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First steps to establish an Small Satellite Program in Peru

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In the past years a couple of developing countries did manage to establish and develop satellite programs in their countries. Now it is the time for Perú in South America to do the same. The aim of this paper is to inform the space community on the first steps and achievements carried out by some Peruvian institutions and individuals to strengthen a national aerospace program. This challenging endeavor will be carried out with the involvement and in collaboration of governmental, research and educational institutions in Peru. Since the last two years, the efforts of Peruvian engineers and academic personal have been centralized in the development of a small satellite program with emphasis on the definition of mission planning and mission design. The Peruvian government is currently working on the further maturity of the aerospace area in the country. The National Commission of Investigation and Aerospace Development of Peru (CONIDA) and the Department of Defense support such challenging and promising plan. A first step has been achieved establishing the National Center for Satellite Imagery Operations (CNOIS). The objective and purposes of CNOIS is to promote the technological and scientific development of the country in the remote sensing area. This paper will describe the, until now, achieved tasks by Peruvian individuals and institutions by setting up a plan for accomplishing this challenging endeavour. The progress of our society and country can be ensured developing the space technology. It will give us the great opportunity to perform space science and space exploration.

I. Introduction

PERU participates in space related activities in the area of remote sensing, satellite communications and global navigation and positioning satellite systems with its neighbors countries of the Andean region but there is now the need to develop an own space technology. Based on the heritage of our ancient folks and following their paths we are nowadays able to create a well based space program for the benefit of the Peruvian industry and society. Once a well based space program is founded it will bring Peru significant economic benefits and expertise through the exploitation of space applications in industry, research and education. This manner Peru will also have the chance to participate directly in the preparation and planning of its space missions and in the strategic orientation of the South American region in outer space affairs.

Certainly, small satellites offer valuable support in performing space missions with emerging technologies. Almost all fields of science and applications can be sustained moreover technology demonstrations and space education and training are the objectives of such satellite missions. It is important for developing countries emerging in the space technology, to invest time and effort to access to space, its applications and spin-off technologies. Together with the decrease of development times, the inherent low investment of launch costs offered by the reduced size and mass of the spacecraft and their more manageable proportions, small satellites become attractive ways to develop and establish a national expertise in space technology. The first ideas and guidelines for the development, design and construction of a pico-satellite based on the CubeSat technology was given to Peruvian educational entities. In the last two years space projects have been initiated by some universities.

The aim of this paper is to inform the space community on the steps and achievements carried out by some Peruvian individuals and institutions to strengthen our national aerospace program. The following sections provide a short description of what has been done in Peru. An overview of past and current activities related to the aerospace field performed by scientific and research institutions as well as by academia is also treated. Individual achievements and what is being done in this direction with contributions of Peruvian engineers who would like to

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guide Peruvian decision makers in the acquisition of a satellite technology for the development of our country is as well presented.

II. Historical Path – From the Nazca Lines through Paulet I

In Peru aerospace has a very long tradition. The Nazca culture (200 BCE-700 CE) drew in the Peruvian desert, south of the capitol Lima, a series of ancient geoglyphs. The Nazca lines with about 300 hundred figures made of straight lines, geometric shapes and pictures of animals and birds represent higher technological knowledge of Peruvian ancient people. Theories and hypothesis indicate an advanced purpose of these lines which might be related to astronomy and cosmology. The geometric figures and drawings can only be seen from high in the air. Probably the Nazca folks were able to fly with primitive hot air balloons to observe these majestic figures.

Later in 1895 the Peruvian engineer and scientist Pedro Paulet (1874 – 1945) designed and built the first liquid fuel engine. The impulse of this engine reached 90 kg and worked without deformations during 1 hour. Beginning of last century he proposed a futuristic, for his time, spacecraft propelled by rockets called the Torpedo Plane. Years later Peruvian engineers working for the National Commission of Investigation and Aerospace Development of Peru (CONIDA) followed the path of Paulet and developed the sounding rocket Paulet I which was launched in 2006.

