UNITED
NATIONS

A

General Assembly

Distr.
GENERAL

A/AC.105/642
21 May 1996

ORIGINAL: ENGLISH

COMMITTEE ON THE PEACEFUL
USES OF OUTER SPACE

REPORT ON THE UNITED NATIONS/UNITED STATES OF AMERICA INTERNATIONAL CONFERENCE ON SPIN-OFF BENEFITS OF SPACE TECHNOLOGY: CHALLENGES AND OPPORTUNITIES

(Colorado Springs, 9-12 April 1996)

CONTENTS

V.96-83572T

INTRODUCTION

A. Background and objectives

1. The General Assembly, in its resolution 43/56 of 6 December 1988, requested the Committee on the Peaceful Uses of Outer Space to consider at its thirty-second session a new agenda item entitled "Spin-off benefits of space technology: review of current status". Pursuant to its work, the Committee, starting in 1992, recommended that the United Nations Programme on Space Applications should consider devoting at least one of its training courses, seminars or expert meetings each year to the promotion of spin-off benefits from space. At its thirty-eighth session in June 1995, the Committee endorsed the activities proposed for the Programme on Space Applications for 1996, as recommended by the Scientific and Technical Subcommittee at its thirty-second session. Subsequently, the General Assembly, in resolution 50/27 of 6 December 1995, endorsed the activities of the Programme on Space Applications for 1996.

2. The present report contains a summary of the proceedings, as well as the recommendations, of the United Nations/United States of America International Conference on Spin-off Benefits of Space Technology: Challenges and Opportunities, organized as part of the 1996 activities of the Programme. Participants will report to the appropriate authorities in their own countries.

3. The main objectives of the Conference were: (a) to address the many new dimensions that were continuously being introduced into Earth based processes and procedures including the enhancement of scientific and technical capabilities made possible by space exploration; (b) to demonstrate to participants from developing countries the many ways that they and their countries have directly or indirectly benefited from space exploration; and (c) to address the opportunities available for developing countries to participate in additional ventures.

4. The participants at the Conference learned of several spin-off benefits of space technology, marketing and use of these technologies, and of industry experiences from the United States of America as well as developing countries. Aspects of spin-offs explored included solar energy; fisheries operation; telecommunications; health and telemedicine; precision agriculture and crop yield assessment; navigation and global positioning; and global monitoring of natural resources and the environment. Participants also discussed, in working groups, what they felt was necessary in order to learn more about the available technologies and how they could be effectively utilized in their own countries.

5. The present report covering the background, objectives and organization of the Conference, as well as the recommendations made by the participants, has been prepared for the Committee on the Peaceful Uses of Outer Space.

B. Participants

6. The United Nations and the United States targeted for participation in the Conference individuals in decision-making positions in governmental agencies and private industry who were working in programmes and projects in which spin-offs of space technology were being utilized. To that end, the co-sponsors invited individuals from specific governmental agencies and private industries to attend and, in order to receive the full benefit of the programme, the co-sponsors also requested that each participating organization or company wishing to attend the Conference should send both the chief operating officer or the equivalent and the senior technical officer.

7. Funds allocated by the United Nations and the United States for the Conference were used to cover international air travel and per diem expenses for the period of the Conference for the senior technical managers from selected organizations and companies from developing countries.

8. The following Member States and international organizations were represented at the Conference: Botswana, Brazil, Bulgaria, Canada, Chile, China, Hungary, India, Italy, Japan, Kazakstan, Malaysia, Mexico, Nigeria,

Pakistan, Philippines, Poland, Republic of Korea and United States; Office for Outer Space Affairs of the United Nations; numerous agencies and departments of the United States Government and the European Space Agency (ESA). Speakers and chairmen of the Conference came from Botswana, Brazil, Bulgaria, Canada, France, India, Italy, Japan, Malaysia, Mexico, Nigeria, Poland and United States.

I. PRESENTATIONS AND DISCUSSIONS DURING THE CONFERENCE

A. Background

9. It was stated that, in the spirit of Agenda 21,[1] sustainable development practices must be utilized fully in order to enhance life on Earth. In furtherance of that endeavour, spin-off benefits of space technology had many applications that could enhance the quality of life. Space technology applications had already had an impact on the lives of many individuals in numerous countries in such areas as distance education, training and development, land and crop monitoring including wasteland monitoring, water management and conservation through remote sensing assessment and run-off forecasting. Spin-offs in the area of health care through telemedicine, hygiene and basic health-care awareness via satellite communication had also improved the quality of life of many individuals. For the purposes of environmental monitoring and impact assessment, disaster prevention, monitoring and management, fragile ecosystem monitoring, forest resource management and regular monitoring of atmospheric gases, space technology and its spin-offs had certainly had a tremendous impact on the way the resources of the world were managed.

