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End-of-Decade Review of the Implementation
of the Vienna Programme of Action on Science and Technology
for Development in the ESCWA Region
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REGIONAL REVIEW PAPER

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CONTENTS

Introduction

This end-of-decade review of the Vienna Programme of Action on Science and Technology for Development in the ESCWA region is presented in two parts. Part one is composed of six chapters. The first chapter is a brief review of the socio-economic setting of the region during the past decade; the second reviews science and technology policies and plans; the third deals with the development of human resources, especially in higher education; the fourth analyses and assesses research and development (R and D); the fifth discusses development in scientific and technological services; and the sixth identifies the role of international and regional organizations in the field of science and technology for development. Part two of the report contains the highlights of the discussion of the Regional Meeting which was held in Amman in November 1988, in connection with this End-of-Decade Review of Science and Technology in the ESCWA region. Part two includes a chapter on future orientation of science and technology in the ESCWA region and an annexed list of participants in the Regional Meeting.

Part One

DEVELOPMENTS IN THE ESCWA REGION

I. THE SOCIO-ECONOMIC SETTING IN THE COUNTRIES OF THE ESCWA REGION

Based on the type of economic system, structure of economy, level of the economic development and the state of science and technology the countries of the ESCWA region can be divided into three categories.

The first category includes Egypt, Iraq, Jordan, Lebanon and the Syrian Arab Republic. These are, in general, countries where the Government plays a dominant role in the economy. Their economies are diversified and not solely dependent on oil revenues, i.e. agriculture, industry and services make a sizeable contribution to the gross domestic product (GDP) and science and technology institutions, apparatus and personnel are generally better developed than in the other two categories of countries. These countries also have a relatively large percentage of university graduates.

The second group includes the six members of the Gulf Co-operation Council (GCC):Bahrain, Kuwait, Qatar, Oman, Saudi Arabia and the United Arab Emirates. With the exception of Saudi Arabia, which has a relatively large population of over 6 million, these countries have a relatively small indigenous population; in most, the population is below 1 million. The countries in this group depend primarily on oil revenues and remittances from the investment of part of their oil revenues abroad. They have a relatively well-developed services sector and are giving increasing consideration to the development of manufacturing industries. Although some of their science and technology institutions and apparatus are well-developed, they nevertheless suffer from a shortage of qualified indigenous science and technology personnel. And while the Governments of these countries play a pivotal role in managing oil revenues and implementing national development plans, their economic systems are more liberal than in the first and third groups.

The third group includes the Yemen Arab Republic and Democratic Yemen. Despite the many differences in the economic systems of these two countries, they share a common characteristic in that they have the lowest per capita income among the countries in the region. They are relatively poorly endowed with natural resources, while their economic structure is weak and underdeveloped. They also lack most of the basic science and technology requirements.

In 1985 the total population of the region was 107.6 million. Nearly 70 per cent of the total lived in the diversified economies, 15.4 per cent in GCC countries and the rest (2.5 per cent) in the two Yemens. Egypt, with 48.5 million inhabitants, has the largest population. The average population growth of these countries is over 2.6 per cent, and a high percentage of their population is composed of young people (50 per cent of the population is below 15 years of age).

Another common characteristic of the region is the small area of arable land. Arable land in the region amounts to only 6.8 per cent of the total area. Cultivated land amounts to only about 54.2 per cent of total arable land. On average, therefore, cultivated land represents only 3.7 per cent of the total land area. The ratio is 7.7 per cent for the diversified economies, 0.5 per cent for GCC countries and 5.7 per cent for the two Yemens.

With regard to the economic structure, only minor changes have taken place in the shares of the various economic sectors in gross national product (GNP). In the diversified economies, agriculture represented on average about 19.0 per cent, manufacturing 13.0 per cent and services 55 per cent. In GCC countries, agriculture represented on average about 2.5 per cent of the GNP, manufacturing 8.0 per cent, and services 40 per cent. Mining constituted the largest sector. In the two Yemens, agriculture represented about 27 per cent of GNP, manufacturing 8.0 per cent and services 55 per cent. The share of the mining sector ranged between 4.2 to 5.8 per cent in the diversified economies, 18.3 to 22.3 per cent in GCC countries and only 0.1 per cent in the two Yemens.

These figures represent a change of only 1 or 2 per cent between those recorded at the beginning of the decade. This reflects the difficulty encountered by these countries in making the structural changes needed to promote self-sustained growth.

The ESCWA region is the world's largest crude oil producer and exporter. All of the GCC countries are oil producers. Among the diversified economies, only Jordan and Lebanon have failed to discover oil. Oil was recently discovered in the two Yemens.

All three groups of countries have a heavy reliance on foreign trade. Crude oil remains the most important export commodity. The share of fuels in the aggregate dollar value of exports ranged between 92 and 96 per cent during the period 1975 to 1985. Exports of petroleum products also increased both in value and in volume. In 1983, they reached 8 per cent of the total exports of the region. The region's non-fuel exports, however, were generally small and stagnant. They consisted mainly of primary agricultural (cotton) and non-agricultural (phosphates) commodities. The share of manufactured and non-manufactured goods was negligible. This has been the trend since the early 1970s. In recent years records indicate that some oil-producing countries achieved a limited diversification of their exports, which was closely linked to oil derivatives such as fertilizers and petrochemicals.

Imports into the region in the 1980s fluctuated, which reflected the sharp changes that took place in oil prices and revenues. Nevertheless, the overall composition of imports remained more or less unchanged. In 1985, imports of merchandise to GCC countries amounted to $US 41.0 billion; those of the diversified economies totalled $US 30 billion, while those of the two Yemens were only $US 3 billion. Machinery and transport equipment represented about 45 per cent of imports of both Iraq and Saudi Arabia, 44 per cent of those of Kuwait, 25 per cent of Egypt, 20 per cent of those of Jordan and 19 per cent of those of the Syrian Arab Republic and the two Yemens. A substantial part of these imports constituted payments for related software.

ESCWA countries import more than half of their food requirements. Net imports of agricultural products amounted to about $US 12.7 billion in 1980, increasing to $US 15.9 billion in 1985. The annual increase in food consumption in the region was about 5 per cent more than the increase in food production in the region.

Therefore, excluding crude oil exports, the ratio of exports to imports in ESCWA countries is unfavourable, low and declining. This indicates a growing reliance on the supply of foreign goods. Moreover, the commodity composition of these imports shows that most imports are made up of food items and consumer goods, both durable and non-durable. Imports of capital goods, although substantial in absolute terms, were next in importance.

Two more trends in trade in the region are worth mentioning. First, from the mid-1970s, when there were dramatic increases in oil revenues, there were (and still are) important flows of manpower (qualified, skilled and unskilled) from the oil-poor and relatively densely populated Arab countries, to the oil-rich countries, and from the oil-rich countries, there was (and still is) a flow of finance to oil-poor countries. This took the form of remittances and aid. Secondly, these two flows were not accompanied by a regional commodity flow. Despite the continuous efforts of the Arab League to promote regional trade of goods, the volume of trade is relatively negligible, which indicates that the production structure of these countries remained relatively weak and that Arab countries have, so far, failed to integrate complementarity into their development plans.

It is against this background, then, that the review of the Vienna Programme of Action on Science and Technology for Development in the Economic and Social Commission for Western Asia (ESCWA) region is taking place. This background is characterized by the prevalence of acute problems such as desertification and the need for better utilization of water resources, lack of complementarity in development plans, generally under-developed production structures, a heavy reliance on imports, even for basic goods, and imbalances in the supply of human resources among these countries. At the same time, however, there are great opportunities for development in the region.

Finally, ideally, it would have been highly desirable and useful to conduct the review for each of the three categories of countries separately. Unfortunately, scarcity of data and the disparity in the information available about the countries in each category made this task extremely difficult. Nonetheless, whenever possible an attempt is made to compare the cases.

II. SCIENCE AND TECHNOLOGY POLICIES IN THE ESCWA REGION

A review of science and technology policies in the ESCWA region will be concerned with two aspects of science and technology policy. First, the policies concerned with the advancement of scientific knowledge, scientific infrastructure, and technological capabilities; and secondly, the efforts made in the region to turn technology trade into technology transfer.

In the diversified economies the 1980s saw the setting up of central bodies responsible for national science and technology policies and plans. The bodies that were already in existence at the beginning of the decade had their responsibilities and functions expanded. Thus, in Egypt the Academy of Scientific Research and Technology is responsible for formulating national science and technology policies and plans. The Ministry of Higher Education and Scientific Research took responsibility for scientific policy. In Iraq, while there was no central body responsible for science and technology policy, responsibility was shared between the Scientific Research Council (SRC), Ministry of Higher Education and Scientific Research, and the National Committee for Technology Transfer. The Scientific Research Council was reorganized in 1980 and entrusted with the task of formulating research and development plans and strategies. The National Committee on the Transfer of Technology is still an advisory committee that has no executive power. The Committee recently submitted a technology transfer plan to the Government to be integrated into the development plan.

In Jordan, the Higher Council for Science and Technology was established in 1987 to take responsibility for formulating national science and technology policies and plans. In the Syrian Arab Republic, the Higher Education Council, which is chaired by the Minister of Higher Education, formulates policies for research at the country level, and the Centre for Studies and Scientific Research implements research programmes designed to serve production sectors. With the exception of Lebanon, all of the countries in the diversified economies group now have ministries of higher education that formulate policies for higher education. The research centres are headed by directors who have ministerial rank.

The development plans of several countries in this group make explicit reference to the principal issues of concern in science and technology for development. This includes for example, enhancing financial resources for science and technology, linking research and development activities to national priorities and needs, developing appropriate science curricula for schools and colleges, establishing centres for standards quality control, setting up information centres and improving local consulting, engineering and design services.

Among GCC countries, Bahrain, Oman, Qatar, and the United Arab Emirates do not yet have national science and technology policy-making bodies. In Kuwait, the Kuwait Institute for Scientific Research (KISR) formulates its research programme in a manner that is consistent with national needs. In Saudi Arabia, the King Abdul Aziz City for Science and Technology (KACST) is responsible for the formulation of national science and technology policies and supporting research activities at the national level.

Among the six GCC countries, only Kuwait and Saudi Arabia have ministries of higher education. These ministries support research at universities and formulate national policies and plans for higher education.