The Geophysical Institute of Peru (IGP, for its initial in Spanish) has been extendedly working in the area of atmospheric research. It was officially created in November 1947. But the history of the Geophysical Institute of Peru goes back to 1920 approximately, the year date in which the Geophysical Observatory is created in Huancayo (Department of Junin, central part of Peru). Nevertheless, it is necessary to consider that the Geophysical Institute passed for three phases before being constituted as such. In a first phase, between 1922 and 1947, the Magnetic Observatory of Huancayo was under the administration of the Department of Terrestrial Magnetism of the Carnegie Institute of Washington and in a second phase, between 1947 and 1962, as Geophysical Institute of Huancayo (IGH), being an autonomous agency of the government of Peru. Finally, in January 1962 in replacement of the IGH the Geophysical Institute of Peru (IGP) arises with the agreement to transfer the executive headquarters from Huancayo to Lima.

Figure 1. Nazca lines

Starting from 1960 there were projects conceived by Peruvian universities and scientific institutions in the field of rocketry. A decade later national and international research institutes initiated projects related to the aerospace field. American research centers and also the National Aeronautics and Space Administration (NASA) started cooperating and working together with Peru.

III. Peruvian Space Activities - from 1970 until now

This section has the goal to describe what has been done in Peru in the aerospace field starting from the seventies and going through the first decade of the 21st century.

A. Sounding Rocket Program

The sounding rocket program in Peru has also a well based tradition. At the beginning of the sixties two Peruvian universities, the National University of Engineering and the Catholic University performed static tests with small rockets. They used solid propellant.

After the foundation of the National Commission of Investigation and Aerospace Development of Peru (CONIDA) in 1974 and because of its location along the Pacific coast the launch site Punta Lobos was constructed south from the Peruvian capitol, Lima. During the first decade after its creation CONIDA began to work with others space agencies investigating the equatorial ionosphere. The missions with sounding rockets began in the 70s and ended late in the 90s. After that other projects were executed together with the cooperation of the Geophysical Institute of Peru, NASA and foreign research institutes in 2004.

Hereafter are listed the sounding rockets missions launched from Peru. Also information about the research field and how many rockets started is given:

1) CROATAN: atmospheric research, 94 rockets were launched
2) EQUION: ionosphere research, one rocket Black Brandt IV was launched
3) ANTARQUI: atmospheric research at an altitude between 20 and 160 Km. Several rockets and stratospheric balloons were started

4) CASTOR in collaboration with the Max Planck Institute (Germany): atmospheric research at 280 km, two rockets CASTOR CR4 were launched
5) 6687-II: atmospheric research of the stratospheric winds, 3 rockets NIKE were launched
6) CONDOR: ionosphere research, 29 rockets were started.

The program purpose of preparing all the national capacities needed for a successful development in national rocketry was fulfilled.

B. National Commission of Investigation and Aerospace Development (CONIDA)

The National Commission of Investigation and Aerospace Development (CONIDA) plays the role of the aerospace agency in Peru. Its mission is to promote scientific research, to develop space technology for national interests, and to create services for driving the national aerospace program.

The major tasks of CONIDA are:

a) Promote in Peru the development and peaceful research in the space field.
b) Organize studies, theoretical and practical research about space topics with national and foreign entities
c) Conclude cooperation agreements with similar national and international institutions.
d) Encourage the exchange of technology and support and execute the training of national specialists. Administrate the national law and legislation applicable to space.
e) Support national and educational space projects.

Bellow are listed the most important activities performed by CONIDA.

