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Developments in space activities in Poland

Piotr Manikowski*

Poznań University of Economics, Insurance Department, al. Niepodległości 10, 61-875 Poznań, Poland

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ABSTRACT

Poland has a long-standing tradition in space activities. Polish institutions have participated as co-investigators in almost all European Space Agency (ESA) science projects, as well as on many other missions. However, the first Polish satellite (PW-SAT) was only launched in 2012. Poland was one of the first Eastern European countries to conclude a Cooperation Agreement with ESA in the peaceful use of outer space; it was signed in 1994 and followed by a second in January 2002. Negotiations on Polish membership in the ESA were started in autumn of 2011, and ended in April 2012. Following ratification of the agreement, Poland officially became the 20th Member State of ESA on 19 November 2012. This article examines how Poland is setting its way as a space nation. It describes recent developments in the Polish space programme, including the road to Poland's full membership in the European Space Agency.

1. Introduction

On 19 November 2012, as part of the Polish space programme's overall expansion, Poland officially became the 20th member state of ESA. An important step on the way was the country's final ratification of the Eumetsat Convention in 2009, whereupon Poland became a new member of this European organization [1].

A little before its ESA accession, on 13 February 2012, Poland, along with Hungary and Romania, joined the exclusive club of countries possessing their own satellite in orbit. The first ever Polish spacecraft, PW-SAT, was delivered into orbit together with eight other satellites during the maiden flight of Europe's new Vega rocket. Two subsequent Polish satellites (one Lem[1] and one Hevelius[2] satellite) are planned for launch (probably in 2013), as a part of the BRITE[3] project. In addition, in September 2012 a Polish–German project on a small educational satellite was announced.

After many years of cooperation with the space agencies of different countries, Poland is becoming more and more self-reliant in terms of its space activities. However, a great deal remains to be done, especially in regard to the creation of a coherent space policy and the development of the country's space industry.

The goal of this paper is to examine how Poland is setting its way as a space nation. The remainder of the article is organized as follows. In the next section, the Polish space programme and its achievements are described. Section 3 presents the technical and scientific background. Section 4 discusses Polish space policy. Poland's route to ESA is described next. The final section offers concluding remarks.

2. Polish space programme

There is no single, coherent space programme in Poland. Nevertheless, it is taking part in several worldwide projects, and its participation in this work is often significant. Many important instruments, scientifically and technically speaking, in these programmes were created by Polish engineers.

Poland has a long aerospace tradition and has contributed to many scientific and technological projects. Historically, activities related to space applications have represented a key priority for the country. However, in recent years, especially thanks to cooperation with ESA, Poland has also taken part in other projects. Among these are several ESA science missions in which Poland participated actively, including Integral, Rosetta, BepiColombo, Solar Orbiter, and Earth observation activities with Envisat and GMES. Poland is also working on ESA microgravity and exploration programmes, on EGNOS for navigation, and on the Space Situational Awareness programme (focussing on space weather), as well as on technology activities and educational projects.

Since 1974, when the first Polish space devices were placed aboard a Copernicus 500 satellite (in the Interkosmos programme),

* Tel.: +48 503719120; fax: +48 61 8543101.
E-mail address: piotr.manikowski@ue.poznan.pl.

[1] To commemorate Stanisław Lem (1921–2006) – a famous and popular Polish science fiction writer, philosopher, and satirist.

[2] To commemorate Johannes Hevelius (1611–1687) – a famous Polish astronomer, constructor and mathematician.

[3] BRIght Target Explorer.

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over 70 different scientific instruments have been launched – always, however, onboard foreign spacecraft. In this context, we should emphasize the importance of the Interkosmos programme for the development of Poland's space activity.

This Soviet space programme was set up to include members of the military forces of allied Warsaw Pact countries in manned and unmanned missions. Begun in April 1967 with unmanned research satellite missions, the first manned mission took place in February 1978. Interkosmos missions enabled 14 non-Soviet cosmonauts to participate in Soyuz space flights between 1978 and 1988. The programme was responsible for sending into space the first citizen of a country other than the USA or USSR. A few months after Vladimír Remek of Czechoslovakia became the first cosmonaut from outside these two countries, Poland became the fourth nation to have a citizen in space, when Mirosław Hermaszewski flew in June 1978 on the Soyuz 30 mission. Later, several other Polish devices were flown onboard Soviet satellites on unmanned Interkosmos missions.

After the fall of the communist system in 1989, Poland began to participate in some Western space missions, especially those being carried out by ESA and NASA. The main programmes involving Polish participation (outside those mentioned above) include Mars Express, Venus Express, Cassini–Huygens, Coronas-F, Coronas-Photon, Interball-Aurora, Demeter, Kompass-2, Apex and Coronas, Herschel, Soil Moisture and Ocean Salinity (SMOS), the Obstanovka and ASIM experiments on the International Space Station, Chandrayaan-1, UNAMSATMAI, NASA IBEX, and Phobos-Grunt [1,2]. Poland has also been involved in some independent projects, such as the Proteus Project (Integrated Mobile System for Counterterrorism and Rescue Operations). This is aimed at developing a modern system which in the future will be able to support the operations of police, fire service and the other services responsible for the security of society.

