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SPACE ARCHITECTURE RESEARCH PROGRAMME

PROGRAM BADAWCZY ARCHITEKTURY KOSMICZNEJ

Abstract

This article presents the accomplishments and achievements, as well as further development plans of the Space Architecture Research Programme established in 2017 at the Faculty of Architecture of the Silesian University of Technology. Prof. Klaudiusz Fross is the head of the Programme. As part of the programme, two analogue space missions have been carried out, numerous popular science meetings have been organised, scientific articles have been published, PBL teaching papers have been published, and programming and design work has been initiated. As part of the programme, the SPSA Student Space Science Club was established. Space architecture offers the freedom of creative research, while the results serve to improve the quality of life on earth. The design of space objects is similar to the approach to designing earthly buildings under extreme conditions.

Keywords: architecture, design in extreme environments, space architecture

Streszczenie

Artykuł prezentuje dorobek i osiągnięcia, a także dalsze plany rozwojowe utworzonego w 2017 r. Programu Badawczego Architektury Kosmicznej na Wydziale Architektury Politechniki Śląskiej. Kierownikiem programu jest prof. PŚ Klaudiusz Fross. W ramach programu przeprowadzono dwie analogowe misje kosmiczne, zorganizowano liczne spotkania popularno-naukowe, opublikowano artykuły naukowe, prace dydaktyczne PBL, a także rozpoczęto prace programowo-projektowe. W ramach programu utworzono Studenckie Kosmiczne Koło Naukowe SPSA. Architektura kosmiczna daje wolność twórczych badań, natomiast ich wyniki służą poprawie jakości życia na Ziemi. Projektowanie obiektów kosmicznych, zbliżone jest do podejścia do projektowania ziemskich budynków w ekstremalnych warunkach.

Słowa kluczowe: architektura kosmiczna, projektowanie w ekstremalnych warunkach

1. DOES DESIGNING IN SPACE BELONG TO THE AVANT-GARDE OF ARCHITECTURE?

Space architecture is the design of buildings in specific conditions and is somewhat reminiscent of the terrestrial design of buildings in extreme conditions, e.g. in Antarctica or under water. For architects, each design guideline, regardless of its specificity, complication and the problems it brings with it, is the basis for analysis, building a functional-utility programme, shaping the form, selecting the structure, installations and cladding. Current times are opening up opportunities for the realisation of buildings in space, with many investors planning to build space settlements or hotels. There are also plans for housing bases on Mars. Time will tell whether this is just a flexing of muscles or a realistic realisation in the near future. Certainly, space architecture can be avant-garde. It is unique

because of its conditions, the technologies used and the complex requirements at all levels of object creation. It can be used as a model for self-sufficient buildings with specific functional needs.

2. WHAT IS THE GENESIS OF SPACE ARCHITECTURE AT THE FACULTY OF ARCHITECTURE OF THE SILESIAN UNIVERSITY OF TECHNOLOGY?

It can be said that the beginnings of serious interest in space research at the Faculty of Architecture began with two master's theses: *City on Mars – Colonisation units on other planets and the possibility of using them in extreme Earth conditions*, with a presentation in VR (virtual reality) technology by Kamil Lis, MSc, arch., supervisor Prof. Maria Bielak, and *Spaceport Abu-Dhabi – Conceptual design of a space port*, by Roman Wala, MSc, arch., supervisor Prof. Klaudiusz Fross. Diploma theses dealing with space also appeared in previous years, but then they were more in the realm of science-fiction and not as today, where the space has become real and within reach. Both diploma projects were excellently prepared in terms of research. The design of the city was done on a real Mars 3D site, specific conditions and technological possibilities were analysed. In addition, the VR presentation using goggles prompted the Dean to create a professional studio in the field of virtual worlds at the RAR5 Department of Design and Qualitative Research in Architecture.

