II. PRESENTATION OF PAPERS

14. Thirty-seven substantive contributions were presented at the Meeting in ten sessions held under the above-mentioned themes. Summaries of these contributions are presented in this chapter. Subsequent chapters include an account of the issues discussed at the Meeting and the recommendations arrived at as a result of those discussions.

A. KEYNOTE ADDRESS: SCIENCE AND TECHNOLOGY INITIATIVES IN ESCWA MEMBER COUNTRIES

15. The keynote address was presented by Vincent McBrierty, Vice Chancellor for Academic Affairs at Sultan Qaboos University of the Sultanate of Oman, based on his paper on S and T initiatives in the ESCWA member countries. The presentation was divided into two parts: the first gave a general overview of developments in the global economy and their relation to national systems of innovation, with examples from Ireland, Oman, the United Kingdom and the United States; while the second part described the Irish experience in university-industry collaboration.

16. The process of continual innovation, driven by technology, as Mr. McBrierty stated, ruled the current era. The high level of global integration and interdependence brought about a new order, and the cumulative international effort in S and T was driving the global knowledge economy. This new economy was characterized by the increasingly strategic role of universities in the need to exploit new technologies and dissolve the boundaries between knowledge sectors.

17. Furthermore, human capital and technology were considered to be at the heart of economic growth, replacing traditional factors of production—namely, capital and labour. This could be seen from the escalating growth of services and high value-added industries, as compared to other sectors. Clustering and other forms of geographical and virtual concentrations of technological know-how and manpower were thus needed to boost information dissemination and technology transfer.

18. As a consequence, the roles played by the main participants in national innovation systems have evolved. Universities, or knowledge generators, were considered valuable repositories of creative thinking and new discoveries. The author pointed out that Governments should formulate flexible and innovative policies to manage knowledge, and would have to involve technologists, social scientists and economists in this process. Business and industry, or technology end-users, were characterized by a globally dispersed mode of operation, a shift towards corporate mergers and an increasing emphasis on small enterprises as major job creators. Moreover, finance and equity institutions were in great need to finance innovation and share risk with new technology-based firms.

19. The above concepts were illustrated through examples from different country groupings. The United States wholeheartedly embraced the knowledge economy, as could be noticed from the development of innovative financial products and the acceleration in labour productivity. In the United Kingdom, initiatives undertaken to harness the nation's knowledge included a large venture capital fund to support technology-based firms, strengthen the university-industry interface and develop high-tech clusters. Ireland also recognized the factors behind socio-economic growth and undertook many steps towards attracting foreign direct investment (FDI), sustaining the supply of skilled personnel and establishing a social partnership. Finally, Oman made a similar commitment to achieve economic growth, in which Sultan Qaboos University played a key role.

20. In the second part of the paper, the leading role of universities in addressing the relationship between knowledge, industrial growth and job creation was stressed. The converging interests of universities and industry could be promoted through the creation of an innovative culture in the universities. This was further driven by the desire of universities to sustain themselves financially through the exploitation of patents.

21. For knowledge to be transformed into economic growth, five issues were considered to be the key elements. The first related to knowledge being a form of equity that needed to be exploited for the benefit of society as a whole. The second related to the innovation process that required input from all participants in

order to flourish. The other three key elements were: protection of intellectual property, conversion of knowledge equity into jobs and mechanisms of technology transfer.

22. The author concluded with a note on the emerging techno-academic paradigm, which encompassed a consolidated approach to the creation of a national knowledge equity base.

B. TECHNOLOGY INITIATIVES IN THE AMERICAS, ASIA-PACIFIC AND EUROPE: CASE STUDIES

1. *National science and technology initiatives for ESCWA member countries: lessons from the South and East Asian region*

23. The paper on national S and T initiatives in the South and East Asian region was presented by Samuel Garrett-Jones, Deputy Director of the Centre for Research Policy at the University of Wollongong in Australia. An overview of the development of the science, technology and innovation systems in the South and East Asian region was given, showing their relation to other national policies, especially industrialization. The modalities of S and T initiatives, such as technology parks and incubators, tax incentives, linkage mechanisms and support for training commonly used in that region, were described; and the main S and T initiatives and policy concerns that have arisen in each of the selected countries in recent years were reviewed.

24. Two case studies were presented. The first concerned the utilization of taxation and other fiscal incentives for research and development (R and D) and technology transfer, features which were common to the S and T strategies of many countries. The second concerned experience with technology incubators, S and T parks and technology cities in the region. Examples included the problems the Philippines faced in the development of incubators and parks, as well as Australia's attempt to translate the Japanese experience with technopoles into its existing system of S and T parks.

25. The paper concluded with a set of lessons relevant to ESCWA member countries, which were related to the following: structural differences in national innovation systems (NISs) and the need to tailor initiatives to local circumstances; importance of specific national S and T initiatives; integration of S and T initiatives within NSIs and broader socio-economic policies; prominence of the global context of S and T initiatives; human resource development as a key to technology acquisition; impact of S and T initiatives on SMEs; science parks and other initiatives as low-cost effective support tools for SMEs; providing adequate resources, effective management and implementation of S and T initiatives; and promotion of international cooperation.

2. *Technical infrastructures and bridging institutions: new roles within national innovation systems (the case of SERVITEC)*

26. The paper on the role of technical infrastructures and bridging institutions was presented by Riccardo Galli, Chairman of SERVITEC in Italy. The first part of this paper dealt with paradigm changes and structural adjustments of NISs and related economic policies, with particular reference to the new roles of emerging infrastructural components and bridging institutions. Despite obvious differences in the characteristics of NISs across countries, the general trend in the direction of change appeared to be relatively uniform, although the stage of transition may have differed significantly. General characteristics of current NISs included the widening of technological options, structural adjustment of enterprises, technological cooperation and the internationalization of S and T activities. Furthermore, the traditional and rigid division of roles between NIS components was much more blurred than in the past: university and Government research was increasingly more oriented towards joint projects and services for private enterprise; and incubators were diffusing knowledge and encouraging high-tech firms. Private enterprise was also active in basic research and education.

27. In the transition to a new NIS, the establishment of new infrastructure elements played an important active role, both in sector restructuring and in promoting greater interconnectedness among the various NIS blocks. The infrastructural subsystem included: (a) the traditional basic infrastructure, consisting of metrology and standards institutions, patent offices and information centres; (b) the innovation infrastructure,

consisting of technology centres and bridging institutions, such as science parks and valorization agencies; and (c) a policy development block consisting of several institutional forms aiming at the generation of an overall view of the innovation system, its development over time and its connections with country economic performance.

28. In the second part of the paper, the case of SERVITEC, a bridging institution operating in the highly industrialized province of Bergamo in northern Italy, was presented as an example of a possible successful pathway to bridge the supply of knowledge available from S and T institutions with the demand by SMEs. Established in the POINT Centre (Pole for Technological Innovation)—a science park that accommodated public and private organizations, an incubator and an innovation centre—SERVITEC offered management and technological consulting, energy and environment services, project financing through venture capital, technological partners and technology transfer agreements. The strategy adopted by SERVITEC relied on the involvement of industrial associations as shareholders, as well as on a demand-side approach and a "small steps" problem-solving line of attack.

3. *Science and technology policy initiatives in the Americas*

29. The paper on S and T policy initiatives in the Americas was presented by Nicholas Vonortas, Professor at George Washington University in Washington, D.C. Several examples of S and T policy initiatives were given, which either directly targeted SMEs or benefited them extensively. These examples, drawn from various countries in the Americas, highlighted the more synthetic modern orientation towards a balanced supply-demand approach to S and T policies.

30. The first part of the paper focused on the United States and discussed in detail three examples of Federal policy initiatives: the Manufacturing Extension Program (MEP), the Small Business Innovation Research (SBIR) Program and the Human Genome Project (HGP). The first two were generic programmes that specifically targeted SMEs, while HGP was marked by a particular technology focus.

31. MEP was geared towards manufacturing SMEs that needed external assistance with respect to technology, finance and product marketing. The more than seventy MEP centres which were operational aimed at linking sources of manufacturing technology with SMEs by organizing networks of public and private providers of resources, capabilities and linkages to serve smaller companies. SBIR and HGP, on the other hand, dealt with new technology-based firms in high-risk, potential high-return technologies. SBIR, in particular, aimed at increasing the allocation of R and D funds to small businesses.

