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EARLY ISS UTILISATION TAXI MISSIONS - A MODEL TO SEND THE FIRST SERBIAN TO SPACE?

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Abstract: In general, space research is perceived as an expensive and complex endeavour. This is exemplified by the fact that space science missions and space stations have been perceived by strong economic nations only. A particular case is that human space flight is even more complex and requires a very wide and sophisticated set of skills, resources, and facilities. This paper aims at demonstrating through three specifically selected examples, that even a small country such as Serbia, although not having a space industry, can engage in international space projects at all levels: that is at the Governmental level, the Institutional level, and the Individual level. Governmental efforts could bring a Serbian citizen within a bilateral agreement to the International Space Station (ISS). Serbian universities or national research institutes could embark on microgravity research by using comparatively less expensive parabolic flight facilities. And last, but not least, even space enthusiasts can nowadays contribute their skills and expertise to international space programmes.

Keywords: Serbia, access to space, ISS, parabolic flight, space amateurs.

1. INTRODUCTION

Mankind achieved access to space since the launch of the first man-made object in 1957. This achievement was possible by a concerted effort of the Soviet Union to pool talent, resources and technologies targeted at the clear objective to gain access to space and demonstrate societal superiority. The same feat was soon accomplished by the United States and only slowly did other nations follow. However, until today, only a handful of nations have built capabilities for space launches and sustainable space programmes. Nevertheless, space nations do tend to develop more advanced technologies and stronger economies, providing evidence that space can be a driver and a tool for progress and comprehensive economic development.

On the other hand, the latest successes in commercial launch capabilities and the diversification of microgravity research platforms, has made it much easier and

less expensive for governmental and non-governmental players to become part of the global space community. Nowadays, there are many different possibilities to conduct space research, including options where researchers do not even leave the ground.

The key takeaway message of this paper is to show through three specifically selected examples, that even a small country such as Serbia, although not having a space industry, can engage in international space projects at all levels: that is at the Governmental level, the Institutional level, and the Individual level.

2. GOVERNMENTAL LEVEL

What today is the most complex and most successful space project in low-Earth orbit started as the space station "Freedom", a national project by the United States, intended to bring other Western nations of its political alliance together via bilateral agreements. Space station "Freedom" was perceived as a counter-concept to the Soviet Union's orbital complex "Mir". With the break-up of the Soviet Union and the changing geopolitical context, a completely new situation emerged which called for unprecedented and pragmatic solutions.

Image 1: The International Space Station (ISS) is mankind's only outpost in space. Although initially set up by 4 national space organisations (NASA, JAXA, CSA, and Roscosmos, plus in the beginning also Brazil) and the intergovernmental European Space Agency ESA, it has enabled access for research stemming from scientists and experts from all over the world. Credit: NASA

It became obvious at the time that a partnership between the two strongest players in the space arena, the US and the Soviet Union would support a sustainable, long-term, and peaceful cooperative space project. The idea of an International Space Station was born.

Europe's decision to join the International Space Station (ISS) programme opened enormous possibilities for European space industry and the European science community, that had not previously existed. The European Space Agency (ESA) has been actively guided by their user communities to get the best possible access to the benefits offered by this multinational and multi-continental ISS cooperation.

Europe's biggest contribution to the ISS is the Columbus research laboratory, launched in 2008. The ISS assembly started in 1998 what meant that the European research community would need to wait 10 years, until the European facility was in space. For that reason, ESA decided to give European scientists the opportunity for flying experiments during so-called 'taxi-missions'. In this respect, 'taxi' meant, the flights had an ad-hoc character and were of short-duration. Another important hallmark was that those missions were national missions, supported by one individual ESA Member State.

From the autumn of 2001 until the spring of 2005, a total of 6 missions to the ISS were conducted using the Russian Soyuz manned launcher. These missions were co-funded by ESA, and the 5 ESA-Member States: France, Italy, Belgium, Spain, and the Netherlands, that took advantage of this opportunity. ESA's taxi missions enabled small countries which had not been traditional human spaceflight nations to send their first or just second citizen into space. Examples in this category are Spain, Belgium, and The Netherlands.