1. *Geomatics*
   Geomatics is the research section, which has among its main objectives, to promote the use of geo space through development, transfer, and application of this technology to all sectors in the country in order to use natural resources efficiently and for improving socio-economic activities in the country
2. *Sounding Rocket Program*
   The development of such activities is seeking ways to access space with our own technological solutions. CONIDA carries out such activities in close collaboration with local industry and universities. Under other objectives worth to mention is advance and improvement in the area of chemical propellants, elastomers, composites, ablative and adhesives, welding and heat treatment of high strength metals.
3. *Scientific Instrumentation*
   Scientific Instrumentation is the unit in charge to develop a functional system and database for acquisition and storage of scientific and technical parameters taken during sounding rocket flights.
4. *Astrophysics*
   The astrophysics section is devoted to the research and development of scientific projects and educational programs (basic and advanced levels) in the areas of solar physics, planetary systems and minor bodies, Sun-Earth connection (forecasts of climate and space environment, solar activity , etc), stellar and galactic astrophysics, cosmic rays, space radio-astrophysics and geophysics. CONIDA operates the Radio Solar Observatory at the base Punta Lobos (south of Lima) and works on the implementation of an astronomical observatory in the city of Moquegua, south part of Peru, at an altitude of 4600 meters above sea level. Since 2007 CONIDA participates in the Latin American project for observation of high energy solar flares through a network of antennas in the VLF band. This project is known as the South America VLF Network (SAVNET).
5. *Educational activities*
   CONIDA coordinates programs in science education and pre-professional training for university students interested in astronomy and astrophysics. Other educational programs support the definition of research theses for undergraduate and graduate students to obtain master and doctoral degrees. CONIDA offers courses and workshops on astronomy and astrophysics for primary and secondary schools and university students. These are given by Peruvian astronomers as well as by invited scientists.

Figure 2. CONIDA: Space Agency of Peru

C. National Center for Satellite Imagery Operations (CNOIS)

The creation of the so called satellite law is merit of the National Commission of Investigation and Aerospace Development, institution that has come prompting for more than 6 years this initiative, and whose effort was concretized the 21st of July 2006 with the promulgation of the Law 28799 by the Congress of the Republic. It does

not fit the smaller doubt that everything was conceived with the best intention of promoting remote sensing and Earth observation fields in support of our national space research activities. The CNOIS is a satellite imagery program and its purpose is to supply to the different national public institutions with satellite information. This is in order to provide the tools required for agriculture, mining, disaster prevention, defense and national security, environmental protection and rational usage of natural resources, human resource training, etc.

The CNOIS manages their actions through strategies and implements specific programs. The CNOIS was conceived to be a multi-sector project and works in coordination with the Presidency of the Council of Ministers (PCM) and in particular with its technical body, the National Office of Electronics and Informatics (ONGEI), which is responsible for the implementation of the section for infrastructure of satellite database and imagery (IDEP - Infraestructura de Datos Espaciales del Perú). The basic components of CNOIS are a satellite data collection center and a training center

The CNOIS operation depends on CONIDA, which works closely with the ONGEI and PCM. This center will be the prime provider of satellite information to all members of the IDEP. However it is noted that there are users who have high demand of satellite information and because of the nature of their activities, they must be considered as prime users. These are such as the Ministry of Defense and the Ministry of Environment.

D. Satellite Engineering - CONIDASAT

CONIDASAT was a technology demonstration project started in the middle of the 90's and had the ambition to launch a satellite platform and payloads completely developed in Peru. Research in the remote sensing area was the central motivation for developing this technology. Our country has a diversity of natural regions, like coast, mountains and tropical forest; and its geography is unique therefore the necessity to deeply observe and study it. CONIDA planed to use the satellite in order to assist agriculture, fishery, mining, and other sectors. Within this program dedicated laboratories and also a clean room class 10.000 were built.

The CONIDASAT team began with the design of the satellite in 1997. Due to the available low budget the team took all the possibilities to save money and built self designed tools (hardware and software). With these tools the team was able to built parts of the satellite in Peru instead of buying these abroad. This way was also possible to save time, because in some cases the delivery of satellite parts and equipment could take months or years. For example four reaction wheels were built for an amount of 25.000 US dollars. In comparison to the price, at that time, it was cheaper because the commercial price for one reaction wheel was about $100.000. The price of the onboard computer was estimated in 80.000 US dollars but Peruvian engineers managed to build the computer for less than $30.000. The same manner others parts of the satellite, built by the national industry, were the magnetic coils, the solar panel boom with its pin puller mechanism, the satellite's structure with honeycomb, the solar sensor, an hydrazine tank, and several mechanical parts. Only the solar cells, thrusters and the batteries were planned to buy abroad.