10. Cooperation was the key to maximize the benefits of products and services derived from space technology. Cooperation should provide mutual benefits. For example, when contracted to build satellite systems for developing countries, private companies had also agreed to train engineers and technicians from those countries in satellite design and assembly. That would enable the ultimate consumers of the technology to use it effectively in its intended manner without having to constantly resort to the manufacturer for advice and assistance. Moreover, it would greatly enhance the indigenous capability of the consumer country.

B. Space technology spin-off sectors of potential benefit to developing countries

1. Telemedicine and human health

11. It was stated that the provision of health services to non-urban and isolated areas had always been a challenge. With the advent of major space exploration programmes, satellite telemedicine became more important. As a result of improved technology, telemedicine was becoming increasingly cost-effective and because the health-care industry was facing growing financial constraints, alternative methods of delivering health care were being sought.

12. In this regard, health information and telemedicine systems were seen as a partial solution to health delivery problems. As an example, in 1985, the International Telecommunication Satellite Organization (INTELSAT) gave a dedicated four-wire satellite telephony link between parts of Africa and the Memorial University of Newfoundland. Through this link, health-care professionals in Canada were able to examine over 100 electroencephalograms from Africa with excellent results. Other non-profit organizations were also attempting to provide improved health communications between developed and developing countries and these efforts were producing tangible results.

13. National Aeronautics and Space Administration (NASA) had also had much experience in the field of telemedicine by the establishment of various spacebridges. In 1989, NASA established a spacebridge to Armenia five months after the earthquake in that region. The system was a double satellite hop using the American Telephone & Telegraph (AT&T), INTELSAT and NASA Satcom satellites. It consisted of a two-way audio channel and one-way black and white video link. Once established, the system was used easily to alleviate the effects of other disasters in the region. As a result, NASA increased the capabilities of the spacebridge by augmenting the system to include regular communication by facsimile and two-way colour video. In 1993-1994, a spacebridge to Moscow

was re-established using the double satellite hop technique. In this case, two-way full-motion colour video and audio capabilities were included but the system was difficult and expensive to establish. However, once established and operating, it was used effectively for consultations on patients. With new technology, the spacebridge to Russia used independent computers connected via the Internet. Store-and-forward consultations and regular communications were emphasized and it had two-way compressed video and audio equipment available for real-time consultations.

14. From the above, a paradigm shift in emphasis could be discerned. That is, telemedicine was moving from real-time consultations, interactive video, dedicated "studio" systems and dedicated, broad-band telecommunications lines to medical informatics, predominantly store-and-forward consultations, desk-top computer systems, Internet and similar connections and interactive video consultations when required. Therefore, a highly cost-effective health-care telecommunications system to even remote areas of the world was possible.

15. With regard to human health concerns, NASA was using remote sensing technology to study and characterize the habitats of different species around the world. That led to the possibility of studying habitats which harboured vectors capable of transmitting diseases from one species to another. Since certain diseases were associated with particular landscapes and environmental conditions, the study of those associations could provide research tools capable of identifying the time and place of future global outbreaks of human diseases.

16. In 1984, NASA initiated the Global Monitoring and Human Health Program which, in its first phase, used satellite remote sensing data to identify potentially high population mosquito rice fields weeks in advance of actual mosquito population increases in order to survey possible malarial outbreaks. The Program had been expanded to include sites in Mexico to identify areas of high-potential malarial transmission risk. Other target sites, such as Westchester County, New York, had been studied to establish if there was a correlation between the proximity of deciduous forest areas and the likelihood of contracting Lyme disease. In addition, studies were being conducted on the role of plankton in the Bay of Bengal and how it related to cholera, as well as an analysis of outbreaks of yellow fever and ebola viruses in Africa. Moreover, in terms of telemedicine, the Program also allowed for instantaneous consultation between agents in the field, scientists, doctors and other health-care workers in the event of disease outbreak.

2. Agriculture

17. It was stated that information derived from satellite remote sensing, aerial photography and space shuttle sensors could be used to estimate food and fibre production, and develop survey sampling frames and prediction models. The data generated by the survey sampling frames and prediction models could be used in agricultural surveys as a way of accurately predicting crop yields, estimating and mapping crop damage, monitoring conservation practices and implementing precision farming practices.