Subsequently, in 2017, the Dean of the Faculty, Prof. Klaudiusz Fross, established the Space Architecture Research Programme. The aim was to highlight and inspire design and research work in the field of space architecture. The following years saw the programme grow. In 2019, architect Leszek Orzechowski, finalist of NASA's 3D printed habitat design competition on Mars, lead designer of a series of reports on manned flights around Mars presented in front of NASA Ames Research Centre, Stanford University, and at the same time manager of the LunAres research centre simulating space missions, comes with a lecture. The year 2019 saw the organisation of a post-competition exhibition entitled "Design body for mars-mobile" during the Faculty of Architecture Seminar at the Silesian University of Technology, under the patronage of the Dean. A Mars rover built for the competitions by the Ai-Meth scientific circle from the Faculty of Mechanical Engineering Technology also entered the hall. In January 2021, the first analogue space mission of a female architecture graduate student in the LunAres habitat took place. This was the 'Panda' mission. The qualitative research was carried out by Wiktoria Dziaduła under the supervision of Prof. Klaudiusz Fross [3]. In 2022, the next mission "Sirius" involved first-year architecture student Igor Gdula. In addition to the missions, the research programme enabled the author's participation in the debate of the Polish Space Agency on "Reaching for the stars – we choose our studies" (2021), or the Faculty's participation in the NASA world event entitled "Observe the moon" (2021) with a lecture by a guest from POLSA. Also of interest were classes with architecture students in the PBL (project base learning) formula, where a simulator of variable gravity on the Moon and Mars was built and models of equipment for space objects were created for simulation studies. In 2021, the Space Design SPSA student research circle was founded, where students visited the LunAres space habitat and are currently involved in programming and designing the space habitat for realisation. In September 2022, the first I-Cosmic Scientific Seminar was held

at the Faculty of Architecture of the Silesian University of Technology in Gliwice (papers were given by Prof. Klaudiusz Fross, Artur Pollak, MSc, arch. Wiktoria Dziadula, MSc). Further dissertations and doctoral theses on space topics are being undertaken. In September 2022, doctoral student Wiktoria Dziadula presented a paper at the IAC International Astronautical Congress in Paris¹.

3. WHY DO WE NEED SPACE ARCHITECTURE?

Don't we have enough problems to solve in earthly space? Space architecture offers new possibilities, freedom of thought, an unknown design context, specific conditions for design and new technological challenges. And beyond that, it makes you curious, frees you from your daily routine and gives you the passion of a designer-traveller into the unknown. Research carried out under different conditions for space exploration allows the research imagination to be unleashed, while the results are often of great importance for improving the quality of life on Earth. Many space inventions we now use on Earth, for example mountaineers and travellers use freeze-dried food.

4. SHOULD ARCHITECTS FLY INTO SPACE?

No matter where, whether on Earth or elsewhere in Space, architects and the know-how are needed to design optimal, economical, ergonomic buildings that meet needs, adapted to specific conditions and surroundings. After all, someone has to oversee spatial order. Knowledge for design comes from research into the built environment. Conclusions from research allow design guidelines to be formulated, good design practices to be used and mistakes made to be avoided. As we know, over the last few years, space has been littered with waste, which causes quite a problem. This is what happens when new spaces (whether terrestrial or outer-space) are not conquered using the principles of pre-established spatial order and sustainability. An example is Antarctica, a scenically beautiful picture with abandoned whaling bases consisting of derelict rusty, disfigured structures. Scattered research bases built from containers. Everyone builds as they please, without any rules. The only rule is to survive under extreme conditions. After all, hard-to-reach regions of earth and space do not entitle one to litter their space. An optimistic note is the new Polish polar station in Antarctica, designed by the architects who won the competition².

In 2018, as part of the AHFE (International Conference on Applied Human Factors and Ergonomics) in Orlando (USA), Prof. Maria Bielak-Zasadzka and I presented a paper entitled: *Space architecture*³.

¹ W. Dziadula, K. Fross, About architecture in extreme conditions. How can space and extreme environment help architects design better? 73rd International Astronautical Congress (IAC), Paris, France, 18–22 September 2022, Astronautical Federation (IAF) 2022.

² K. Fross, W. Dziadula, *Kosmiczny architekt i konstruktor – zawody przyszłości*, "Forum Budownictwa Śląskiego" 2022, 61, 62, pp. 37–41.

