prevailing in Egypt did not permit the adoption of essential reforms in the domains of planning, technology policies and manpower development. The new government of Egypt, just like the old one, was obsessed with the importance of personal loyalty to the regime rather than with the competence of professionals and the institutionalization of policy and procedures; government officers had a blind belief in the power of subservient bureaucracies and in the capabilities of such institutions to 'make things happen'.

Scientists and engineers in Egypt were rapidly increasing in number thanks to government subsidies for study abroad; but these young scientists and engineers found themselves increasingly alienated from public service and sought the brain drain route out of their predicament. The beginning of a massive brain drain began to take shape. Egypt lost large numbers of its professionals to other Arab states, to the US and to Europe. Despite these negative features, Egypt was able to place itself among the leading Third World countries as measured by per capita output of scientific publications. The development of Egypt during th

The contents and scope of higher education, however, fall below the standard programmes on offer in industrial countries. Thus, many of the new areas of knowledge which have been developed during the past ten to thirty years may be taught either superficially or not at all. The expansion of higher education in Egypt since the 1950s was not, however, accompanied by adequate attention to the quality of education, to the relationship of enrollment to facilities, or to the development of academic disciplines in new and emerging academic areas in the social and basic sciences, engineering and technology. The quality of academic standards suffered considerably because of the limited research opportunities available to university professors, and the poor and congested teaching facilities. Furthermore, the system of governance of universities has remained highly underdeveloped, and does not provide the proper environment for intellectual and creative activity.

Egypt has accumulated a substantial population of university graduates over the past forty years. No official figures are published oil the total professional manpower available. Statistics focus on the annual number of graduates. The outflow of Egyptian professionals to the Arab countries and the brain drain to other OECD countries make it difficult to estimate the numbers remaining at home. It is unlikely that the total pool of university graduates available to Egypt exceeds 1 million, inclusive of graduates in law, the arts and humanities. There were, in 1990, more than 120,000 engineers and 50,000 MSc and PhD scientists who were involved directly or indirectly with education, planning, and/or scientific and technical research. There are 50,000 scientists employed in the educational sector (75 per cent), service sector (13 per cent) and production sector (11 per cent). About half the scientists (21,000 out of 45,000) hold a PhD degree (Hubaysh, 1992). Fifteen per cent of the age group 20-24 are enrolled in some four-year university course in Egypt. The system of education is extensive, and as will be shown later, it continues to churn out substantial numbers of graduates in a large number of fields.

Since the mid-1980s, the government has sought to reduce the number of university students in order to make the system of higher education more manageable. The proclaimed purpose of these changes in enrollment is to spread the available budget to a smaller number of students. Table 3.1 shows that an overall decline of 14 per cent in enrollment was achieved over the period 1984—1990. This decline was registered in most disciplines: arts, science, engineering and law. The decline, however, varied according to university, gender and discipline. Egyptian universities are so severely under-funded that even a reduction of 15 per cent, or even 50 per cent, in enrollment may not result in noticeable changes in quality.

Egyptian universities graduated 115,000 students in 1984-1985 and 105,000 in 1989-1990. Of these, 31,000 and 26,000 respectively obtained their degrees in basic and applied sciences. The number of graduates is still

TABLE 3.1
Number of Students Enrolled in Egyptian Universities by Major Discipline

Discipline	*1984-85*	*1989-90*
Grand Total	682348	569126
Humanities	505267	431220
Arts	69593	62704
Commerce	154182	114501
Law	74935	72020
Economics	1171	1409
Science and Technology	167541	137906
Medicine	28443	26885
Pharmacy	7857	6639
Engineering	35350	29092
Agriculture	33863	23185
Sciences	23302	18621
Technology	12708	6919
Electronics	1875	1972
Petroleum and Mining	476	507

Source: *Statistical Yearbook,* 1991. Cairo: Central Agency for Public Mobilization and Statistics.

large. These young people are entering a labour market that is already saturated—investments in Egypt have not been able to employ available professional and non-professional manpower. Hence, there is a high level of unemployment and the constant outflow of manpower out of the country. The challenge, which has still to be addressed, is to increase the absorptive capacity of the economy for investment and manpower; such reforms, however, involve major changes in science policy.

