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SPACE PROGRAM IN BRAZIL AND ITS CONSEQUENCE TO THE PUBLIC

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I - HISTORICAL

INPE, The Brazilian Institute for Space Research, exists since 1978, approximately. Before that it operated as a commission during other 10 years. Its campus is located in the city of São José dos Campos, in the state of São Paulo, in an area close to 1 square km. The Institute is subordinated to the Ministry of Science and Technology. INPE operates in three main R&D areas: applications (remote sensing, meteorology, etc), space sciences (astrophysics, aeronomy, etc) and engineering.

Through INPE, the country has received for more than 10 years now, satellite images from Landsat, Spot, NOAA and GOES. These were the first satellite applications available to the general public that got used, since then, to follow the weather forecasts in newspapers and tv news. Also, one decade ago, the Brazilian Telecommunication Company - EMBRATEL, has purchased two communication satellites from Spar. This was the second type of satellite application the Brazilian public was introduced to, although, many times, even without knowing it.

As a follow up to these applications, INPE is receiving images from ERS-1 and dedicating a lot of effort in developing interpretation algorithms for these micro-waves generated images. These images are particularly interesting due to the large areas of cloud covered regions in the country such as in the Amazon region. EMBRATEL also has purchased two other communication satellites (this time from Hughes), in order to replace the previous ones. One of these was launched in Kourou last July, and the second one waits for the Ariane launcher restart its program. The EMBRATEL satellites are operated by their own personnel, and INPE participation was limited to some training activities at the Hughes facilities and some final tests at INPE Integration and Testing Laboratory - LIT

In 1979, the Federal Government decided that the country would develop the Complete Brazilian Space Mission - MECB. This program called for the local development of 4 satellites, its launcher, the launching site, the control center, ground stations and data network. In this program, INPE was given the responsibility for the development of the satellites, the control center, ground stations and data network. The Air Force was responsible for the development of the launcher and the launching site. The first of these satellites was launched in February of 1993 by a Pegasus launcher, from OSC. The second satellite is ready to be launched which is scheduled to happen this year.

The launching of the first Brazilian developed satellite generated other plans for space applications and this resulted in the creation, last year, of the Brazilian Space Agency, responsible, among other things, for the national policy for space applications. At the present time, the country is ultimating the development of its launcher (expected to be ready next year) and its launch site (less than 3 degrees south of the Equator).

II - THE COMPLETE BRAZILIAN SPACE MISSION (MECB)

The first Brazilian satellite (SCD-1) is an octagonal prism with a basis fitting in a 1.0 m. diameter circle and with a 1.2 m. height. It weighs 100 kg. and its attitude is spin stabilized. The mission is to collect data from sensors (platforms) spread over the country with different purposes (rain fall, temperature, carbon monoxid, etc) and retransmit it to a central point where these data are available to the public.

SCD-1 was developed with a great contribution of the Brazilian industry. The structure, service telemetry transponder, part of the attitude control subsystem, data network equipment, part of the control center software were some examples. The experimental on board computer, thermal control design, orbit determination software and some other elements were developed at INPE and are now being transferred to the industry in other satellite developments. Others were imported, such as solar cells, pay load transponder and energy supply subsystem, but INPE and the Brazilian industry are working to develop these components in the country as well.

SCD-1 was launched in Feb. 9th., 1993. Its useful life was specified for 1 year, but a few days ago we had the joy to commemorate its second year of flawless operation in space at an altitude of 750 km. The satellite enters its 3rd. year and running; spin rate is down from 120 to 60 rpm (control may be granted until 30 rpm) and the component to show some sign of weariness is the battery. The high quality control measures not only internally but also required from the industries, is a prime factor in this extended life.

The application portion of the satellite, in fact, was overlooked by the concern during the design phase with the operation of the spacecraft itself and the ground segment. As a result too few ground platforms were placed across the country and the data is not being used as it should be. The main advantage of this application is to prevent the need of local data collection by humans, mainly in regions where the access is difficult, such as in the Amazon and in the water. With this system the user can get the data comfortably installed in his/her air conditioned office.

The second satellite of the MECB program - SCD-2, is a continuation of the first satellite. The two spacecraft are practically identical, with the exception that the spin rate for

the attitude control is kept by a magnetic coil at 30 rpm +- 2rpm. The satellite will also carry an experiment for the axis, bearings, and electronics of a reaction wheel developed by INPE. On the other hand, attention has been given to increase the potential users for the data transmitted by SCD-2. Water level for many dams in the country will be monitored by this system, as well as ecological data from the amazon region. The industry participation increased in SCD-2 with many equipments and subsystems purchased abroad or developed by INPE being transferred to these industries. The satellite is ready to be launched pending a decision about the launcher.

The MECB program calls for three other satellites (besides the launcher and the launch site). One experimental communication satellite - SCD-3 (185 kg. at 1,100 km. altitude in equatorial orbit) and two remote sensing satellites - SSR-1 and 2 (200 m. resolution and 200 kg.). SCD-3 will carry an experiment for voice low orbit communication as well as a dedicated data collection and location payloads for the amazon region. It is a more sophisticated satellite with three axis attitude control and it is scheduled to be launched in 1997. SSR-1 and 2 are presently under review to complement another program presently being developed with China.