18. Of the applications listed above, precision farming was the most promising as it provided farmers with pertinent information about growing conditions of a specific field area. Using global positioning system (GPS) satellite technology, farmers had the possibility of providing detailed information about how conditions varied across a field to computer-assisted trackers that applied fertilizers or pesticides to areas in need of treatment. This would undoubtedly reduce costs to farmers as well as the impact on the environment by the effective and selective utilization of fertilizer, water and other growth aids.

19. Crop acreage estimates could be produced through the use of Earth resource satellite data in combination with farmer-reported data. Satellite and ground data analysed conjunctively could produce acreage data with substantially more statistical precision at local levels. Earth observation and weather satellite data could be analysed together to aid in monitoring crop conditions throughout a growing season. Also, monitoring of vegetation conditions on a national scale could be done through the use of data generated from polar orbiting weather satellites and other related data on crop stage, condition and yield data.

20. In the case of precision agriculture in the United States, the government-industry partnership had been particularly valuable for those small companies lacking available resources to develop an idea into a commercially viable project. In close cooperation with the Space Remote Sensing Center in the NASA Stennis Space Center, a private industry initiative consisting of placing a series of four satellites in a low Earth, sun-synchronous orbit was under consideration. This system being developed, would utilize change detection analysis using a multispectral satellite system with a 10 metre ground resolution. By analysing images from space, farmers were able to identify locations in their fields that were under stress at an early stage and therefore apply fertilizer to the most affected areas as well as be able to determine what kind of fertilizer had been applied previously and what other farming methods had been used in the past in order to determine what method yielded the best results. The project ultimately intended to provide farmers with an opportunity to make more informed farming decisions, maximize productivity and profits and minimize environmental degradation.

3. High resolution and data imaging applications

21. In the field of high resolution imaging, countries and individual users were able to access a wide range of products that had many useful applications. High resolution digital data that could be used for small-scale mapping, storm water run-off monitoring, fire damage assessment, monitoring of illegal logging, or even for generating a comprehensive model of the planet, was now available to users worldwide.

22. In terms of global security, high resolution imaging and data applications could be used to monitor regional conflicts as well as terrorist and criminal activities, to a certain extent. More importantly, in the field of peace-keeping, these images and data could be made available to countries and individuals around the world in a timely, accurate and cost-effective manner.

23. The distribution and relative abundance of many pelagic fisheries resources such as tuna, squid, sardines and anchovies were related to surface oceanographic conditions. Normal fishing operations depended upon a captain's experience, which usually related to specific fishing zones at a specific time of year. Nevertheless, fish abundance was more related to surface conditions than the calendar date, and such operations were variable with low catches predominating. In the field of operational fisheries in Mexico, one particular company was using high-resolution oceanographic information to aid the operation of fisheries vessels and resource administration in near-real time. That company had found that the information was useful in optimizing natural resources and the existing fishing infrastructure in the most cost-effective manner possible.

24. The National Oceanic and Atmospheric Administration weather satellites of the United States carried the advanced very high resolution radiometer, whose sensors provided 1.1 km resolution data which allowed the calibration of sea-surface temperature images over large areas of ocean. This data could be made available to fishing vessels in near-real-time to direct their search operations to those areas more likely to contain fish. The SEAWIFS sensor aboard a new satellite would shortly be able to provide information on sea-surface colour which could relate to plankton concentration and food availability. By understanding the relationship between different pelagic resources and surface oceanography, large areas of limited fishing potential could be readily eliminated from the search strategy.

C. Research and development: government and industry roles

1. Federal Laboratory Consortium

25. Much of the work accomplished in the area of spin-off benefits of space technology was the result of the effort of scientists in the Federal Laboratory Consortium (FLC). FLC represented the technology outreach programmes of 16 federal departments and agencies operating over 600 national research and development laboratories. The mission of FLC was to cooperate with the federal laboratories and the private sector in: (a) developing and administering technology transfer activities; (b) advising and assisting federal laboratories and industry in transferring technology; (c) providing a clearing-house for requests at federal laboratories for technical assistance from states, local governments and industry; and (d) facilitating communication, coordination and resolution of federal technology transfer activities throughout the federal research and development community.

26. Mechanisms used for accessing the resources and expertise of FLC included sharing information, exchanging personnel, finding technical assistance, using unique federal laboratory facilities and capabilities, licensing patents and technical know-how, acquiring software, performing cooperative research and development, using cooperative research and development agreements directly with private companies and other entities, working cooperatively with NASA, forming consortia and using technology developed under government contracts. FLC also linked customers with producers and the FLC network was an invaluable tool when attempting to find out what information was available and where.