As mentioned before also a clean room was mounted. There an optic table was installed which was useful for testing the high resolution camera. The resolution of the camera was designed to reach 2m/pixel. The satellite should have a mass of 200 kg and the orbit would be 560 km of altitude. Unfortunately the project was canceled in 2003 due to insufficient budget.

E. Launch Base Punta Lobos and CONIDA Infrastructure

Currently CONIDA infrastructure consists of one chemical laboratory, one physic laboratory and one optic laboratory. Also the launch site Punta Lobos is part of this national infrastructure. Currently CONIDA and its engineers work on the development of solid propellant and perform static tests on small rockets in the installations of the above mentioned launch site.

The launch base Punta Lobos belongs to CONIDA and is located at the central part of the western pacific coast 70 km south from Lima. The exact location of Punta Lobos is: latitude: 12.50 deg and longitude: 76.80 deg. Because of its location close to the magnetic Equator from Punta Lobos significant experiments in cooperation with NASA could be carried out especially for investigations of the Ionosphere. Over 100 sounding rockets were started from Punta Lobos. During the 20 years usage of this launch site the following sounding rockets were launched: Arcas, Blanck Brandt, Nike-Apache, Nike-Orion, Nike-Tomahwak, Terrier-Malemute, Super Loki, Taurus Orion, and Taurus Tomahawk.

Figure 3. Launch base Punta Lobos

F. New Age of Sounding Rockets - "Paulet I"

Moreover CONIDA has its own sounding rocket program. The first sounding rocket launched in Peru was the "Terra LM". It was a small sounding rocket which reached 20 km altitude. It was a result of international cooperation on space activities between the Commission for Space Activities in Argentina (CONAE) and CONIDA.

The sounding rocket "Paulet I", a joint venture between the Peruvian Air Force and Peruvian scientific entities, was named in honor of the Peruvian engineer and scientist Pedro Paulet (1874 – 1945) and was launched on December 27, 2006. It reached an altitude of 45 km carrying to space a payload of 2 kg weight. In September 2009 the newest version of the last mentioned sounding rocket, the "Paulet IM" (2.8 m long), was launched and reached 90 km altitude carrying 5 kg of payload.

CONIDA does continue working on its sounding rocket program and plans to launch end of this year the next rocket version. Future plans in this field includes the usage of the rocket Paulet IM for atmospheric research, measurements of air composition, investigations of the ozone layer and ionosphere effects produced under the influence of the sun.

Figure 4. Sounding Rocket: Paulet I

IV. A New Era for the Peruvian Aerospace Program

In the recent years CONIDA has been signing agreements with others space agencies and research institutions in order to initiate future immediate space activities of mutual interest in a framework of technical cooperation in space science and space technology.

The central idea behind signing agreements and treaties is to start international cooperation for the peaceful use of the outer space.

A. International Relationships and Agreements

Below is given a short overview of international relationship between our Peruvian national aerospace agency and other similar ones:

1) Argentina: the Commission for Space Activities in Argentina (CONAE) and CONIDA have strengthened ties of mutual cooperation in the technological and scientific fields.
2) Brazil: CONIDA is discussing with the Brazilian Space Agency (AEB) about new cooperation agreements in space research projects.
3) India: CONIDA is trying to reactivate the memorandum of understanding (MoU) signed with the Indian Space Research Organization (ISRO).
4) Russian Federation: a similar case is with Russia. The MoU with the Russian Aviation and Space Agency was expired and CONIDA has already met the Russian authorities to reactivate this memorandum. Furthermore CONIDA is close to sign a scientific cooperation with the Tsiolkovsky State Technological and Aerospace University (MATI).
5) South Korea: In November 2008 CONIDA signed a MoU with the Korean Aerospace Research Institute (KARI). The MoU has emphasis in remote sensing.
6) Germany: A delegation of the German Aerospace Center (DLR) visited Peru in November 2008 with the intention to know more about Peruvian space activities and its experience in this field. They visited the installations of CONIDA, like main building, its laboratories and the launch site Punta Lobos. This delegation could visit as well the Geophysical Institute of Peru (IGP), the Jicamarca Radio Observatory and the installations and facilities of three universities, the National University of Engineering (UNI), the Catholic University of Peru (PUCP), and the Peruvian University of Technology (UTP). A year later, in September 2009, CONIDA signed a memorandum of understanding with DLR. A first mission planned with participation of scientific institutions of both countries will be a sounding rocket mission. The participants in this project will be DLR, CONIDA, IGP, and the Leibniz Institute of Atmospheric Physic.