Some components for these satellites are being developed by the industries, although still in a very low amount (financially) to raise a firm interest of these industries in their commitment to space activities in the country.

III - THE CHINA BRAZIL EARTH RESOURCE SATELLITE

This is a much larger satellite (1.2 ton), for remote sensing purpose, being developed in a joint participation of INPE and China. INPE is responsible for 30% of the satellite (including costs) and China for 70%. Launching is schedule to October 1996, in China, by a Long March 4 chinese launcher. Control of the satellite over brazilian territory is going to be performed by INPE's control center.

INPE is responsible for the development of part of the structure and thermal control subsystems, data handling and control computers, one of the CCD cameras among other equipments. All of these were hired from the industry in a larger scale than previously for the MECB program. Those figures started to raise the interest of the industry for space related oportunities, although still timidly.

The CBERS program calls for a second identical satellite. Much of the integration and testing for this second satellite will be done at the Integration and Testing Laboratory at INPE.

This program has opened a lot of oportunities to a increased cooperation between the two countries in space related activities and future joints projects, including in geostationary communication. Until the present time Brazil is the only country in the world to have a joint space project with China. It has

been a difficult task due to differences in languages, cultures, ways of thought and approaches to the project, besides the distance for communication. But the country space program can benefit a lot from this cooperation.

IV - NEW PROJECTS UNDER WAY

IV.1 - Equatorial communication (ECCO)

This is a system presently under study, composed by a constellation of 11 stellites (425 kg., 2,000 km. altitude) in equatorial orbit for low orbit communication. This system covers approximately 25 degrees north and south of the Equator and will be used for communication in remote regions, among other communication applications. The constellation will serve all the countries within these area in different continents, and may be seen as part of a global coverage system (although brazilian participation may be restricted to the equatorial portion). The project in Brazil is being led by Telebras, the holding of the telecommunication companies in the country, and INPE is acting as a technical designer on its behalf.

The project is expected to have two international partners, one from the US and another from Asia. Each partner will be responsible for 33% in the project. Brazilian investors and/or space related companies are expected to join Telebras in the partnership. Therefore, this will be the first space system developed in the country (even partially) that will have to be profitable in its operation. Not only in exploring the system but also in developing it, the oportunities here for the brazilian industry and other related space companies are much higher than ever before. The launching site is expected to be in Alcântara, the brazilian launching center being finished up, and the launchers, at least for the first satllites, may be contracted abroad. Furthermore the ground segment and communication equipments represent a considerable investment. Therefore, because of all these different parts of the system (satellite, launching and launching site, ground segment and communication equipments), this system may be a breake through in the participation of brazilian companies in the brazilian space program.

IV.2 - Scientific microsattellites

INPE is just starting a program for microsattellites. The first one will fly in piggy back with the brazilian-chinese remote sensing satellite, and will carry 5 scientific payloads offered by the scientific community from INPE and brazilian universities, some in association with foreign paryters.

It is a 50 kg. satellite and will use INPE's experience in developing SCD-1. Development will be both internally and with universities and private companies. This program will follow the orientation of the newly created Brazilian Space Agency - AEB, in order to involve different brazilian universities, not only in

providing the payload but also to extend their participation in the space activities in the country.

V - FUTURE PROJECTS

Two projects that seem to be feasible for the future are a remote sensing satellite dedicated to the amazon region and a geostationary communication satellite. Talks are starting for the first one, using funds of the international community destined to ecological preservation.

For a geostationary communication satellites there are private brazilian groups, including banks, interested in having their own satellite; this would be a complete new approach in Brazil. The experience gained with China with CBERs, may be useful in developing such system.

VI - CONSEQUENCES

- SCD-1, although a success above the highest expectations, has had little impact on the public, in general. This may be due to the lack of scientific or technological interest of the public for the space activities in Brazil so far. The increase of data and applications with more data sensor platforms in SCD-2 may increase the recognition of the potential users of these data.
- The benefits for the industry so far for their participation in the brazilian space program has been very small. However, with the perspective of new programs, of larger scale, together with the development of the launch site and launch campaigns and ground subsystems, it may become attractive in the near future. This is particularly truth for those with related activities, such as aeronautics, electronics, project management, defense, mechanics and software. On the other hand, these industries don't have yet the required trained personnel to participate in these bigger projects. The Brazilian Space Agency is trying to develop the space culture at the universities, in order to supply these people in the near future.
- The activities so far in R&D has allowed INPE and the industries to participate in the aerospace technology market.
- The last governments have increasingly supported the space activities in Brazil. However, political and popular culture about space in Brazil practically don't exist. There is a major political convincement to be done in the years ahead.
- Two applications stand out as major ones in the near future: communications (profitable) and remote sensing dedicated to the amazon region (politically acceptable).
- The main question persists between to buy or to develop the technology. The last governments seem to have chosen the second option, even operating under a very limited budget.