Tables 3.1 and 3.2 show the distribution of students and graduates by discipline. The number of university graduates has been increasing at the rate of more than 100,000 a year; this is in addition to the number of Egyptians who study abroad. Many of these graduates migrate to Arab countries or other countries. Thus, the annual rate of increase of the pool of university graduates is increasing at a relatively high rate—probably somewhere between 10 and 20 per cent, depending on the proportion of graduates who remain in Egypt. Unemployment among university graduates is also fairly high; no systematic statistics have been published. However, figures have been quoted that claim that more than 30 per cent of the engineers are unemployed.

Regional Influence of Egyptian Universities

The population of Egypt is the largest of all the Arab countries (25 per cent of the population of the Arab world). Muhammad Ali initiated the first

TABLE 3.2
Number of Graduates from Egyptian Universities by Major Discipline

Discipline	*1984-85*	*1989-90*
Grand Total	115727	105144
Humanities	84841	79009
Arts	12667	12004
Commerce	28611	22673
Law	11536	12799
Economies	191	157
Science and Technology	30876	26135
Medicine	5105	4101
Pharmacy	1450	1179
Engineering	6502	5417
Agriculture	6789	5323
Sciences	4516	3906
Technology	1687	1376
Electronics	254	356
Petroleum and Mining	81	69

Source: *Statistical Yearbook,* 1991. Cairo: Central Agency for Public Mobilization and Statistics.

effort in the region to introduce European technology and know-how. It may not have been undertaken in the best possible way, but it still had a massive impact, not only on Egypt but on the entire region. Egyptian institutions and universities were usually the first in the region; they attracted students and set role models. Egyptians served as advisers and consultants; they supplied presidents, deans and professors for many of the universities established in the other Arab countries. For better or worse, many of the new universities, especially those in the Gulf states and Saudi Arabia, were deeply influenced by the experience of Egyptian universities. Unfortunately, the transfer of the model often took place without a critical evaluation of what is best to transfer and what should have been adapted before adoption. During the nineteenth century, Egypt suffered from a shortage of labour and attracted all types of professionals and workers from the Arab countries and Europe. Since the 1950s, Egypt has supplied many of the countries of the region with teachers, university professors and technical services. Egypt commands a special place in the Arab world. It is the home of many Arab regional institutions, such as the League of Arab States; many other régional institutions are also based there.

Research and Development Activities

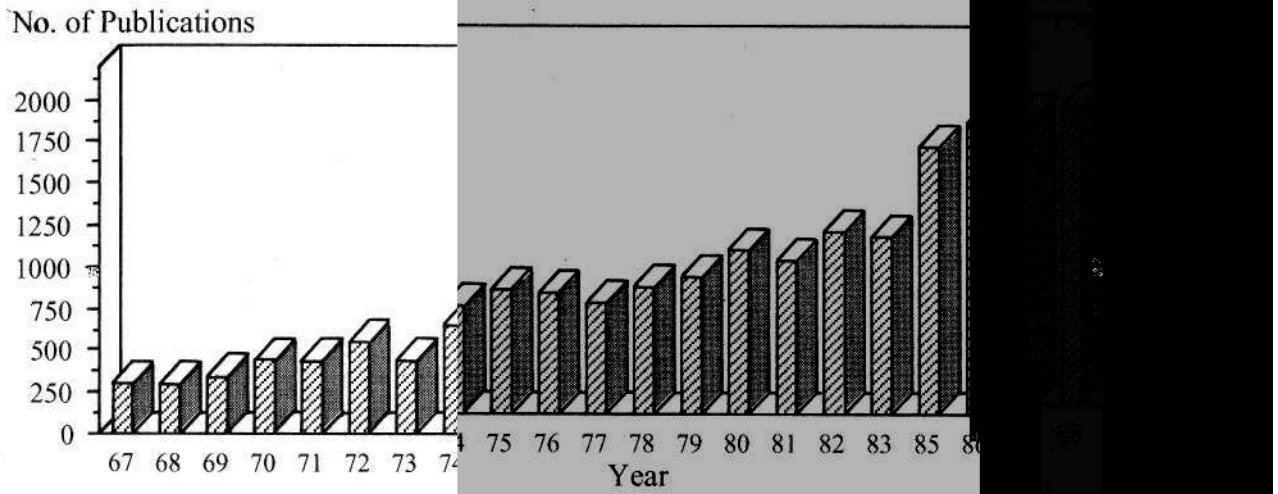
Research work is pursued in thirteen universities and in 200 research institutes. There were, in 1990, more than 66,000 researchers in Egypt; of these, 21,000 held a PhD, 12,500 held an MSc, 16,000 a BSc and 17,000 a Technical Diploma. These researchers were distributed as follows amongst the various disciplines: 11.5 per cent in engineering, 16.7 per cent in medicine, 21.9 per cent in agriculture, 23.8 per cent in the basic sciences and 26.1 per cent in the social sciences.

