TRANSLATION - Architecture at the limit without gravity (MadameWien)

Name: Barbara Imhof, born 1969 in Vienna, lives in the 20th district. She studied architecture in Vienna (Vienna University of Technology and University of Applied Arts Vienna (*Angewandte*)), London, Strasbourg and L.A. and founded LIQUIFER Systems Group in 2003, specializing in architecture for space and space travel.

Name: René Waclavicek, born 1976 in Graz, lives in Brigittenau. He studied architecture at the Vienna University of Technology, works as a space architect and is managing partner of LIQUIFER Systems Group.

Who would expect space architecture behind a scaffolded facade of a municipal building at the Danube Canal, with a washing machine store on the street side and a kindergarten with cheerful children's voices in the backyard? What would you imagine exists below? And what role does Vienna play when it comes to the conquest of space? MadameWien went to the 8th floor and asked Barbara Imhof and René Waclavicek at the LIQUIFER Systems Group office.

Architecture is often difficult, controversial, and limited even on earth. Why did the two specialize in space, where there is no gravity, extreme radiation, difficult to transport building materials and people living in an exceptional situation? "In my youth, I was interested in protecting our environment to make human life possible. In my architectural studies at the *University of Applied Arts* I developed my interest in the future. After all, you always plan for a future, and if you think that a bit further ahead, you cannot help but think of scenarios. Scenarios where we no longer live on Earth, but on the surface of the moon, Mars or somewhere in between," explains Barbara Imhof.

The idea of how people would live together there, what forms of sociality, systems and architecture would be needed, prompted her to go to the International Space University in Strasbourg (France) after her master's degree in architecture for an additional degree. In the late 1990s, space exploration, let alone extraterrestrial habitat, was barely present in the media. Nevertheless, her stay at NASA's Johnson Space Center transported the architect to a different reality: "Every month, a space shuttle took off on a mission or to MIR. Living or being transported into space was something commonplace there."

René Waclavicek has been enthusiastic about space since childhood, he was influenced and fascinated by Carl Sagan. He met Barbara Imhof while studying at the Vienna University of Technology, where she taught at Helmut Richter's *Hochbau 2* Institute and tendered space architecture design programs. His “AHA” experience was right there when he realized that he could combine both interests. In 2005 the crew consisting of Barbara Imhof, Waltraut Hoheneder, Susmita Mohanty (ISU) and René Waclavicek agreed to venture the "mission into the unknown" and found the LIQUIFER Systems Group for Space Architecture.

As an architect, René is involved in planning for space "because it offers special challenges. You operate in extreme conditions, with extremely limited space, all activities take place in one room, and you must think about how to repurpose and transform it. It's very tempting to design for weightlessness, an environment where it is possible to spread out in all directions."

LIQUIFER is always about creating a space for people and people living together. "The needs of people do not change, no matter where we live. We need something to eat, we need air and water, we like to have something meaningful to do, we're curious by nature, and as a species we're dedicated to exploring." Speaking of food, LIQUIFER worked with 13 partner organizations led by the German Aerospace Center (DLR) to develop EDEN ISS, a greenhouse that optimizes the use of space and resources.

EDEN ISS focuses on an aeroponic application where the roots do not need soil and are sprayed with a tuned nutrient solution. The vegetables grow under energy-saving LED light in a specific spectrum in a container. Currently, EDEN-ISS is being tested on Earth in Antarctica under extreme conditions. "Because space dictates these extreme conditions, you have to be very focused and have a sharpened eye. This benefits us in applications on Earth, where the boundary conditions are even simpler but change," explains Barbara Imhof.

At EDEN ISS, the connection to earth is relatively direct because the technologies are also applicable in the middle of urban areas for production in vertical indoor farming with few resources, little water, no pesticides, and high yields. For René Waclavicek, not only the technological but also the international aspect of space technology plays an important role: "After 20 years of the space race between the super powers, this is now a peace project. The ISS is a huge international cooperation project." Accordingly, all the projects LIQUIFER works on are team efforts in consortia, where each organization brings a different special expertise: "We put our skills in architecture, product design and space engineering at the service of the overall project. After 20 years, we speak the common language and thus successfully dock with affiliated disciplines."