³ K. Fross, M. Bielak-Zasadzka, *Space architecture*, International Conference on Applied Human Factors and Ergonomics (AHFE) 2018 and the Affiliated Conferences to be held at the Loews Sapphire Falls Resort, Universal Studios® Orlando, Florida, USA July 22–26, AHFE 2018.

5. WHAT DID THE FIRST FEMALE ARCHITECTURE STUDENT DO IN SPACE?

The biggest event was the professional qualitative research carried out from 15–31 January 2021 as part of the BK thesis under the direction of Prof. Klaudiusz Fross, carried out, among others, by analogue astronaut Wiktoria Dziadula, BEng, (2nd degree student) during the 2-week PANDA space mission in the LunAres habitat (a simulation of a lunar mission). LunAres is an analogue space base in Pila. The expedition was led by Greek space engineer Eleftherios Karagannis. The architectural research included qualitative assessments of the habitat (in technical, functional, organisational, economic and behavioural qualities), observations of the use and user behaviour. This was complemented by interviews with LunAres users during the PANDA mission. In parallel to the qualitative research, the student carried out a detailed planned study of the space programme and collected material for her master's thesis. The topic of the thesis is the architectural concept of a space habitat. The main scope of the PANDA project focused on research into the effects of isolation on human health, wellbeing and reactions. This is a timely topic in a pandemic period. Also analysed was a freeze-dried food-based space diet, testing of astronaut equipment, self-sufficiency of the facility, and soilless crops. An interesting element was the addition of the necessary everyday equipment⁴.

6. WHAT FURTHER RESEARCH PLANS DOES THE FACULTY OF ARCHITECTURE HAVE?

The results of both missions ('Panda' – qualitative research and 'Sirius') in the LunAres habitat have provided a lot of interesting research inspirations. Our new interest in space means new research opportunities, as well as new chances for the international promotion of the University and thus the city of Gliwice.

The research work of the Department of RAr5 – Design and Qualitative Research in Architecture, of which I am the head, intends to continue research in the field of space architecture. The scope of the research requires collaboration across multiple disciplines in interdisciplinary teams. In the period 2021–2024, research is planned in the field of selected elements of space architecture necessary for the construction of living environments (e.g. habitation capsules, space hotels) in different gravities (Moon, Mars), the construction of small pieces of equipment for testing in a habitat, and an attempt to build a mini habitat capsule combined with VR technology at the Silesian University of Technology or with a business partner. The Faculty of Architecture is open to cooperation with the socio-economic environment. It is worth emphasising that everything interesting and innovative that happens at the research facility of the Silesian University of Technology promotes Gliwice and the region (Metropolis).

As was said at the beginning, "space architecture" provides freedom for creative research, while its results serve to improve the quality of life on Earth. Therefore, space

⁴ K. Fross, W. Dziadula, *Analog space habitats – research and self-concept*, "Builder Science" 2022, pp. 4–9; *eidem*, *Kosmos na Ziemi – analogowe habitaty kosmiczne. Badania jakościowe podczas symulowanej misji kosmicznej*, "Builder Science" 2021, 7, pp. 8–11.

architecture can be avant-garde. It is unique because of its complex conditions. The design of space objects is similar to the approach of designing earthly buildings under extreme conditions. Patterns can be drawn from them for self-sustaining earthly facilities with specific functional needs.



Ill. 1. Prof. Klaudiusz Fross, analogue astronauts Wiktoria Dziadula and Igor Gdula. Banner of the Space Architecture Research Programme established in 2017 by the Dean of the Faculty (author's archive).



Ill. 2. Commander and participant of the PANDA mission and members of the SIRIUS mission (author's archive).



III. 3. SPSA student space science club in the LunAres habitat (author's archive).



III. 4. Diploma project of the space habitat, architect Wiktoria Dziaduła, supervisor Prof. Klaudiusz Fross, 2021 (author's archive).



III. 5. Space architecture on Earth, diploma project of the space flight station, architect Roman Wala, supervisor Prof. Klaudiusz Fross, 2017 (author's archive).



Ill. 6. International Astronautical Congress IAC Paris, 2022 (author's archive).

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