The Academy of Scientific Research and Technology (ASRT) has published a considerable volume of information on scientific activity in Egypt (ASRT, 1990a). In 1990, it published eight volumes (in Arabic) on the history of science in Egypt. In these volumes, the history of each department and research institution is described and the activities of its staff members are reported. The account is narrative and descriptive. Although it lacks analytical details, it provides a useful compilation of historical information (ASRT, 1990b). Figure 3.1 shows the evolution of research output of Egypt measured in the number of mainstream publications over the period 1967-1991—a seven-fold increase in output can be noted over a period of 24 years.

The universities are the major sources of scientific publications in Egypt. Table 3.3 shows the leading publishing centres. The prominence of universities can be noted, with Cairo University in the lead. Except for 1990, Cairo University has been the leading publishing institution in the Arab world. In 1990, the University of Kuwait assumed that position. Although the National Research Centre (NRC) is the largest research institution in the region—in terms of number of professionals on its staff—it does not appear in Table 3.3. In 1977, the universities of Alexandria and Cairo had similar outputs; but over the past fifteen years, Cairo University appears to have taken the lead. Some of the new universities, such as those of Menia, Manoufia and Tanta, have not been able to sustain an output of even fifty publications a year.

It is clear from Table 3.3 that the output of each institution is relatively small when compared with the large number of staff (66,000) participating in R&D, the number of students enrolled, or the number of persons holding a PhD degree inp(lead) Tj0 Tc(e) Tj1.1m0 Tw0.353 Tc(Th) 4j0 Tc(e) Tj1.108 Tw0.367 Tc(outpu)

FIGURE 3.1
Research Output of Egypt, 1967-1991



Source: Institute of Scientific Information, Philadelphia, USA

TABLE 3.3
Egyptian Institutions Publishing Fifty or More Refereed Publications

Institutions	*1977*	*1983*	*1986*	*1989*	*1990*
Atomic Energy Authority	-	—	(40)	56	(42)
University of Alexandria	105	163	232	213	237
Cairo University	107	203	338	304	359
University of Assiut	(40)	86	100	162	160
Ain Shams University	81	101	157	203	190
Al-Azhar University	-	-	71	93	77
Manoufia University	-	-	(13)	53	(42)
Mansouria University	-	-	125	176	164
Menia University	-	-	-	57	(37)
Tanta University	-	-	69	59	(44)
Zagazig University	-	-	80	54	84

Source: Institute of Scientific Information, Philadelphia, USA.
Note: Figures in brackets indiate < 50 publications.

2. Nine research centres and institutes.
3. The Technical and Technological Studies and Research Fund.
4. The National Authority for Remote Sensing and Space Studies.