Two projects, BRITE and PW-SAT, although not among the country's more dominant applications projects, demonstrate to the public (as they are occasionally discussed in the mass media) that a Polish space sector does indeed exist and that Poland is able to build a satellite; thus, they are described below.

A historic milestone in Poland's space activities was the decision of the Ministry of Science and Higher Education to grant funding (over 14 million zlotys, about €3.5 million) in December 2009 for the BRITE project: the first Polish scientific satellite. Poland became the third member of the BRITE Consortium, joining Canadian and Austrian scientific institutions in building a fleet of nanosatellites designed to observe the brightest stars in our galaxy [1]. The BRITE Constellation currently consists of six nanosatellites, contributed by three countries: Austria with the BRITE-AUSTRIA (TUG-SAT-1) and UniBRITE satellites, Poland with its Lem (BRITE-PL1) and Hevelius (BRITE-PL2) satellites, and Canada with the BRITE-CA1 and BRITE-CA2 satellites.

According to its agreement with the Space Flight Laboratory, the Canadian side provided most of the components and subsystems necessary for the integration of the first satellite (Lem), the complete documentation, and will train a team of Polish engineers to properly carry out the integration and testing of the satellite before it is launched. In the case of the second satellite (Hevelius), the number of components supplied by Canada was limited. Moreover, a large part of the subsystems was developed and manufactured in Poland.

The satellites will be taking images of the sky with a wide-field camera in order to precisely measure the brightness of the brightest stars, something that has proven difficult from the Earth's surface, even though they are easily detectable during a cloudless night. A few hundred (500–800) stars in the Milky Way will be observed during the experiment and Polish scientists intend to investigate the convection mechanism (the transportation of energy that takes place in the hottest stars). This is an important occurrence in nature which does not yet have a mathematical description. The BRITE project will help explain the phenomenon. Disturbances in the Earth's atmospheric transparency severely limit the accuracy of the measurement of brightness. A small wide-angle camera sent into space will see a large amount of bright stars, without the distortion and unpredictable impact of the atmosphere [3].

A few months earlier, on 13 February 2012, PW-SAT became the first Polish satellite in Earth orbit. The project began in 2005 when a group of students from the Warsaw University of Technology[4] decided to undertake an unusual challenge – to design and build a complete satellite from scratch. The final construction phase was carried out in cooperation with the Space Research Centre of the Polish Academy of Science. It was decided that the satellite would be a CubeSat[5] type and that its mission would be to test a deorbiting technique and innovative solar panels (flexible photovoltaic cells).

The PW-Sat's deorbiting system consists of a structure known as a tail with a 1 m-long square-shaped sprig. The sides of the tail are covered with flexible solar panels attached to the spring. At the time of launch the entire structure is folded – tucked into a specially prepared space inside the satellite. A few weeks after launch, upon command from Earth a string locking the spring mechanism is burnt, and the tail is released in a split second.[6] With its antennas and tail outstretched, the satellite will measure roughly 150 × 100 × 13 cm. Without its deorbiting system (a 10 × 10 × 13 cm cube), it would stay on its elliptical (300 × 1450 km) orbit for almost four years but the expected increase in aerodynamic drag should shorten the satellite's lifetime to just one year. A similar system could be mounted on newly-built satellites and engaged when their mission is nearly over. This would allow unwanted space debris to be cleaned from Earth orbit [4].

Most of the Polish equipment placed on space missions has been financed through Polish sources in exchange for access to scientific data [5]. However, recently more rapid development of Poland's space activity has been made possible due to participation in numerous R&D projects related to space technologies that were funded through the ESA Plan for European Cooperating States (PECS) or supported by EU FP7 and EU Regional Development Funds.

3. Scientific and technical considerations

Space activity in Poland is limited by constraints in terms of staff, their level of qualification, and available technical facilities, as well as by the country's organisational structures. The Space Research Centre of the Polish Academy of Sciences (SRC PAS) is the main institution carrying out space research in Poland. Other institutions involved in part in the study of space include the

[4] In Polish: Politechnika Warszawska – therefore the "PW" in the satellite's name.

[5] CubeSat is a project managed by California Polytechnic State University (CalPoly). Its main goal is to provide students with broader access to space. The main limitation for students are the costs of satellite subsystems and payload delivery into orbit. CalPoly proposed reducing these costs by serial production of some components and use of commercially available elements. In addition, the satellites should be small enough so that a number of them can be launched on one rocket (usually as a piggyback payload). According to the general guidelines, a CubeSat class satellite should be a cube 100 × 100 × 113 mm in size with a mass no greater than 1330 g (this class of satellites is called picosatellites). During takeoff and while in orbit, no elements should separate from the satellite main body during operations. Use of any type of pyrotechnic or dangerous materials is strictly prohibited (CubeSats do not have manoeuvring motors).

[6] Unfortunately, there are some problems with launching this device.