32. Examples of S and T policy initiatives from four States were also presented—namely, the Regional Technology Alliances Program in California, the Commercialization Corporations Program in Kansas, the Investment Financing Program in Maryland and the Technology Development Corporation in Massachusetts. While all four initiatives targeted new technology-based firms, each programme was different from the other, reflecting the specific needs and perceived strengths of the sponsoring State. In addition, policy initiatives were related to cooperative public-private technology programmes, and R and D tax incentives were adopted in almost all the United States.

33. The second part of the paper turned to initiatives in Central and South America. Those discussed were the City of Knowledge in Panama, the Chilean Development Project, the Mexican Knowledge Spaces and the Brazilian Technological Development Company, in addition to cooperative industry programmes in Honduras, Jamaica, Mexico and Nicaragua. Although all these initiatives targeted SMEs, either directly or indirectly, they differed significantly according to socio-economic environment, stage of development and specific Government objectives.

34. The author concluded with a set of points relating to SMEs and amalgamated from all the policy initiatives discussed, including the role of intermediate organizations; systemic policy approaches; increasing focus on innovation; business-oriented assistance to SMEs; clusters, industrial districts and networks as mechanisms of regional development; inter-firm networks; business incubation; reform of the role of the public sector; the importance of local programmes and decentralized authority for programme implementation and evaluation; and country particularities related to the socio-economic context.

C. Science and technology initiatives in selected Arab countries

1. *Initiatives undertaken to promote dissemination, implementation and development of science and technology in Egypt*

35. The paper on S and T initiatives in Egypt was presented by Mohamed Yousry Mohamed Moursy, President of the Academy of Scientific Research and Technology (ASRT) in Egypt. In the introduction, a brief explanation was given regarding the reasons behind the inability of developing countries to harness S and T to achieve economic growth—namely, poor endogenous S and T capabilities, misuse of existing potentials and the non-selective acquisition of foreign technologies.

36. The major targets of the current S and T policies in Egypt were listed, as well as strategies and work plans, which included the increase in international integration, the application of information and communication technologies, biotechnology and genetic engineering and achieving sustainable environmental development.

37. The institutional S and T framework in Egypt included institutions with deliberative functions—namely, national advisory councils and a ministerial committee for technology transfer and development, Government ministries and ASRT. Work plans were implemented by public, private and non-governmental organizations (NGOs) engaged in S and T, while funding was largely provided by the Government, which allocated 0.6 per cent of the gross domestic product (GDP) to S and T.

38. The paper referred to a World Bank study on the Egyptian S and T system which showed that the latter benefited from a wealth of R and D institutions and human resources and from a general commitment to S and T. It also identified some of the weaknesses of the system, such as non-explicit S and T policies, limited financial resources, inefficient organizational structure, weak industry-university linkages and laissez-faire policies.

39. Recently, the Egyptian Government undertook a restructuring of its R and D system, including the Ministry of Scientific Research and ASRT. R and D centres in universities were also reorganized, with the aim of improving linkages with industry and increasing flexibility of administrative procedures. Conferences, workshops and training courses were held to enhance technology and R and D management and to promote the commercialization of research results.

40. The paper also described recent steps undertaken by the Government to build technological capabilities—namely, formulating a national programme for the advancement of technology, where sectoral considerations are provided by concerned ministries; identifying information technology (IT), biotechnology and genetic engineering, new materials, pharmaceuticals and space technologies as focus areas in the planning of strategies; launching science parks and technology projects, such as Mubarak City; initiating an incubator programme to be implemented by the Egyptian Incubator Association; starting an S and T cooperation programme to fund research projects; providing incentives for R and D and for S and T awards; carrying out legislative reforms related to R and D institutes and patenting; and making cooperative arrangements at the bilateral, regional and international levels.

2. *Initiatives for science and technology capacity-building in the Kingdom of Saudi Arabia: past experience and future development*

41. The paper on S and T capacity-building initiatives in Saudi Arabia was presented by Abdullah Al-Rasheed, Vice President for Scientific Research at King Abdulaziz City for Science and Technology (KACST) in Saudi Arabia. KACST was founded in 1977 and has, since then, formulated and overseen the implementation of national S and T policies and strategies. It has also played a pivotal role in conducting, supporting, coordinating and directing R and D activities in the Kingdom, as well as in the areas of manpower training and international cooperation.

42. Some of the more prominent national S and T initiatives that were formulated and are being implemented in the Kingdom of Saudi Arabia were examined. These include the expansion of scientific and technical education and training; the King Abdulaziz and His Companions Foundation for the Gifted; applied research grant programmes; the establishment of R and D institutes, as well as strategic industrial sites; the economic offset programme; disseminating IT; the Internet services unit; the telemedicine centre; and the Net project of the Abdullah Bin Abdulaziz School. The date of establishment and the objectives and implementation phases for each of these initiatives were also indicated.

43. The obstacles facing the implementation of those initiatives were addressed, such as the lack of bridging institutions between R and D institutes and industry, insufficient R and D funding and the shortage of skilled manpower.

44. The author called for a new approach to national S and T initiatives and recommended that a comprehensive national S and T plan be formulated and implemented, that R and D support services, science parks and venture capital be supported and deployed and that the building of endogenous S and T capabilities be awarded top priority.

45. Finally, the paper briefly described the National Science and Technology Action Plan (2001-2020), which was still under preparation, and noted that it should fully integrate the S and T needs, capabilities and expectations of the Kingdom. As its broad objectives, the Plan would increase public awareness of S and T and promote R and D activities, S and T capacity-building and the acquisition and adaptation of new technologies.

3. *Development of science and technology capacity-building in Kuwait Institute for Scientific Research*

46. The paper on the development of science and technology capacity-building in the Kuwait Institute for Scientific Research (KISR) was prepared by Abdulhadi Al-Otaibi, its Director General, and Yousuf Al-Sultan, its Assistant Director General. The presentation was made by Mr. Al-Sultan, who began by stating the mission of KISR, which is to promote scientific and applied research in areas vital for Kuwait's techno-economic development. Since its establishment in 1976, KISR has achieved much through its five-year research programmes. Its fifth five-year plan (2000-2005), in particular, focused on R and D in five areas—namely, oil and petrochemical processes, water technology, food resources, environmental management and techno-economic analysis. In addition, human resource management continued to receive high priority, in order to establish the national expertise needed for socio-economic development. Information technology, as well as R and D strategic alliances, were cited by the author as the major processes used in the execution of the plan.

47. In the second part of the paper, KISR's capacity-building activities were described in three main research areas: development of water resources, plant tissue culture and energy conservation in buildings.

48. Fresh water scarcity in Kuwait led to a greater interest in seawater desalination. Multistage flash distillation was the preferred desalination method used. However, the achievements of the Doha reverse osmosis (RO) plant triggered a shift towards the use of RO membrane technology, in terms of both reliability and cost effectiveness. In effect, KISR planned to train Kuwaiti professionals in the area of water desalination and to engage in R and D geared towards RO technologies.

49. Plant tissue culture was also being awarded R and D priority by KISR, in particular in areas related to mass propagation of selected plant varieties, plant diseases and variety improvement. For this purpose, the

tissue culture lab was built in 1995 and a number of staff were highly trained. The strategy adopted by KISR relied on undertaking research in tissue culture and providing highly technical services to the commercial sector.

50. More recently, the Institute focused on energy conservation in buildings, owing to the increasing cost of electricity coupled with the rising demand for air conditioning. In this regard, it undertook the development of a code for energy conservation in buildings. In addition, KISR established laboratories, trained Kuwaiti staff and conducted research and studies on energy-efficient strategies and technologies, especially as related to cooling systems.

4. *Research and development institutes and industry: the Egyptian experience*

51. The paper on R and D institutes and industry in Egypt was presented by Nabil Saleh, Professor Emeritus and former president of the National Research Centre in Egypt. In the first part of the paper, an overview of the current status of R and D institutes and industry in Egypt was given. Having 16 universities and 53 research institutes, Egypt benefited from a wealth of R and D human resources, though a large proportion of these resources were devoted to non-industrial applications, mainly medicine and agriculture.

52. The industrial sector was administered by the Ministries of Industry, Public Enterprise Sector, Electricity and Energy, Military Production, and Petroleum. Over the past decade, industry took the lead over other sectors to become the major contributor to national income, as indicated by the remarkable increase in industrial exports.

53. Linkages between R and D institutes and industry existed at three levels: inter-ministerial, inter-institutional and private sector.