The Academy of Scientific Research and Technology (ASRT)

ASRT was established in 1971. It is the central body responsible for the support of scientific research and for the application of current technologies in the national programmes of socio-economic development. It is also responsible for setting policies to bridge the gap between the scientific community and the demand side (industry, agriculture and other sectors) of the economy in Egypt. ASRT has given attention to the provision of scientific information to researchers. A number of services have been established to achieve this goal. The two main services are the National Information and Documentation Centre (NIDOC) and the Egyptian National Scientific and Technological Information Network (ESTINET). ASRT has also established a database on international patents and publishes a number of scientific journals.

The Specialized Councils of ASRT sponsor R&D projects. During the period 1987-1992 (Phase II), ASRT continued the support of 131 ongoing R&D projects at a cost of LE 10 million and initiated 630 new projects at a cost of LE 57.6 million. These sums of money are relatively small. Practically all of the nearly 350 projects supported by ASRT are in very applied and technical fields: food, agriculture, irrigation, construction, and so on. Thirteen were in the 'basic sciences' and twenty were in economics and management.

One of the most common difficulties in the application of technology in developing countries is the neglect of the economic and management aspects of technology. Unlike science, technology implies the production of a useful service or product; this in turn implies marketing, attention to cost, and the competitiveness of the product and service. It is clear from the allocations of funds to projects that these essential aspects of technology are generally neglected. This may be one of the factors that has worked against the utilization of local suppliers of technology.

The Nine Research Centres

Egypt has over the years established a large array of. research centres. Many of these were initiated as departments in NRC. There are now eight other research centres in Egypt: the National Institute of Oceanography and Fisheries, the National Institute of Standards, the Institute of Astronomy and Geophysics, the Central Metallurgical Research and Development Institute, the Petroleum Research Institute, the Theodore Bilharz Institute and the Electronic Research Institute.

NRC, founded in 1956, is the largest in Egypt.' It has 900 qualified research scientists on its staff in addition to 200 research assistants. NRC addresses many of the basic technical problems facing Egypt today. Its activities are on a basic and applied level. After it was established in 1956, there was a tendency to use the facilities as an extension of the different universities in Cairo to generate MSc and PhD dissertations. However, since the early 1970s, this tendency has been curtailed and a mission-directed management has taken over.

The Technical and Technological Studies and Research Fund

The Technical and Technological Studies and Research Fund (Al Sanduq al-Istisharat wal-Dirasat wal-Buhuth al-Faniyya wal-Technologiyya), also known as The Sanduq, was established in 1988 by the Ministry of Scientific Research. It aims to mobilize the professional resources currently available in private and public organizations. It has a database on the available professional resources and has developed procedures to mobilize these resources, when and if required, for consultancy projects. The Sanduq executed more than 67 studies up to November 1991. These were economic-technical studies in a variety of subjects including: *(a)* assessment of existing firms and studies of specific opportunities for import substitution, *(b)* ecology and environmental studies including waste disposal and sewage disposal projects, dispersal of oil spills, etc., and (c) market and feasibility studies, and educational training consultancies.

The National Authority for Remote Sensing and Space Studies

The Authority was established in 1971 in collaboration between ASRT and the US National Science Foundation. The Authority operates a well-equipped centre capable of utilizing and interpreting satellite data for the conduct of geological surveys as well as the use of aerial photography. The services of the Authority have been used extensively in Egypt in the planning of development projects, archaeological explorations, mapping, environmental studies and in mineral resources exploration. The facilities available at the Authority have been the object of constant expansionand improvement. Since 1976, the Authority has been acknowledged as a regional resource serving the Arab and African countries.

Other Research and Development Organizations

The Ministries of Agriculture and Health in Egypt also operate a large number of research stations in agriculture and medical research (generally conducted in hospitals). In fact, some two-thirds of all publications in Egypt, as in other Arab countries, are in medicine and the agricultural sciences. Thus, medical personnel and agricultural scientists are the leading arms of R&D activity. Needless to say, practically all these publications are of a very applied nature.