27. In addition to the FLC network, six regional technology transfer centres that were exactly aligned with FLC, had been established through a competitive process. Four of the six were managed by universities. Within each region, a series of affiliates provided a liaison service and, whenever possible, provided solutions to industry questions. Forty per cent of the activities of this network was related to technology and concepts developed by NASA. The centres worked with the innovative process model in high technology development aiming to benefit a specific industry. The concept was developed and commercialized and then appropriate market research was done on the market viability of a product. Once all steps were completed and a product was deemed appropriate for possible commercial ventures, the product would be offered to the private sector for financing and ultimate distribution to the market.

28. In the area of renewable energy, the United States Department of Energy had undertaken extensive research in the areas of the production of energy through wind, solar thermal sources, photovoltaic cells, as well as research in lasers, and high-temperature superconductivity. In this regard, it had also worked with many developing countries to promote the use of renewable energy sources as a viable, cost-effective and environmentally friendly way to provide necessary power generation.

29. For the private sector, the advantages of working with the United States federal laboratory system was that the laboratories had a reservoir of facilities and talented people with the ability to undertake long-term projects that required more time and resources than what some private industries could provide. One example involved imaging spectrometry. In that field the technology allowed a user to gather information over an observed area in order to determine what types of minerals were found in it and where, by a spectral analysis of the reflectance of some minerals. The technology behind this tool was developed by the NASA Jet Propulsion Laboratory.

2. National Aeronautics and Space Administration

30. As NASA had a significant amount of technology that was being continually developed, it could be of interest for developing countries to work with it on mutually beneficial projects. Many countries had entered into broad-based cooperation agreements with NASA in fundamental science and technology areas. That is, NASA was striving to cooperate with civil space programmes of a particular country where mutually acceptable benefits could be derived. That process entailed many steps. The first was an initial request from a country interested in working with NASA. That was followed by an exchange of teams for discussions to determine common areas of interest. Once a

determination was made and the beneficial interests met the national interests of both countries and did not conflict with national policies on transfer of technology, then NASA would act as a coordinator for the benefit of that country with all other agencies and departments of the United States Government. For a developing country looking to benefit from space exploration, that opportunity was unique and ultimately would provide the country with an example of how space exploration could be used. In turn, that example could be examined and adapted by that country to meet its particular needs.

31. NASA also offered internships to foreign officials as long as reciprocal opportunities could also be made available for NASA officials. The idea behind that policy was to create reciprocal relationships where knowledge was shared through mutually beneficial cooperation that furthered the interests of all involved.

3. European Space Agency

32. In the area of technology transfer, ESA was actively engaged in providing opportunities to interested companies, individuals and other entities in learning about and acquiring new technology. In this regard, it had created a European network of technology transfer information. It had also undertaken feasibility studies on technology transfer projects and actively supported and promoted national initiatives in that area.

33. Some of the results and benefits of the ESA activities in that regard included the human reliability software developed through and for air-traffic control, alloys for use in medicine, human physiology experiments performed in microgravity and the peristatic pump currently used in panda pregnancy projects.

34. To facilitate technology transfer and enhance the benefit of space technology, ESA provided technical support, scientific data and financial and legal support. That was performed in a manner meant to add value to a particular product or service and provided an appropriate basis for relevant pricing policies for products and services generated from space technology.

D. Commercial use of space

1. Specific industry experiences in developing countries

35. It was stated that by its very nature, space was a global market-place opportunity. The opportunities available included, among others, commercial remote sensing, wireless communication, access to space (commercial launch) and precision positioning and timing. In developing countries much work had been done on products that had been derived from work in their space agencies and organizations. The industry opportunities in the area of spin-offs of space technology were also great.

36. High-technology companies operating in developing countries faced many issues that required attention. Among them were the following: their removed location from sources of information and special components; the relatively low number of specialized training centres resulting in more expensive in-house and foreign training requirements; the lack of qualified suppliers, which resulted in more expensive in-house process development; and a less efficient country infrastructure. The advantages for those companies were that more government incentives were available, labour was cheaper and there were more opportunities available because nearly everything was in need of some kind of improvement.

37. In the field of solar power, a company in Botswana was currently manufacturing and marketing solar panels for use in homes and businesses. In the view of that company, because a majority of the world's population lived in rural and remote areas beyond national power grids and because the cost to build necessary infrastructure to reach those areas was high, using solar energy provided a less expensive alternative.