As will be seen in the next chapter, the main concern of science and technology policies in GCC countries is to increase the supply of qualified indigenous manpower. Improving the education system, encouraging women to join the labour force and improving technical skills also form part of this strategy. In Saudi Arabia, for example, one of the eight major strategies included in the Fourth Development Plan (1985-1990) is concerned with the development of human resources and the promotion of scientific research.

In the two Yemens, there is no national body with responsibility for science and technology and there are no ministries of higher education. Science and technology infrastructure, institutions and manpower remain underdeveloped.

But how well did the science and technology policies and plans fare in the region.

With respect to building the basic science and technology infrastructure and producing qualified manpower and skilled workers, there have been improvements. In the 1980s, substantial progress was made in these fields in comparison with the previous decade. However, some intricate problems still remain. For example, there is a marked imbalance between the demand and supply of qualified manpower. The root causes of this disparity will be discussed in the following chapter. One institutional contribution to this imbalance has been the failure to match the supply of qualified manpower to the development needs of ESCWA countries. In 1984, there were approximately 1 million students in the universities of ESCWA countries, of whom 62 per cent were studying humanities and the social sciences. The number of students studying subjects related to basic human needs, industry and services was much smaller. As a result, there is a chronic imbalance in the composition of qualified manpower in the region. Closely connected to this is the question of how far technology policies here helped to develop the technological capabilities that are needed to attain self-reliance in science and technology.

A technology policy tailored to meet this objective would emphasize the development of local capabilities for integrating science and technology policies into the development plan, define the technologies that are needed, negotiate contracts on advantageous terms, adapt and absorb newly acquired technologies and execute these technologies in selected areas. These five issues are closely connected with the transfer of technology, and this transfer is at the heart of the development process in the region. It represents the largest part of the investment expenditure of ESCWA countries and it is in this area that these countries are facing a crisis.

For the purposes of review and analysis, only the main technological components of technology projects and the main types of technology transferred will be considered. This will suffice to outline the nature of the problems faced in the region.

The three most important technological components of a technological project are machinery and transport equipment, construction and technical services. During the period 1980-1982, ESCWA countries awarded technological contracts valued at $US 150 billion to foreign companies. Of this amount, $US 22.5 billion were for technical services.1/

It was noted above that ESCWA countries are heavily dependent on the import of all types of goods. Table 1 shows the total value of imports during the period 1980-1983 for a number of ESCWA countries, the value of imports of machinery and transport equipment, and the relative importance of each country. The table shows that during this period the total imports of ten ESCWA countries amounted to $US 396.4 billion, and that $US 145 billion (i.e. 37 per cent) were for machinery and transport equipment. The table also shows that this ratio was 40 per cent for GCC countries, 28-30 per cent for the diversified economies and approximately 27 per cent for the two Yemens. These ratios are higher than (in the former case) or equal to (in the latter two cases) the world average, for upper-middle-income countries.

An analysis of import data (see table 2) reveals two important points. First, in terms of the value of imports the following technologies were of greatest importance: telecommunications, medical equipment and services, petrochemical industries, commercial airline support systems, water supply and sewage treatment plants and nuclear power plants.

Secondly, about 80.0 per cent of non-military technology in the region is supplied by six industrial countries. These countries are Japan, the United States, the Federal Republic of Germany, Italy, France and the United Kingdom. These countries were also the main suppliers of machinery and equipment. Japan was the leading supplier, supplying 21.4 per cent of all of the machinery and equipment imported into the region, followed by the United States, with 19.7 per cent, the Federal Republic of Germany, with 14.4 per cent, the United Kingdom, with 9.9 per cent, Italy, with 9.5 per cent and France with 8.6 per cent

If the analysis is taken further to both the home front and the supplying market, an interesting situation unfolds.

In the ESCWA countries, a proper approach to technology transfer would emphasize selection, acquisition, adaptation, assessment, management, maintenance and development of technology. These aspects are currently handled either by special departments in the ministries or by other agencies, such as the technology transfer office in the Ministry of Planning, a national or foreign consultancy firm, a private sector firm, a national research institute, or people working in the universities. Egypt is currently in the process of establishing a national network of technology transfer. When complete, this network will be the closest any ESCWA country has come to formulating a comprehensive and coherent policy for the transfer of technology at the national level.

1/ Economic and Social Commission for Western Asia, Patterns of Technology Transfer in the ESCWA Region and Methods for Improving their Efficiency (E/ESCWA/NR/87/18) (Baghdad, December 1987), p. 47, table 29.

The fragmented set-up for the transfer of technology at the national level is paralleled by the equally fragmented attitude of Arab countries when dealing with technology suppliers. There is, as yet, no co-ordination between the Arab countries with regard to the transfer of technology.

The technology suppliers, on the other hand (the six main suppliers referred to above), are all members of a group of industrial countries that have adopted a policy of co-ordination on several global issues, including the transfer of technology. Four of these countries are members of the European Economic Community, which co-ordinates technology transfer policies. Nevertheless, there is some competition between these countries. But if ESCWA countries are to use this to their advantage, they first have to be in a position to co-ordinate their technology policies. The advantages of co-operation and co-ordination become clearer when the patterns and forms of technology transfer in the region are considered.

Several patterns of technology transfer have been used in the region: turnkey projects, joint-ventures and the direct purchase of technology.

Joint ventures are employed in Saudi Arabia and Qatar. Egypt and Jordan are also encouraging them. Among the large projects that were established through joint ventures in Saudi Arabia are the Saudi Yanbu Petrochemical Company (a joint venture with Mobil involving $US 2 billion), the Al-Jubail Petrochemical Company (a joint venture with Exxon involving $US 1.3 billion) the Saudi Methanol Company (a joint venture with a consortium of Japanese companies involving $US 268 million), and the Qatar Petrochemical Company (a joint venture with CDF Chemie of France, involving $US 600 million). In all these cases the national government provided part of the financing and the raw material, while the foreign partners provided part of the financing and the entire technology package, including the licensing agreement.

These joint ventures are currently being run by the foreign partners. The extent to which the recipient countries will increase their participation in technical operations, management, maintenance and development will depend on the speed with which local capabilities in all of these areas can be developed.

The most common pattern of technology transfer especially in Egypt, Jordan, Iraq, the Syrian Arab Republic and also in some of the Gulf countries, is the direct purchase of technology. The recipient countries bear the cost of the project, but have the advantage of separating design and supervision from construction, procurement and management. The supplier generally provides training for local personnel on how to operate and maintain the project. In the absence of local technological capabilities, some ESCWA countries have tended to hire independent consultants in order to obtain advice on the best course of action to take. In some cases, when the supplying country also provided the funds, restrictions were imposed that the equipment had to be purchased from companies in the funding country. This was the case with the supply of telecommunications technologies to Yemen by the United States company AT and T.

In all three types of transfer, the two most common patterns have been licensing and contracts. Licensing might be part of a package, a contract, a joint venture, or the direct purchase of technology. A large number of technology transfer arrangements for the production of durable and non-durable consumer goods, pharmaceuticals, telecommunications and computers were through licensing agreements. However, this pattern of transfer frequently contained restrictive clauses. Indeed, licensing is the form that is closest to technology trade. At least two countries in the ESCWA region, Iraq and the Syrian Arab Republic, do not have licensing arrangements. In Egypt, the manufacture of pharmaceutical products under licence failed because there were too many restrictive clauses. Subsequently, Egypt successfully developed its pharmaceutical industry with its own capital and without a licence.

The transfer of technology through a contractual arrangement is the most popular method. As was mentioned above, between 1980 and 1982 technology contracts amounted to $US 150.4 billion. From the recipient's point of view, this form of technology transfer is the least restrictive. Efficient transfers through contracts require the availability of a national technological capacity to define needs, select suppliers, formulate contracts conduct negotiations, etc. In a number of ESCWA countries, therefore, when relatively sophisticated projects were involved, foreign consultancy firms were hired to draw up contracts. This was the case with the two Yemens and with many GCC countries. In Egypt, Jordan, Iraq and the Syrian Arab Republic, government design and contract units in the ministries participate with foreign firms in the formulation of contract documents. Iraq and the Syrian Arab Republic established public consultancy firms to prepare contract documents for construction activities.

The private sector in all ESCWA countries depends on the Government and on foreign firms to draw up contracts. It is interesting to note that financing institutions do not play any part in these operations.

This heavy reliance on foreign consultancy firms to prepare contracts to some extent offsets the advantage of transfer through contracts, as it is difficult to judge where the loyalties of the consultancy firm lie. Indeed, some countries hired a second consultancy firm to assess the contracts drawn up by the first firm.

What, then, are the main characteristics and problems of technology transfer in the ESCWA region?

The preceding review has revealed a number of points. First, the institutions concerned with the process of technology transfer are fragmented. As a result, decision-making bodies are diffused. Secondly, there are certain disparities within ESCWA countries regarding the development of science and technology infrastructure and human resources. Generally speaking, the development of a national infrastructure has not taken place at the same pace as that of the technology transfer. Most ESCWA countries still have a weak scientific and technological capability in such important areas as telecommunications, petrochemicals, electronics and informatics. In all these areas, there is a lack of specialized institutions, competent manpower and national development programmes.

The cause of the imbalance in the development of human resources lies in the policy for developing indigenous technological capabilities. The tendency in almost all ESCWA countries has been towards developing university graduates, mainly at B.Sc. level, and not towards development of skilled and semi-skilled manpower. It is common in ESCWA countries to see a large number of highly qualified manpower and a shortage of technicians in the same institution .

Thirdly, ESCWA countries suffer from an acute shortage of technicians and managers to operate and maintain technological projects. GCC countries relied on non-nationals to meet their needs, but the two Yemens were unable to pay this cost, and as a result they have suffered. However, all ESCWA countries currently face severe problems of maintenance and the supply of spare parts. This is primarily the result of the multiplicity of makers and suppliers and lack of local technological capabilities. In addition, the absence of co-ordination of technology policies at the national and regional level has effectively contributed to the problems of maintenance.

What therefore are the main directions which could be followed to alleviate these problems?

Three important points arise in this regard. The first is the need for a regional body to provide consultancy, engineering and design services to countries in the region. This was often emphasized during the Decade, but the need still exists, even more than before. Secondly, ESCWA countries stand to gain from co-ordinating the transfer of technology policies. Co-ordination such as this will improve the negotiating position of ESCWA countries <u>vis-à-vis</u> the technology suppliers. Thirdly, in order to be successful, any attempt at co-ordination needs to be given an order of priority that has to be agreed upon by the countries concerned.