54. The most influencing forms of inter-ministerial linkages were the specialized research councils that were affiliated to ASRT. The role of these councils, which were made up of representatives from R and D institutes and ministries, in addition to independent experts, was to set priorities according to sectoral needs. These priorities were then translated into research projects.

55. Inter-institutional linkages were achieved either through requests from industry to the R and D institutes for specific technical assistance or through R and D institutes looking for enterprises to market their results. In either case, an agreement was usually signed to regulate funding and intellectual property rights that might be involved.

56. Private sector consultancy offices were playing an increasingly important role in linking R and D institutes to industry. Funded mainly through foreign grants, these offices contracted experts from R and D institutes to offer consultancy services to industry.

57. Future challenges facing industry in Egypt were also discussed in the paper. The main ones were: the establishment of a strong industrial base; finding suitable markets; facing competition; and preparing for the application of the General Agreement on Tariffs and Trade (GATT) and the agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS). The latter challenge, in particular, should exert more pressure on industry to innovate instead of passively transferring technologies. This, in turn, would require a solid R and D base, especially in basic sciences.

58. In order to face these challenges, the industrial and R and D sectors needed advanced knowledge of R and D management, including project management, market and feasibility studies, human resource development, funding and negotiations. In addition, technology transfer to SMEs could be greatly enhanced through the establishment of technology incubators and parks. Projects for their establishment in Egypt were still in the planning phase, however. Priority areas for these incubators and parks included information and communications technology (ICT), microelectronics, new materials, biotechnology and renewable energy.

59. The environmental impact of industry became increasingly important in government planning. All industrial establishments were required by law to carry out environmental impact assessments, usually

undertaken through local or foreign consultancy offices. This should promote a shift towards the use of environmentally-friendly technologies.

60. In conclusion, the author recommended the adoption of a programme similar to the "Foresight Programme" in the United Kingdom—in which all parties played a role in setting priorities and formulating and implementing S and T policies—as a mechanism to promote innovation and sustain development in high-technology domains.

5. *Science and technology initiatives: the case of Palestine*

61. The paper on S and T initiatives in Palestine was prepared by Marwan Awartani, Associate Professor at Birzeit University. Initiatives aimed at S and T institutional capacity-building were described. The Science and Technology Planning Unit, affiliated to the Ministry of Planning and International Cooperation, acted as a focal point for S and T policy formulation. The Palestine Academy for Science and Technology, which served as the national umbrella and governmental advisory body in S and T, aimed at the establishment of national databases, the development of human resources and the building of regional and international cooperative networks. Furthermore, several ministerial departments were set up to coordinate and supervise R and D programmes. A project to establish a National Research Council had recently been put on the table.

62. With respect to policy initiatives undertaken in Palestine, the Ministry of Higher Education had renewed its efforts to formulate a national policy for scientific research and higher education, aided by input from Government, academia, civil society institutions and the private sector. In addition, the Science and Technology Planning Unit conducted in 1997 the first national assessment exercise on scientific research at universities and research centres. Copyright and patent laws were drafted by the Ministry of Culture and the Ministry of Economy and Trade, while efforts were made to develop enforcement mechanisms.

63. Twenty-six R and D centres were established. Most of them were affiliated with universities, while others were either independent or governmental. The centres faced a scarcity of expertise, a high reliance on foreign funds and the absence of a national coordinating body. Three centres were presented in detail as case studies—namely, the Institute of Community and Public Health, the Applied Research Institute of Jerusalem and the UNESCO Biotechnology Educational Training Centre.

64. Several information technology initiatives were discussed, among them the Palestine Information Technology Association, the Palestine Information Technology Special Interest Group, the Information and Communications Technology Advisory Board, the National Institute of Information Technology, the Cisco Regional Network Training Academy, the University Information Technology Centre of Excellence, the Palestinian Development Gateway Project, and the Network of Palestinian Scientists and Technologists Abroad.

65. In concluding his presentation, the author reported that several industrial estates had been established for the purpose of achieving industrial development and attracting foreign investors and had been awarded legal incentives. Two of them were earmarked for technology-intensive industries: the Khadoura Information Technology Estate and the Rafah Industrial Estate, which promoted electronics and rubber and plastics industries.

6. *The role of universities in promoting capacity-building in science and technology*

66. The paper on the role of universities in promoting S and T capacity-building was presented by Haseeb Bashi, General Director of Research and Development at the Ministry of Higher Education and Scientific Research in Iraq. First, a general overview of S and T capacity-building was given, in which the author defined it as comprising the development of human resources, organizational structures and institutions and also pointed out that capacity-building should address all sectors of the economy, be flexible and achieve the aspirations of the S and T community.

67. Second, the growing importance of universities as centres of knowledge was highlighted. Action should therefore be taken to improve the quality of higher education programmes and encourage specialization in technological fields such as ICT, biotechnology and robotics.

68. Third, the status of S and T capacity-building in Iraq was reviewed. Several technical colleges were established and new specializations were introduced in tissue culture, remote sensing, composite materials and informatics, for example. Training and development courses on new production technologies were given to workers in the industrial sector. Examples included polymer lining, metal corrosion, image processing and digital transmission. In addition, a number of bureaus were established inside colleges to provide consulting services and to construct and operate pilot plants. Finally, university teaching staff were encouraged to undertake research in application areas of direct interest to the industry and were given the opportunity to be seconded to jobs in other institutions during the summer holiday.

7. *Initiatives for science and technology capacity-building in Jordan*

69. The paper on S and T capacity-building initiatives in Jordan was presented by Munther Masri, Secretary General of the Higher Council for Science and Technology (HCST) in Jordan. It highlighted the role of HCST as the focal point of all S and T activities in Jordan, including the formulation of policies and strategies, S and T cooperation and the establishment of specialized research centres. The national S and T policy, formulated in 1995 with the consensus of all stakeholders, revolved around four axes—namely, R and D, technologies, human resources and information. A national human resources development strategy was formulated and a study on S and T requirements and potential was prepared, which focused on matching S and T supply and demand in terms of training, scientific research, funding and services. This study formed the basis of a document on national priorities for R and D. Meanwhile, S and T policies and strategies were complemented with industrial policies aimed at strengthening SMEs, in particular, with the cooperation of several global partners.

70. The second part of the paper described the Jordanian S and T institutional framework, which consisted of research institutes and universities. The main activities of eight research institutes affiliated with HCST were described. These institutes specialized in the areas of industrial development, computer science, electronics, human resources development, information systems, agriculture, health sciences and energy. In addition, universities maintained active ongoing R and D programmes which were linked with the research institutes of HCST.

8. *Initiatives for science and technology parks in Kuwait*

71. The paper on initiatives for S and T parks in Kuwait was presented by Salah Al-Mazidi, Director of the Division of Policy and Planning at the Kuwait Institute for Scientific Research. He began with a brief account of the worldwide growing importance of S and T parks and noted that such parks could not be established without an interventionist Government role and a public-private collaborative approach geared towards technology acquisition and development. The paper stressed that comparative advantage could not be achieved without a growth strategy based on investment in advanced technology transfer and infrastructure-building. As an example, the author cited the experience of a number of East Asian countries in transforming their economies by building knowledge-intensive industrial structures. A development strategy for Kuwait should, however, take into account the peculiarities of Kuwait's economy, which relied mostly on State-owned oil companies and Government institutions.

72. Moreover, Kuwait was in great need of technology-based firms, technical training and cooperation between the public and private sectors, on the one hand, and between research centres and national industries, on the other hand. The Higher Planning Council recognized these needs and endorsed a project for building an S and T park in Kuwait. Such a project could only be pushed forward with support from major research and educational institutions, the availability of funds and a fairly well established R and D infrastructure. Constraints, however, included the absence of a national S and T strategy, coupled with weak linkages and coordination between R and D institutions.

73. The paper concluded with a set of recommendations and suggested steps to be followed for the creation of an S and T park in Kuwait.

9. *Lebanese National Council for Scientific Research incubator project*

74. The paper on the incubator project undertaken by the National Council for Scientific Research (NCSR) of Lebanon was prepared by Mouin Hamzé, Secretary General of NCSR, and Mohammad Mrayati, Regional Adviser for Science and Technology at ESCWA. The presentation at the Meeting was made by Mr. Mrayati. Statistics on expenditure on higher education in the ESCWA region and the distribution of Lebanese students by level and gender were given as background to the subject. Projects already launched or planned by NCSR were also enumerated, the most recent one being the initiative for a Lebanese technology incubator.