Utilization of Research and Development

ASRT has published an analysis of its R&D contributions to the socio-economic development of Egypt (ASRT, 1990a and b). It is clear from this account that the economic impact is far greater than the expenditure on R&D. Yet, the under-utilization of R&D capabilities has been clear to planners and decision makers for many years—in fact since 1940. Various reforms of the R&D system have been planned and discussed, and some measures have been adopted with a view to enhancing the utilization of existing professional resources. The potentialities are so considerable that enormous effort is required to harness them. So far, the efforts made have not been commensurate with the potentialities.

The central obstruction to the use of Egyptian potential in S&T in development arises from the absence of sound technology and economic policies. The absence of careful analyses of the requirement of the economy in terms of technical services, the over-centralization of decision making and the weakness of professional organizations have all undermined the genuine attempts made to overcome this problem. Egypt has no excuse for remaining in the Third World category.

A few illustrations of successful efforts are presented here. One of the earliest projects entitled 'More and Better Food' was initiated by ASRT in 1978. It was concerned with improving the production of a large variety of crops and animals. An important component of the project was to promote the integration of R&D institutions with the users of R&D. Substantial improvements in quality and yields were achieved (El-Nockrashy et al., 1987). A promising approach adopted by ASRT for harnessing some of the scientific talent was to sponsor, in 1990, the Science and Technology Cooperation Programme (STCP) in cooperation with USAID. The objective of the STCP was to develop bridges between the users and producers of R&D. All projects to be sponsored by the STCP have to be led by a user, that is, by the demand side. The secretariat of the STCP assists the user by developing an effective link-up between the user and the provider of the R&D. The STCP also supports the project between the two parties by funding the foreign exchange component of the research contract.

During the first three years of the STCP, sixty-four contracts were arranged between fifty-four firms (thirty-two public and twenty-two private) and thirty-six R&D institutes. The implementation of these projects involved 1,705 researchers and technicians. Of these, 35 per cent came from the user side and the balance from the R&D side. The user had to make a cash contribution. The size of these research contracts varied from $60,000 to $1 million. Although the programme is still new, the success rate has been high—more than half the projects sponsored have led to a positive economic result to the user. ASRT also established a Small Scale Industry Programme in 1988 to encourage young entrepreneurs with limited capital to establish small scale industries. ASRT initiated this programme by inviting proposals from entrepreneurs. A total of 1,500 such proposals were received; each was studied and evaluated by professionals. Forty-eight projects emerged from these 1,500 proposals; techno-economic studies proved the viability and usefulness of each of these forty-eight projects.

Four demonstration centres were established to diffuse the know-how to interested entrepreneurs, and detailed instructions and training programmes were prepared. An entrepreneur, given a small capital, can receive free technical assistance to set up a small industrial or agricultural activity. The reactions to these programmes have been very promising (El-Nockrashy, 1993).

A Survey of Publications from the Arab Countries in National and International journals

Comprehensive surveys of scientific output are difficult and expensive to undertake. The Committee for the Development of an Arab Strategy in

Science, established by the Arab League Educational Cultural Scientific Organization (ALECSO), commissioned a field study to determine the research output of the Arab countries.[2] The following Arab countries provided information: Algeria, Egypt, Iraq, Jordan, Kuwait, Saudi Arabia, Sudan, Syria and Tunisia. The study was based on available official and/or semi-official records of a country's publications. These records included publications in national and foreign periodicals as well as notices of presentation of papers in scientific meetings, books and dissertations presented in foreign universities. It is not certain whether these national bibliographic sources quoted only refereed journals and publications in professional journals. No information could be gathered about the editorial policies of these compilations. The compilations included research of an academic and applied nature. No information was provided on the completeness of the data utilized; many of the compilations were found to be incomplete and the bibliographic information in them was not standardized.

