GEOLOGICAL ASTROIKOS

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The colonization of other planets

In December of 2014, with the title "NASA´s Journey to Mars" [1], the US Space Agency itself acknowledged that *"Engineers and scientists around the country are working hard to develop the technologies astronauts will use to one day live and work on Mars, and safely return home from the next giant leap for humanity*", proposing the possibility of having habitable sites both on the moon and in the Martian surface by means of several appeals - public competitions, among them - with the purpose of calibrating the possibilities of its construction with the greatest guarantees of safety for the crew, reduction of material to be transported in space vehicles, and lower environmental impact and energy expenditure, among others.

In this regard indicates the astrobiologist Christopher P. McKay, planetary scientist of the Ames Research Center of NASA, *it is essential that we first take experience in making space bases on the moon, before venturing to Mars*, having expressed in turn that, *a Lunar base would give us the opportunity to test habitats* [2], among others.

Safety

In the same line of research on planetary habitability, the experience of the International Space Station (ISS) has been revealed as essential, so that *astronauts on the orbiting laboratory are helping us prove many of the technologies and communications systems needed for human missions to deep space, including Mars. The space station also advances our understanding of how the body changes in space and how to protect astronaut health* [3]. In this way, when analyzing any possible site prepared to receive such users, even beyond the scope currently covered by a Space Station as we know it today, we prioritize the field of security by examining not only the parameters of the hostile environment of an environment in conditions other than those that promote the natural development - without artificial help, or external devices- of human life, but also considering the physiological aspect of the human being in front of the type of known adversity to which he must deal with the same before the type of space missions to be treated.

Through testimonies such as Scott Kelly, detailed in his book "Endurance: A Year in Space, A Lifetime of Discovery", we can know concrete aspects of the development of human life inside the Station, assimilating their stay in it as if living in a building. He relates that, *when you live for months inside, you do not perceive it as an object, but as a home, a very specific place with its own personality..., with rooms and more rooms...,* each with *a unique sensation and smell...* In the same way, he conveys the importance of the conditioning of the premises, pointing out as relevant information his experience with the headache that he himself suffered when he separated too much from the clean air vent that they had inside the station, during his stay in space, opening the door to reflection on the possible health problems of the human being in this type of enclosures, outside the terrestrial sphere, linked to an artificial habitat outside this area (Fig. 1).

The collected experiences of the type described above, reinforce the thesis on the need to reflect carefully on future planetary habitats, having to configure a type of planetary architecture whose conception is established from the premise of the pursuit of the needs of the astronaut as a human being in itself, as it is a typology of architectural project whose function is focused on sensitive users, and in need of the environment, as if it were an area that cared for the physical and mental health of its inhabitants. It is therefore necessary to point out the field of sanitary architecture as another

reference in this search, since, just as in a hospital, it is essential to pursue the comfort of the user as an influential situation both in the cure of the patient (especially the long stay) as in the elimination of possible nosocomial diseases through prevention -through asepsis-, along with other environmental qualities such as shapes, colors, smells, sounds, materials, lighting, temperature, radiation control, encounters, travels , relationship between specific spaces, accesses, signs, openings and levels, through research in architectural matters it is possible to equip the members of a crew destined to establish their home in another celestial body, of the necessary well-being for a better physical development and psychic of each one of the members that conform it. If, based on practice and studies, *"a comfortable stay for the patient means a better and faster cure..."* (*Le Corbusier*, in relation to his project for the Hospital of Venice, 1961), with a similar approach also we will be able to take a leap forward in terms of spatial architecture since, after all, the first prototypes of habitats with which we will have to accommodate a possible planetary settlement distant from the terrestrial one, will not only be a "home for the man", but they will represent those spaces in which perhaps the same astronauts should be treated as if they were their own health centers or hospitals.

FIGURE 1. *NASA astronaut Scott Kelly, Expedition 25 flight engineer, is pictured in the Cupola of the International Space Station on Oct. 14, 2010. Image Credit: NASA*

The Humanization of Space Architecture

We intend to configure a type of planetary architecture whose conception is established from the premise of the pursuit of the astronaut's needs as a human being in itself. Thus, starting from the above, and taking the user -in this case the astronaut- as the main entity of the possible habitats to be developed, we consider a type of space that "rotates" around man. But not a man in conditions similar to the current, but one in need of an enclosure which allows to reduce cardiac problems, decalcification, muscle loss, and stress, which the astronaut suffers once in space, in addition to the limitation in front of to the exposure of solar and cosmic radiation with which they will have to contend during their long stay in the lunar satellite and even, as the case may be, in the planet Mars.