From the 14th to the 18th of September 2009 CONIDA hosted the United Nations/Peru/Switzerland/European Space Agency Workshop on Integrated Space Technology Applications for Sustainable Development in the Mountain Regions of Andean Countries held in Lima. The goal of this workshop was to discuss how remote sensing

and satellite communications can contribute to sustainable development in the mountain regions of Andean countries. Another objective was the identification of priorities for building local capacity in remote sensing for the benefit of the Latin American region.

B. Peruvian Universities and their Space Activities

a) *National University of Engineering (UNI) - Project CHASQUI*[2]

The picosatellite CHASQUI is a project conducted by the Center for Technological Information and Communications (CTIC) at the National University of Engineering (UNI – for its initials in Spanish) in Lima. The satellite is based on the CubeSat technology and it will be designed and assembled completely in Peru. The initial idea to build an academic satellite in Peru was conceived by the electronic engineer Jaime Estela and the aerospace engineer Juan Martín Canales Romero with the goal to demonstrate that in Peru such a space program is as well doable. The project cemented its basis in October 2008, when they met the project team leader. The motivation for the project development is primarily educational; it is to educate Peruvian students and engineers in space technologies and space system engineering with the further goal to develop in a near future a national program on small satellites. Since end of 2008, the efforts of Peruvian students, academic personal and advisers have been centralized on the mission design and mission planning definition. They have already mastered to define which equipment and payloads the satellite will carry into space. At the moment the Chasqui team is testing the different subsystems of the pico satellite and plans to launch the spacecraft at the end of 2010 or beginning of 2011. The key elements of the project are:

i. Educate Peruvian students and engineers in space technologies
ii. Technology demonstration and in-flight verification of the in-house built power electronics, high efficient solar cells (donated by EADS-Astrium Germany), two cameras, one color and one NIR camera
iii. Cooperation with national and international partners, like universities and space related institutions.

b) Catholic University of Peru (PUCP) - Project PUCPSAT

The Catholic University of Peru has similar ambitions in developing and building its own pico satellite for educational purposes. The satellite is also based in the CubeSat standards. The mission of this project is again the technology demonstration one in order to prove the capabilities of a self-built low power S-Band communications system. In Peru the PUCP is leader in the radio-astronomy field and currently a project to built a 20 meters radiotelescope is ongoing.

c) The Peruvian QB50 team

The Von Karman Institute of Belgium (VKI) is organizing with support of the European Space Agency (ESA) the university project called QB50. In this project 50 picosatellites will be launching together within a Russian rocket at the end of 2013. It is envisage the participation of 50 universities worldwide, about 30 from Europe and 20 from the rest of the world. Peru will participate with an integrated team of five universities and one research institute. We have managed to gather the "Letter of Intent" from the Peruvian universities and the VKI has already received them. The Peruvian team plans its participation and contribution in the project with two slots, it means contributing with two CubeSats developed and constructed in Peru. The project coordination with our five educational entities has began and we plan for each university to concentrate in the design of a dedicated subsystem or module and after their integration, the spacecrafts will follow the required mechanical and thermal tests in the installations of these universities. The interested universities participating in the Peruvian QB50 team are the National University of Engineering, the Catholic University of Peru, the Peruvian University of Technology (UTP), the University Alas Peruanas (UAP) and the State University San Agustin (UNSA).