The problem of fragmentation and diffusion of decision-making in technology transfer could be dealt with by establishing institutional contacts. Egypt is currently attempting to find a solution by establishing a national network to deal with matters related to science and technology. Another approach is being developed in Jordan and Saudi Arabia through the establishment of co-ordination and co-operation at the sectoral level. Under this method, in agriculture, for example, the assessment and development of agricultural technology would be the responsibility of the National Agricultural Research and Development Centre, which in turn is able to sub-contract the implementation of projects to a network of related institutions. A common feature of both approaches is that they facilitate regional co-ordination.

The problems of inconsistency, imbalance and maintenance could be alleviated through the co-operation and co-ordination of technology policies between ESCWA countries. One aspect of co-ordination would be to establish group negotiation with the technology suppliers in order to improve the conditions of transfer. In the short term, the aim of co-ordination should be to negotiate better terms for training nationals to operate, maintain and manage the technology being transferred. This can be achieved through a general strategy of improving licensing rights and removing restrictive clauses from contracts. The long-term aims should be to involve technology suppliers in the establishment of joint institutions for the transfer process, to agree on the local manufacture of spare parts and to secure the right to establish maintenance and training facilities in the region.

Indeed, maintenance is an important aspect that can be developed in the future. Maintenance and quality control are activities closely linked to the development of indigenous technological capabilities on the firm and national levels. If co-ordinated, organized and funded, they provide a systematic long-term cumulative contribution to building indigenous technological capabilities. The extensive range of technologies that have been introduced into the region over the last two decades provides such an opportunity. Therefore, serious efforts should be made to develop maintenance capacities in such priority areas as medical equipment, research and development equipment, civil aviation facilities and airplanes, as well as industrial projects with processing lines. These are areas where close co-operation can take place within the region.

Countries in the region can also benefit from co-ordinating their technology policies to acquire telecommunications technology, petrochemical and pharmaceutical industries, biotechnology, informatics, micro-electronics, agricultural technology and water resources development, including recycling. The advantages of group negotiation of the terms and conditions in all of these areas can not be over-emphasized. One important point, however, should be stressed: co-ordination and co-operation should first take place in the countries themselves. This requires the integration of technology policies into development plans, a condition which has not yet been met in any ESCWA country.

A. Science and technology policy at the regional level

In the 1970s and 1980s, several regional organizations and Arab summit meetings concerned themselves with science and technology policy issues. Judging from the declarations and joint plans of action that were formulated, they were well aware of the problems and their implications.

The implementation of the recommendations of regional meetings and summits, however, is far from satisfactory. For example, the 1976 decision by the Conference of Ministers of Arab States Responsible for the Application of Science and Technology to Development (CASTARAB) to establish a joint fund for the financing of joint research programmes has been shelved, although a detailed feasibility study was carried out by the Kuwait Fund for Arab Economic Development and several ministerial committee meetings discussed the fund's charter. With regard to the Regional Centre for Development and the Transfer of Technology, this project, with the extensive participation of Arab countries, was prepared by ESCWA in 1978 at their request. It was approved by representatives of Arab Governments and was submitted to the Arab League for implementation. The Social and Economic Council of the Arab League decided to shelve it. In 1980 the 11th Summit of Arab Heads of States in Jordan approved the strategy for joint Arab economic action. The content of this strategy is almost in line with the Vienna Programme of Action. Food and technology security are given priority with the aim of achieving self-reliance, satisfying the basic needs of the population, and increasing economic integration among Arab States. The strategy, however, is only an indicative document that points to future actions. Its implementation depends on the member States themselves. Since technology policies in these States are not incorporated into their development plans, it is not surprising therefore, that progress in implementation of this strategy has been very slow.

Table 1. Total imports and imports of machinery and transport equipment (M and TE) in a number of ESCWA countries (1980-1983)

(Billions of US dollars)

Country	Total imports	Percentage value of M and TE	Value of total M and TE
Saudi Arabia	154.9	41	74.1
Iraq	83.8	30	27.1
United Arab Emirates	83.8	30	14.1
Kuwait	32.7	40	13.1
Egypt	36.4	28	10.3
Syrian Arab Republic	17.7	28	5.3
Oman	9.8	41	4.1
Jordan	12.9	28	3.5
Yemen Arab Republic	7.0	28	1.9
Democratic Yemen	4.5	27	1.2
Total and average	396.4	33	144.9

Source: Economic and Social Commission for Western Asia, Patterns of Technology Transfer in the ESCWA Region and Methods for Improving their Efficiency (E/ESCWA/NR/87/18) (Baghdad December 1987), p. 34.

Table 2. Composition of imports by main type of technology and value of contracts awarded in four types of technology for four ESCWA countries (1978-1982)

(Millions of US dollars)

ESCWA country	Technical services	Supply of equipment	Construction	Total	Total telecommunications in four countries (percentage)
	Telecommunications				
Saudi Arabia	1 362	5 881	293	7 536	68.0
Egypt	21	2 442	4	2 467	22.3
Iraq	15	828	149	992	8.9
Kuwait	13	73	7	93	0.8
Total	1 411	9 224	453	11 088	100.0
	Commercial airline support systems				
Saudi Arabia	953	338	2 348	3 639	66.99
Egypt	7	135	122	264	4.9
Iraq	3	11	1 486	1 500	27.6
Kuwait	0	4	36	39	0.7
Total	963	447	3 992	5 442	100.0
	Medical services				
Saudi Arabia	1 925	31	2 950	4 906	78.1
Egypt	0	3	47	50	0.8
Iraq	0	16	1 264	1 280	20.4
Kuwait	1	18	22	41	0.7
	Petrochemical facilities				
Saudi Arabia	-	751	4 497	5 248	92.2
Egypt	-	-	168	168	3.0
Iraq	-	2	-	2	0.0
Kuwait	-	131	139	270	4.7
Total	-	884	4 804	5 688	100.0
	Total for the four sectors				
Saudi Arabia	4 240	7 001	10 088	21 329	74.8
Egypt	28	2 580	341	2 949	10.4
Iraq	18	857	2 899	3 774	13.3
Kuwait	14	225	204	443	1.5
Total	4 300	10 663	13 532	28 495	100.0
Percentage	15 0	43 5	47 5	100	

Table 2 (continued)

ESCWA country	Technical services	Supply of equipment	Construction	Total
	Distribution of share of three groups of countries			
Six major industrial countries	46	69.1	76.1	68.9
Other countries outside the region	23.2[a/]	30.3[b/]	16.2	22.5
Countries of the region	30.7	0.6	7.6	8.5
Total	100.0	100.0	100.0	100.0
	Distribution of the share of the six major industrial countries			
Unites States	75.5	37.2	43.6	44.4
Japan	3.4	16.5	7.9	10.7
Federal Republic of Germany	2.8	10.2	7.0	7.8
United Kingdom	16.3	11.6	1.5	6.8
France	0.2	21.5	30.9	24.3
Italy	1.9	2.9	9.1	6.1
Total	100.0	100.0	100.0	100.0

Source: Economic and Social Commission for Western Asia, Pattern of Technology Transfer in the ESCWA Region and Methods for Improving their Efficiency (E/ESCWA/NR/87/18) (Baghdad, December 1987), pp. 41-42.

a/ Comprised of one Canadian communication technical service contract (Bell of Canada).

b/ Comprised of several Swedish and Netherlands companies in telecommunications.

III. DEVELOPMENT OF HUMAN RESOURCES IN THE ESCWA REGION

In ESCWA countries, education at all three levels, primary, secondary and higher, is provided free by the Governments, except in Jordan where a fee is charged for university education.

There has been marked development in basic education in the region. The number of first level students in the region increased from 11.3 million in 1980 to 13.2 million in 1984 (the last year for which aggregate data were available). In each of the three categories of countries considered, growth rates in enrolment in the first and second level of education in the same year were high, ranging from about 5.0 per cent in the diversified economies to 9.0 per cent in GCC countries and the two Yemens. But there were wide disparities in enrolment according to age groups. In Egypt, Iraq, Jordan and the Syrian Arab Republic, the enrolment ratio by age group for the first and second levels increased from 66, 89, 91 and 71 respectively in 1980, to 72, 82, 93 and 89 in 1984. In GCC countries, this percentage ranged in 1984 from 55 in Saudi Arabia to 81 in the United Arab Emirates. In Democratic Yemen and Yemen, figures remained very low at 52 and 42 respectively. However, taking into consideration the substantial increases in the budget allocations for education in these countries, the difference could be narrowed in the near future.

The increases in enrolment in technical and vocational schools are unsatisfactory. Only Egypt reported a ratio of 21 per cent. In Iraq, Jordan, and the Syrian Arab Republic it ranged between 7 and 9 per cent in 1984, mainly owing to the low priority given to manual work and technical professions in the societies.

Visible increases were also recorded in higher education. There are now 52 universities in the ESCWA region, nine of which were established during the 1980s. The total number of university students increased from 751,000 in 1980, to 1.05 million in 1985, representing an average annual increase of 7.9 per cent. The number of university teaching staff increased from 25,294 to 35,594 during the same period. The number of graduate students studying for Ph.D. and M.Sc. degrees also increased, from 34,807 to 52,336, representing an average annual increase of 10 per cent. High growth rates in university education were achieved by countries in all of the three categories under consideration.

Serious efforts have also been made to eradicate illiteracy in the region. The percentage of illiteracy has fallen in almost all countries, ranging between 21 to 43 per cent in the first two categories of countries, and 49 and 58 per cent respectively in Democratic Yemen and Yemen.

Was the growth in the number of students matched by adequate teaching facilities? Did universities provide the right education for the economy? Was the standard of quality maintained? Did universities provide the type of education demanded by the society?

The answers to some of these questions will be discussed here and in other sections. It should also be noted that the following is based on a sample study of five ESCWA countries: Jordan, Kuwait, Democratic Yemen, Saudi Arabia and the Syrian Arab Republic.1/

(a) In the Syrian Arab Republic and Saudi Arabia, local universities supply most of the graduates in the fields closely related to science and technology (science, engineering, medicine and agriculture). During the period 1984 to 1985, only 15 per cent of graduates in these fields were educated abroad. However, in Democratic Yemen between 40 to 50 per cent of the graduates in these fields were educated abroad. In Jordan, which is unique in the field of higher education, the number of graduates educated abroad far exceeds those in local universities. Although three new universities have been established in Jordan during the 1980s, it is estimated that during the period 1986 to 1990, the number of Jordanian graduates abroad will be about 14,000, whereas graduates from Jordanian universities will number about 8,000.