Taking into consideration, then, the search of the planetary enclosure able to combine the generation of positive stimuli that accompany the astronaut during his possible long stay under the shelter of the habitat prepared for it, and the factors related to the ideal development of his life inside the We would get into the path that leads to the Humanization of Space Architecture, as one of the goals proposed in our research work in this regard.

The idea is to promote the development of human activity in any of its possible forms, within the expectations that the scientific community has about the possible establishment of an extraterrestrial human colony, trying to demonstrate the capacity of the planetary architecture once it has been thought at the service of the human condition. The aim is to establish criteria and guidelines for the projection and materialization of planetary habitats specifically intended for the purpose of, among others, contributing to keeping the astronaut in the best possible physical and emotional state during his stay for long periods of time inside those , based on environmental comfort conditions such as lighting, thermal, acoustic, material, form and composition, and relationship with other spaces necessary for its favorable development, as well as protection against external harmful agents. In this way, we seek the comfort and positive response of the astronaut's health, using the planetary architecture to be considered in accordance with those aspects related to functionality, construction outside the terrestrial environment and even form, which would entail the same under the aforementioned guidelines to reach.

At this point, and once the architectural needs for the conformation of the habitat have been recorded, we consider the formal aspects related to it, interesting us, in a particular way, for the study of the indigenous material or the place itself. Taking into consideration, in particular, the teachings of Marco Lucio Vitruvio (flourished 1st century BC), Roman architect, engineer, and author of the celebrated treatise "De Architectura", regarding the understanding of the architectural discipline, among which he indicated that it should not be understood without providing *the proper and best possible use of materials and land, and to procure the lower cost of the work achieved in a rational and powerful way* [4], we can not fail to emphasize the importance that in the geology will find the planetary architecture to pose, given the implication of the lunar and Martian regolith in the natural habitats to be colonized then, if in the Earth we have come to take into consideration these principles of economy in relation to the construction materials to be used -from antiquity-, we should still pay more attention to them given the added difficulty of the missions that concern us in space.

The Architecture of the Place

Continuing with the annotations in the previous section, we see as essential to take into consideration the concept of vernacular architecture (from Latin, "vernaculus", meaning "domestic, native, indigenous") for its implementation in the planetary formations to be treated. One of its main characteristics is the use of materials based on local natural resources that may remain in the place of origin once their life cycle has elapsed, without risk of contamination of the same and thus, without injuring it, contributing in this way to estimate the necessary factors to avoid natural conflicts and project the implantation of the possible refuges estimating the bases of the Geoethics like essential discipline in the field of the Planetary Sciences.

In this way, we must count -both in the lunar sphere, as in the Martian one- with the geological resources that are given to us, being these, in the case that concerns us, the main natural resources to be used; they would follow like this, the guidelines of the exposed thing before when considering the same resources - together with the natural formations that by the geologic activity have been able to develop - for the implementation of safe planetary habitats for the possible crews in space mission, and the *establishment of habitability criteria according to the conditions of stability of the different mineralogical associations and textures that present the aforementioned materials and resources (minerals and rocks)* existing in the satellite and planet considered, *such as jarosite, gypsum, epsomite, basalt, etc* [5].

Like the Igloo, typical of the Arctic, it shows us an example of how the environment itself -nearly- can extract the material that will form the structures that give safe shelter to its inhabitants without the

need to spend more energy or resources, beyond of the essential, we must attend to the use of habitats compatible with the conditions and resources of the specific environments considered -in this case- for its possible continuity over time, economic and energy savings, so that we can generate efficient work in the scope of the planetary architecture.

Not in vain the Egyptians incorporated the hypogeo (in Greek, underground chamber) as architecture excavated in the rock. A constructive typology after the pyramid, whose cost -both in terms of its execution and maintenance- was inferior to it but also gave greater security to the bodies inside. If these dwellings of eternal rest constituted for decades the constructions chosen to safeguard the protection of the deceased with the necessary means to erect them, together with their valuables, under the thought of keeping them intact prolonging their existence without temporal limits, and they were effective not only the inclemency of the weather but also the looting of monuments such as the pyramids, the volcanic formations evidenced both on the Moon and on Mars, both in its complex structure -with different branches, as if corridors of a funerary monument will be treated- and multiple sizes, as in their simplest forms-hobbit cave type-, show us the field of action to be able to contemplate them as the possible "castles of eternity" in the face of the danger of impacts by flows of micrometeorites and cosmic radiation, existing in such environments, or in the face of possible damage two by the volume of sand moving after a storm of this type, in the Martian environment.