The Russian side drew on its extensive experience gained through the Soviet INTERKOSMOS-Programme - when cosmonauts from its allied Eastern European countries, Asia and Cuba were assigned to flights to the Salyut space station or the Mir Orbital Complex.

In similarity with the INTERKOSMOS programme, most experiments and other activities in the taxi missions were tailored to the needs of the science community in the respective countries. During these 6 taxi missions more than 100 experiments in all fields of space research were carried out, including many educational experiments. These educational experiments were made possible via an allocation of 1% of the ISS research budget for educational purposes.

The total cost for one such mission by that time was a fraction of what needs to be paid now for a seat on a Russian spacecraft. The 'emotional' value of the mission, however, cannot be stressed enough. All taxi mission participants experienced the overwhelming Russian hospitality and high level of professionalism in the area of human spaceflight.

3. INSTITUTIONAL LEVEL

While human space missions are very emblematic space projects, it is reserved for a limited number of persons and still requires a high degree of governmental involvement.

Access to microgravity can also be provided by means of a specially adapted aircraft capable of performing parabolic flight manoeuvres. During such a flight, a plane flying on a horizontal flight path, starts to climb a steep trajectory up to the highest point of a parabolic arc, before 'falling' again up to the end point of the parabola when the pilot must accelerate and bring the plane back into horizontal flight.

Image 2: The Airbus 300 of French company NOVESPACE in Bordeaux, France, used for parabolic flight campaigns throughout Europe. An A310 replaced the A300 in 2015. Credit: NOVESPACE

Parabolic flights are a simple way to get hands-on experience in microgravity research and build space research capacities even for nations which do not have their own space programme. Parabolic flight campaigns are popular with national space agencies which allocated the research spots in the aircraft mainly to national universities and research institutes.

Image 3: The Airbus 310 of the French company NOVESPACE injects into the 43-degree flight path for flying along a parabolic arc. Credit: NOVESPACE

As part of the preparation for a flight campaign all participants are required to attend a safety briefing.

A typical campaign consists of 3 flight days with 31 parabolas flown each day. During each of the three flights of a campaign, the same procedure for each of 31 parabolas is followed:

- Announcement of time to next parabola
- 5, 4, 3, 2, 1 There are three announcements over the audio: “Pull Up” and the plane starts to climb; then “Injection”, followed by ‘Pull Out” at the bottom of the parabola.
- Image 3 shows the point of “injection” ~ 43 degrees.

Images 4 and 5: Experiment teams and their equipment during the microgravity phase of a parabola. Credit: NOVESPACE

Various experiments and their team members (normally around 10-12 individual teams) are shown in Figures 4 and 5.

For Serbia, several options for participation could be of interest:

1. Universities or research institutions should set up long-term strategic partnerships with academic institutions in ESA Member States to take part in teams which are already involved in parabolic flight opportunities. For such an option, the individual team members only must bear their own cost of hardware development and travel costs.
2. Universities or research institutes could address the Serbian government to find a combined funding for a national parabolic flight campaign conducted by NOVESPACE for example but starting from Belgrade Nikola Tesla Airport, since parabolic flight campaigns can be conducted from almost any location in Europe. The overall cost of a parabolic flight campaign might be of the magnitude of 400,000 to 500,000 Euros. The latest quotation needs to be requested from NOVESPACE.
3. Parabolic flights are not limited to large aircraft and can be conducted by any highly experienced flight crew. Technically, parabolic flight campaigns can be conducted from almost any location in Europe. Therefore, provided there are resources and institutional support available, Serbia could set up its own parabolic flight capabilities. Such a move could also be considered within a network of other Balkan countries to share costs.
4. Serbia could join with other former Yugoslavian countries to purchase a parabolic flight campaign with NOVESPACE or join to build its own capacities.

Image 6: The Airbus 310 of French company NOVESPACE in Bordeaux, as used for Parabolic Flight Campaigns. Credit: NOVESPACE

The images 3, 4, 5, and 6 show French company NOVESPACE's[1] Airbus aircraft A310 based at Merignac in Bordeaux. This aircraft is regularly used by ESA, DLR and CNES space agencies.