LIQUIFER is currently working on two projects with a living environment in zero-g: two 1:1 Training Modules for preparing crew members, which will be set up in Europe and the USA. The International Habitat module of the Lunar Gateway space station in lunar orbit shall fly in 2026. "We are building the two training modules together with our French partner SPARTAN SPACE, whom we have been working closely with for almost ten years. In this collaboration, good team spirit and expertise complement each other," emphasizes Imhof. LIQUIFER is not making flight hardware yet. There might be possibilities for this in the future. There are also strict regulations for the interior. Flame-retardant materials are mandatory and there no imprints on astronauts' clothes are allowed that could outgas. Therefore, emblems in spaceflight are always embroidered on. Two large rolls of the space fabric Nomex are in the office.

We learn that noise exposure from the life support systems in a space station is high and that a sleeping bag must be shaped for a squatting embryo posture (neutral body position) for relaxation in zero gravity. Compared to the original design, the gateway habitat module had to be re-dimensioned for a smaller launch vehicle. Where do you cut corners when minimalism is mandatory anyway? "Life support systems are not shrinking. Storage space is the easiest to do without. Even habitable space must be cut back to $10m^3$ for everyone," describes René Waclavicek.

However, mission durations are limited to 30 days and there are other spaces on board. The schedule is tight: 2024 to 2026 is when the modules are to be built and put into operation. The Lunar Gateway is located in lunar orbit and serves as a gateway for further missions to the lunar surface, as well as preparation for Mars missions. To survive on other planets, it depends on what resources you can use on the ground.

So, another consortium in the Regolight project is working to use lunar dust, lunar rocks and powerful solar energy to build radiation-shielding domes (including against micrometeorites). "With the University of Aachen, we are considering application fields for basalt fibers that are melted, drawn out and spooled using solar energy. They are very resistant and can fiber-reinforce components," says René Waclavicek. The components for the domes are to be sintered from lunar sand, i.e., in a 3D printer powered by concentrated sunlight. You can tell he can almost see it in front of him: "In two layers with an airtight balloon inside that you can transport to save space, you can create a living space like that."

In the Corona crisis, astronauts were also asked about isolation and spatial confinement, because they know about it. Corona, however, came suddenly and unprepared, unlike missions into space. Barbara Imhof is also familiar with helpful strategies such as creating a daily structure and regularly rearranging/reorganizing living space. "Being locked down is not like a space mission. We've worked out three publications at Lockdown for our long-running City As A Spaceship project with lots of experts around the globe."

Where is Vienna particularly spacey? With us!

What is unique to Vienna? Barbara: The coffee house. It is a little kitschy, but when you have been away for a long time and then you sit in there, read the newspaper, make yourself comfortable, have a little coffee. You can only find that in Vienna. René: The Heuriger. The more you get around, the more you realize that mentalities and people are not fundamentally different from place to place. You meet the same types all over the world

A favorite Viennese spot? Barbara: The Viennese forest and Hermannskogel. That's always such a destination, the highest mountain in Vienna. René: I like the 2nd and 20th district, this corner of Vienna. I feel comfortable there, I appreciate the cultural diversity and the proximity to the Danube.

A favorite Viennese word? René: The long-drawn-out fits with a hard b at the beginning. Like this: baaaast! (laughs).

The best space movie? René: "A Space Odyssey" is the mother of all Sci-Fi movies.

The best space book? Barbara: Solaris by Stanislaw Lem and the "Star Diaries".

The best space music? Barbara: For my Radio Orange broadcasts Space Specials I always use Surfing on a rocket by Air. It reminds me of the movie Dark Star.