Self-Construction

We consider as crucial the identification and analysis of possible potentially valid underground spaces for the location of habitats of the type the natural formations called lava tubes in the lunar and martian environments (Fig. 2), as a human habitat in an extraterrestrial environment, as well as the study of the architectural configuration with which we can provide them as a type of habitable enclosure in these areas, even with the possibility -also study- of complementing these enclosures with artificial structures as valid prototypes of support for the indicated formations, in search of an environment conducive to the development of life and the protection of the individual against the possible colonization of the satellite, on the one hand, and the planet, on the other, thus joining the following premise or objective to be reached during our research process, such as it is self-construction(Fig. 3).

FIGURE 2. *2016-10-26_LavaTube-Traverse2-S.Sechi-GH3-012.The first Pangaea course took place in 2016 to train astronauts in identifying planetary geological features for future missions to the Moon, Mars and asteroids.*

Through the principle of effemerization, coined by the American architect, writer and inventor, Richard Buckminster "Bucky" Fuller (1895-1983), aware of the importance and limited resources that can count the human being at a given time, the emphasis is on being able *to do more with less* [6], proposing *the recycling of resources and waste material in order to create valuable products, increasing the efficiency of the entire process* [7]. Said economy of means will not only facilitate the work of the astronaut in his already complicated space journey, but also the work of the different space agencies in terms of transport or transfer of pieces for the achievement of missions in terms of space colonization.

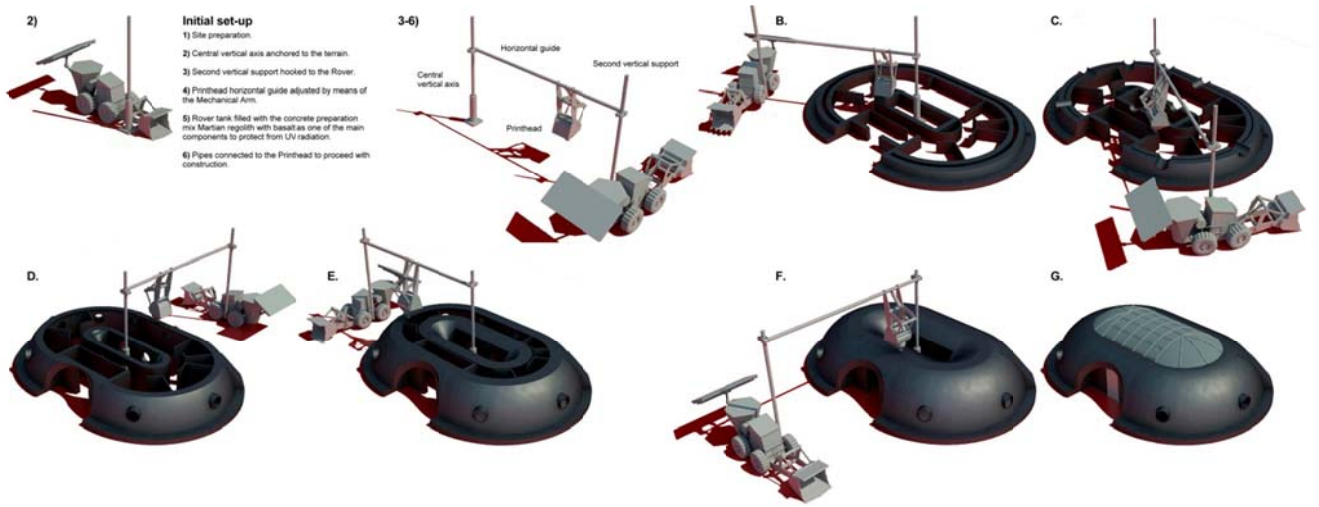

FIGURE 3. *Phases of self-construction of a habitat. Project FALLAMARS (2015 3D-PRINTED HABITAT CHALLENGE) Team: Yasmina Eid-Macheh y Sánchez[1], Jesús Matínez-Frías, Juan José García Valverde[1], Antonio Torres Ferrer, John Aaron Graves.* [1]GAREID PROYECTOS, Planetary Architecture Study

Our goal is to project a habitat for human beings capable of contributing to the progress of life and science, willing to abandon their natural environment in order to open a new horizon that can help establish a new settlement with new and advanced parameters of survival, for present and future generations, who also had to spend long hours cloistered in a volume built in a quite hostile environment, which not only makes them feel protected, with the tranquility and comfort that this entails, but also in turn provide an environment capable of transmit desire to live and be.