(b) This shortfall in meeting local demand for qualifications in the fields of science and technology is accompanied by a shortage in the facilities of doctoral degree programmes. There are no universities in the ESCWA countries with doctoral degree programmes. Very limited M.Sc. degree courses are offered (in civil engineering, electrical engineering, chemistry and mathematics) in Egypt, Iraq, Kuwait, Saudi Arabia and the Syrian Arab Republic.

(c) Moreover, the ratio of students to university staff remained at about 29 to 1 throughout the period. However, there were wide disparities between individual countries. For example, in the Syrian Arab Republic it was 29 to 1, in Egypt and Iraq it was even higher, while in Jordan and Kuwait it was 22 to 1 and in Saudi Arabia 10 to 1.

(d) The ratio of students enrolled in universities to those enrolled in technical and vocational schools was very high, but it varied from country to country: in Saudi Arabia it was 9 to 1, compared with 25 to 1 in the Syrian Arab Republic and 1 to 0.8 in Democratic Yemen and Jordan.

(e) With regard to the adequacy of university facilities and based on direct interviews with faculty members teaching science and technology and related subjects in the five countries mentioned above, the availability of material resources needed was adequate in most cases and poor in others.

The extent to which existing education patterns are in line with the requirements of science and technology development will be reviewed in the section on science and technology service.

1/ Economic and Social Commission for Western Asia, Education for Higher-level Scientific and Technological Manpower: Identification of Measures and Mechanisms (E/ESCWA/NR/87/22) (Baghdad, January 1987).

IV. ANALYSIS AND ASSESSMENT OF RESEARCH AND DEVELOPMENT

The 1980s witnessed a number of changes in R and D in the ESCWA region. There has been a substantial increase in the number and qualifications of R and D personnel, in the number and types of R and D institutions, in the fields covered by R and D activities and in the plans, strategies and policy measures that have been introduced to strengthen R and D activities and their links with the production sectors. However, there are still a number of serious shortcomings in the organization of R and D in the region. Indeed, it is widely believed that the developments that have taken place in R and D were neither sufficient, compared with the rate of economic development in the region, nor fully in line with the requirements of that development.

There have been differences in the development of R and D activities in ESCWA countries, with wide gaps in the level and coverage of R and D activities. Egypt was (and still is) the most developed country in this respect. There are 297 institutions in Egypt that are concerned with science and technology, of which 275 institutions carry out R and D activities. Iraq, Jordan, Kuwait, Saudi Arabia and the Syrian Arab Republic narrowed the gap considerably between Egypt during the decade, but the two Yemens and the small Gulf countries are still far behind.

Another common feature of the region is the lack of separate and accurate data for R and D. Very little was achieved during the decade in this respect. There is no unified system for defining and classifying R and D data, neither for the region nor even for the same country. As a result, no accurate aggregate picture of R and D could be drawn up for the region. The following aggregate estimates give, at best, only a rough indication.

In all of the countries of the region R and D, particularly research activities, are carried out by three types of institutions: scientific research centres, universities and R and D units in government ministries. As noted below, the role of the research centres has been enhanced in almost all of the countries covered. Thus, in Egypt the Academy for Scientific Research and Technology is at the centre of planning and monitoring Egypt's five-year research plan. The same is also true of Iraq's Council for Scientific Research. In Jordan, a new institution, the Higher Council for Scientific Research and Technology, was recently established, and includes the Royal Scientific Society. In Saudi Arabia, the National Centre for Science and Technology was superceded by the King Abdul Aziz City research complex. These centres, which are primarily responsible for applied research, are largely government-financed, although recently the emphasis has turned to contract research as a source of financing.

Although in general the allocation for R and D as a percentage of GNP in the region increased during the 1980s (in some countries quite considerably), it still remains well below the world average and that for developing countries. Based on estimates of recurrent expenditure at R and D centres and universities in 12 ESCWA countries, and assuming that an average of 10 per cent of the universities' recurrent expenditure is spent on R and D activities, it is estimated that in 1984 total expenditure on R and D in the countries concerned amounted to $US 445 million. More than half this sum ($US 231 million) was spent on basic research in universities and the rest ($US 214 million) was spent on applied research in the research centres. The estimates do not include expenditure on R and D in research units in the ministries. But it is unlikely that much improvement will be made when this is included. Even adding 0.1 per cent of GNP for capital expenditure on R and D, at 0.25 per cent, the ratio would still be lower than 1.8, the world average for 1980: the average for the developed countries was 2.3 per cent, and that for developing countries 0.47 per cent.

In Egypt, the total expenditure on science and technology, including R and D, increased from 0.8 per cent of national income in 1979 to 1.2 per cent in 1980. In absolute terms, expenditure on R and D alone (which was available for one year only, 1983) amounted to $US 40.4 million. The total allocation for research in the 1983 to 1987 Five-year Research Plan amounted to $US 120 million. Although these expenditure figures do not include R and D capital expenditure, they are nevertheless still very low. For example, they are lower than the annual allocation for R and D in Kuwait, a country with a population of 1.5 million, compared with almost 50 million for Egypt.1/ In Jordan, the allocation for R and D activities in the development plan covers only capital expenditure and expenditure for the development of human resources. This allocation was not only relatively small in both development plans during the decade, but remained between $US 15 to 20 million for the five years of the plan. Some informed sources have placed the average ratio of expenditure on R and D during 1980 to 1985 at 0.15 per cent of GNP. This was about one fifth of the planned ratio stated in the successive five-year development plans. In Iraq, R and D expenditure data are not available, but the official estimate for expenditure on R and D for the period 1980 to 1985 is 1.2 per cent. In Kuwait, the government allocation for R and D increased from $US 20 million in 1977 to $US 50 million in 1982. Although the latter figure amounted to only 0.23 per cent of GNP, the low percentage is due to the relatively high level of oil revenues in GNP. The total sum allocated was nevertheless greater than in Jordan, for example.

During the period 1986 to 1987, the budget of the Kuwait Institute for Scientific Research (KISR) amounted to $US 60 million. Nearly $US 9 million of this budget was self-financing. In Saudi Arabia, the latest available data relates to 1979. It combines expenditure on higher education and science and technology, including R and D. Expenditure amounted to $US 5 billion. Higher education and educational projects, however, claimed the highest share. Taking into consideration the number of new research centres and the institutional changes that have taken place during the decade, research funds and facilities are more than adequate.

1/ Although the figures are much lower in Egypt, allowance should be made for the exchange value of dollars in both countries.

But the question remains as to the origin of R and D expenditure and its allocation between the various research sectors.

Egypt has no separate data on the main contributions to research activities. There is, however, a breakdown of researchers by the main research institutions which will be examined below but, it should first be noted that although the Academy has overall responsibility for research in Egypt, and it is the main financier of the research projects, the greatest part of its research funds are allocated to research carried out by universities and ministries. A breakdown of research expenditure figures was available for 1983 only. It showed that nearly 77 per cent of R and D expenditure was for research in higher education, 19.0 per cent for the commodity-producing sectors and 4.0 per cent for the service sectors. Moreover, nearly 15 to 20 per cent of the total represented capital expenditure, and the rest recurrent expenditure. Based on the information given for the five-year research plan (1982/1983 to 1986/1987), almost half of Egypt's total research funds were allocated to food and agriculture (48.6 per cent), followed by petroleum, energy and mineral resources (14.5 per cent), and health and medicine (9.0 per cent). The sum allocated to industry, environment and infrastructure did not exceed 21.0 per cent over the five-year period.

Also in Jordan, expenditure on research in universities was the largest (40 per cent of the total), followed by the Royal Scientific Society (RSS), with 27 per cent, and the Ministry of Agriculture with 11 per cent. The expenditure of the Phosphate Mining Company, one of the largest companies in Jordan, was relatively low and a breakdown of expenditure by activities was not available.

In Kuwait and Saudi Arabia, the expenditure pattern was similar to that in Egypt. Allocations between the different activities, nevertheless, were quite different. An analysis of completed and ongoing research projects in KISR for 1985 indicates that of the five programme areas, food and water resources, environment and engineering research claimed the highest share, followed by techno-economic studies and petroleum.

Analysis of employment figures in R and D activities bears out the same pattern. Employment figures are more complete and comprehensive in almost all the countries covered.

In Egypt, in 1982 to 1983, 46,797 persons were engaged in R and D activities. More than half were scientists and technicians, and the others (20,178) were employed in auxiliary R and D activities. Nearly 48.0 per cent of the scientists and technicians were in higher education and 31.0 per cent in the commodity-producing sectors. Based on the figures given in the 1982/1983 to 1986/1987 Research Plan, 40 per cent of researchers worked in the universities, a similar percentage in the ministries, and 20 per cent in research centres coming under the Academy.

Nearly half of the researchers held a Ph.D. or M.Sc. Only 8.2 per cent were engaged in engineering and technology research, while the majority were employed in natural, medical, and agricultural sciences.

In Jordan, no accurate information is available on the number of researchers. This is primarily owing to the fact that a unified concept has not been applied to define those who work in R and D activities. One source suggests that the number of researchers in Jordan increased from 1,241 persons in 1981 to 1,934 in 1984-1985. Most of the increase was among Ph.D. holders. The figures also show that most of the researchers (669) were in universities, followed by the Royal Scientific Society (293). The commodity-producing sectors employed 279 researchers (i.e. 27 per cent of the total). The highest proportion of researchers was in social sciences and humanities (31 per cent), followed by natural and engineering sciences (25 per cent) and agricultural and biological sciences (17 per cent). The majority of researchers were employed in the public sector, with only 4 per cent (49 persons) in the private sector. Although this situation has not changed fundamentally during the decade, it will only be verified when the survey recently completed by the Higher Council is published.

In Kuwait, KISR is the main research centre. The number of staff in KISR increased from 570 in 1979 to 989 in 1986, but only one third of this number were nationals. In 1986, the number of researchers increased to 334 (compared with 118 in 1979), and the number of nationals increased from 43 to 163.

