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Committee on the Peaceful
Uses of Outer Space

Report on the Eleventh United Nations/International Academy of Astronautics Workshop on Small Satellites in the Service of Developing Countries

(Prague, 28 September 2010)

I. Introduction

A. Background and objectives

1. The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) recommended, inter alia, that the joint development, construction and operation of a variety of small satellites offering opportunities to develop indigenous space industry should be undertaken as a suitable project for enabling space research, technology demonstrations and related applications in communications and Earth observation.[1] Additional recommendations emanated from the activities of the Technical Forum held at UNISPACE III.[2] In accordance with those recommendations, the Office for Outer Space Affairs of the Secretariat has substantially extended its existing cooperation with the Subcommittee on Small Satellites for Developing Nations of the International Academy of Astronautics (IAA).

2. At the meeting of the IAA Subcommittee held in 1999, it was agreed that the fifty-first International Astronautical Congress, which was to be held in Rio de Janeiro, Brazil, from 2 to 6 October 2000, would be an ideal opportunity to review the status of programmes in Latin America. It was further agreed that the Congress should be open to participants from other regions, but that the situation in Latin America would be used as an example of how developing countries could

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[1] *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.00.I.3), chap. I, resolution 1, annex, para. 32 (b).

[2] Ibid., annex III.

benefit from small satellites and that that topic should form the core of the discussion. After the first United Nations/International Academy of Astronautics Workshop on Small Satellites at the Service of Developing Countries: the Latin American Experience (A/AC.105/745), held in Rio de Janeiro, Brazil, on 5 October 2000, and based on the positive response from participants and from States members of the Committee on the Peaceful Uses of Outer Space, it was decided that that regular activity should continue, with emphasis on different aspects of the issue and the specific needs of individual regions.

3. At its fifty-second session, in 2009, the Committee on the Peaceful Uses of Outer Space endorsed the programme of workshops, training courses, symposiums and conferences of the United Nations Programme on Space Applications for 2010.[3] Subsequently, the General Assembly, in its resolution 64/86, endorsed the Programme.

4. Pursuant to General Assembly resolution 64/86 and in accordance with the recommendation of UNISPACE III, the Eleventh United Nations/International Academy of Astronautics Workshop on Small Satellites in the Service of Developing Countries was held in Prague on 28 September 2010. The Workshop was organized jointly by the Office for Outer Space Affairs and IAA within the framework of the sixty-first International Astronautical Congress.

B. Attendance

5. The Workshop was an integral part of the International Astronautical Congress and was attended by more than 100 registered Congress participants. Many of those attending had also attended the United Nations/International Astronautical Federation Workshop on Global Navigation Satellite System Applications for Human Benefit and Development, held in Prague from 24 to 25 September 2010 (A/AC.105/984). The sponsors of that workshop provided financial support to selected participants from developing countries.

6. One of the main objectives of the Workshop was to review the benefits of small-satellite programmes, with particular emphasis on the contribution that small satellites could make to supporting scientific, Earth observation and telecommunication missions. Emphasis was placed on international cooperation, education and training, and on the benefits of such programmes for developing countries. The Workshop was also attended by several participants of previous workshops, who provided valuable continuity and were able to assess the progress that had been made during the series of workshops.

II. Summary of presentations

7. Eleven papers dealing with the use of space technology for the benefit of developing countries were presented and discussed. The papers covered success stories with respect to developing space programmes, reviewed the economic impact of small-satellite programmes, provided a framework for capacity-building

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[3] *Official Records of the General Assembly, Sixty-fourth Session, Supplement No. 20* (A/64/20), para. 83.

in small-satellite technology in developing countries and demonstrated new small-satellite technology options.

8. The first presentation explored the process of building technological capability in new satellite programmes within developing countries. It described the strategy used by many developing countries to facilitate local technological learning via international collaboration, as well as gave examples from Asia and Africa of developing country space agencies hiring foreign companies to build a satellite and to train local engineers. The current global reality was that a growing number of countries were moving from passive consumption of satellite services to active participation in space activities. Additional countries on every continent were creating or strengthening local satellite programmes. Countries such as Malaysia, Mexico, Nigeria, South Africa and the United Arab Emirates were joining countries with more established programmes such as Argentina, Brazil, China, India and the Republic of Korea. At the same time, there were many inherent challenges in the foreign partnerships, including misaligned incentives among the partners, differences in culture and language and imperfect information. The presentation also highlighted how literature on technology transfer, technological learning and project management provided insight into those collaborative satellite training projects.