The data was compiled f69 Tw0. 0 1 21.8 Tw0.254 Tc(abou) 41ht Tj0(d) Tj1.782 Twa.457 Tw0Tw0.1 T

TABLE 3.5
Publication Output in the Arab World by Country and by Field, 1981-85

Country	*Basic Sciences*	*Medicine*	*Engineering*	*Agriculture*	*Economics and Manage-ment*	*Total*	*Per cent of Arab World*
Egypt	829	1924	747	1089	497	5086	70.6
Saudi Arabia	71	255	104	49	30	509	7.1
Algeria	12	172	71	14	44	313	4.3
Tunisia	12	146	40	57	–	255	3.5
Jordan	93	48	28	21	19	209	2.9
Kuwait	80	82	32	4	–	198	2.8
Morocco	57	80	14	42	–	193	2.7
Iraq	80	20	23	36	12	171	2.4
Sudan	19	31	11	83	1	145	2.0
Syria	28	34	29	21	8	120	1.7
Total	1281	2792	1099	1416	611	7199	100
Per cent of Total	17.8	38.8	15.3	19.7	8.5	100	

Source: **Ahmaretal.,** 1987.

Distribution of Output by Field

Table 3.5 shows that 75 per cent of the output of research work is in medicine, agriculture and engineering. This emphasizes the applied nature of research in the Arab countries. In fact, many of the publications listed under the basic sciences are in the applied sciences. Strictly speaking, R&D in advanced fields of S&T is on a very limited scale in all Arab countries. The scale of the activity is often circumscribed by a new faculty member who may have recently returned from studying or working abroad. The country distribution of the publications in international journals is very different from that in national publications. Egyptian scientific workers publish heavily in national scientific journals; this is not the case in most of the other Arab states.

Comparison with Other Third World Countries

The research output of the Arab countries, and especially that of Egypt, compares favourably with that of other Third World countries. Table 3.6 summarizes such data. Egypt stands well above other major Third World countries. The performance of the combined Arab world compares

TABLE 3.6
Annual Per Capita Output of Scientific Publications (Average for 1978-80)

Country	*Annual Per Capita Output*
USA	890.0
India	26.1
Turkey	8.1
Iraq	19.9
Algeria	4.0
Morocco	3.8
Brazil	17.1
Egypt	34.0
China	1.2
Nigeria	14.0
Mexico	12.2
Taiwan	31.2
Saudi Arabia	26.0
Republic of Korea	4.7
Sudan	6.9
Lebanon	36.9
Kuwait	77.9
Tunisia	14.6
Libya	20.9
Jordan	17.9
UAE	11.3
Somalia	1.5
Syria	0.8
ARAB WORLD	17.3

Source: ISI, Philadelphia, USA.

favourably with the rest of the Third World in terms of per capita research output in international journals monitored by ISI.

Arab Scientific Journals

Arab scientific journals are, at best, of limited importance. These publications have yet to attain a high level of maturity in terms of their continuity, quality, regularity of publication and uniformity of content. The bibliographic information on Arab publications serving the scientific community is incomplete. The best that could be done was to estimate their number and assess their contents by examining available records, such as those at the Library of Congress and an extant survey published by ALECSO.

The Arabic section of the US Library of Congress compiles and collects periodicals in a systematic manner. These records indicate that there were eighty-three periodicals known to the US Library of Congress that were published in Arabic in the Arab countries. The US Library of Congress was unable to obtain copies of all the issues of these publications on a regular basis. Many of these periodicals are published erratically. Thus, it was not possible for me to examine copies of all these publications to verify whether they would meet the minimum requirements of professional journals. These eighty-three periodicals were published in Egypt (forty-four), Iraq (thirteen), Saudi Arabia and Morocco (five each), Jordan and Palestine (three each), Sudan, Lebanon, Tunis and Kuwait (two each), and Algeria and Syria (one each). The largest number of these publications was in the medical field (twenty-two), followed by seventeen (mostly published in Egypt) in the basic sciences, fifteen in engineering, thirteen in agriculture, six in geology, five in general technological areas and the balance in other fields.

The only other source that could be utilized to verify these findings was the ALECSO publication (ALECSO, 1981). This listed only fifty-eight professional journals. Of these, seven were from Egypt, eight from Iraq, ten each from Libya and Morocco and seven from Jordan. The distribution of these journals by field was: medical (five), agriculture (nineteen), general science (seven), petroleum (three), engineering (five), information (seven) and the balance in other fields. Clearly the two lists do not correspond to each other. Since these journals are not published regularly, they cannot become instruments for the diffusion of useful knowledge. They lose the interest of their potential readers and the information published in them is often so late that it is obsolete.