75. A general introduction highlighting the importance and growth of technology incubators was provided. A global shift in the focus of incubators towards new technologies was noted, as was the fact that economic development organizations were assuming the largest share in financing incubators as against a decreasing share of Government funding.

76. The Lebanese incubator project was expected to support technology-based start-ups, commercialize their R and D results and create value-added jobs, thus contributing to the diversification of the economy. In addition, the incubator would foster networking between know-how sources and venture capital, both local and foreign. Management of the incubator would be shared by NCSR and an advisory board comprised of local and international members and representatives of the tenant companies themselves.

77. Proposed priority sectors included agro-food, textile and metal industries, while proposed technologies included ICTs, new materials and biotechnology. It was pointed out that the project could face several risks, such as low occupancy, financial problems and inexperienced staff. These risks should be taken into consideration in the design and implementation phases of the project. The authors finally proposed that ESCWA, as well as other United Nations organizations, offer advisory services, assist in training programmes and evaluate the implementation phases of the project.

10. *Initiatives for science and technology capacity-building in Tunisia*

78. The paper on initiatives for S and T capacity-building in Tunisia was presented by Mohamed Rached Boussema, Director for Prospective Planning and Evaluation at the Secretariat of State for Scientific Research and Technology in Tunisia. The author described the major steps undertaken in the late 1990s in Tunisia to reform and restructure the national system of scientific research and technology, including the evaluation of existing research programmes and institutions; the development of international technology cooperation; the provision of R and D grants and other incentives for investment; legislating intellectual property laws; launching incubators and technology parks; and establishing an agency responsible for the valorization of research results.

79. Under a national S and T programme, three pilot incubators were established in universities (Sfax, Tunis and Gatsa) through the concerted efforts of the United Nations Development Programme (UNDP) and the Tunisian Agency for the Promotion of Industry. Owing to their location in universities, these incubators benefited from a pool of research expertise and fresh entrepreneurs. A convention between the Ministry of Higher Education and the Ministry of Industry was signed in 1999 to regulate the operation of these incubators. Furthermore, a network including all involved parties was set up to promote and coordinate incubator initiatives.

80. The first technology park to be established in Tunisia was the Technological City of Telecommunications, while two other parks were under development. The 60-hectare park was comprised of industrial zones outfitted with a modern infrastructure, including communications, two higher education institutions for telecommunications, an incubator area targeting IT applications, a training centre and a development centre. A law regulating the installation, management and financing of technology parks was being promulgated as well.

81. In order to reinforce innovation and the commercialization of R and D, an “orientation law” for scientific research and technological development was issued in 1996. The law envisaged the creation of units within research institutions that would aim at valorizing research results and granting financial support

(mostly through fiscal advantages) to both innovators and firms undertaking the commercial exploitation of the research results.

82. In conclusion, the author considered Government and international funding, as well as capacity-building, as prime prerequisites for the success of the Tunisian S and T system.

11. *National action plan: Moroccan information society*

83. The paper on the Moroccan information society was presented by Najat Rochdi, General Affairs Director of Cooperation and Information Technology Development for the Ministry of Post and Information Technology of Morocco. The author began by noting that, in view of the emergence of knowledge economies, Arab countries were occupying a weak position, owing to a number of conditions, among them the lack of R and D, venture capital, high-technology exports and skilled human resources. In this situation, ICTs could play an enabling role in facilitating the acquisition of knowledge.

84. Realizing the consequences of the digital divide, the Moroccan Government in 1998 launched an ICT action plan focusing on five areas: (a) education, training and research; (b) modernization of public administration; (c) promotion of innovation by SMEs; (d) development of e-commerce; and (e) diffusion of ICTs. The implementation strategy consisted of preparing the necessary legal framework; building consensus for change among all benefiting parties; and launching an ICT promotion campaign at all levels. Actions taken included the creation of a fully digital network; liberalization of the telecommunications sector; installation of computers in schools and public administrations; and changes in educational programmes. Tangible results were starting to appear, with a net increase in the number of Internet service providers (ISPs), cyber cafés, web sites, telephone lines and Internet subscriptions. Within this context, the role of Government was not only to provide a vision and facilitate the work of the private sector, but also to lead by example.

12. *Initiatives for science and technology capacity-building in Maghreb countries*

85. The paper on S and T capacity-building initiatives in the Maghreb countries was presented by Abdelkader Djeflat, Professor at Lille University in France. The Maghreb countries included were Algeria, the Libyan Arab Jamahiriya, Mauritania, Morocco and Tunisia. The paper gave a brief review of new laws and regulations, institutions and S and T policies and programmes in the Maghreb countries and examined their crosscutting capacity-building initiatives, as well as their sectoral and enterprise-level schemes. The requirements to attain optimal benefits from those initiatives were also highlighted.

86. The new institutional setup for S and T policy implementation was described, under which most of the Maghreb countries had set up single institutions to coordinate their R and D efforts and formulate S and T policies. In addition, all the countries had a multitude of research and capacity-building bodies that included universities, research institutes and training centres. Laws geared to S and T enforcement, such as R and D incentives and restructuring, were promulgated in Tunisia and Algeria. R and D and technology transfer associations, both public and private, were also established.

87. Few differences existed in the S and T priority areas of the Maghreb countries. Industrial competitiveness, socio-economic growth and human resources development were considered top priorities, followed by environmental management and a higher standard of living. Technology transfer, the acquisition of know-how and joint research projects were the methods listed to achieve those objectives.

88. Both Tunisia and Morocco had created technological poles, grouping institutions with similar research interests and aiming at optimizing the use of R and D resources and promoting partnerships between research and industry. Algeria had plans for poles in areas of high industrial and training potential. These three major Maghreb countries had established centres of excellence and had a non-negligible potential of researchers in advanced technology, energy, environment and water, social sciences, agriculture and life sciences.

89. Several incentives were initiated by the Maghreb countries during the last five years, such as funding for industrial R and D and innovation awards. In particular, the promotion of innovation by SMEs was awarded top priority. The efforts made to allocate funds for S and T capacity-building, particularly through research and technological development programmes, increased significantly.

90. Coordination and cooperation arrangements to exchange experiences and integrate S and T into socio-economic development took place, including intra-Maghreb cooperation through civil networks, the Maghreb-European Union relationship and cooperation with subregional agencies such as the African Agency of Biotechnology.

91. According to the author, obstacles facing the implementation of the above initiatives included disorganized and fragmented national systems of innovation, an inadequate information basis of S and T bodies, the shortage of qualified policy-making personnel, weakness of the institutional R and D setup, the lack of innovation incentives and the weak linkages between research centres and industry.

13. *National science and technology policy initiatives in the Syrian Arab Republic*

92. The paper on national S and T policy initiatives in the Syrian Arab Republic was presented by Ihssan Shureiteh, Professor at Tishreen University in Latakia. The author gave an account of the initiatives launched by the Syrian Government in conjunction with academic institutions, research centres and NGOs, in order to promote and enhance the country's S and T system and develop a blueprint for a national policy that could serve as a guideline for concentrated efforts at the national level.

93. Among the initiatives listed were: a presidential decree legislating the opening of new faculties of computer engineering at the universities of Damascus, Aleppo, Tishreen (Latakia) and Al-Baath (Homs); presidential decrees legislating the establishment of new agricultural and environmental research centres; a study for the creation of an S and T park; a governmental decision to establish a network of Syrian scientists and technologists abroad; and the organization of a national symposium on S and T policies that was expected to help outline the framework of a national innovation system for the country.

14. *The Arab Science and Technology Foundation: an overview*

94. The paper on the Arab Science and Technology Foundation (ASTF) was presented by Abdalla Alnajjar, President of ASTF. This newly established institution was defined as an independent, non-governmental, non-profit regional and international organization aimed at identifying and supporting outstanding scientific research activities conducted in the Arab world. ASTF would also attempt to act as a mediator between those who produce, develop, finance or benefit from scientific research, as well as seek to become a centre for assessing the performance of scientific programmes. ASTF, which was established in response to the demand of the Arab scientific community living inside and outside the Arab region, is based in Sharjah.

95. ASTF had identified several goals, including the mobilization of human and material resources; the coordination and fostering of collaborative research programmes within the Arab countries and also with other developed and developing countries; carrying out studies and organizing expert meetings, workshops and symposia; and the transfer and adaptation of innovation.

