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14. Abstract/Notes

The aim of this report is to briefly discuss the recommendation of UNISPACE-82 and the plans of action that could be established for their implementation on the development of such indigenous capabilities in Latin American an Caribbean countries. Two essential aspects are considered: the existence of human resources and the availability of research and development, laboratory and industrial infrastructure. The mechanisms for the implementation of the recommended plans of action are also analysed in this report.

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CONSELHO NACIONAL DE DESENVOLVIMENTO CIENTÍFICO E TECNOLÓGICO

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UNISPACE-82 RECOMMENDATIONS ADDRESSED TO MEMBER STATES ON THE DEVELOPMENT OF INDIGENOUS CAPABILITIES AND FOLLOW-UP ACTIONS FOR THEIR IMPLEMENTATION

by

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Invited paper

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I. INTRODUCTION

At its thirty-seventh session in 1982, the General Assembly endorsed the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) that the United Nations Programme on Space Applications be directed towards seven main objectives, one of which is:

- Stimulation of the growth of indigenous nuclei and an autonomous technological base, to the extent possible, in space technology in developing countries with the co-operation of other United Nations agencies and/or Member States or members of the specialized agencies.

This resolution by itself points out the importance that the development of indigenous capabilities presents for developing countries, in order for them to make use and to fully benefit from space technology.

In the discussions that took place at UNISPACE-82, a great deal of effort was directed in order to obtain the consensus about controvertial points, like militarization of outer space, occupation of the geostationary orbit, the right of one country to remotely sense another country, etc. However, there was one point about which all countries very quickly agreed upon:

- the necessity to have indigenously-developed national capabilities to deal with space science, applications and technology,

a point, one must recall, that is valid not only for space but for all sciences and technologies.

The above mentioned point appears, sometimes explicitly, sometimes implicitly, in almost all recommendations of UNISPACE-82, thus reflecting the preoccupation presented by all developed and developing nations.

The aim of this presentation is to briefly discuss the recommendation of UNISPACE-82 and the plans of action that could be established for their implementation on the development of such indigenous capabilities in Latin-American and Caribbean countries.

II. DIFFICULTIES AND SOLUTIONS

Most countries - and developing ones in particular - face a number of difficulties with regard to space technology and its efficient utilization. At UNISPACE-82 some of the major problems were identified and enumerated. They are related to a large number of factors, such as financial and industrial resources; human resources; equipment and its suitability; transfer of technology; internal co-operation and organization; continuity, compatibility and complementarity of systems, equipments and methodologies; and availability of data and information.

The proposed solutions to overcome such difficulties and the raised possibilities and mechanisms for enabling all countries to benefit from space technology include, generally speaking, the development of indigenous capabilities.

However, as clearly mentioned at that Conference, there is a basic question that any country should answer before entering the vast range of options spanned today by space technology, that is, what applications and which technologies the country wishes to pursue. This is an important problem to be pointed out, since nowadays the variety of space applications is quite substantial and the necessary equipment has costs that range from a few hundred to many millions of dollars, and the investments required to develop and produce such equipment differ in many orders of magnitude, as do the infrastructure and technical skills involved.

The choices to be made are clearly determined by:

- the needs of the country and its priorities;
- the feasibility of meeting these needs and priorities through the use of space technology with regard to other countries' needs;
- the financial resources, the industrial infrastructure and the technological capabilities that exist and that are necessary;
- the availability of matching scientific and application - oriented as well as managerial and decision-making infrastructure and human resources required for effective utilization of data and of the information derived therefrom.

It is evident that no fixed formulae of universal validity can be established and that costs and benefits vary from situation to situation, from place to place and from country to country. Thus, each choice has to be unique and based upon the parameters of its particular context.

In deciding upon and implementing a space application, there is a whole hierarchy of possibilities ranging from problem analysis, choices of systems, type of equipment and the selection of the most suitable methodological approach to tackle the problem in question. The latter is of particular importance because it has a significant influence on the choice of the most appropriate system or instrumentation and consequently determines other parameters such as cost, organizational set-up, degree of self-reliance, level and extent of indigenous participation, etc. Thus, countries at different levels of development would be in a position to undertake different magnitudes of indigenous efforts and,consequently,different programmes of development of indigenous capabilities should be implemented.

