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Architecture for humans in space: design, engineering, concepts and mission planning (1)

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MOON LAVA TUBE HABITAT DESIGNS –FROM THE THIRD SPACE ARCHITECTURE CONTEST
IN JAPAN

Abstract

Elon Musk made his announcement about the Interplanetary Transportation System in Sep., 2016, which will take us to Mars and beyond. Habitat plans were not included, but we can expect the age of living on Mars within 30 years. UAE also announced a Mars initiative with a Mars city in 2117. Jeff Bezos had made the Blue Moon delivery service plan for lunar economic development after Elon Musk's lunar circumnavigation tourism announcement.

Space Architecture is no more a concept but reality. ISS is now the destination in space. The BEAM, Bigelow Expandable Activity Module, was attached as the first commercial inflatable module last year. Now is the period of ISS transition. A RFI has been issued for a commercial docking port and the NASA NextSteps 2 habitation systems designs are underway. Commercial companies such as Bigelow Aerospace and Axiom Space have a plan to make independent commercial space stations. These are on orbit space architecture plans. For surface architecture, NASA and ESA have concepts to construct human lunar base such as Evolvable Lunar Base and Moon Village. Bigelow Aerospace has developed a Moon Base as well, after beginning commercial lunar delivery services. Space architecture is the newest creative expression in our human culture. Over the next century space architecture will evolve from simple and utilitarian engineering structures to new monumental forms and iconic structures which capture the spirit of the expansion of human culture and creative expression.

Japanese general construction companies have developed concepts and engineering RD for space hotels, lunar bases, and Mars bases since late 1980's. Although the pace of these activities slowed down since 2000, it has recently become active again. Now several general construction companies have developed ISRU systems and other technologies under JAXA's planetary open innovation hub. A new Space Architecture Organization was established in 2014 and started an annual Space Architecture Contest and Award Program as a STEAM activity in addition to research activities. Now Tokai University and TNL, a students' architecture organization, successfully manages the competition.

The theme of the third space architecture competition was "UZMARCH", which is the acronym which combines UZUME, (Unprecedented Zipangu Underworld of the Moon Exploration), and Architecture. To construct a moon habitat to make best use of lava tube on the moon is to use special geography and moon environment and ISRU. This paper will introduce the winner's lunar habitat and discuss moon habitat design using lava tubes.