38. In the late 1970s many government incentives were given in Brazil for industry to start industries based in high technology. As Brazilian industry experience in that area grew, the National Institute for Space Research of Brazil (INPE) also saw an opportunity and sought to find suitable companies to manufacture solar panels. With its staff

of engineers and scientists, INPE was capable of testing complete satellites and components as well as providing an environment where an exchange of ideas between private companies and the Institute could take place. Through this relationship, a private company had been able to manufacture solar panels for INPE as well as work on the China-Brazil Earth Resources Satellite programme. It had also built space components and assemblies for the Brazilian space programme. As was the case in India, INPE continued to collaborate and work with Brazilian industry in the development of its space-based industry.

39. In Bulgaria, research work was being undertaken by the Bulgarian Aerospace Agency on Neurolab-B, which was designed for use on board the Mir space station for psycho- and physiological examination of crews. A version of that system was also being developed for clinical environments on Earth. The Agency had also developed an ultraviolet (UV) indicator for personal use that determined the presence and intensity of UV-A and UV-B radiation. That device provided individuals with a clear indication of the intensity of the sun and therefore assisted individuals in determining the maximum amount of exposure to the sun under different circumstances.

40. Since the 1980s, the space technology and research industry of China had implemented a policy of applying space technology to benefit other national industries. Of space research-derived applications, over 20 per cent were usually incorporated into other industries.

41. Satellite temperature control, satellite and payload control, low temperature technology and others had added significant improvements in product quality, working environments and energy conservation in traditional industries. Some examples of spin-offs in China included a low temperature thermal tube transducer, a new energy resource, Zn-Air cell, based on the H_2-O_2 fuel cells used in satellites and large Zn-O_2 storage batteries, a photoelectronic diameter measurement system and an elaborate industrial process control system.

42. The Chinese space industry endeavoured to apply space technology to common and special projects and had achieved significant results in noise reduction, electromagnetic shielding, surface processing, anti-seismic consolidation technology, flame-proof technology, modern greenhouse technology and environmental protection technology among others. China actively supported the work of relevant departments to carry out projects involving the redevelopment and application of space technology.

43. India provided another example of government/industry cooperation in developing countries. In terms of technology transfer arrangements, the Indian Space Research Organization (ISRO) worked closely with industry in all facets of development of space-derived products and services. It was not simply the case that technology was handed directly to industry. There was continuous interaction between companies and ISRO in order to ensure that proper quality control procedures, inspection standards and other manufacturing requirements were followed.

44. Examples of that interaction included spin-off products that had been marketed under various trade names. These products include a polymeric resin developed through the work and know-how of ISRO. That product had been used for many applications including coating for many space components and parts and other industrial machinery.

45. Through the effective participation of engineers of a private Indian company in all stages of development of low-cost optical equipment for visual interpretation of satellite remote sensing data, a licence agreement was granted to that company to market those products. From that work, several products had been successfully marketed by the company and it had been able to expand into areas of medical imaging equipment and machine tool manufacturing.

46. Some conclusions that could be drawn from the highly cooperative and interactive venture between Indian industry and ISRO included the following: (a) smaller companies run by technically qualified entrepreneurs were more likely to succeed in absorbing technology quickly; (b) the licensor should identify a single person in its organization with whom the licensee could communicate directly for all matters related to technology transfer; (c) the number of recipients for a particular technology/product know-how should be in proportion to its perceived or

estimated market potential; and (d) technology transfer, if effected properly, would enable the licensee to acquire skills that would be used for developing new products using the same technology but for totally different applications. The last recommendation was another form of spin-off benefit of space technology that could have a multiplier effect, resulting in the development of many different products by the licensee, with or without assistance from space laboratories.

47. A Mexican fishery company was optimizing natural resources by using high-resolution oceanographic information to help with the operation of fisheries vessels (see paragraphs 23 and 24, above).

48. A Nigerian company based in the United States, was currently planning and undertaking an ambitious project called the African Telecommunications, Applications, Manufacturing, Research and Development Project. The project's goal was to establish in Africa an indigenous operation to improve and expand telecommunications services and applications, and to design and manufacture, for domestic and export markets, a range of telecommunications products, using state-of-the-art technology. The project aimed at developing a significant, competent and globally competitive African capacity in communications technology, with a genuine scientific and technological cutting-edge capability by the provision of products.