Saudi Arabia faces a similar problem. In 1983, of a total of 89 researchers, in King Saud University (which had the largest number of researchers among the universities in the Kingdom), 70 were non-Saudi Arabian. During the decade, the main thrust of the development strategy in the country has been to redress this situation and increase the number of qualified Saudi Arabian researchers.

Tangible progress was made during the decade in the preparation of R and D projects and programmes. Some countries, notably Egypt and Iraq, have introduced five-year research plans and strategies. There have also been improvements in the method of selecting research projects, monitoring their execution and evaluating their results.

In all countries in which R and D plans were introduced, central responsibility for co-ordination with sectoral ministries and implementation was left to the national research centres. It would therefore be useful to make an analysis of the changes that have taken place in the methods of formulating research plans and their content.

In Egypt, a number of specialized research councils have been set up within the Academy, where each one roughly corresponds to one sector in the development plan, namely: food and agriculture, industry, petroleum, energy, mineral resources, health and medicine, the environment, transport and communications, construction and housing, new settlements, management and economic sciences, social sciences, demography and basic sciences. These were linked to networks of numerous commissions and committees, including 851 scientists, experts and retired high-ranking officials. The general principles that have guided the selection of research projects by council members include solving national problems, utilizing local technological capabilities and strengthening the links between research centres and the production sectors. The principle of bidding was applied to the selection of contracts in the majority of cases. However, in some cases bidding was limited when special expertise and facilities were required.

More or less similar procedures were applied in the preparation of the research plans in Iraq and the Syrian Arab Republic. Iraq, in fact, has also developed an R and D strategy. It is currently in the process of implementing its second research plan. Information on the latter is very scanty. The planning procedure, however, is not very different from what was described above for Egypt.

The plan included 357 research projects. They were predominantly in the public sector with some in the mixed sector and the private sector. Each research project contained a comprehensive assessment of at least five aspects, the human and material resources needed for implementation, the institutions which would benefit from the research, the institutions which would be involved in executing the projects, the type of technical training needed, and the plan of action for implementation. No information is available on the number of research projects which were actually implemented, the funds invested, the local and foreign capabilities involved and the results obtained.

Following the introduction of the first plan, the 1980 to 1985 plan, Iraq also formulated its first strategy for scientific research. The strategy deals with two important problems which characterize R and D activities in Iraq. The first is the weak mechanism for linking the producers and users of R and D in the development process. To deal with these problems, the research strategies were formulated at a sectoral level with clearly defined objectives, defined methods for conducting R and D in selected priority areas, and the working out, in detail, of the requirements for implementing the R and D in each case. The strategy has considered the following eight areas to be of particular significance to attain self-reliance: national security, industry, food security, oil and chemical industries, biology, building and construction, space and astronomy, and electronics and information. In each of these areas, the strategy defined the R and D institutions concerned, set up long-term and short-term targets for the R and D activities, stated the broad research problems to be addressed, described the research methods to be followed, and the physical, financial and human requirements for implementing the projects. In a number of cases, there is even mention of policy measures to facilitate the implementation process, for example, in food security and agriculture.

The research activities are to deal with utilization and protection of natural resources, improvement of land productivity, and land reclamation, development and utilization of water resources, mechanization of the production process and development of agro-industries. Such detailed objectives have been spelt out in each of the eight above-mentioned strategically important fields.

The second problem is the following: while it is fair to say that some significant research results have been produced and applied, especially in petrochemicals, construction and agriculture, it is doubtful whether the aims of the strategy and the plan have been attained. Both in Egypt and Iraq the research plan and strategy documents show extensive awareness of the problems involved. But this is one thing: having policies and capabilities to produce solutions is another. Since a great deal of technology in these two countries is imported, it is imperative that the R and D personnel are actively and effectively involved in the process of technology transfer. This, as the successful experiences of other countries have shown, is essential to achieve the aims of technology adaptation, changes and development.

Jordan did not, until recently, have a central body to identify research problems, formulate research projects, co-ordinate research activities with the development plan or follow up on their implementation. In addition, the part of the development plan which deals with R and D contains information on planned capital expenditure for R and D activities and not for R and D per se. This is in contrast to the plans in Egypt and Iraq, which do not give separate data for capital expenditure on R and D activities. The vacuum in Jordan was filled recently by establishing (in 1987) the Higher Council for Science and Technology for Development. This Council is now given the responsibility for the overall technology policy in the country, drawing up strategies for developing the country's scientific and technological potential and supporting R and D through the provision of funds and services. Moreover, the implementation of two development plans specifically concerned with building R and D facilities in the country has helped to expand markedly the country's capacity to carry out R and D activities. This is discernible in the increases in research activities in universities, the RSS and ministries, especially in agricultural engineering and medicine.

Throughout this period, the RSS played an important role in Jordan, both as a national research centre and as a centre for supplying technical services. Circumstances in the country, however, made RSS more of the latter than the former.

RSS is a non-governmental organization which was established to conduct industrial research and provide scientific and technological services including material testing, trouble-shooting, standards and other extension services. Most of the infrastructure at RSS is established by the Government of Jordan, but in 1984 nearly 80 per cent of its revenues were self-generated, through technical service contracted with the public and private sector. Although research accounted for 40 per cent of RSS activities in 1986, for most of the 1980s decade prior to 1986, R and D activities did not exceed 10 per cent of its total activities. The reasons given shed interesting light on the type of adverse conditions which often confront research centres in ESCWA countries, especially those with a small population. At the country level, lack of explicit technological policy and of a body to co-ordinate the actions of the various government departments not only perpetuated the reliance on foreign technology but it also did not help to exploit fully the emerging demands for R and D activities from these departments.

Moreover, frequently the technologies supplied were not fully suitable to the environment in which they were used, and often the research personnel were not adequately familiar with the technology used. There was therefore, a need to acquaint the local staff, the majority of whom were trained abroad, with the problems of technology and production in the home market. There was also pressure to meet the demand of the production sectors for technical services to handle the problems of the imported technology. By putting emphasis on the supply of technical services in the first stage, the RSS personnel were able to accumulate appropriate knowledge and expertise. This helped them to focus on R and D activities later.

In Kuwait, KISR research projects are selected within the framework of its Five-year Strategic Research Programme. The latter is formulated in relation to the goals KISR serves and through interaction between the scientific research divisions in KISR, a core group within KISR, which includes the Director of the Policy and Planning Division and senior advisors, and the Board of Trustees (which includes university dean, industrialists and eminent scientists). In addition, the strategy is the subject of widespread consultations with concerned authorities in the private and public sectors. Note is taken of the relevant sections in the government development programme and research needs. These needs are outlined in seven programme areas which include food and water resources, petroleum and petrochemicals, environment, industry and services, monitoring technological advances in potentially valuable industries, (e.g. solar energy, micro-processors, electronics, computer applications, chemical processes and biological studies).

In Saudi Arabia, there are different types of research programmes in King Abdul Aziz City, the main research centre in the country. There are programmes for supporting applied research, national research projects, solar energy research, fish farming projects, national observatory projects, lunar observation, remote sensing and international co-operation. In each of these programmes there are ongoing activities and a network of interlinks with the users is established. All these programmes are Government-financed. But the users could be Government departments, public enterprises and the private sector. Most Government-requested research projects are in the field of medicine, health, traffic, construction and electronic computers.

In general, however, it is known that the countries concerned suffer from a number of shortages. There are shortages in R and D capabilities, managerial talents and R and D infrastructure and facilities. However, the countries concerned also face a multiplicity of research problems which have visible results on the welfare and well-being of the population, mainly in the areas of health, environment, energy, agriculture and industry.

In Egypt, in order to deal with the perennial problem of the scarcity of cultivable land in the face of an ever-growing population and the increasing demand for food, research activities have been directed towards maximizing land and water use and improving agricultural production. As a result, almost half of the country's total research funds went to food and agriculture. Agricultural research included research in plant production, plant protection, the development of natural agricultural resources, soil improvement, and development of fish and animal husbandry. The research projects show a concern for developing vertical cultivation, intensifying the use of hybrids, high-yielding and fast-growing seeds, expanding the production of strategic agricultural products, controlling plant diseases and integrating plant production and plant protection processes. However, these, together with a number of other projects, will be conducted over a five-year research period with total funds of $US 15.7 million.

There is no doubt that research activities in agriculture have produced valuable results, but these are in no way commensurate with the magnitude of the problem. It is not surprising therefore that in recent years Egypt's food production has fallen well behind food consumption, and that the country has to rely heavily on imports. Although it is not known how much it would have had to import in the absence of agricultural research, it is true that Egypt's performance in agriculture has not matched that of other highly populated countries like India and others in the Far East. In 1981, India had net imports of 17 million tons of grain, whereas, in 1986, it exported grain. These countries, like Egypt, applied intensive agricultural research programmes and followed effective policies to utilize their results, but seem to have succeeded where Egypt has not. A new agricultural research strategy which places emphasis on conducting research in fewer priority areas and encourages co-operation with foreign and international agencies, has now been put into effect. Thus, although Egypt's research community has a large number of successes to its credit, the successes achieved are not at the level of the challenge faced. The potential of Egypt's research community was not fully utilized.

A. Conclusions

Although serious efforts are being made to prepare research programmes and plans, these plans tend, at best, to comply with the requirements of supply side. Concern with the demand aspects of R and D is still inadequate. So long as the R and D plans and programmes in the countries concerned are not linked to the process of technology transfer, the usefulness of R and D activities will be limited. Already there is evidence to suggest that the existing separation or division between local R and D and the technology transfer process is impeding the strengthening of links between the local research community and the production sectors.

There are many indications that R and D activities are producing results and making a useful contribution, but no notable breakthroughs have been reported. Moreover, the results that have been achieved have not always been satisfactory.

In the diversified economies, allocations for R and D have been inadequate compared with the wide range of research activities carried out. As a result, scarce research resources have been thinly deployed. This has had a serious effect on the success of research results.