96. Activities projected in the near future included awarding grants to distinguished Arab scientists, establishing incubators, launching awareness-raising media campaigns, creating a database of Arab researchers, setting up an Internet portal for S and T, publishing regular reports and organizing conferences.

97. ASTF has a distinguished board of directors and an advisory board of elected members from several national, regional and international organizations and research centres.

D. APPLICATION/DISCIPLINE-SPECIFIC SCIENCE AND TECHNOLOGY INITIATIVES

1. *Information technology in the service of science and technology education in Arab States*

98. The paper on IT in S and T education was presented by Tarek Shawki, Regional Adviser for Informatics at the UNESCO Cairo office. He described in detail the activities undertaken within the Upgrading Science and Engineering Education (USEE) programme, an initiative launched by the UNESCO Cairo office in 1997 to assist the Arab academic community in modernizing the university teaching of basic sciences and engineering through investigative and dynamic use of the latest in ICTs. Since 1999, the programme has evolved and expanded to integrate the inputs of various specialists from the three UNESCO sectors concerned with Natural Sciences, Education and Communications and Information.

99. The USEE programme was structured along four basic and complementary modules: Courseware Development Projects; Capacity-building of Human and Physical Resources; Technical and Advisory Support; and Regional Dissemination of Information.

100. The Courseware Development Projects module aimed at assisting small faculty teams in planning and implementing projects for upgrading the teaching of specific courses in basic sciences and engineering, facilitated through the awarding of two-year grants. Since its inception in 1997, the USEE programme has supported the development of 15 projects in such disciplines as statistics, physics, chemistry, biology, computer programming, engineering mechanics and fluid mechanics.

101. The Capacity-building module represented the main pillar of the USEE programme. Modalities of support in this vital area included: (a) faculty training workshops; (b) faculty training visits; (c) technical and fund-raising support for the development of ICT infrastructure; (d) preparation of self-learning training kits; and (e) incorporation of international standards for the certification of basic computer skills and knowledge.

102. Stemming from the fact that without adequate facilities and resources the real benefits of ICT to many Arab countries would be severely limited, the USEE programme placed special emphasis on providing technical and fund-raising support to member States towards the development of an up-to-date ICT infrastructure.

103. The fourth element of the USEE capacity-building component involved the development of an array of interactive, self-learning training kits on topics related to the utilization of IT in educational applications. To facilitate their use by the largest number of regional faculty, the kits were made available on a variety of media. Topics of interest included basic Web technology skills for courseware development, JAVA, audio, video, graphics, Active X, database connectivity and others.

104. In 2000, the UNESCO Cairo office added, at the request of the ESCWA member States, a new element for capacity-building in basic computer skills and knowledge. This was prompted by the general belief that this vital area of proficiency was, by and large, suffering from the proliferation of different IT courses that made varying and conflicting claims without any objective evidence to support such claims. To overcome this difficulty, the UNESCO Cairo Office explored the possibility of adopting the concept of an International Computer Driving License as an effective means for the certification of computer literacy.

105. The Technical and Advisory Support module of the USEE programme provided interested Arab higher education institutions, at their request, with short-term advisory support for assistance in the planning and/or assessment of ICT-based programmes and activities. Countries that have benefited from this support included Egypt, Jordan, Morocco, Saudi Arabia and the United Arab Emirates.

106. Dissemination of information, a major aim of the USEE programme, facilitates the exchange of ICT-related information and the sharing of experiences among Arab science and engineering faculty members, departments and colleges. Efforts in this regard included the development of a comprehensive web site for the USEE programme; the preparation and distribution of various brochures and newsletters for familiarizing the region with the USEE programme and summarizing its activities; the establishment of a multimedia unit at the UNESCO Cairo office, furnished with adequate hardware and software resources for effective

utilization in faculty training workshops; and the preparation of newsletters and media announcements, as well as the delivery of keynote addresses, papers and presentations at relevant conferences held in the Arab region.

107. Aiming to further enhance its potential impact and sustainability, a new millennium vision for the programme was articulated. The International Grid for Learning Programme, an interdisciplinary framework that effectively integrates the expertise of the Science, Education and Communications and Information sectors of UNESCO, was structured to include four primary modules. These were: offering IT primer workshops for faculty/teachers on the basic technology skills and tools needed for courseware development; preparing a series of self-paced, interactive training kits for gaining the necessary expertise for courseware adaptation/development using recent technologies; compiling topical, indexed and reviewed electronic libraries of high quality to provide copyright-free educational material on a regional server; and establishing a network of regional centres furnished with all required resources, facilities and tools to assist the faculty in their endeavours to integrate ICTs in their classrooms.

2. *New approaches for the university-industry interactions*

108. The paper on new approaches for university-industry interactions was prepared by Luigi Nicolais, Professor and Chairman of the Department of Materials and Production Engineering at the University of Naples and Gianfranco Carotenuto from the Institute for Composite Material Technology of the National Research Council of Italy. It was stated in the first section of the paper that universities were replacing corporate research centres, because integrated product development required a strong interdisciplinarity which only universities could offer. This may be seen in the United States, in particular, where universities contributed a great deal to the development of high-tech companies.

109. The university-industry relationship could be improved through the modification of educational programmes, through devoting university research to industrial application topics and through facilitating the work of professors with industry. It was suggested in the paper that universities, in addition to undertaking research, also offer testing and calibration services and business counseling. A liaison office could be established to act as an interface between the universities and industry.

110. The remainder of the paper presented four examples of the new materials industry, where the university-industry partnership could be extremely beneficial. The first example was related to the processing methods of polymer-based composites, in which the high cost and level of technology involved required the optimization of those methods in university laboratories before their diffusion to industry. The second example dealt with the production of thermo-electric switches made of polymer/metal composites. Because of the experimental difficulties involved, this process constituted a good candidate for university research. The development of biomedical devices, such as prosthesis, required a multidisciplinary analysis that was easily available in university laboratories. Finally, the milling of mechanical parts made of ceramics, for example, required numerically controlled machines and special computer-aided design programmes which engineering departments could develop and optimize.

3. *Strengthening the regional dimensions in seed industry development*

111. The paper on regional dimensions in seed industry development, which was prepared by Michael Turner, Head of the Seed Unit of the International Center for Agricultural Research in the Dry Areas (ICARDA), and Zewdie Bishaw, its Seed System Specialist, was presented by Mr. Turner. In reviewing the evolution and current status of seed programmes in the ESCWA region, the paper noted that while some countries had adopted policies towards the privatization of the seed sector, most Governments continued to be the main seed suppliers and to provide high subsidies, thus making private sector participation virtually impossible. It was therefore recommended that, rather than undertake production, Governments should aim at creating a favourable policy environment and provide services to assist in the establishment of a seed system in which other suppliers can participate. This would protect national interests and prevent over-dependence on foreign companies. In this context, the role of institutions that oversee the development of the industry becomes essential.

112. Technical and social factors that profoundly affected the development of the seed industries were defined—namely, the farming system, access to seed varieties, agricultural productivity, market prices, regulations and developments in hybrid technology and biotechnology. As a result, an integrated regional approach to seed sector development would be the most viable in order to share information and experience and facilitate the movement of seeds and varieties across national boundaries. In particular, harmonization of variety registration procedures, seed quality standards, phytosanitary regulations and seed trade regulations would stimulate a regional approach to technology generation and diffusion.

113. The West Asia and North Africa seed network, established in 1992 and coordinated by ICARDA, became the major regional forum for all matters related to varieties and seeds. This seed network was considered by the author as a platform for developing regional seed activities and disseminating information. Furthermore, in collaboration with other regional and international organizations, the network could provide valuable support for Governments with respect to seed policy and regulatory reforms. This should be complemented by national and regional seed associations, which would create the link between official regulatory agencies and the private sector.

114. Finally, more active participation in international organizations should ensure that any new regional initiatives are complementary and do not duplicate or compete with existing arrangements. This would also help to cope with recent global developments affecting the seed industry, such as laws for the protection of plant variety property rights and advances in agricultural biotechnology.