However, because developing countries - despite their widely varying levels of economic, scientific, technological and industrial development - recognize the similarity of their problems and the complementarity of their needs and resources, it can be assumed that the co-operation among them will be the most effective tool to solve the faced problems and to allow them to profit from space science, applications and technology. Developing countries with greater experience in a particular space application, or with greater scientific and technological capability in a given field, can help other developing nations which may only now be getting into these areas. It is therefore highly desirable that developing countries - and in especial the Latin-American and Caribbean nations - get together and co-operate whith each other in the most profitable way.

The following paragraphs were directly extracted from the report of UNISPACE-82 and show how the co-operation among developing countries can help them to better profit from space science, applications and technology, and how it favours the growth of indigenous capabilities.

While satellites operate in a common "neutral" environment, the ground reception or processing equipment - which often forms a larger part of the total investment - has to operate in varying climatic and cultural environments. Equipment developed in and for developed countries is not always suitable for the physical environment of developing countries, and is even less suitable for their cultural environment: the way it is handled, carried, operated, etc. is generally somewhat different. Also, the problem of technical assistance in general became a limiting factor, thus providing the developing country to make the better use of the acquired equipment. In this regard, equipment developed by a developing country is more likely to be relevant and suitable for the total environment of another developing country. Efforts should therefore be made - both by countries concerned and by international agencies - to encourage and stimulate the flow of equipment made by developing countries to other developing countries.

The above argument is equally applicable to "environmentally-suitable" experts. Experience has shown that an expert from a similar socioeconomic and physical environment is likely to adapt quickly and work better in a foreign country. His experience is often more relevant and his recommendations generally more practical. Developing countries might, therefore, find it to their mutual advantage to seek and provide expert assistance - when required - from and to each other. National and international funding and technical assistance agencies, when providing expertise assistance, might first seek the necessary experts from developing countries.

Training and education are essential ingredients in any long-range plan for beneficial applications of space technology. Developed countries do have the best equipped, and often best run, training/educational facilities. However, these facilities often do not have the specific purpose of providing training and education compatible with the needs of developing countries. Therefore, the experience gained in such institutions is often not relevant for developing country situations. There are now, in some developing countries - and this is true for Latin-America and Carib - centres which can provide training or on-the-job experience that is of high quality and of greater relevance to developing country situations. This is because, as mentioned before, of the similarity of situations and problems in developing countries, making work-experience gained in a developing country more useful than similar experience gained in a developed country. Thus, it would be most useful if developing countries with active programmes of space applications would provide on-the-job experience or training opportunities to persons from other developing countries.

Consequently, concrete and mutually beneficial co-operation between those nations should therefore include, in a first step, the exchange of information, experts and experiences and the utilization of equipment and the availability of maintenance and spares parts, involving, whenever possible, the creation of internal indigenous competence in the area. In a second step, regional, bilateral of multilateral co-operative space applications programmes, or even jointly-owned and shared ground and space hardware, could be established. Cost-sharing and the use of complementary resources of the countries involved would result in better cost-benefit ratios, while simultaneously helping to develop the infrastructure in these countries.

Developing countries have between them accumulated a large amount of experience in many space applications. They have also a great deal of competence in nonspace areas relevant to space applications and on a variety of equipment. But there has so far been very little exchange of know-how among them. Although some co-operation has been established among Latin-American and Caribbean countries, much more can and must be done.

Taking all these important points into consideration, the next section will deal with the main recommendations of UNISPACE-82 for the development of indigenous capabilities in space science, applications and technology in Latin-American and Caribbean countries, and the plans of action to implement them.

III. RECOMMENDATIONS AND PLANS OF ACTION

When talking about the development of space-related indigenous capabilities in a developing country, two essential aspects should be considered, which are:

- the existence of human resources for:
  - the development of space science and applications technologies and methodologies;
  - the project, development, operation and maintenance of specific equipments (hardware and software) used for the generation/transmission/reception/processing/analysis/archiving/distribution of the relevant data or information;
- the availability of research and development, laboratory and industrial infrastructure necessary for the production and maintenance of such equipments.