49. Because most telecommunication products and services currently used in Africa were imported, many products were not specifically tailored to the needs of the African continent and were therefore underutilized, became obsolete quickly, did not build sufficient capacity for Africans and created an environment of perpetual dependency on foreign companies and policies. Using space technology in the telecommunications field would deliver a wide spectrum of products and services custom-tailored to the specific needs of Africa and would contribute to its overall development and modernization. The scope of the project would cover a comprehensive field of communications including signals, information and data processing, transmission (cable and satellite), switching (central office and private exchanges) and end-user products and services. The project would start with a core of services and products and expand to a wider scope as experience, local needs, demand and business opportunities increased.

50. Following the recent change in the political situation in the late 1980s and early 1990s, the aviation industry in Poland began to concentrate on the development of high-quality products. Transfers of technology became possible and led the Polish aviation industry to also enter the space technology market. As a result, in 1993 a consortium of scientific and technical institutes in the field of space, avionic and electronic industries, and smaller private sector firms dealing with space technology was established. That consortium provided products and services in the area of construction of scientific instrumentation for satellites and probes, tracking systems, mechanical structures, board electronics, data collection, processing and transmission, ground support equipment, space telecommunication subsystems, environment protection with space technology, satellite geodesy and navigation and other related applications. In terms of spin-offs of space technology, the consortium was currently involved in the manufacture of universal hand-held receivers to be used with GPS and in the Central European satellite for advanced research (CESAR).

2. Intellectual property concerns

51. Once a business had intellectual property either through the federal Government or developed on its own, appropriate action should be taken to protect that property. Protection of trade secrets, inventions and designs, computer software, trademarks and product configuration should be sought in order to protect rights inherent in those products. Confidentiality agreements could be used in addition to applying for patent and trademark protection. Before offering an invention for sale or publicly using the invention or disclosing it to others, businesses or individuals should apply for protection in each country where protection was desired. Moreover, before commercializing an invention, it was necessary to ensure that that invention did not infringe on the patents owned by others. Also, compliance with export control and foreign licensing regulations was essential.

52. Another area in which care was required was licensing technology. That practice was done for a variety of reasons depending on business goals, market situations, type of licensee and antitrust considerations. Licenses could

be exclusive or non-exclusive and could be limited in geography, field of use or time. Royalties depended on patent strength, industry practices, value added and other factors. It was essential that proper planning and preparation was undertaken in order to ensure that intellectual property was clearly protected.

E. Human resource development

53. For many companies from developing countries involved in the field of space technology, certain preconditions should exist in order to proceed with space research as a tool for the development of advanced technology. The preconditions included an existing level of experience and education in order to quickly absorb new knowledge; the organization of existing groups and institutions in a way that enabled the smooth flow of relevant information; close collaboration between research groups in order to produce the best results; international cooperation; and, in particular, cooperation with more experienced partners in order to successfully transfer technology and subsidies from government or other sources.

54. Developing countries should also take cognizance of the resources available for training and education. For example, regional centres for space science and technology education were forming in various regions of the world. One had recently been established in India. Those centres offered unique opportunities for individuals to learn about space technology, including spin-offs on the themes of remote sensing, satellite meteorology, satellite communications, geopositioning systems and atmospheric science.

55. The overall objective of the centres was to contribute to the utilization of all opportunities provided by space exploration. The training to be offered by the centres should provide opportunities for individuals in the region to receive enhanced knowledge in priority application areas of space technology, as well as increasing the capacity of those individuals to exploit Earth observation data for environmental monitoring and disaster management and mitigation. Research and development support for national institutions in the various regions should also be available through the work of the centre.

56. The United States Space Foundation had, as one of its objectives, the aim of inspiring students and enhancing learning by using space science and technology. To that end, since 1986, the Space Foundation had organized a five-day graduate-level course designed to teach educators how to incorporate space and aviation themes into school lesson plans. The programme had effectively provided training to over 5,000 educators who had, in turn, passed that knowledge on through their classrooms.

II. OBSERVATIONS AND RECOMMENDATIONS

57. On the final day of the Conference, participants had the opportunity to participate in working groups to discuss space technology applications in health, biomedicine and education and human resource development, and communications for development.

58. Within the framework of the specific theme of each working group, observations and recommendations were requested from the groups on the following issues:

(a) The challenges and opportunities facing developing countries in those areas;

(b) The way in which the challenges were being met;

(c) The way in which local indigenous entrepreneurs and industries could prepare themselves for such a role;

(d) The roles of Governments in ensuring the necessary enabling environment;

(e) The way in which support of developed countries for technical development at the local level was obtained;

(f) The role of the United Nations as a facilitator.