9. The second presentation discussed recent trends in the design and utilization of small satellites in developing countries. A number of small remote-sensing satellites had been developed and launched during the previous decade by several developing countries in Africa, the Middle East and East Asia. Those satellites shared several common features, the main one being that they had been developed for use in developmental planning and for gaining access to space technology. The first generation of those satellites had a relatively low spatial resolution of about 30 m, but the second generation reached a resolution of 2.5 m. The latter group of satellites also had “similar” designs, which originated from the fact that they had been developed to achieve a similar purpose: introducing developing countries to space technology and applications through small Earth observation satellites. The other side of building national space programmes in developing countries was constructing the technological base for satellite manufacturing, building the infrastructure for the operation and utilization of those satellites and, most importantly, building a user community that was able to use the satellite-derived data for sustainable development. The presentation discussed the degree to which those objectives had been achieved for various satellites in different countries, as well as elaborated on some aspects of recent trends in the design of small remote-sensing satellites.

10. The third presentation reviewed a CubeSat programme justification model. A new paradigm in the satellite community was the practice of developing small satellites, i.e. satellites with a mass of under 500 kg and capabilities comparable to those of much larger satellites. Small satellites had been described as a disruptive technology owing to their significantly lower costs and faster development cycles. Workshops and conferences were held that specifically focused on the potential of small-satellite capabilities. A particular class of small satellite with a mass of 1 kg, the CubeSat, initially developed as an educational platform, had attracted considerable interest from academic, government and industry stakeholders. Over 50 CubeSats had been developed and launched into orbit. More than 100 universities around the globe were pursuing CubeSat development. Awareness

of the potential utility of CubeSats had reached a level where private industry was beginning to commercialize the technology. Indigenous space technology capacity could be facilitated and augmented by CubeSats. Also introduced in the presentation was a model which, on the basis of information from past and current CubeSat projects, could help interested nations to understand and to estimate the benefits and hurdles that must be overcome in conducting their own small-satellite programmes in the future.

11. The fourth presentation reviewed small-satellite missions carried out by developing countries. The example of the Brazilian NanoSat C-BR project was used to demonstrate the opportunities that had arisen for developing countries to gain access to space through very low-cost programmes, supported by the availability of off-the-shelf components for building small satellites and by new trends in international technology transfer policies. The important role of universities in developing small-satellite projects was emphasized; however, it was also noted that the majority of universities in developing countries were in need of qualified teaching staff and of the required infrastructure. The NanoSat C-BR, which would contain a magnetometer and a particle dosimeter as payload, was considered a very inexpensive satellite project, with a total budget of less than $280,000, including for the clean room, the tracking station and launching. In spite of delays and hurdles, the project was considered successful owing to its substantial contribution to the capacity-building process.

12. The fifth presentation discussed the Technical University of Berlin satellite (TUBSAT) training programme, which had been developed at the university for developing countries. Building a sustainable small-satellite programme could by itself be both time-consuming and costly; therefore, most developing countries that were interested in their own small satellites were looking for an experienced partner to help them in developing their programmes. For the previous 20 years, many countries had been participating in technical transfer programmes offered by the leading small-satellite providers, but only a limited number of those countries had actually achieved the goal of establishing sustainable national small-satellite programmes. In contrast, the TUBSAT training programme had been remarkably successful. All of its partnering agencies (the German, Moroccan and Indonesian space agencies) had active small-satellite programmes and independently built small satellites based on the TUBSAT heritage. To further improve the results of technology transfer programmes offered by the university, the Berlin Space Industry Association had conducted a study with the aim of analysing why some technical transfer programmes had been more successful than others and to define best practice for sustainable capacity-building in small-satellite systems. The study, which was still under way, identified such important elements of the success of technical transfer programmes as a multistage approach, public visibility, fast turnaround and an "all required infrastructure included" approach, as well as offering a technology that fit the client's industry base and a team size that fit the client's engineering base and developing a business model to support the client's success.