The recommendations made at UNISPACE-82 and the plans of action that can be implemented in Latin-America and Carib related to these two important and basic questions will be discussed in the following paragraphs, where sometimes lightly modified transcripts from the report of the conference are presented.

HUMAN RESOURCES

Development of space technology, as for any other new technology, requires a strong base of high-calibre manpower: scientists, technologists and technicians familiar either with space technology itself or with related technologies - especially electronics, computers, optics, etc. But space technology is only a tool to a higher aim. Its effective use also requires a large number of adequately trained personnel in the respective application areas (meteorology, agriculture, geodesy, geology, forestry, etc) and a fair number of knowledgeable people at the decision-making level, who are aware of the potential contribution of space derived data, information and services to development and capable of efficiently integrating them into the decision-making process. Most developing countries lack well-trained people at all these different levels; however, almost all do have at least small nuclei which need to be identified and expanded through suitably tailored national and international efforts on training and education.

The importance of trained manpower at all levels is recognized by all countries embarking on development and use of space technology. Besides the need for technologists and application

specialists, there is also a need for developing a cadre of technical managers for the planning and speedy implementation of technological as well as application programmes. Equally important is that - with the growing role of technology - countries also appropriatly induce technologists and application-oriented specialists from various disciplines into the administration or government decision-making machinery. This will certainly enable countries to make better choices and to derive greater benefits from space technology through more efficient and knowledgeable ways of integrating the results and services from space applications into the decision-making process. Popularization of space technology and its potential contribution to socioeconomic advancement can help to create this broad awareness at all levels of a society.

However, adequately trained manpower is - by itself - not sufficient. The organization of this manpower into productive teams through appropriate institutional frameworks and the overall mechanisms for co-ordination an co-operation within a country are equally important. Especially in an applications project, there is a need for considerable and close co-ordination between a wide variety of agencies. Such co-ordination has taken different forms in various situations: committees, joint management, a focal agency, etc. While the precise mechanisms of co-ordination will vary from country to country - dependent on them are social, economic, cultural and other factors - the need for them has been clearly established. Therefore, countries embarking on the use of space technology should organize and set up inter agency co-ordination mechanisms, appropriate to their situation and needs. Obviously, there is no unique solutions applicable to all countries and all situations. However, the critical importance of a good organizational structure is now an established fact and countries planning to use space technology need to pay special attention to the organizational frameworks, appropriate to the country and task, conducive to the co-ordination and speedy implementation of efforts.

A country can begin to apply space technology with just some simple equipment, data products and a few applications experts who convert the data into useful information. This data analysis itself can, of course, be taken to increasingly sophisticated levels, requiring large, sophisticated and expensive equipments. How far a country wants to go would depend upon its needs, priorities and extent of matching infrastructure to utilize the information. However, it should be observed that infrastructure and the extent of use of space technology are completely interdependent.

Training and educational programmes should be established in Latin America and Carib in order to increase the existing national capabilities. However, as different countries present different levels of competence in different space science and applications technologies, distinct plans of action should be implemented for obtaining the desirable results.

For simplicity, Latin-American and Caribbean countries will be divided, for a given area of specialization and according with their level of development, into two distinct classes.

To the first group belong nations that present a fairly good base of qualified manpower and infrastrucutre. In general, they present a reasonable educational systems and curricula, where a great emphasis is placed on science and technology. Also, at specialized, graduate and postgraduate levels, interdisciplinary courses on areas connected directly or indirectly with space science and technology and its applications exist and are regularly offered.

A plan of action should be established with the help of the United Nations and the interested countries in order to adapt or to modify these courses and on-the-job training, in such a way that they can be taken by specialists coming from other countries of the region. Although the basic information given to the scientists or technologists could remain the same, the work to be developed at the courses and training should be tailored to the student needs, and whenever applicable, should be based on projects related to his own country. The student will not only acquire the indispensable knowledge about space science or technology, but will also be trained on how to apply it to solve problems of interest to his country.