A recent ESCWA study on research and development in the region, which covered five countries (Egypt, Iraq, Jordan, Kuwait and Saudi Arabia), arrived at the following conclusions:

"A common denominator which characterizes R and D in the countries concerned is the weakness (of their) ... capacities (to) ... transform research results into products... (This capacity) includes engineering design of products and process, capabilities to carry out techno-economic studies; sample products, prototypes and pilot projects ... As a consequence ... the results of industrial R and D either have not been utilized or have been exploited by foreign companies."1/

In order to solve this problem, the nucleus of an intermediate chain of technological capabilities should first be developed and then expanded. This policy, it should be noted, requires that R and D centres be directly involved in the process of technology transfer, which is not taking place at the moment.

The weak link in the agricultural R and D chain is in extension services which act as an intermediary to introduce new ideas and technologies onto the farm.

In the services sector, there is a need to concentrate on unpackaging the imported technology. More emphasis should be placed on R and D and on training on how to unpackage the equipment, machinery and maintenance requirements as the first stage for the gradual development and manufacturing of the technologies involved. "Thus government legislation, priorities, fundings, education systems and training should be directed towards strengthening these areas in the technological capacity building."2/

A recent meeting of experts and government officials involved in R and D activities in the region made the following statement:

"National efforts in the field of science and technology, and particularly in R and D, continue to have a marginal impact in the absence of adequate and effective technology policies in the countries of the ESCWA region and the Arab countries in general. This has affected the standard of achievement in scientific and technological research. Necessary measures should therefore, be taken to achieve ... coordination between science and technology and development policies...; regional, interregional and international co-operation in the acquisition, adaptation and utilization of technological know-how in a manner suited to the needs of the Arab countries ..., and establishment of the Arab Centre for Transfer and Development of Technology..., to study the experience of other countries in technology transfer and assist the countries of the region in regulating contractual arrangements for the transfer of technology."3/

1/ Economic and Social Commission for Western Asia, Strengthening Research and Development Capacity and Linkages with the Production Sectors in Countries of the ESCWA Region (E/ESCWA/NR/87/23) (Baghdad), p. 103.

2/ *Ibid.*

3/ *Ibid.*, p. 109 and 110.

B. New developments in the region relating to R and D

Two developments that have implications for R and D activities and the science and technology community in the region have taken place over the last 10 years. The first occurred simultaneously in Kuwait and Jordan. In Kuwait, the private sector began to take an interest in scientific research. The Foundation for Advancement of Sciences (KFAS) was established, with funds provided by Kuwaiti share-holding companies through a contribution of 5 per cent of their net annual profits. KFAS has assisted the development of the scientific community in the region in a number of ways, among which was the awarding of prizes for outstanding scientific journals and journals that translated articles into Arabic. Moreover, in the period 1976 to 1986, KFAS funded 105 research projects. Its budget for 1987 and 1988 stood at $US 8.5 million and 9.5 million respectively. Its planned activities for the period 1987-1991 include the allocation of 35 per cent of its budget for scientific research, 10 per cent to prizes, and 11 per cent to translation and publication. In 1985 it financed nine research projects in the University of Kuwait at a cost of $US 5 million. The research covered such areas as clinical medicine, pharmacology, civil engineering, petrochemicals and economics.

The Shoman Foundation in Jordan is another private institution that directs its activities towards promoting research and scientific cultural activities. It is also funded by private donations, in this case 2 per cent of the annual profit of Arab banks. Over the last 10 years it has spent almost $US 10 million on promoting scientific activities in a number of Arab countries.

The second development referred to above relates to the role played by a number of regional banks in the promotion of science and technology activities. For example, the 1986 programme of the Islamic Development Bank included $US 700,000 for scholarships, $US 32,000 for seminars and training and $US 2.5 million for technical assistance. The Arab Fund for Economic and Social Development expanded its technical assistance programme, increasing its allocation to $US 12.3 million.

V. SCIENCE AND TECHNOLOGY SERVICES

Science and technology services in the industrial and services sectors have three main components: technical norms and standards; consultancy, engineering and design (CED); and information. How did these components develop in the ESCWA region? How did they contribute to the development of production and technological capacities? And what type of problems did they face?

At present, almost all ESCWA countries have departments or national organizations for standards and quality control. Some ESCWA countries, notably Egypt, Iraq and Lebanon, established their organizations during the 1950s. The Arab League has been instrumental in promoting national organizations for standards. In 1965 it established the Arab Standardization and Metrology Organization to co-ordinate the work of standards organizations in Arab countries.

However, despite the significant role that standardization can play in creating a demand for scientific and technological knowledge, as well as the improvements it can bring into the sector, the impact in the region has generally been marginal. In a number of countries, national standards are still optional. Furthermore, because of heavy import restrictions, local producers have no need to aspire to a high level of standards. At the same time the function of formulating and applying national standards is often dispersed and needs co-ordinating.

In export industries, on the other hand (e.g. petrochemicals, phosphates and refinery products), producers diligently conform to international standards that are dictated by market forces.

Consultancy Engineering and Design Organizations (CEDOs) carry out a number of different services. These include feasibility studies, design, construction, operation, maintenance and the management of projects. From studies on selected countries in the region, it can be seen that efforts are being made to develop and enhance the role of local CEDOs. For example, in 1985 the Jordanian Government enacted a by-law to regulate the operations of CEDOs. The Jordanian Engineering Association was given responsibility for administering and supervising the registration of CEDOs. The scope of work and type of organizations that are qualified to perform CEDO services were clearly defined. A set of measures was introduced to protect and enhance the operations of local CEDOs. Thus, local CEDOs cannot function as agents for foreign companies, only as partners. Foreign CEDOs were excluded from public works, unless they engaged a local CEDO in full partnership.

The same arrangements are more or less followed in the remaining countries in the diversified group. Governments in these countries have established several State-owned organizations that deal with public projects in construction, agriculture, irrigation, and the petroleum and other industries. In order to increase their efficiency, some of these organizations have now been turned into independent companies managed by a board of directors. Some CEDOs performed well in the diversified economies. To take one example, since its establishment in 1970, the State Engineering Company for Industrial Design and Construction in Iraq has carried out about 500 industrial feasibility studies. In addition, it has either constructed or supervised the construction of more than 200 industrial projects, including a petrochemical complex, nitrogenous fertilizer plants, a steel mill, paper industries and cement plants. The services rendered by CEDOs include feasibility studies, the evaluation and selection of technologies, the preparation of technical documents and technical specifications, the analysis and evaluation of international offers, conducting negotiations with suppliers, the design of engineering works, the approval of drawings and specifications, construction testing and procedures for preventive maintenance. In the majority of cases, however, the projects were either small or medium-sized.

The Centre for the Development of Engineering and Industrial Design in Egypt also has adapted imported technology and contributed to the development of products and process in Egyptian industry.

But was the volume of services rendered in line with demand in the countries concerned? Did the services rendered by CEDOs meet the range of services that were needed? And what use was made in the region of efficient local CEDO capabilities?

Unfortunately, the answers to all of these questions are negative. In 1985, the Arab Industrial Development Organization (AIDO) published an index of CEDOs in Arab countries. It showed that of a total of 284 CEDOs in the ESCWA region, 205 were in housing and construction. All large construction, industrial and infrastructural projects requiring relatively sophisticated technical and managerial know-how (e.g. dams, airports, high-rise buildings, power plants, telecommunications networks and industrial projects) were contracted to foreign companies which had little input from local CEDOs. Iraq provides an additional example of this. Despite the successes reported above, the aggregate picture tells another story. In a study of the experience of the Ministry of Industry and Minerals in transfer and adaptation of technology in Iraq between 1973 and 1983, it was found that a total of 250 industrial projects were established in the country, costing about $US 11 billion. They included projects in six main industrial branches: engineering, chemicals, construction, food, textiles and electricity. However, only 2 per cent of these projects, amounting to US$ 21.4 million, were carried out by local capabilities, whereas 93.2 per cent of the projects, costing US$ 10 billion, were executed by foreign companies.1/

The reason for this can be found in the technology policy and current structure of science and technology in the region. In none of the ESCWA countries is there the expected organic link between CEDOs and the technology transfer process. This is especially true with regard to the involvement of local CED services in CED activities following the commissioning of projects (namely plant operation, product and process improvement, quality control, etc.). But there are also a number of reasons on the supply side.

First, the education system, which is the source of manpower supply, is characterized by a severe structural imbalance. Secondly, the type of knowledge offered in the education system and the type of knowledge required are incompatible. Thirdly, manpower lacks experience. In order to explain these, Jordan can be used as an example.

1/ Economic and Social Commission for Western Asia, Strengthening Research and Development Capacity and Linkages with the Production Sectors in Countries of the ESCWA Region (E/ESCWA/NR/87/23) (Baghdad).

In 1984-1985, 38,000 Jordanian students were enrolled in universities both inside and outside the country. Almost 50 per cent were studying humanities and social sciences. Of the others, 50 per cent were enrolled in programmes on agriculture, engineering, medical science and pure sciences; only 1 and 2 per cent respectively were enrolled for Ph.D. and M.Sc. degrees. Moreover, within engineering, such important fields as chemical engineering, applied engineering and mining accounted only for 9.1 per cent of all engineers registered in the country. The majority were in civil engineering (45.4 per cent), electrical engineering (20.4 per cent) and mechanical engineering (17.3 per cent).

An analysis of the cumulative number of graduates shows that the majority of graduates in engineering and the medical sciences had less than six years of experience. It is not surprising, therefore, that only 10 per cent of engineers work in CEDOs. The remaining 90 per cent work in the public sector.

This picture repeats itself with regard to the other scientific disciplines. Nearly 88 per cent of graduates in agricultural sciences, 98 per cent in pure sciences, 80 per cent in economics and management are employed by the public sector.[1/]

Finally, building and construction offers an example to explain the disparity between the knowledge acquired in educational institutions and the knowledge required in the real world. The existing national codes and standards for building are so inadequate, both quantitatively and qualitatively, that students in national universities learn more about foreign codes and standards than about national ones. An engineer who wants to design an irrigation project will not find a reliable data base to enable him to design a system to suit local conditions. Thus, whenever designs are needed, engineers are forced to use foreign codes, standards and models that are consistent with the local environment and national needs. This information should be incorporated into the curricula so that it is more widely available.[2/]

Finally, regarding information services, most of the information centres in the ESCWA region are centres for collecting and processing documents and information such as libraries, computer centres and computer data bases. Recently a number of user dependent information centres have been established. The scientific and technological information centre at King Abdul Aziz City for Science and Technology in Saudi Arabia is the largest in the ESCWA region. It is linked to around 500 international and national data bases mainly in advanced countries. Both Iraq and Kuwait also have well-established information links in this regard. The scientific community uses the information centres of the second type. The type of information which is used by the production sectors is usually provided by industrial research institutes and centres for industrial extension services. These institutes and extension services are in short supply in the region because of the limited use for them and this in turn, is the direct result of the pattern of technology transfer which has not relied on the participation of local capabilities.