4. INDIVIDUAL LEVEL

As a last inspiration, a beautiful example of what can be achieved by an individual if one is passionate about what one does and determined to achieve it! Image 7 is a photo of DK5LA, otherwise known as Reinhard Kühn, who lives in the North of Germany (Sörup) and has been a radio amateur since the 1970s.

Image 7: German radio amateur Reinhard Kühn DK5LA. Credit: Reinhard Kühn DK5LA

He started as a youngster, building his own antennas – experimenting with different constructions and configurations. Reinhard Kühn is fascinated in Earth-Moon-Earth connections (that is bouncing signals off the Moon) since 1977 and was able to establish such connections via the Moon, becoming one of 100 radio amateurs worldwide – a very exclusive club.

[1] https://www.airzerog.com

Image 8: The antenna of German radio amateur Reinhard Kühn DK5LA next to his house in Sörup. The Moon was inserted in this photo to illustrate how a radio wave would bounce back upon hitting the Moon's surface. In reality, radio waves are invisible. Credit: Reinhard Kühn DK5LA

In 2017 he and radio amateurs from The Netherlands and South Africa worked together to successfully reactivate the radio amateur satellite ZA-Aerosat. An achievement which became known to the Harbin Institute of Technology (HIT) in China – the radio amateur laboratory there had a payload on the Longjiang 2 satellite – which was launched together with the Chang'e 4 relay-satellite Queqiao (part of the Chinese governmental lunar exploration programme). HIT was looking for a European ground station which could keep a two-way communication contact with the Longjiang 2 satellite after the Moon had set in China. They turned to DK5LA because of his unique 8 x 32 element antenna with state-of-the art transceivers, amplifiers, and computers.

Image 9: View of the antenna of German radio amateur Reinhard Kühn DK5LA next to his house in Sörup. Credit: Reinhard Kühn DK5LA

DK5LA, together with the international team of radio amateurs wrote space history when on 2 July 2019 they photographed a solar eclipse on the Earth taken from the vantage point of the far side of Moon.

Image 10: This modern day "Earth Rise image" showing a Solar Eclipse on 2 July 2019 as seen from the Moon was taken by Inory Eye camera on board the Chinese Longjiang 2 microsatellite. Without the support of the German radio amateur Reinhard Kühn, the data would not have been received. Credit: Wei Mingchuan (Harbin Institute of Technology, BG2BHC/BY2HIT), CAMRAS Dwingeloo Radio Telescope, Reinhard Kühn DK5LA.

Because of advances in technology (internet, miniaturisation, high-performance receivers, etc.) amateurs can contribute at the highest professional level. The AMSAT- Radio Amateur Satellite Corporation is a network, where radio amateurs from around the globe contribute to the promotion of space exploration and communication. For those interested in space, AMSAT offers many areas to become involved. Likewise, there are many examples of technical developments by radio amateurs which could be used commercially. Those examples underline that amateur radio is even today a highly interesting hobby. And by the way: every astronaut is a radio amateur, but not every radio amateur is an astronaut.

4. SUMMARY

Governmental level: support a partnership for the first Serbian in space to generate a wave of public awareness for space, inspire a new generation of talent and for capacity building in the space sector: industry and academia.

Institutional level: universities could strategically delegate students to universities in ESA Member States to join existing teams conducting parabolic flight research or other space research. Alternatively, Serbia could investigate options to find resources for a national or regional parabolic flight campaign.

Individual level: radio amateur enthusiasts are still a strong link to space exploration – with their hands-on activities they can lay the educational foundation for future space projects but can also find ways to directly become involved in governmental space programmes. The same applies to other space enthusiasts to let them contribute to projects for citizen science (e.g., Mars Society).

There are many, many possibilities for hands-on space research – ranging from the utilisation of remote sensing data (ESA's Earth Observation data are for free and publicly accessible!) to the downstream sector of applications and user services. It is hoped that the SEE Universe 2020 conference will lay the foundation and provide the inspiration for a space industry and space research ecosystem in Serbia … and maybe the first Serbian in space?

Image 11: On 24 January 2018, ESA's Proba 1 satellite captured this maze-like image of the capital city of Belgrade, in Serbia.
Credit: ESA/2018, CC BY-SA 3.0 IGO