These training programmes would therefore be scientific, technological, application-oriented and multidisciplinary in content, and would be designed to meet specific needs of requesting countries. They would take into consideration appropriate environmental, economic and social factors, and would incorporate elements of fundamentals, applications, research design, manufacturing and maintenance in their curricula.

A trend has been observed in Latin America and Carib towards the establishment of a localized regional center, where this kind of in-depth training would be offered. However, due to the fact that in some areas, more than one country presents competence to offer the desired programme, a new concept of a distributed regional center should be adopted. Acoording to it, compatible courses and training programmes would be offered by centres located at different countries - here called participating centres -, with the assistance, when necessary, of foreign experts under the auspices of the United Nations or other sponsoring agencies and Member States. Depending upon the specific requirements of the sponsoring Government or agency, the specialist will be directed to the participating center that presents a higher experience on the area of interest or that offers programmes better adapted to his needs. This proposal has the advantage of making optimal use of all available existing competence for the benefit of all Latin-American and Caribbean nations.

It should be pointed out that a fellowship programme that contains the above characteristics and directed to education and in-depth training in basic science, remote sensing, meteorology and communications for scientists and technologists from developing countries, has been appproved by the United Nations General Assembly as a proposal for implementing the recommendations of the Conference regarding space science and applications. (document A/AC.105£313 - 21 January 1983, item I-C, pages 9-14).

The United Nations and other agencies and bodies with established operational activities should support not only the fellowship programme, but also some other activities which are important for the success of the concept of distributed regional centres. They are:

- travel and per-diem expenses for staff members of one participating center to take part in the activities of another participating center in the region; and

- institutional grant to the participating centres to cover the expenses related to the special courses, training and work offered to the foreign participants.

As mentioned before, whenever pertinent, these programmes should always involve the training of specialists on the use and maintenance of important equipment, with special emphasis on the equipment indigenously-developed in the local country.

In order to implement such an idea, the following plan of action is proposed:

"A group of representatives to be indicated by the Seminar should get together and design such a distributed regional center. There will be one sub-group for each area of interest (for instance, space science, meteorology, remote sensing, communications, etc.) and each one will produce a report indicating the actions to be taken. The United Nations, other agencies and the participating countries should make funds available for the necessary meetings.

The final report will then be submitted to the United Nations and other agencies for approval and later implementation".

If not included in the final report mentioned above, another action is proposed in order to allow the strengthening of the indigenous capabilities of the countries that possess the participating centres:

"A regional research program on space science, applications and technology should be proposed by the countries participating on the distributed regional center to the United Nations and other agencies and bodies for complementary funding".

The second class of countries is formed by those nations which are beginning to use space science and technology. For them, sending people to be trained in foreign centres as proposed before, represents the first step to bruild the basic framework of its needed and indispensable infrastructure. However, in order to stimulate the growth of indigenous capability inside the country itself, subsequent actions should be taken.

The next step consists of giving to the trainee, at the conclusion of his training or even to other existing specialist, ample opportunity in his own country to use his acquired skill. This can be achieved with the provision of special funds for the development of his work back home. The trainee or specialist's Government ought to have the clear understanding and has to commit itself to provide him with all the necessary back-up support and materials that may be pertinent to the execution of his work. Generally speaking, the existence of long-range programme which can absorb the trainee or the specialist and make a gainful use of his new skill and experience is highly desirable.

However, if funds are not available, the United Nations, in co-operation with other agencies, should provide the trainee or the specialist with the indispensable support for him to develop projects at his own country and to have the necessary flexibility and mobility to go to the participating center where he was trained or even to another center in order to discuss problems and ideas related to his work or to use the equipment and facilities existing on those centres.

As soon as a "critical mass of specialists" starts to exist in a given country, long-range programmes that include the purchase of basic and indispensable equipment for data acquisition and analysis should be implemented. For the reasons already pointed out and to be discussed in next section, preferably the equipment should be procured in developing countries, in special at the institutes of Latin-America and Carib.