59. The Working Group on Space Technology in Health, Biomedicine and Education Applications and Human Resource Development addressed the issues in detail. The Working Group identified an adequate human resource base as a necessary starting-point. Furthermore, such a base would need to improve its skills periodically in order to meet future challenges.

60. The Working Group felt that because technology transfer was a two-way process and required both the user and the provider to benefit, it was important that when contacts were made between a potential provider and user, both parties should realize that each would benefit from the transaction. With regard to initial contacts between potential providers and users, it was noted that large companies might not necessarily be the best contact for research and experimental institutions when seeking potential partners in specific transactions. It might therefore be more appropriate to approach small- to medium-sized firms. However, a potential problem in that approach was that such firms did not necessarily have available the resources needed to establish business contacts with industry counterparts, such as in connection with industry trade shows.

61. The Working Group recommended that the United Nations could perform a vital role in filling information gaps. Because there was either limited or no exchange of information about technical papers and research being conducted throughout the world on subjects related to spin-off potential of space science and technology, owing to cost and effectiveness factors, the Working Group suggested that the United Nations should develop a database that contained that information in an electronic format. It was hoped that the database could serve as a catalyst for the further development of space spin-off technology. With regard to the organization of such a database, the Working Group suggested that it should be practical, completed within the next three years and could receive input from, and feed back into, the worldwide university system.

62. Other potential roles for the United Nations included the identification of companies that had received spin-off technology from the space laboratories of space-faring nations, an assessment of their capabilities, and an inquiry about their interest in participating in transferring their know-how to other interested companies in developing countries. Recognizing that some of the following actions required the agreement of governments, the Working Group indicated that the United Nations could prepare and periodically update a comprehensive brochure listing technologies/products available for transfer, prepare guidelines for recipients and providers of those technologies/products and devise a legal framework within which the technology transfer could take place. The United Nations could give wide publicity to the comprehensive list by providing it to interested industries in developing countries as well as arranging seminars and meetings with significant industry participation in order to fine-tune the system.

63. The Working Group also suggested that the next conference on the subject of spin-off benefits of space technology should be in a developing country and should focus on how the suggested database should be developed. It was suggested that participants at the next conference could, among other activities, comprehensively define the parameters of the database prior to its development and distribution. With regard to its contents, it was suggested that the database should have search capabilities so that interested companies, industries, individuals and others would have the opportunity to find information on potential partners and to publicize their capabilities in an easily accessible forum, as well as to solicit industry-specific partners.

64. Finally, it was suggested that industries, companies and firms in developing countries involved in that field as well as in other terrestrial-based industries needed to send information on their products and services to commercial attachés at the embassies and missions of various countries, as well as to their own embassies and missions around the world. That would not only keep interested parties informed about the existence of these entities, but could also attract interested industries to the products and services offered.

65. The Working Group on Communications for Development: Development of Communications Infrastructure with Emphasis on Application Opportunities in Agriculture, Natural Resources and Global Information Systems also analysed each issue in detail. With regard to the challenges facing developing countries, it was felt that there was a low penetration of existing communications technology in developing countries as opposed to developed countries. In particular, agricultural areas were poorly serviced because of the sheer size of the areas and the expense associated with placing and operating the technology in those areas. The Working Group also felt that there was a lack of training and knowledge of the technology. Finally, the group felt that another important challenge was the availability of investment capital.

66. Given the challenges, the Working Group stated that opportunities for industries, companies, individuals and other entities in developing countries existed in installing, furnishing equipment and operating communications services. In this connection the Working Group felt that partnerships with experienced providers through joint ventures or other types of business arrangements might be a way of providing necessary services as well as receiving required technology. In terms of the poor penetration of agricultural areas that required specialized types of services, the Working Group stated that opportunities existed to provide alternative services such as radio communication systems, space or ground based. With regard to installation costs and communication costs, the Working Group noted that opportunities were available for financial institutions who could provide competitive financing to those parties interested in creating communication networks.

67. In terms of a communications system itself, it was suggested that opportunities for entrepreneurs to introduce innovative low-cost systems such as a party-line were readily available. With regard to training necessities as well as concerns with acceptance of the technology by the general public, the Working Group stated that an opportunity existed to provide specialized training to individuals on the manufacture and maintenance of the technology. That, coupled with effective public relations, could help to make the technology more acceptable to the general public.