4. *"Intelligent manufacturing systems": a case study of global collaborating initiative for research and development*

115. The paper on intelligent manufacturing systems (IMS) was presented by Akram El-Tannir, Assistant Professor at the School of Business and Management of the American University of Beirut. IMS is a programme for research collaboration that was started by major manufacturers from Australia, Canada, the European Union (EU), the European Free Trade Association, Japan and the United States. It is an international initiative for scientific research and technological development aimed at gathering advanced manufacturers from different parts of the world around agreed projects of common interest to all participants. These projects address and try to resolve the issues resulting from the new global challenges, such as environmental concerns, efficiency in energy use, ICT, open markets and the higher demand for quality. Projects are categorized according to five themes:

(a) Product life cycle;
(b) Production process;
(c) Strategic planning and design;
(d) Human resource development, institutional forms and social interactions;
(e) Virtual and extended enterprise networks.

116. Projects were evaluated before being endorsed, and the evaluation criteria specified that projects be market-driven, have value-added, bring equitable benefits to all participants and do not duplicate individual governmental projects. A steering committee regularly reviewed the progress of projects. Funding was provided equally by the participants and possible resulting patents were dealt with according to the provisions on intellectual property rights.

117. The author recommended that lessons be drawn from this consortium initiative for application in the ESCWA region, where common themes could be identified for prospective regional partnerships between research institutions, private business and Governments. Proposed themes for such an initiative in the region included ICT and e-commerce, strengthening SMEs, human resource development, oil research and agricultural industries.

5. *Environmental initiatives under the Mediterranean Strategic Action Plan*

118. The paper on environmental initiatives under the Mediterranean Strategic Action Plan was prepared by Fouad Abousamra, Programme Officer at the United Nations Environment Programme (UNEP)

in Greece. The first section of the paper presented an overview of the Plan, which was adopted in 1999 and was based on the preliminary findings of a regionally-prepared transboundary diagnostic analysis that represented a synthesis of regional actions with regard to the protection of the Mediterranean marine environment from land-based activities. Its main objective was to improve the quality of the marine environment through better-shared management of land-based pollution.

119. One of the main targets of the Plan was the abatement of pollution generated by industrial companies, such as oil, petrochemicals, metallurgy, fertilizers and paper and cement production. Priority was given to persistent toxic and bio-accumulative pollutants because of their highly damaging consequences.

120. Two major initiatives were undertaken under the provisions of the Plan: the "Pollutants Releases and Transport Register" (PRTR) and "Pollution Prevention Planning".

121. PRTR provides information on potentially harmful pollutants released into the air, water and soil, as well as on wastes transported to treatment and disposal sites. The register represents a means for Governments to track the generation, release and consequences of various pollutants over time. Using this information, authorities could set priorities for reducing or eliminating the most potentially damaging pollutant releases, while those who generated pollution could pinpoint priority candidates for the introduction of cleaner production technologies. Implementing PRTR, however, would require planning and the allocation of resources, as well as collaborative efforts on the part of all those affected by pollution.

122. In conclusion, it was emphasized that pollution prevention should be an integral part of business company planning. Usually, pollution could be prevented through chemical substitution, control of material flow, automation, process control and the adoption of cleaner technologies. Formulating pollution prevention plans would involve the assessment of current practices and the analysis of feasible and clean options. This would call for the calculation of a baseline expressed as pollution to production ratio, which would require the gathering of data related to product, process, chemical handling and cost. An analysis of alternative solutions could be made easier through the use of decision support systems, while implementing the best option selected would involve formulation of a plan and schedule, as well as an outline of expected benefits.

6. *Flexible maritime marketplace*

123. The paper on a flexible maritime marketplace was prepared by Yousry El-Gamal, Vice President for Education and Research at the Arab Academy for Science and Technology and Maritime Transport, and Imad Abdul Seoud of the Maritime Research and Consultation Centre in Egypt. The presentation was made by Mr. El-Gamal. The paper dealt with a project for an electronic commerce (e-commerce) strategy and architectural framework to manage electronic business applications within the maritime industry. The project aimed at providing a flexible maritime marketplace that would allow users to build their own e-commerce community for the various vertical domains of the maritime industry. Maritime business models that could be implemented included, for example, container fleet management, ship brokerage auctions and ship-to-shore Internet services.

124. The paper described in detail the aspects of constructing an e-commerce system, including the use of model-based and component-based methodologies, the development of computer-aided software engineering tools and the development of novel architectures of e-commerce systems.

125. The enterprise framework was explained in terms of different e-commerce application layers, including the workflow-enabled e-commerce layer, the business process layer, the common business object layer, the business transaction services layer and the middleware services layer.

126. The inter-operability infrastructure of the maritime marketplace was described in detail, including the e-commerce processes and agents for enactment of the workflow process. Previous work on building agent-based workflow management systems was also presented.

E. TECHNOLOGY INCUBATORS AND SCIENCE PARKS

1. *The evolving role of academia in the United Kingdom: case studies of technological partnership with industry*

127. The paper on the evolving role of academia in the United Kingdom was presented by Muthana Jabbar, Professor at the School of Social Science of Middlesex University in the United Kingdom. The paper dealt with the globalization process and the rapidly changing industrial dynamics that introduced a new mutually beneficial perspective to university-industry partnerships. From the viewpoint of universities, reduced public funding urged them to commercially exploit the results of their R and D efforts. As for industry, more particularly SMEs, they were also limited by low capital investments, in addition to the absence of in-house R and D, time constraints and an inability to bear risks.

128. An overview of initiatives undertaken in the United Kingdom to promote university-industry partnerships was given. These initiatives took many forms, including the establishment of university companies, teaching companies and university-based regional technology centres. Examples for each mode of partnership were cited, with a brief description of their services and outcomes.

129. University companies provided consultancy services and R and D for local industries through contracting academics from the university. These companies disseminated technologies to local industries and, at the same time, provided university professors and students with hands-on experience.

130. The teaching company scheme was adopted and supported by the public sector to improve the industrial competitiveness of SMEs through technology transfer partnerships between academia and local industries. Staff members recruited by the company to work on a specific project were trained by the university. The cost of training was borne mostly by the Government, which also played a supervisory role. Financial returns, as well as qualitative impacts resulting from the teaching company scheme, have been quite encouraging, especially in rural areas.

131. University-based regional technology centres acted as incubators and provided a range of technological and business services to local industries, as if they were multifaceted intermediary agencies working between universities and SMEs.

132. The author concluded that university/industry co-dependence and tapping into the research and knowledge base of the former was assuming a more decisive role in the growth and development of both parties. The three modalities of cooperation discussed were all effective to varying degrees. Success factors included the industrial and commercial experience of the academics involved in such initiatives, the adoption of an approach that was more sensitive to the needs of particular client groups rather than offering standardized services and technologies, and the organizational structure and culture of the universities involved.

2. *BERYTECH, a technology park in Lebanon*

133. The paper on the Lebanese BERYTECH technology park project was prepared by Maroun Asmar, Dean of the Faculty of Engineering at the Saint-Joseph University, and Fady Rahme, Managing Director of Asda'a, in Lebanon. It was presented by Mr. Rahme. BERYTECH, an initiative of the Saint-Joseph University in Beirut, has a twofold objective: to offer an experimental workplace for university students and graduates; and to serve as an incubator of technology-related SMEs. It is expected to host existing local and foreign high-tech firms, as well as specialized training centres.

134. Three phases for the incubation process were identified: conception, start-up and take-off. Services offered by BERYTECH should be tailored according to those phases, including communications networks, administrative services and security and leisure facilities. Businesses in the conception phase would be provided with assistance and counseling, in addition to access to the university's research facilities and guidance in their search for investors and potential partners.

135. Areas of high priority for BERYTECH included ICTs, water and environment, food industry, health sciences and biotechnology. Implementation would involve a real estate development firm and a resources centre management company. Subsequent operation would be supervised by a technological and scientific committee.

3. *Internet and technology incubation in the Arab world*

136. The paper on Internet and technology incubation in the Arab world was presented by Wissam El Solh, Chief Executive Officer of Netakeoff Incubator in Lebanon. In its introduction, the paper gave an overview of global developments with respect to the Internet. The Arab world seemed to witness a tremendous growth rate in Internet usage, surpassing that of the world average growth. This should be accompanied by a significant increase in the volume of e-commerce and, in turn, would signal a greater need for Internet infrastructure and services. Thus, Internet incubation becomes a must in order to assist in the start-up of e-commerce companies and reduce their rate of failure.

137. Incubation services, main incubation characteristics and the requirements for incubator success were described, as were the challenges facing incubators in the Arab world, among them regional political instability and the lack of Government support, incentives and enforcement laws.