The ISI publishes annually a series of bibliographic compilations essentially based on citations of scientific articles by the scientific community itself. In other words, the policy of ISI is that if scientists cite particular articles in particular journals, it means that they find them useful. It uses the list of cited journals as a base to compile its bibliographic lists. In 1989, the ISI included only one Arab journal in its list of surveyed journals—a journal published by the University of Kuwait. None of the journals published in Egypt were cited or surveyed by ISI in 1990. This gives us an idea of the relevance of Arabic publications to the international monitoring of scientific output.

Bureaucratization of Science

The professional performance of scientists and technologists depends on their creativity and motivation. The relationship between the individual, his institution and society is delicate and complex. Science is managed by peer groups and not by bureaucracies. Scientific activity is heavily dependent on access to information and to the belonging of individual scientists to invisible colleges that regulate the rapid diffusion of research information. Unless society provides the basic requirements for undertaking scientific research, the scientist is disabled and cannot participate effectively in scientific enterprise. Government is called upon to facilitate the processes of diffusion of knowledge, the provision of education and training, the encouragement of invention and innovation, and the promotion of the application of knowledge. Bureaucrats play a back-seat role in science; intelligent governments seek to harness creativity and talent, and not to deem it within their power to intervene bureaucratically in scientific matters. In general, they leave it to the scientific community to argue findings, and formulate theories and educational systems. The standards of the scientific profession are thus self-applied. Needless to say, governments influence scientific activity indirectly by providing funding for some and refusing funding for others. Here the intervention is peripheral; the allocation of funds to specific projects is generally performed by the scientists themselves, who evaluate the research proposals and the qualifications of the research workers.

In Egypt, the process of bureaucratization of S&T preceded the emergence of scientific communities. The very programme which led to the selection and dispatch of young people to study abroad in the nineteenth century was centrally decreed. The selection of students was not a reflection of the personal scientific and intellectual aptitudes of the scholars but rather based on a bureaucratic process. The post-independence educational programmes established by most Arab states were of a similar nature: the state provided scholarships to students to study abroad and the students were often selected on the basis of their loyalty to a political party. It is reasonable to expect that countries which discover a need for an increase in the number of professional and scientific manpower would pursue their objectives through some central planning. The issue is not the need to plan foreign study, but rather the manner in which students are selected and assigned courses of study. The allocation of jobs to scientific manpower returning from study abroad is generally not any more logical than the initial process of selection. Most elements of personal choice and scientific interests are usually eliminated from the selection of a foreign study programme and the later assignment of a post.

A major feature of the process of bureaucratization is the development of ministries that are responsible for higher education and scientific research. The senior staff of these ministries, despite their apparent enthusiasm, lack essential practical experience. The staff of these ministries generally subscribe wholeheartedly to rigid centralized forms of organization. These bureaucrats plan science as if it were a matter of counting tomatoes. Creativity, concepts and institutions are downgraded and reduced to vacuous arguments. The sensitivity of an intellect, the level of creativity of the individual scientist, or the particular needs of each member of the scientific community is not a subject of concern or interest to these bureaucrats. The educational systems that were to transform the Arab world have never been subjected to critical analyses and appraisals. Alternative approaches are rarely discussed with any thoroughness, nor are the experiences of other cultures compared or examined.