13. The sixth presentation presented a new joint initiative of the United Nations and Japan on capacity-building in basic space technology development through on-the-job training in the design, building and testing of nanosatellites. Developing countries that in the past had focused mostly on the applications-oriented aspects of

space technology had now become increasingly interested in building indigenous capacities for basic space technology development. In order to support that trend, the Office for Outer Space Affairs, within the framework of the United Nations Programme on Space Applications, had launched the Basic Space Technology Initiative, which was aimed at assisting developing countries in their capacity-building efforts, primarily through nanosatellite development programmes. Opportunities to participate in long-term fellowship programmes had been identified as important contributions to capacity-building. In that regard, the Office for Outer Space Affairs and the Kyushu Institute of Technology of Japan had announced the launch of a new long-term fellowship programme in nanosatellite technologies, leading to a PhD, for postgraduate-level students from developing countries and countries with economies in transition. The length of the "doctorate in nanosatellite technologies" fellowship programme would be three years; the first recipients of the fellowship grant were expected to start studying at the Institute in October 2011. Participants would work in the newly established Centre for Nanosatellite Testing on the Institute's campus, which could provide a full range of environmental tests required for a 50-cm-class nanosatellite. Owing to both the experience of the Institute in the successful implementation of nanosatellite projects and to the availability of test facilities directly on the Institute's campus, intensive and efficient cycles of research, design, building and testing would become possible.

14. The experience of students from the Indian Institute of Technology Bombay in the system engineering and integration of the Pratham microsatellite was reviewed in the seventh presentation. The Pratham was a fully functional microsatellite built by students of the Institute and scheduled for launch by the Indian Space Research Organisation in the fourth quarter of 2010. It had the shape of a 26 cm^3 cube and weighed nearly 10 kg. The fourfold mission statement of Pratham included educating students and faculty in the field of satellite and space technology, developing the flight model of the satellite and launching it into orbit, measuring the total electron count of the ionosphere and involving students from other universities in the satellite mission. The presentation elaborated in detail the steps taken to maintain budgets of weight, power and data, as well as described integration sequence and strategies. It was envisaged that the system engineering and integration concepts used in the Pratham project would serve as valuable stepping stones for student satellite projects all over the world.

15. The next presentation focused on the microsatellite project carried out by students of the Faculty of Engineering of the state university of Uruguay to build a CubeSat, which would be Uruguay's first satellite. The project, called Project LAI, was aimed at undergraduate students in order to involve them in activities that demanded creativity, responsibility, scientific thinking and extensive research in a professional team environment. Another long-term goal of the project was to modify the methodology of teaching at the Faculty of Engineering. There were three groups of students working on the satellite design; four groups of students had worked on the initial stage of the project, which involved the release of stratospheric balloons filled with helium in order to perform experiments at high altitude and to gain experience for building the CubeSat. The most advanced group was working on the satellite's power system, which would rely on solar panels. That group also was in charge of making a thermal analysis of the CubeSat, as well as developing protection for the various subsystems against a phenomenon called "single event latchup", which occurred when a high-energy particle hit a device. Another group of

students was responsible for the satellite attitude determination and control system, and the third group was working on the telemetry system. There was an intention to test the CubeSat for release in 2012. It had not yet been decided what the payload would be, but there were several options under consideration.

16. The ninth presentation reviewed the Peruvian space programme and, in particular, the country's efforts with respect to the development of small-satellite projects. Space-related activities were carried out with the involvement of and in collaboration with governmental, research and educational institutions in Peru. Since 2009, the efforts of Peruvian engineers had been centralized by the establishment of a satellite programme with an emphasis on acquisition of the Earth observation satellite. The National Aerospace Research and Development Commission (CONIDA) and the Department of Defence had worked on the further development of aerospace projects in the country. A first milestone had been reached by CONIDA with the establishment of the National Centre for Satellite Imagery Operations, which supplied various national institutions with satellite information required for agriculture, mining, disaster prevention, defence and national security, environmental protection and rational usage of natural resources, and human resource training, among other things. The picosatellite project carried out by the Centre for Information and Communications Technology at the National University of Engineering in Lima was also presented. The satellite, named CHASQUI, was based on CubeSat technology and was planned for launch in 2011. The main objectives of the picosatellite project were the following: (a) to educate Peruvian students and engineers; (b) to conduct technology demonstration and in-flight verification of domestically built satellite components and two cameras; and (c) to promote cooperation with national and international partners. Another project was carried out by the Pontifical Catholic University of Peru, which was developing and building its own picosatellite for educational purposes, called PUCPSAT. That satellite was also based on the CubeSat standards. The mission of that project was the demonstration of technology in order to prove the capabilities of self-built low power S-Band communications systems.