Due to our active participation since the beginning of the QB50 project a Peruvian delegation represented by Mr. Jaime Estela participated in the first QB50 Workshop held in November 2009 at the Von Karman Intitute in Brussels, Belgium. One of our priorities is the well coordination and management of the Peruvian consortium in a way to facilitate the communications between the Von Karman Institute, all project's involved European organizations and the team formed by five Peruvian Universities and one research institute.

d) Interuniversitary Cooperation and Projects

The universities UTP, UAP and UNSA are combining their efforts to create the first faculty of space engineering in Peru and the first space research institute. This enterprise covers satellite design, sounding rockets development including experiments to carry out by those rockets and the design of ground stations. Here also our task is to ensure that these universities obtain support from European universities and institutions. We want to contribute to such an

[2] Chasqui is a Quechua word used for "messenger". The Chasquis were agile and well-trained runners that delivered messages, royal delicacies and other objects throughout the Inca Empire

interuniversitary cooperation and we seek profesionals and students from other universities and fields of studies to joint this initiative.

V. Strategic Plan and Future Aerospace Development

A. Strategic Plan for Aerospace Development

As starting point for the elaboration of a strategic plan for the development of an aerospace technology in Peru, an assembly of joint strategies should be elaborated that will permit to reach the objectives and goals proposed in a national strategic plan. The fundamental criteria and the strategies can be implemented by:

a) Formulating studies, programs, policies and legislation of all what is related to the development of aerospace activities.
b) Using and applying space technologies through the development of space projects and the utilization of satellites, rockets and space infrastructure.
c) Improving technology transfer activities, promotion and training for the generation of local know-how and capacities in science and aerospace technology and geomatics. It implies disclosure, information and diffusion of space knowledge to governmental and public institutions, but not restricted to offer such service to private institutions and companies in the country.
d) Cooperating internationally with space agencies and research entities worldwide. This contemplates tasks related to the subscription and signing of agreements and international treaties, with the objective to prompt the program for development of this national strategic plan.
e) Creating a National Institute for Aerospace Science or "Instituto Nacional de Ciencias Aeroespaciales – INCA" (for its initials in Spanish) with the goal to play the role as center for development in space research and Ministry of Science and Technology.

A national space program would further promote the use of space technologies and satellite data for sustainable economic and social development of Peru. By raising the awareness of decision makers we can demonstrate the cost effectiveness and additional benefits obtained with the acquisition of space and satellite systems. This will facilitate to establish and strengthen the capacity, man power and infrastructure, in our country to use space technology; and consequently strengthen outreach activities to disseminate awareness of the obtained benefits for our society.

The overall strategy of the program is to focus on selected areas that are critical for our national interest like disaster management, control of natural resources and also national defense. Emphasis should be put in the definition and work towards objectives achievable in two to five years and should be built on the results of previous activities. A roadmap has been recommended in order to be presented to the government and decisions-makers and to guide them towards the direction to go in the framework of our space related activities in the next decade.

B. Future Space projects

The Peruvian space program considers the improvement and progress in following areas:

a) Microsatellite for Earth Observation and Telecommunications satellite

A handful Peruvian engineers and experts based in Lima and abroad are recommending the Peruvian government to consider the acquisition of a satellite for Earth Observation. Nowadays the international satellite market offers a wide variety of products starting from micro-satellites through satellites having a weight of 1.5 tons. The number of companies that builds and operates satellites has increased in the last decades. The acquisition of a satellite for Earth observation is very important for our country. It is proposed that the satellite system shall include both a ground segment and a space segment. An important criterion to be taking into account in this case is that the selling company should ensure the provision of the satellite, the establishment of a ground station and as well the technology transfer.