1/ Economic and Social Commission for Western Asia, Engineering Design and Consultancy Services in an ESCWA Country: The Case of Jordan (E/ESCWA/NR/86/8) (Baghdad, February 1987).

2/ Ibid.

VI. THE ROLE OF INTERNATIONAL AND REGIONAL ORGANIZATIONS IN SCIENCE AND TECHNOLOGY

The United Nations exists to meet the needs of countries. In the field of science and technology, the United Nations system can assist government efforts, provided there is co-operation and co-ordination within the government establishment itself. In the absence of such co-operation and co-ordination, the way the United Nations system works can unfortunately accentuate the chaos. Therefore, in order to utilize the United Nations system efficiently, and to obtain the optimum impact from its activities, it is essential that countries introduce a strong element of co-ordination in their operations. It is also important that the United Nations system assist countries to establish and maintain a well-integrated system. One way to begin this is to assist countries to execute science and technology projects, programmes and plans by integrating them into their development plans.

One way in which the ESCWA region benefited from the Vienna Conference held in August 1979, was that decision-makers in the field of science and technology were actively involved in the preparations for the Conference. This raised awareness, crystallized the problems that existed and encouraged further action to be taken.

Two of the regional recommendations are of particular importance although they have yet to be implemented. The first is the recommendation to set up a Regional Centre for the Transfer of Technology, and the second, the CASTARAB recommendation to establish the Arab Fund for Research.

Another significant contribution to the development of science and technology has been made through the activities of ESCWA and the United Nations Centre for Science and Technology for Development (UNCSTD). These two organizations are pursuing a new approach that is based on working together with the countries themselves in order to identify the main elements of science and technology that can affect development, the problems and constraints that impede progress and priority areas where there is an immediate tangible impact. Through its programme on indigenous capability building, UNCSTD also helps to clarify the fundamental issues involved in the development of local technological capabilities.

Furthermore, the effects of the Vienna Programme of Action can be seen in the region through the Strategy for Joint Arab Action. This Strategy was formulated by the Arab League with the assistance of the Council of Arab Economic Unity. It was approved by the Arab heads of State who attended the summit held in Amman in 1980. The main thrust of the Strategy is based on the ideas contained in the Vienna Programme of Action and in the United Nations New International Economic Order. The Strategy indicated the future direction of the region. A more recent development is the Arab League Educational, Cultural and Scientific Organization's (ALECSO) current effort to formulate a strategy for the development of science and technology in the Arab world. This programme, which was initiated in 1984, will be published this year. The main themes and recommendations of this strategy follow the Vienna Programme of Action.

ESCWA countries also have a number of non-governmental organizations, which total about 22. Generally, those that deal with science and technology issues are still new and do not have sufficient financial resources.

Therefore, their efforts have generally been limited. However, there have been a number of successes that deserve mention. One such case is the Kuwaiti-based Arab Federation of Chemical Fertilizer Producers (AFCEP). The major fertilizer producers of Bahrain, Jordan, Algeria, Iraq, Qatar, the Libyan Arab Jamahiriya, Morocco, the Sudan, the Syrian Arab Republic, Saudi Arabia and the United Arab Emirates are members of this federation. AFCEP currently employs around 100,000 people, and has invested more than $US 17 million in improving national capabilities in the operation and management of fertilizer production facilities. In addition, AFCEP has held workshops aimed at improving productivity and examining environmental and pollution issues, corrosion and maintenance. Another equally important non-government organization is the Federation of Arab Engineers. It is composed of the national engineering associations in Arab countries. Recently, it adopted the Arabic language technical terminology related to engineering professions. The contribution of this organization to science and technology development has been less than that of similar organizations in developed countries. This is partly owing to the fact that local CED services are still very weak, as noted above.

A. Concluding remarks

During the last decade, marked progress has been made in the field of science and technology in the ESCWA region. The pattern and speed of this progress, however, has tended to differ between the three groups of countries outlined in this review. Progress was less marked in the case of the two least developed countries in the region.

Most of the progress that has been made, however, could be described as falling within the realm of actions necessary but not sufficient to take full advantage of the potential of utilizing science and technology for development in the region. In this respect, achievements in the region did not compare favourably with those in the newly industrialized countries, despite the region's obvious advantages in natural, financial and human resources.

The good investment opportunities in the region were not fully utilized to develop the region's CED services, which remained by and large embryonic. In a few cases where local CED has reached a certain level of sophistication, the practices adopted by regional banks, together with inappropriate national technology policies, were not conducive to the process of the gradual accumulation of experience through practical learning. Therefore, only a few local CEDOs have emerged, and even fewer are competent to take on large projects other than in building and construction. At the same time, very limited use was made of local CEDOs at the regional level.

This failure to integrate CEDOs into the process of technology transfer and the failure to integrate technology policy and planning into socio-economic development have meant that, both individually and collectively, these countries have lost the opportunity to develop an indigenous capability in CEDO services and R and D activities.

Allocations for R and D were rather small, especially in the diversified economies, and the resources were spread thinly. As a result, there has been no great impact or notable breakthrough.

Recently a number of countries have embarked on the formulation of R and D plans and strategies. Great efforts are being made to co-ordinate these activities with the real needs of society. Most, if not all, of these efforts have been confined to the supply side. There has been no serious effort to activate demand. As mentioned above, the development of local technological capabilities has not been organically linked to the technology transfer process. In addition, decision-making bodies in charge of technology transfer remain diffused and unco-ordinated. Some countries, notably Egypt and Iraq, are trying to remedy this.

However, the problems originate not only from the demand side. There are still serious shortcomings on the supply side, particularly in education. The higher education system is not adequately adjusted to the developmental needs of society. The system still relies heavily on foreign sources to supply highly qualified manpower.

Opportunities are lost not only at the national level; even greater opportunities are lost at the regional level in the absence of a centre for co-ordinating technology policies, negotiation strategies, training facilities, etc.

It is ironic that in a region where one often hears complaints about duplication in regional and international organizations, the one centre that does not exist in any form is a centre for transfer of technology, be it national, regional or international. Yet it is in this field that the Arab countries' interests are most exposed and exploited.

Part Two

HIGHLIGHTS OF THE DISCUSSIONS OF THE REGIONAL MEETING ON THE END-OF-DECADE REVIEW OF THE IMPLEMENTATION OF THE VIENNA PROGRAMME OF ACTION (AMMAN, NOVEMBER 1988)

VII. BACKGROUND

The Economic and Social Commission for Western Asia, in co-operation with UNCSTD and the Higher Council for Science and Technology of Jordan (HCST), organized a regional meeting from 21 to 23 November 1988 in Amman, Jordan, to discuss the regional review paper prepared by ESCWA in co-operation with UNCSTD. The meeting was attended by 50 experts from a number of ESCWA member States and Europe and major agencies and organizations of the United Nations involved in Science and Technology for Development. Crown Prince El-Hassan, in the opening session delivered an important speech urging scientific institutions and universities in the region to concentrate on exchange of ideas and information. He was followed by Adnan Badran, Secretary General of HCST, by the Executive Director of UNCSTD, and by the Chief of the ESCWA Natural Resources, Science and Technology Division, who delivered a speech on behalf of the Executive Secretary of ESCWA. The keynote speech was that of Essam El-Din Galal, current member and former chairman of the United Nations Advisory Committee on Science and Technology for Development (ACSTD). In their opening addresses, the speakers emphasized the importance of technological policies to enable the Arab and other developing countries to attain prominent status among world nations and to play an important role in international co-operation, especially in technology transfer. These policies should be crystallized, and the effectiveness and efficiency of setting up science and technology policies in support of economic development strategies should be improved to a large extent. Developing countries should be assisted to help themselves to achieve "home-grown" capability to make decisions. This could be aided by a process of consensus-building, national/sectorial policy dialogues among those who have a stake in the development process. This dialogue would promote understanding and agreement on how to bring science and technology in explicit terms to the mainstream of social and economic life.

In the general discussions, the experts first evaluated the activities in science and technology for development during the decade. They noted that the credibility of science and technology systems and initiatives at both national and regional levels was declining owing to the lack of organic links between policy formulation and effective policy instruments, the slow process of restructuring science and technology institutions, and inadequate financing at capital expenditure and operating levels. The resources for the not-so-successful multilateral co-operation were analysed, as were several measures for subregional co-operation which could be of value in strengthening science and technology capabilities.

For future orientation, the experts stressed the importance of systematic compilation and dissemination of information, the need to accelerate the learning process and adapt to desirable change, the ability to choose the right niche for achieving sustainable breakthrough, the desire of synchronizing supply push and demand pull, the achievement of popular support, the linkage of educational, science and technology and production systems, the initiatives in funding, the integration of technology assessment in the decision-making process, and the revitalization of South-South co-operation. Specific suggestions were also made. These issues are examined in some detail below.

VIII. RETROSPECTIVE REVIEW OF SCIENCE AND TECHNOLOGY IN THE ESCWA REGION DURING THE 1980s

The review process with regard to the prevailing assumptions about the relations and interactions between science and technology on the one hand and development on the other, initiated in the region in the 1970s, crystallized in the 1980s into a generally acceptable understanding. The "supply push" strategy that had prevailed under the influence of current thinking and examples of success in the industrialized countries has not fulfilled the national and regional expectations for indigenous science and technology capabilities to play an effective role in the development effort. It is also generally accepted now that the scale and mode of transfer of technological products has suppressed demand for the services of nascent indigenous capabilities. The mechanisms for proper interfacing of science and technology development with national socio-economic development have yet to be articulated and implemented. In general, the same holds true for policy formulation which has not been matched by articulation of effective policy instruments.

Consequently, a process of restructuring science and technology institutions gathered momentum in the decade and examples of successes at the national, subregional and regional levels were identified by the group. Other examples at the level of the enterprise were also noted. However, these were of a fragmented and non-cumulative nature. The process goes on in all countries; experience indicates, however, that bringing about desirable changes takes a relatively long time. The learning process has generally been slow. Consequently, the viability of some of the ongoing initiatives has yet to be confirmed in practice. The process of operationalizing new orientations needs closer attention. The translation of vision into action in an integrated strategy subject to popular discussion and consensus has yet to be mastered.