In order to increase the indigenous competence towards the fully control of the different aspects of the technology, two other steps should be undertaken. One is related to the establishment of appropriate educational programmes (regular courses and on the-job training) on different aspects of space science and technology; the other consists on obtaining the necessary know-how and research and development infrastructure to start the indigenous adaptation, modification or even the development of equipment (hardware and

training, other activities which will greatly contribute for the implementation of the presented plans of action. Just for the sake of completeness, they are mentioned below:

- participation of specialists from developing countries in relevant sessions of scientific and technical meetings of international organizations;

- symposia and workshops on specific topics on space applications at regional, inter-regional or international centres;

- short-term visits to centres of expertise, institutions and laboratories engaged in appropriate space - related programmes for specialists from developing countries;

- visits of specialist from centres of expertise to countries in need of assistance;

- short-duration training seminars on specific subjects;

- demonstration seminars through which information would be disseminated on new and advanced applications systems, and system developments with emphasis on their relevance and implications for developing countries (held on a regional/ inter-regional/international basis);

- workshops on space technology applications within the framework of educational systems (held on a regional/inter-regional/ international basis);

- local development and production of appropriate educational programmes on different aspects of space science and technology;

- provision of technical advisory services; focusing on the development of indigenous capability in the technology.

FABRICATION OF EQUIPMENT

It is sometimes assumed that any involvement in space science, applications and technology requires a substantial infrastructure of very large research and development laboratories and very sophisticated industry; it is therefore out of developing countries' reach. In fact, this is not the case, and quite a few developing countries are actively involved in a variety of space applications and in the development of space technology. Some infrastructure is certainly required, but this is not more substancial than what exists now in many developing countries.

On the other hand, a handful of developing countries have now both human resources and the infrastructure to develop and fabricate ground and space hardware. This is a very important capability, because the equipment should frequently be tailored to the needs and the environment of the particular country. Also, with indigenous fabrication comes better maintenance, development of know-how, employment and greater self-confidence. Apart from these benefits, the indigenous fabrication of equipment has been found to lead, in many cases, to advantageous industrial and management spin-offs. There is, therefore, a strong case encouraging indigenous fabrication to the maximum extent possible.

However, many developing countries do no present the "minimal capacity" required for the development of space technology. Although they are urged to establish such a capacity in order to ensure independent decision-making, to absorb and to adapt technology and methodology and to promote the indigenous development, they probably will need to use equipment existent in other countries or even to buy them. In this case, developing countries would be well advised to first look for appropriate equipment built in another developing country, because, as discussed before, in most cases, these equipments are more appropriate to the country needs and to its physical and cultural environments.

Developing countries in general - and Latin-American and Caribbean nations in particular - should strive to build their own technological capabilities to the limit of their human and infrastructure resources and should adopt a pragmatic, need-based approach with regard to the development of a given equipment (hardware and software).

Developed as well as other developing countries, the United Nations and international financing agencies should help developing countries in the setting up of such indigenous centres for absorption, adaptation and development of space technologies.

Besides the traditional and normal procedures adopted, the following plan of action should be established in Latin-America and Carib:

"Developing countries that have indigenously produced equipment for data acquisition, analysis and processing should:

a) offer training programmes on the use, maintenance and whenever possible on the fabrication of such equipment to specialists from other developing countries of the region;

b) *make use of the equipment available to specialists from other developing countries in a low-cost basis;*

c) *try to propose low-cost contracts for leasing or selling of such equipment;*

d) *allow the participation of specialists from other developing countries in the project and development team of related instrumentation or establish joint team to adapt, modify or even develop instrumentation for the interested developing countries;*

e) *try to help the other developing countries to establish the basic infrastructure for equipment fabrication and maintenance".*

The funds, whenever necessary for the implementation of such a plan of action, should be provided by the United Nations and other agencies and bodies, as well as by the countries involved.

It is interesting to observe that this plan of action has a reasonable assurance of success, since in developing countries most of the prototypes of the equipment are produced on research, development and educational institutions which do not present the rigid property rights policy adopted by industry.

As a conclusive remark, it should be pointed out that the magnitude of the investment and the technological base required to develop space harware may limit the number of countries that can at present embark on such programmes. However, joint effort to produce both space-based and ground equipment and the adequate mechanisms for implementing it should be explored by developing countries in Latin American and Carib.