The acquisition of a telecommunication satellite is also under discussions and is considered part of our future space program. Peru is a big country but with only 30 millions inhabitants a telecommunication satellite with a low number of transponders is enough to cover the telecommunication demand of the country. That means a small communication satellite is appropriated and the cost of the satellite will be low. Normally a telecommunication satellite has more than 20 transponders. The Peruvian government has already received interesting offers from some space companies that provide Earth observation and telecommunication satellites.

b) Future Sounding rockets program

Peruvian institutions will continue the development of sounding rockets and payloads. CONIDA and Peruvian academia will joint efforts to achieve this target in a short time. This will be an opportunity to educate and train the new Peruvian experts in this field.

c) Satellite launcher vehicle

The development of a satellite launcher is also envisaged and is listed in the plans of the Peruvian space ambitions.

d) Development and production of high quality space products

In cooperation with local companies, many institutions are considering the possibility to manufacture equipment and products for space applications.

e) Peruvian astronaut in space

Within its aerospace plans and future program CONIDA considers the selection, training and launch into space of the first Peruvian astronaut.

VI. Conclusion

The realization and development of a satellite project in Peru, like as an academic pico satellite is nowadays possible. For the first time, a spacecraft – primarily designed and built by Peruvian professionals, engineers and students is being developed and will be launched into space. The intention of our work presented in this paper is to promote the use of space science and technology in the country giving the opportunity to several educational and research institutions to play an important role in this field. Raising this kind of technology in our country will contribute for a better future of the Peruvian society and industry.

CONIDA and governmental institutions are working on a plan to kick-off Peru's space adventure. If we are successful in our plans, in less than 5 years we will have significant progress in the space area and at least one satellite orbiting the Earth. After that, we will have lifted the lid on limited belief towards what we can achieve in Peru. We think it is time for making the first and crucial step towards changing attitudes and expectations in the space area. A combination of Peru's historically innovative nature and a belief that anything can be achieved is an exciting prospect for our country.

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References

[1]Woodman J., *Nazca - Mit dem Inka Ballon zur Sonne*, 1st edition, Lübbe Bastei Verlag, Cologne, 1980.

[2]Kenneth G., *Exploring Space*, 1st edition, Mc Donald Phoebus, New York, 1972.

[3]Prof. Thomas Esch, *Raumfahrtantriebe*, Fachhochschule Aachen, Aerospace Engineering 2009

[4]Mejía A., Canales Romero J. M., Estela J., "Pedro Paulet - Peruvian Pioneer of the Space Age", 43rd History of Astronautics Symposium, International Astronautical Congress, 2009.

[5]"La Agencia Espacial de Tailandia y la Agencia Espacial del Perú Firman Memorando de Entendimiento" [online database], URL: http://www.conida.gob.pe/prensa/PDF/2010/18012010_Tailandia.pdf

[6]"Representantes de la Agencia Espacial Alemana Visitan CONIDA", [online database], URL: http://www.conida.gob.pe/prensa/PDF/DLR.pdf

[7] Canales Romero J. M., Estela J., "The Pico satellite Chasqui I Project", 10th UN/IAA Workshop on Small Satellite Programmes at the Service of Developing Countries, International Astronautical Congress, 2009.

[8]"Más allá de lo evidente", [online database], URL: http://www.pucp.edu.pe/puntoedu/dmdocuments/num167.pdf, *Publicación de la Pontificia Universidad Católica del Perú*, Lima, 2009, N° 167, pp. 8-9.

[9]"International cooperation in the peaceful uses of outer space: activities of Member States", [online database], URL: http://www.oosa.unvienna.org/

[10]Chau J. L., Farley D. T., et all, "The Jicamarca Radio Observatory", [online database], URL: http://isr.sri.com/uars-uaf-2008/presentations/UARS-Jicamarca.pdf, National Science Foundation 2008 Upper Atmosphere Research Section (UARS), Workshop and Upper Atmospheric Facilities (UAF) Meeting, 2008.

[11]QB50 an international network of 50 CubeSats, Von Karman Institute and the European Space Agency. www.vki.ac.be/QB50

[12]Canales Romero J. M., Estela J., "Design of a Peruvian Small Satellite Network", Session for Small Satellites Potential for Future Integrated Applications and Services, International Astronautical Congress, 2009.