17. Academic aerospace programmes at the National Autonomous University of Mexico (UNAM) were presented in the tenth presentation. The university had been working on space projects for years; however, there were currently new challenges to develop with respect to developing more projects in the aerospace field. Among them were the development of new academic programmes, the foundation of an internal research and development network and the design of a new satellite platform. Those projects would help to consolidate a group of researchers with expertise in the field and capabilities for proposing and executing research and development projects with international partners. The presentation described the integration processes for the Mexican satellite platform, the development of academic programmes and the foundation of the university network of space technology at UNAM. Projects were supported by a group of specialists in different fields, including engineers, geophysicists, geographers and other users of satellite technology. The design of satellite platforms was the main focus for the group, which was working on the CONDOR UNAM-MAI project. The process for developing components and systems for the satellite platform was contributing to establishing research areas and promoting international academic and scientific cooperation in space technology projects. Academic programmes supporting satellite development projects had been established for students at both the

undergraduate and postgraduate levels in engineering. A strong effort was dedicated to generating cooperation links or partnerships with different institutions and industries. Through those activities, UNAM was strengthening research in space technology and supporting the formation of specialized research groups in the aerospace field.

18. The final presentation described the university satellite programme initiated recently by the Technological Institute of Aeronautics in Brazil. The Institute had started its aerospace engineering course in March 2010 as a phased programme aimed at creating the basis for a sustainable space industry in Brazil. As an integral part of the course's curriculum, students in each class would develop the concept for, design, implement and operate one microsatellite. In the initial phase, the ITASAT microsatellite project would be completed and the satellite launched in 2012 from the Alcântara Launch Centre in Brazil. The main mission of that satellite would be the collection of meteorological and environmental data from data collecting platforms spread throughout the territory and territorial oceanic waters of Brazil. The guiding principles of the Institute's university picosatellite programme would be as follows: (a) the satellite must be simple enough to be conceived, designed, implemented and operated by the students during the timeframe of their educational course, i.e. three years; (b) each year's class would develop its own picosatellite, and it was planned to have one satellite per class starting from 2012; (c) it was decided to import CubeSat platforms for the first two satellites, to be replaced later by a domestically developed standard platform; (d) the development cost of the university picosatellite should be below $100,000, and the cost of the ground station should be no more than $10,000; those funds would be obtained as research grants and managed directly by the research coordinator of the project; and (e) each project should receive the support of key stakeholders involved in every stage of the project life cycle, from mission definition to operations.

III. Conclusions and recommendations

19. The Workshop clearly demonstrated that there were tremendous benefits to be gained by developing countries from introducing space activities through small-satellite programmes.

20. The Workshop also demonstrated how the recommendations made by UNISPACE III and by previous workshops were being implemented. The series of workshops was considered an important contribution to raising awareness in developing countries.

21. The Workshop took note of the fact that small-satellite programmes were extremely beneficial for education and training, particularly at universities in developing countries.

22. The presentations made at the Workshop highlighted how effective small satellites could be in addressing national and regional problems in developing countries. Information was presented on programmes that were already providing benefits, especially in such areas as natural disaster mitigation, agriculture and infrastructure development.

23. Speakers and participants reconfirmed and complemented the recommendations made previously. In particular:

(a) They stressed the importance of focusing on applications that would provide sustainable economic benefits for developing countries. In order to provide maximum economic and social benefits to the populations of such countries, it was recommended that programmes should be established in such a manner as to ensure continuity and sustainability;

(b) The continuing and ever-growing interest in Earth observation programmes for developing countries and the benefits of international cooperation efforts, including those directed towards natural disaster management, were highlighted;

(c) Participants recognized the benefits of small-satellite programmes in the acquisition, development and application of space science and technology and the associated development of a knowledge base and industrial capacity. It was therefore stressed that space activities should be an integral part of any national programme devoted to the acquisition and development of technology and capacity-building;

(d) Participants considered positively the contribution of students to the workshops and recognized that the interest of students and young professionals in the subject of small satellites was a clear sign of growing public awareness. The role of universities in developing space capacity was highlighted as a potential tool for developing space assets in developing countries. It was therefore recommended that each country should recognize the important role that space assets could play in education, the need to incorporate space science and technology in curricula and the key role that universities could play in implementing national space plans;

(e) Participants emphasized the need for greater awareness among the public and decision makers of the potential benefits of space technology applications. Every country or group of countries should consider the attainment of a minimum level of space capability, as that could be invaluable in enhancing socio-economic development, as well as the health and quality of life of the population. In that respect, a dedicated organization or agency could play an important role in the definition and implementation of space programmes.