The deterioration in the international scene has compounded the difficulties of bringing about desirable changes. Financing levels of science and technology activities were generally inadequate both at capital expenditure and operating levels. Regional initiatives that were started in the previous decade lacked sustained funding to bring about the results hoped for. Foreign aid and technical assistance were fragmented and did not play a markedly positive role in developing national science and technology bases. Recipients did not always have a well-defined objective and focus for foreign assistance, which has been in most cases rather short-lived.

These various factors have resulted in a loss of credibility of science and technology systems and initiatives, both at the national and regional levels.

In addition to the national and subregional initiatives, a notable regional effort during the decade has been the ALECSO project to formulate an Arab strategy for scientific technological development. The experts in praising this timely initiative, expressed hope that this would be widely disseminated and discussed, in order that it might provide useful guidance in the future, based on as wide a consensus as possible.

The recession and disillusionment with multi-lateral co-operation were noted and analysed. The experts felt that the prerequisites for successful co-operation were missing in most cases. These are: a commitment on the part of all participants as well as clear benefits for them. Furthermore, the mechanisms of conducting, monitoring and evaluating co-operative efforts have not always been carefully worked out. It has now become clear that effective regional co-operation need only involve those deriving a clear benefit from a particular regional activity. Past experience indicates that such initiatives need also to be provided with effective safeguards from the volatility of political tensions and counter-productive interference at the operational levels, i.e., co-operation must be achieved on the basis of an autonomous mandate.

However, the decade has witnessed the initiation and development of a few subregional co-operative efforts. Even at such an early stage, the indications are that they can be of value in strengthening science and technology capabilities, exchanging beneficial experiences, formulating common positions in dealings with the outside world, achieving the necessary critical mass and avoiding costly duplication of effort and investment.

It is against this marked change from the enthusiasm and support of the previous decade that new initiatives and strategies based on activating demand for the services and output of the science and technology systems are being formulated and implemented.

IX. FUTURE ORIENTATIONS

The deliberations of the above meeting highlighted the need for systematic compilation and dissemination, throughout the region, of information on science and technology capabilities (human and institutional), activities and achievements. This provides the necessary basis for more effective synergy at the national level, beneficial co-operation at the subregional, regional levels and sound bi- and multilateral co-operation at the international level.

The long-time horizons of the past in implementing desirable orientations and structural changes will be totally inadequate in the next decade. There is a need for accelerating the learning process and acquiring the ability to build effective feedback and response mechanisms adapted to changes in the environment, both national and international.

With the limitations on resources, material or human, the ability to choose the right niche for achieving sustainable breakthrough that could have visible impacts on national development needs to be fostered. The criteria for selection in each particular national or supranational setting have to be developed carefully on the basis of reliable assessments of capabilities and the international environment.

Achievement of the desirable synchronization between supply push and demand pull calls for concerted effort at the "shop floor" levels to bring about incremental technological changes in the imported technologies. The accumulation of such initiatives, based on first-hand experience of operations, rather than on scientific theory, will finally lead to proper articulation of the demand on science and technology services.

The scientific technological community needs to pay greater attention to building a national constituency and achieving popular support, based on sound understanding of the specificities, modes of operation and needs of the national science and technology system, beginning at the level of the new generation within the educational system. In this context, positive achievements need to be acknowledged and publicized. Credit should be given where it is due, in an attempt to strengthen the self-confidence of the science and technology community and garner popular support.

The beginnings of the move for an in-depth review of the current practices and orientations of the educational and training system need to be encouraged and such a review should involve the end-users more effectively so as to remedy the mismatches and consequent social tensions that have manifested themselves in the past. Greater mobility of personnel and closer interactions between the educational, science and technology and production systems need to be encouraged and fostered. The new and emerging sciences and technologies calls for substantial revision of curricula and teaching methods in a number of disciplines. R and D activities in these new areas need to be encouraged whenever linked to development needs.

New initiatives in formulating innovative ideas in the funding of science and technology activities and involving the financiers and entrepreneurs need to be encouraged and carefully monitored.

Integration of technology assessment in the decision-making process calls for acquisition of the capability to conduct thorough technological analysis (TA) at all levels of the hierarchy: technical, economic, social, political, environmental, and even moral and ethical. Related to this is the capability to forecast and manage crises effectively.

South-South co-operation needs to be revived in accordance with national and regional needs, assimilating past experiences in such co-operation.

More specifically, the Group has recommended the following actions:

(a) Development of technological services (CEDO contracting, etc.), and encouraging the use of the results of science and technology national activities;

(b) Encouragement and upgrading of existing national and regional networks and the creation of new ones whenever feasible and useful, as well as linking them to international ones;

(c) Consolidation of the emerging interest in science and technology policy studies and the creation of national and regional institutional bases for such activities. International experiences need to be analysed and appropriate lessons gleaned from them.

Annex

LIST OF PARTICIPANTS IN THE REGIONAL EXPERT GROUP MEETING, 21-23 NOVEMBER 1988 (AMMAN, JORDAN)

- Hamdi Abou el-Naga
  Laboratories and Research Manager
  Misr Petroleum Company
  Cairo, Egypt

- Ferdous Shahbaz Adel
  Ministry of Planning
  Amman, Jordan

- Saleh al-Athel
  President
  King Abdul Aziz City for Science and Technology
  Riyadh, Saudi Arabia

- Ishaq Salim al-Jallad
  Deputy Managing Director
  Jordan Phosphate Mines Co.
  Amman, Jordan

- Waleed al-Khateeb
  Director, Health and Environment Sector
  The Higher Council for Science and Technology
  Amman, Jordan

- Ussama el-Kholy
  Senior Advisor
  Kuwait Institute for Scientific Research
  Kuwait

- Ahmed Bashir al-Naib
  President
  Technology University
  Vice-President of the National Committee
  of Transfer of Technology
  Baghdad, Iraq

- Jawad Anani
  President
  The Royal Scientific Society
  Amman, Jordan

- Mazen Armouti
  Director, Communication and International Relations
  The Higher Council for Science and Technology
  Amman, Jordan

- Adel Assem
  Director, Techno-Economic Division
  Kuwait Institute for Scientific Research
  Kuwait

- Adnan Badran
  Secretary-General
  The Higher Council for Science and Technology
  Amman, Jordan

- Kazem Behbehani
  Vice-Rector for Research
  Kuwait University
  Kuwait

- Omar F. Bizri
  Assistant General Director
  Scientific Studies and Research Centre
  Damascus, Syria

- Fakhruddin Daghestani
  Advisor
  The Higher Council for Science and Technology
  Amman, Jordan

- Ali el-Nosour
  General Manager
  Arab Potash Company
  Amman, Jordan

- Mohammed Fayez
  Emeritus Professor
  National Research Centre
  Cairo, Egypt

- Essam el-Din Galal
  Professor
  Ex-Chairman, United Nations Advisory Committee on the Application of Science and Technology for Development.
  Cairo, Egypt

- Munther Haddadin
  Director, Regional Office for Integrated Development
  Amman, Jordan

- Khaled Ibrahim Hariri
  Director General, Secretariat of Council of Ministers
  Aden, Democratic of Yemen

- Khair el-Din Haseeb
  Director General
  Centre for Arab Unity Studies
  Beirut, Lebanon

- Norbert Konrad
  Assistant Professor, University of Economic Sciences
  German Democratic Republic

- Adib Koulo
  Head, Department of Management Science
  Higher Institute of Applied Science and Technology
  Damascus, Syrian Arab Republic

- Mohammed Kamel Mahmoud
  Ex-President
  Academy of Scientific Research and Technology
  Cairo, Egypt

- Mahmud Mardi
  Director, Mineral Resources
  The Higher Council for Science and Technology
  Amman, Jordan

- Mohamed Sameh Nasser
  Vice-Rector, Planning
  Kuwait University
  Kuwait

- Subhi Qasem
  Dean of Graduate Studies
  University of Jordan
  Amman, Jordan

- Adel Sabet
  Ex-Under Secretary of State
  Ministry of Scientific Research
  Cairo, Egypt

- Andrew Sundberg
  Managing Director
  Geneva, Switzerland

- Assad Takla
  Chairman
  Afamia Consulting Engineers
  Lattakia, Syrian Arab Republic

- Hassan A. Tayim
  Director, Technology Transfer
  King Abdul Aziz City for Science and Technology
  Riyadh, Saudi Arabia

- Antoine Zahlan
  Director, Zahlan Consultants Ltd.
  United Kingdom

- Hani Fawzi el-Mulki
  Executive Director General
  Islamic Academy of Sciences
  Amman, Jordan

- Mahdi Hnoosh
  Secretary General
  Arab Standardization and Metrology Organization
  Amman, Jordan

- Ismail el-Zabri
  Director
  Research and Studies
  Arab Fund for Economic and Social Development
  Kuwait

- Mohamed Ali Toure
  Senior Officer
  Islamic Foundation for Science and Technology for Development
  Jeddah, Saudi Arabia

- Sergio C. Trindade
  Assistant Secretary-General
  UNCSTD
  New York, U.S.A.

- M. Anandakrishnan
  Deputy Director
  UNCSTD
  New York, U.S.A.

- Haiyan Qian
  Special Assistant to the Executive Director
  UNCSTD
  New York, U.S.A.

- Ali Attiga
  Resident Representative
  UNDP
  Amman, Jordan

- Abdel Gader O. Elshabani
  UN Transport and Traffic Planning Expert
  Regional Development Planning Project in Saudi Arabia
  Riyadh, Saudi Arabia

- Mohammad Tahseen Al-Koudsi
  Informatics Specialist
  UNESCO/Regional Office for Science and Technology for Arab States
  Amman, Jordan

- Ahmad Radjai
  Chief, Natural Resources Science and Technology Division
  ESCWA
  Baghdad, Iraq

- Zeki Fattah
  Senior Economic Affairs Officer
  ESCWA
  Baghdad, Iraq

- Jalal Mourad
  First Economic Affairs Officer
  ESCWA
  Baghdad, Iraq

- Nour Eddine Al-Rifai
  Regional Advisor
  ESCWA
  Baghdad, Iraq