138. Netakeoff Incubator, a Lebanese Internet technology company, was presented as a case study. This company, which focuses on areas such as business-to-business e-commerce, software development and telecommunications, has an advisory board and a professional management team.

F. INITIATIVES TO PROMOTE INNOVATION: ENHANCING CORE BUSINESS FUNCTIONS

1. *ICT: a medium for small and medium enterprises entry into the global market*

139. The presentation on ICT as a medium for the entry of SMEs into the global market was given by Nader Ghazal, General Manager of Total Quality Consultants in Lebanon. In the first part of his paper, the author gave an overview of the major characteristics of SMEs, with emphasis on their growing socio-economical importance. SMEs were becoming increasingly globalized and competitive, while focusing on knowledge and innovation-intensive sectors. SMEs in the ESCWA region were facing several constraints on both the input and output sides. Funding difficulties, lack of incentives and skilled personnel, bureaucratic complications, increasing competition and narrowing markets were some of the constraints listed.

140. Governments, therefore, could play a major role in supporting SMEs. Financing, regulatory incentives, training, linkages and information dissemination were some of the governmental actions called for in the presentation. In addition, an SME evaluation kit could be designed in order to provide useful statistics as well as simple techniques for measuring results and performing benchmarking.

141. E-commerce was considered an excellent tool for SMEs seeking to enter distant markets. Equally important, e-commerce would reduce setup costs and also allow SMEs to respond quickly to market changes. However, several difficulties existed, such as infrastructure access, lack of IT and management know-how, e-commerce logistics and securing transactions. In conclusion, the author presented some successful e-commerce case studies.

2. *Core business functions for new small and medium enterprises in production and service sectors*

142. The presentation on core business functions for new SMEs in production and service sectors was given by Georges Nicolas, Director of the Center for Sponsored Research and Development at the Lebanese American University. The first part of the presentation shed light on the internal and external factors affecting SMEs—namely, Government bodies, industry clusters, stakeholders, external environment, markets, partners, supply chain, competitors and financial, technological and human resources.

143. Within this framework, a brief outline of principal core business functions related particularly to SMEs in the production and service sectors was presented. The functions discussed included planning, design and production, marketing, service and support, procurement, operations, administration, financial

management, quality systems, infrastructure, knowledge base and R and D. In all of these functions, the sole input should be the customer's requirements, while output should be directed to product or service delivery. In a context where survival of SMEs increasingly relied on human capital and the use of information technologies, continuous training and knowledge management were becoming crucial to achieve business excellence and cope with global competition.

144. Finally, initiatives that may be launched by SMEs and other parties in the region were identified. The use of IT, the development of human resources and core competencies and the creation of strategic alliances were some of the initiatives to be undertaken by SMEs. On the other hand, Governments and other concerned parties should work to develop a responsive regulatory framework, formulate policies, provide incentives, invest in new technologies and modernize the infrastructure.

3. *Technological change and core business functions in manufacturing enterprises: the case of human resources development and production*

145. The paper on technological change and core business functions in manufacturing enterprises was presented by Toufic Mezher, Associate Professor at the American University of Beirut. The effects of current changes in internal and external corporate environment on two core business functions were discussed, namely, human resources development and technological changes in production. In order to meet future challenges, specific managerial knowledge and skills were needed at all levels of the organization. A recent study covering Lebanese organizations identified a large number of managerial and technical skills that were lacking at the top, middle and lower management levels.

146. In addition, the paper discussed the current status of labour in terms of basic and specific skills, and the availability of training and rehabilitation institutions. Firms were facing a serious brain drain, increased training costs and lack of vocational training and Government support. Job design was identified as a key factor in achieving competitive advantage. Firms must adopt the right mix of job "enlargement", job enrichment and job rotation and also assign all staff the responsibility of total quality management.

147. From a production point of view, the paper described prevailing technological conditions in the manufacturing sector in the region as being obsolete and lacking in both product and process innovation. Furthermore, technology strategies to apply new technologies in all operations subsystems, including production, were rarely formulated. Modern production technologies that industries in the region should benefit from included flexible manufacturing systems, computer-aided manufacturing, automation and robotics.

148. Six best practices were identified and should be included in an integrated strategy: (a) a focus on simultaneous improvement in cost, quality and delivery; (b) closer links to customers; (c) closer relationships with suppliers; (d) the effective use of technology for strategic advantage; (e) less hierarchical and less compartmentalized organizations for greater flexibility; and (f) human resources policies that promote continuous learning, team work, participation and flexibility.

149. Imperatives for more productive and competitive manufacturing companies included focusing on the new fundamentals of manufacturing, cultivating a new economic citizenship in the workforce, blending cooperation and individualism, learning to live in the world economy and providing for the future.

150. In conclusion, the author presented a set of strategies addressed to industry, Government and universities, stressing that in order to ensure human capital development, business development, infrastructure building, wealth-generating capacity, competitiveness and sustainable development of countries in the region, there should be strategic interaction and cooperation among the three players.

4. *Identifying, mapping and improving core business functions of small and medium enterprises in ESCWA member countries*

151. The presentation on core business functions of SMEs in the ESCWA region was given by Nader Ghazal, General Manager of Total Quality Consultants in Lebanon. The first part of the presentation

consisted of brief definitions of SME business processes and business functions. The difference between processes and functions was explained and the types of business functions and processes were listed. For instance, the latter could be "no value-added", "real value-added" or "business value-added".

152. Core business functions should involve as many real value-added activities as possible, in order to compete in the global marketplace. Therefore, an important task for SMEs consisted of identifying the "non-core" functions and outsourcing as many of them as possible. In order to identify and plan core business functions, a customized balance scoreboard model could be used, whereby the perspectives of shareholders, customers, stakeholders and the organization itself are all taken into account.

153. Following the identification of the core functions, they should be mapped and linked to all entities in the enterprise. A business modelling software could be used to achieve this result. Examples of the process were given during the presentation.

154. Finally, the benefits of ICTs with respect to SMEs were enumerated. In addition to the software tools for identifying and mapping core business functions, ICTs enable the enterprises to respond quickly to market needs and foster innovation and networking among other SMEs.

G. TECHNOLOGY INITIATIVES FOR WOMEN

1. *Technology and women: strategies between local actuality and global virtuality*

155. The paper on technology and women was presented by Seta Dadoyan, Professor at the American University of Beirut. The paper described the status of women in the Middle East, as related to science and technology. Inherent problems existed and continued to exist in women's access to education and training and also in the opportunity to work in particular technological areas. The labour market for women—especially married women—was still restricted to low-skilled and low-paying jobs. Although the employment of women was considerable from a quantitative perspective, an equitable distribution of wages, training and institutional support was still required.

156. The image projected by the West of the Middle Eastern woman being powerless should be reconsidered. Middle Eastern women were actually powerful in certain areas, such as education, family, arts, health and food sciences. The main problem lay in the fact that most women in the Arab region were outside the socio-political sphere and did not comprehend the politics of S and T, nor their impact at the local and global levels. Therefore, the author proposed an S and T based strategy stemming from the above "areas of power". S and T must be introduced by and through women—as legislators and implementers—into those areas, since the more advanced the labour is, the greater the return of the investment will be, for the women themselves and for society and the region as a whole.

2. *Information and communications technology: new ways for women participation in development*

157. The paper on ICT and women participation in development was presented by Najat Rochdi, General Affairs Director of Cooperation and Information Technology at the Ministry of Post and Information Technology of Morocco. In the first part of the paper, the role of ICT in empowering women was discussed. The Internet could provide an international forum for activism and information exchange, through which collaboration and leadership among women could be fostered. In addition, the even spread of ICT in all locations, at work and at home, would offer the potential of achieving socio-economic balance, in general, and gender balance, in particular.

158. Several strategic objectives should be pursued, including: awareness among decision makers of the implications of the knowledge economy; formulation of ICT policies and action plans; improving connectivity of rural areas; institutional and human resources capacity-building; arabization of web contents; use of appropriate technologies; creation of multimedia access points; and a flexible payment system for e-commerce.

159. The Moroccan e-commerce pilot project was also discussed, covering the elaboration of a legal framework for e-commerce; the development of sectoral portals; the launch of e-commerce initiatives targeting women in rural areas; the establishment of a training business centre for women entrepreneurs; and the development of microcredit programmes. In addition, three companies from the private sector were selected to provide business-to-business services and business-to-consumer services.