With some needs already exposed, we have named the possible new planetary habitat based on natural geological formations with the new term of ***Geological Astroikos***, whose suffix *Oikos* ("house", in Greek) helps us from a concept that in classical antiquity used to define the *set of goods and people that constituted the basic unit of society*, allowing us to identify it as the possible refuge of a multidisciplinary team of astronauts in order to colonize other worlds, which would be based on the ideas mentioned. But not just any shelter, but the one that would originate fundamentally from a formation with geological material typical of the place.

After all, the history of architecture, and of civilizations, opens our eyes to the fact of establishing a human colony under habitats on natural formations of the type more or less deep underground caves, since we have already been transmitted the idea of being able to live in an enclosure different to a module or standard housing, in the best way. Expressed in the words of a great novelist, poet, linguist philologist and British university professor, JRR Tolkien, in relation to those who became his most beloved and recognized characters, the hobbit, who needed attention because of their short stature and need of protection, and thus of *holes in the ground* endowed them, but:
Not a wet hole, dirty, disgusting, with the remains of worms and the smell of mud, nor a dry hole, naked and sandy, with nothing to sit on or eat: it was a hobbit hole, and that means comfort. [8]. (Fig.4)

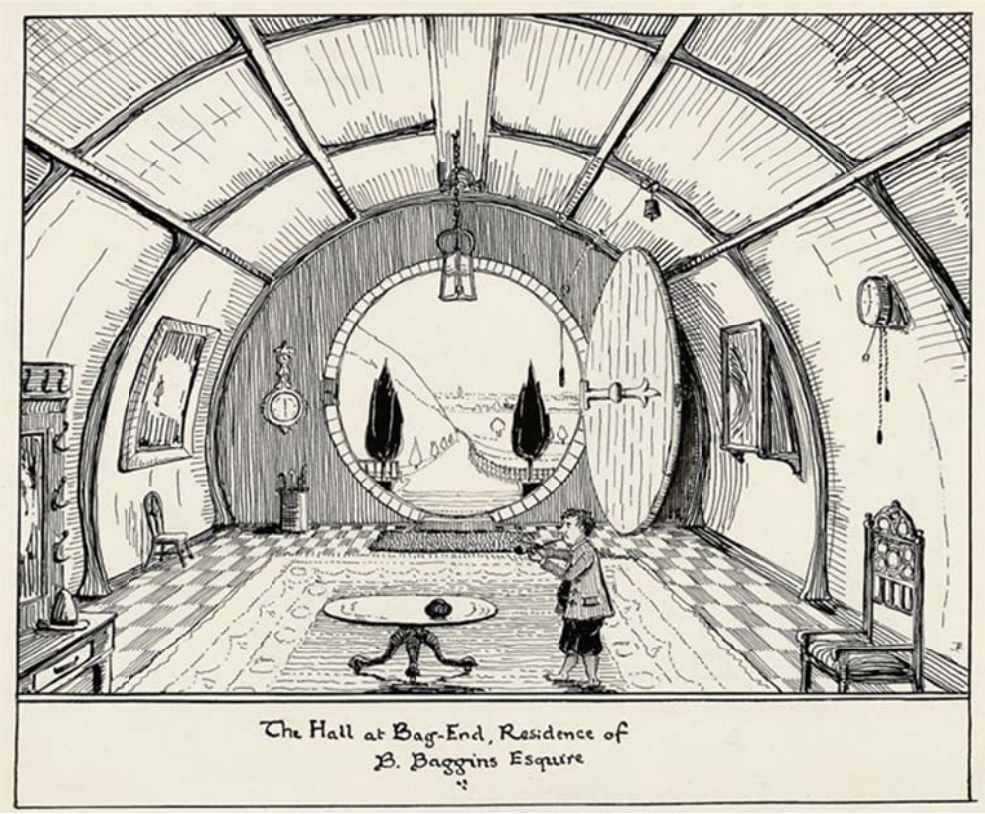

FIGURE 4. *"The Hall at Bag-End, residence of B. Baggins Squire". Bodleian Library, University of Oxford, from its fund Ms Tolkien Drawings.*

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