Not surprisingly, the only independent 'external' inputs have been made by a small number of bureaucrats in a few UN organizations—such as UNESCO—or the World Bank. Very few of the consultants working in these organizations have any meaningful intellectual experience in industrial or developing countries. Furthermore, their contributions usually support the belief prevalent in central planning and the importance of linkages to the top decision maker. Governments and regional Arab conferences discussed reforms. UNESCO sponsored the Conference on Science and Technology Policies in the Arab States (CASTARAB) in Rabat in 1976. It was shown elsewhere that CASTARAB avoided serious discussion of the important issues and concentrated instead on the issuance of the pompous and vacuous Rabat Declaration (Zahlan, 1980). None of the modest recommendations made at the CASTARAB conference were implemented. The follow-up conferences failed to materialize. Similarly, ALECSO sponsored three different programmes of study on education, culture and science in the Arab world. In each case, 'responsible' and 'competent' scholars, officials and scientists formed the committees designated to undertake the studies. The latest exercise of this nature was the one sponsored by ALECSO leading to the preparation of an Arab Strategy in Science. All these bureaucratic attempts have failed to deliver useful results.

The process of bureaucratization of the management of scientific communities and institutions as practised in the Arab countries has resulted in a number of bizarre patterns of behaviour. Two examples may be cited to illustrate this point. First, one of the characteristics of scientific activity is that information circulates freely. One of the consequences of the process of bureaucratization is control over the process of circulation. Second, often a research institute produces nothing worth publishing; in some cases the 'research' findings are of such a local character that there would be few periodicals interested in publishing these findings. Judging from a survey of the journals published by the colleges of science and engineering of various Arab universities, it is unlikely that the papers that they publish are of scientific relevance or importance.

Conclusion

The condition of the persistent underdevelopment of Egypt and the rest of the Arab countries is not due to the lack of access to scientific knowledge,

nor is it due to a shortage of scientists and technologists. The abundance of scientific and technical manpower, their under-utilization and the resulting brain drain confirm the importance of relevant economic and technology
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Notes

1. About the research activities of the NRC see annexure.
2. For a detailed account of the report presented by this Committee, see ALECSO (1989).

References

Ahmar, Salah al-, Akram Nasser, Muwafak Da'aboul and **Munzer Hindawi** (1987). 'Arab Scientific Output' (mimeo.). Damascus: Strategy Committee.

ALECSO (1981). *Arabic Periodicals* (in Arabic). Tunis: ALECSO.

———. (1989). *A Strategy for the Development of Science and Technology in the Arab Nations: The General Report and the Sectoral Strategies* (in Arabic). Beirut: The Centre for Arab Unity Studies.

ASRT (1990a). *History of the Scientific Movement in Modern Egypt* (8 volumes in Arabic). Cairo: ASRT.

———. (1990b). *Science and Technology Development in Egypt: Ten Years Review and Outlook, 1982-1992.* Cairo: ASRT.

Bernai, M. (1987). *Black Athena: The Afroasiatic Roots of Classical Civilisation, Volume 1: The Fabrication of Ancient Greece, 1785-1985.* London: Free Association Books.

Davis, E. (1983). *Challenging Colonialism: Bank Misr and Egyptian Industrialisation, 1920-1941.* Princeton: Princeton University Press.

El-Nockrashy, A.S. (1993). *A Case Study on National System for Productive R&D Management: The Science and Cooperation Program.* Cairo: ASRT.

El-Nockrashy, A.S., Osman Galal and **Jay Davenport** (1987). 'More and Better Food: An Egyptian Demonstration Project'. Unpublished Report. Cairo: ASRT and Washington: The National Research Council.

Hubaysh, **Ali** Ali (1992). *Absorption of Technology and Contemporary Challenges* (in Arabic). Cairo: ASRT.

Sabet, Adel (1969). 'UAR Commitments to Science and Technology', in C. Nader and A.B. Zahlan. *Science and Technology in Developing Countries.* London: Cambridge University Press.

Zahlan, A.B. (1980). *Science and Science Policy in the Arab World.* London: Croom Helm.

———. (1990). *Future Manpower Needs of the Arab World* (in Arabic). Amman: Arab Thought Forum.

***Zahlan*, A.B.** and **Rosemarie, Said Zahlan** (eds.) (1978). *Technology Transfer and Change in the Arab World.* Oxford: Pergamon Press.

Ziadat, Adel A. (1986). *Western Science in the Arab World: The Impact of Darwinism, 1860-1930.* London: Macmillan.