

Connecting Space & Earth



1. ESA Space House concept

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Space architecture broadly encompasses architectural designs of living and working environments in aerospace-related facilities, habitats and vehicles, in the process covering a multi-disciplinary scope of industrial design, environmental psychology, ergonomics, human factors, life sciences, structural engineering, information technology, material sciences and life support systems. Susmita Mohanty tries to justify the need of space architecture and why is it important for the future of human space flight.

Since the launch of the first human in outer space in 1961, the design of space habitation systems has primarily been the forte of engineers. So far, human survivability and safety had been the prime drivers in the design of space capsules. As the duration of human stay in the extreme environment of outer space increases from few days to several weeks with the launch of the orbiting stations, the social and psychological stressors (an agent, condition, or other stimulus that causes stress to an organism) become more pronounced. In order to counter these stressors, it is important to ensure high standards for space habitats. Thus, habitability becomes a critical design driver for space habitation systems as survivability and safety. Space agencies and companies have traditionally applied rigorous attention to risk mitigation in mechanical systems. The new reality for long duration space missions in future calls for the focus on reducing the level of risk inherent in mechanical systems to be applied with same deliberation to the humans within the machine. This is the fundamental premise that justifies the need for Space architecture.

Space and terrestrial architecture have lot in common because both deal with the design and construction of habitats in inhabitable environments. Both can inform and influence each other in many ways. The one developed for a space habitat could be adopted for urban, suburban and rural housing, thereby, removing the need for long and expensive sewage networks allowing the wastes to be recycled locally. The technology transfer from space to terrestrial architecture is not limited only to waste management systems. There are many other advanced technologies developed for space exploration that can be used for housing on earth.

European Space Agency developed the idea of a 'Space House' for earth applications. It is a novel concept for sustainable housing based on advanced materials and technologies developed by Europe for its space programs. The 'Space House' proposed by ESA is a dome-like structure standing on multi-legged base. The spherical form of the 'Space House' is the result of the use of high-tech composite materials developed for rigid, strong spacecraft structures. As it stands on legs, it is isolated from any movements underneath it. In its current design, the 'Space House' can withstand vibrations from earthquakes of up to 7 on the Richter scale,

wind speeds of up to 220 km/h and up to 3 meters of flooding. The house is designed to be autonomous. It uses highly efficient solar panels from spacecraft to generate electricity, which is then stored in lithium - ion batteries, further optimized by the use of a special energy management system developed for satellites. The house is super-insulated and uses advanced heating, cooling and ventilation concepts. It uses sophisticated systems for recycling and cleaning water. The Germans plan to use ESA 'Space House' technologies for their next generation Antarctic base Neumayer-III. To meet Antarctic environmental requirements, structures must be entirely removable after use and should not pollute the surroundings. They must also be able to withstand the harsh environment. The lightweight design of the 'SpaceHouse' will enable it to withstand snowfalls of up to 1 m/year without sinking into the ice and facilitate its removal after use. It also exceeds the other environmental requirements for buildings in the Antarctic. Neumayer-III station will replace the existing Neumayer-II and is expected be operational by 2008. The architectural model below shows one third of the complete station; the complete configuration will have 12 legs. The above examples give an idea of how technologies developed for space can be adapted for Earth applications. The reverse is also true.

Take the case of dense cities like Sao Paulo, Mumbai, New York and Tokyo. These cities are case studies in how humans adapt to the stresses of living and working in crowded cities, how they cope with lack of privacy, cramped living spaces and human density. Take Mumbai for example. It is the world's third-largest metropolis with 18 million people and the fifth-highest in population density at 17,550 per square mile. Compare Mumbai's human density with that of the Space Shuttle. The Shuttle mid-deck (or living quarters), when it is empty is like a room measuring 4m (13 ft) in length, with a 3.7m (12ft) rear width and a 2.7m (9ft) front width. But with all the necessary equipment in place (avionics bays, lockers, airlock, galley and toilet), you can hardly see the 2.1m (7ft) high curved sidewalls. And this living space is shared by a crew of up to seven astronauts on missions lasting from 10 - 15 days. One can study human responses to prolonged exposure in extreme spaces with reference to the dense cities here on Earth and apply that knowledge to the design of environments for human habitation on deep space missions. In summary, one can say that it is difficult to draw a line between 'Terrestrial' and 'Space architecture'. There are reciprocities that can be applied to benefit both worlds.



Lunar Base Design Workshop

Project : KOPERNIKUS Lunar Base [One of the nine concepts for advanced lunar bases generated at the European Lunar Base Design Workshop (LBDW)]

Year : 2002

Companies : LIQUIFER, Vienna + MOONFRONT, San Francisco in collaboration with other international organizations

Hosts for Lunar Base Design Workshop : ESTEC, European Space Agency (ESA) in The Netherlands and Institut für Hochbau II at the Technical University of Vienna

Gravity : 1/6 G

Project Type : Habitat Design

Brief Description
The LBDW was organized and led by a multinational, trans-disciplinary team of independent space professionals: Engineers, Architects, and an Industrial Designer. The workshop was hosted at the ESTEC Center of the European Space Agency (ESA), Noordwijk, the Netherlands. The base features a design generated by one of the nine teams. A design studio approach was adopted to conduct the workshop. The workshop was supplemented by

guest lectures by international space and architecture experts, and a tour of the ESA-ESTEC facilities (Concurrent Design Facility, planetary test bed, and payload assembly and testing facilities).

The KOPERNIKUS Lunar Base is a surface habitat designed to house a crew of nine. The mission scenario adopted for the base is the year 2069 and the assumption that the base will provide commercial services to lunar communities. It is made up of a combination of solid structures and lightweight inflatable structures. The base is designed to support evolutionary growth of the outpost using a modular, scalable system. Elevation above the lunar surface provides protection from lunar dust. The provision of an automatic robotic arm allows loading of the various containers and transport units on the chassis waiting for their tasks. The vehicles are divided into walking-chassis, container-unit and cockpit, to provide ultimate flexibility in vehicle configuration and function: paramedic services, cargo transportation services and human transport from other locations to the recreation facilities at the Base. The shelter, located in the middle of the base, is a multi-functional space used for exercise, relaxation and radiation protection. The main leisure activity engine of the station is a bar, positioned up on the bow of the structure, and designed to serve guests as well as the crew operating the base.