68. In terms of meeting the challenge, it was stressed that further development of educational institutions and programmes in developing countries was necessary. In order to build a solid foundation for future entrepreneurs and innovators it was felt that basic education was of particular importance, with an emphasis on applied research and technology transfer and adaptation.

69. In order to create an investment atmosphere, the Working Group stated that the political will and commitment of national leaders for the introduction of new technology should be apparent. The Working Group also stressed that infrastructural needs such as roads, electricity and water supply should already be established, with the recognition that the needs of each country were different from one another. In the same vein, steps should be taken that encouraged the existing financial systems in each country to develop a long-term commitment to the development activities in a country in the area of space technology spin-offs and generally, for basic sustainable development programmes.

70. The Working Group also stated that a significant step in meeting the challenges was the establishment and maintenance of contacts with potential facilitating organizations from around the world such as NASA. Therefore, when an opportunity for a cooperative venture arose, it was both encouraged and taken. Also of importance to the Working Group was the substantive involvement of the private sector as much as possible in those projects in order to ensure their sustainability. Moreover, business leaders needed to talk to government representatives to state their interests as well as using other methods to express their views, including contact with chambers of commerce. Finally, the information generated from this Conference should be passed on to relevant and supportive government agencies in order to facilitate follow up.

71. The Working Group stated that local entrepreneurs and industries could prepare themselves to begin development activities by acquiring licences to technology, training on how to effectively utilize know-how and how to effectively manage a high-technology based business. Another possibility was to use the turn-key approach to receiving technology as long as in-depth and substantive training came with the technology. It was important to be

familiar with local market conditions and technologies. Also stressed was an understanding of the concept of "added value" at each stage of a development process.

72. The elaboration of a sound business plan was recognized as being of paramount importance in explaining future plans in a manner capable of attracting interested investors to the value of products and services to be offered to the public. Also, participants felt that in order to attract the participation of developed industrialized countries, any proposed activity also had to provide those countries with a benefit. The shared interests of both parties had to be met in order to obtain commitments of entities from the developed countries.

73. Networking facilitated technical development opportunities in the establishment of contacts with government, industry, academia, financial organizations and others. Those should not be missed. With regard to obtaining the support of the developed countries, participants were of the view that contacts should be established on a person-to-person basis at the local level. Direct contact among industry leaders could also do much to facilitate partnerships and collaborative ventures.

74. In terms of creating a friendly investment climate to facilitate national and foreign capital flow into spin-off industries, participants suggested that Governments could create technology incubators where small businesses could have the chance to germinate and build their businesses. Governments could provide subsidies and financing on a liberal and competitive basis and they could provide research and development, funding and facilities to encourage and facilitate technology transfer and could provide tax incentives to pioneering investors. The caveat with regard to incentives was that all entities or individuals should have equal opportunities to obtain them. Participants also noted that a proper and appropriate regulatory environment should be established that kept pace with improvements in the technological environment. As a result of the discussions in the Conference, it was felt that effective and close coordination between government and industry was absolutely necessary to further development programmes in the area.

75. Finally, creating an investment-friendly environment by having political, social and economic stability would greatly enhance the possibilities of foreign investments in emerging markets. Incentives to encourage foreign investment could be given; foreign investment was important, in that technology acquired from abroad could be adapted to meet local needs as long as incentives for local investors were balanced against that.

76. The participants felt that the United Nations could create and promote networking opportunities and provide neutral advice to interested entities. It could also continue to take a proactive approach in this area and assist in continued training and education through conferences, workshops and training courses on space technology applications. Also, as a clearing-house of information, the United Nations should strive to further advertise and disseminate funding opportunities that were available.

77. Participants also discussed the possibility of the appropriate funding and development institutions of the United Nations system providing seed money directly to least developed countries to develop space technology applications, spin-offs of space technology and other areas. Participants also indicated that funds involving projects in the private sector could be provided directly to those projects. The proposal included the caveat that a proper monitoring mechanism would ensure that the funds were being used for the purposes intended.

78. Beyond the issues examined, the Working Group discussed the potential interaction between developing countries. It was felt that developing countries should strengthen their own networks and strive to cooperate further. Developing countries should work together in partnerships for their own mutual benefits in order to enhance regional, multinational and global ties. Developing countries should also look to the possibility of reducing local trade barriers with the assistance of the World Trade Organization, the United Nations system and other regional organizations. Finally, the more developed of the developing countries should make continuing efforts to assist the less developed countries.

Notes

[1] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992* (United Nations publication, Sales No. E.93.I.8 and corrigenda), vol. I: *Resolutions adopted by the Conference*, resolution 1, annex II.