H. DESIGN AND IMPLEMENTATION OF FUTURE INITIATIVES FOR SCIENCE AND TECHNOLOGY CAPACITY-BUILDING AND INNOVATION PROMOTION

1. *Modern trends in the management of science and technology parks*

160. The paper on modern trends in S and T park management was presented by Marco Baccanti, Vice-President of the International Association of Science Parks. An overview of the role, characteristics and development of S and T parks was given. It was stated that the classic "real estate" approach to science parks, whereby proximity of stakeholders, by itself, promoted technology transfer and business development, had strongly evolved during the last decade. The emergence of the global knowledge-based economy changed the factors for competitiveness, thus requiring new managerial practices and skills in S and T parks.

161. Examples of practices crucially needed for the success of S and T parks were presented, including internal and external networking, information brokerage, technology transfer, knowledge management, project management, training and human resource management, marketing and international business connections.

162. As an example, the Centuria S and T park and its cluster of agro-industrial businesses, located in Cesena, Italy, was briefly discussed. The park, mostly privately-owned, was able to generate revenues through a wide range of services in business and technology consulting, training, recruiting, technology transfer and information management.

163. The author concluded that science parks played a powerful role in fostering competitiveness, even in traditional and low value-added economic activities.

2. *Knowledge management in research and technology organizations: policies and practices to make research and technology organizations competitive in the 21st century*

164. The paper on knowledge management in research and technology organizations was presented by Omer Kaymakçalan, President of the World Association of Industrial and Technological Research Organizations (WAITRO). The paper presented the main highlights of an international conference on knowledge management organized by WAITRO during October 2000 in the Hague, the Netherlands.

165. The aim of the conference was to assist managers of research and technology organizations to define their role and position in the current knowledge economy. In recent years, many research and technology organizations were confronted with a diminishing level of the knowledge resources necessary to support their client base. This situation was made worse by growing internationalization and globalization.

166. Topics discussed included the role of knowledge-intensive organizations in the knowledge-based economy; key factors in knowledge management, the human factor affecting building and sustaining a learning organization; and global knowledge-sharing using "smart" technologies.

167. Universal solutions for all knowledge management issues in RTOs did not exist, but very useful lessons could be learned from various regional and national collaborative networks.

3. *Major initiatives in implementing science and technology strategies: science and technology parks, incubators, and innovation centres*

168. The paper on major initiatives in implementing S and T strategies was presented by Mohammad Mrayati, Regional Advisor on Science and Technology, ESCWA. The paper stated that new S and T

initiatives such as S and T parks, incubators and innovation centres grew in response to the emergence of a knowledge-based economy, in which "classical" initiatives, including industrial zones and free zones, were deemed less effective in driving economic development.

169. The features of different types of parks were described. "Science park" was the most general and encompassing term used to describe a business-support and technology-transfer initiative that supported the start-up, incubation and development of innovation-led businesses while providing links to universities and research institutions. "Technology parks" focused on specific technologies, such as software or telecommunications. "Research parks" were linked closely to universities, research institutes or large corporations undertaking R and D activities and aimed at promoting and commercializing R and D activities. "Innovation centres" hosted small high-tech start-up firms and were usually located in science parks. An emerging type of park was the "virtual park", which offered Internet-based access to high-quality information and the possibility of links to the park's tenants.

170. Statistics were given on S and T parks, according to international and national park associations in the Czech Republic, France and the United Kingdom. An in-depth view of a science park in Singapore was presented, showing the growth in the number of tenant firms, their sectoral distribution and the number of researchers and support staff employed.

171. The paper discussed the steps involved in designing and implementing S and T parks, including feasibility analysis and strategic planning; Government commitment, organization and management; resources; technology transfer strategies; legal issues and intellectual property; partnerships and public relations. Successful factors for the creation of S an T parks included collaborative ties between industry and universities, venture capital, a culture of competition and collective learning and a cluster effect. Problems encountered, on the other hand, included the lack of high-tech human resources and venture funds, bureaucratic inefficiency and the need for a local stock exchange market.

172. The role of incubators was also discussed in detail, including their organizational and management structure and the criteria for their success. In brief, an incubator was defined as a facility that provided a range of technology/business support services to start up businesses. These centres may be either specific to a particular technology or general in nature. They provided hands-on management assistance, access to financing, and orchestrated exposure to critical business or technical support services. Incubators could be sponsored by universities, research institutes, large private firms or NGOs. Examples of successful incubation schemes in France, Germany, Israel, the United Kingdom and the United States were also given.

4. *Science and technology parks and incubators in ESCWA member countries: models and criteria*

173. The paper on technology parks and incubators in ESCWA member countries was prepared by the Technology Section of the Sectoral Issues and Policies Division of ESCWA, and presented by Mansour Farah, First Economic Affairs Officer of the Section. It explored what the three institutional forms of S and T initiatives—namely, S and T parks, incubators and industry clusters—had to offer to ESCWA member countries.

174. Salient features of S and T parks, including technopoles and science cities, were described, starting with the services offered by those parks, such as technology brokering, business linkage and general assistance. The role of the parks in local development and in generating employment, as well as in facilitating technology transfer and stimulating innovation, was discussed. The institutional aspects of science parks incorporating tenant firms of various kinds, research facilities and university branches were also presented, including reference to the linkages between these major components. The importance of management for the success of science parks was stressed, differentiating between the two major phases in their development—namely, the institutional and the entrepreneurial phases.

175. Two case studies were also presented: the Sophia Antipolis Technopole and the Cambridge Science Park. The first was one of the first European science cities or "technopoles", reaching 12,000 firms and 26,000 technical and scientific personnel after 30 years of existence. It succeeded in creating a large number

of start-up firms, constituting nearly 70 per cent of the tenant firms, in domains such as ICTs and the medical, chemical and natural sciences, the largest employment being in ICT enterprises. It was considered a successful case with respect to job creation, bringing together academic and industrial partners and establishing an appropriate environment for innovation and interaction between universities, research centres and industry.

176. The second case study was on the Cambridge Science Park, which distinguished itself in computing, scientific instrumentation and biotechnology and had nearly 65 firms and 4,000 employees. It led to the formation of a cluster of about 1,200 high-technology firms in the Cambridge area, employing around 35,000 people. The University of Cambridge, particularly Trinity College, played a key role in the development of the park and the Cambridge area, having been at the origin of most new start-up companies, which averaged 11 employees per company. The healthcare/life sciences sector was the dominant domain, followed by the ICT sector. The Park has also been successful in building up a network of individuals and institutions that interact continuously in a positive way.

177. Technology incubators, as a special case of business incubators, were also analysed and shown to be an instrument for enhancing economic growth, restructuring and development through technology diffusion and its commercialization. By helping start-up firms in their first steps towards establishing themselves in the market on scientific, technological, organizational, commercial, financial and legal fronts, incubators increased their chances of success. "Graduating" enterprises became a source of innovation and job creation, while acquiring new technologies and contributing to their national economy. It was pointed out that the development of an entrepreneurial culture was the most important characteristic of incubators, leading to increased productivity and competitiveness of SMEs on the global market.

178. Government support for technology incubators is a key factor in their success, as witnessed in many instances. One example, in particular, is the Israeli Technology Incubators Programme, in which the Ministry of Industry supervised and shared the risk by injecting seed funds into the incubators. Through a steering committee, it carried out supervision of the programme and invested up to 85 per cent of the budget for approved projects in the 26 incubators currently functioning. So far, over 600 projects have graduated, with nearly half of them leading to start-up enterprises that have attracted investment capital in excess of US$ 320 million. Universities were also heavily involved in this incubator programme. Such models could be appropriate for ESCWA member countries, in which start-ups are in need of advice on raising funds and guidance in setting up their business.

179. High-technology industry clusters were also presented as geographic concentrations of competing, collaborating and related enterprises, in addition to technology and academic institutions, that work together in order to improve their efficiency and competitiveness. Such clusters were initiated in the United States and achieved phenomenal growth in targeted industrial segments with limited public support, thus providing a rich ground for dynamic interaction among a range of essential partners. Successful cases in the United States were discussed, such as the Information Technology Cluster in Minnesota and the North Carolina Biotechnology Centre.

180. The presentation discussed criteria for enhancing the success of various S and T initiative models in the ESCWA region on various fronts, including the political, legislative and regulatory environments; financial aspects; ways and means of establishing efficient technology parks and incubators, and their successful management; the maturity of S and T institutions; and networking.