LADE

Lunar Architecture Design Exploration

Alta Scuola Politecnica, Politecnico di Milano, Politecnico di Torino, Thales Alenia Space, MIT
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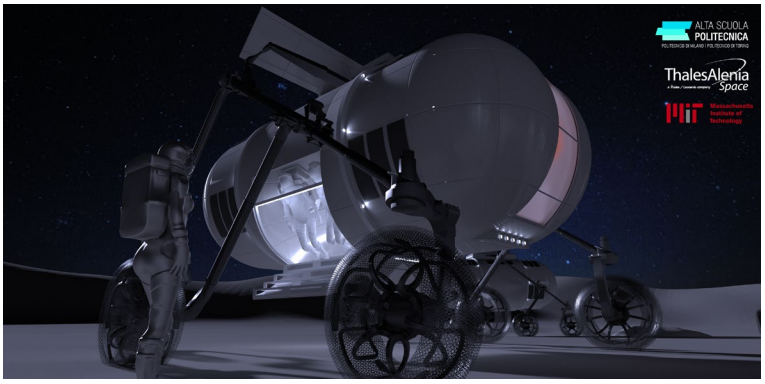
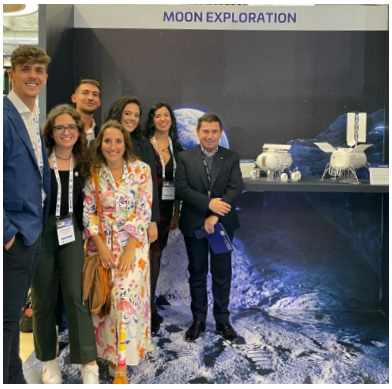


General View of LADE's design, a mobile surface lunar habitat.

Since Apollo missions, robotic exploration of deep space has seen decades of technological advancement and scientific discoveries. Today, NASA's Artemis Program is envisioning a plan to drive humanity to live on the Moon. Indeed, the possibility of building a permanent settlement on the Moon is still a major challenge. In this framework, Alta Scuola Politecnica and Thales Alenia Space partnered to design a novel agile habitat through a holistic multi-disciplinary approach to allow crewed surface exploration missions. The output of the project has been presented at the 2022 International Astronautical Congress (IAC) through a paper presentation and an exhibition of a physical mockup.

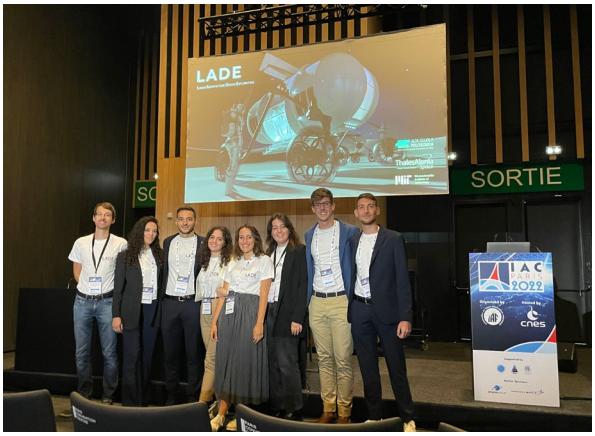
Lunar Architecture Design Exploration (LADE) project's goal is to design a mobile space architecture system that enables human presence on the Moon, allowing medium to long term missions. This module is the key movable part to build a more complex system of hybrid class II and class III shelters that aims at the construction of a lunar village.
The goal of the design effort is to allow the permanence of four astronauts for 30 days on the South Pole of the Moon, next to Shackleton crater. The location is strategical for surface exploration goals and provides favourable environmental conditions for a future permanent settlement. To achieve this, a combination between a mobile habitat and a network of robotically constructed shelters will be necessary. The design of both systems aims at satisfying all habitability and mobility requirements in the harsh and extreme lunar environment, while exploiting ISRU(In situ resource utilization), through the demonstration of 3D printing capabilities for micrometeoroids and radiation shielding purposes.
The presence of a sheltering system will concur with a series of minimum infrastructure requirements, which will be reached through a first robotic mission. The aim will be defining the first mission elements necessary to sustain a human settlement, including the construction of solid foundations, roads and landing pads, stabilising the soil, providing an energy production and storage sub-systems.



Team LADE and Thales Alenia Space Deputy CEO ESVP Observation Exploration Navigation Massimo Comparini at the company stand next to LADE's physical mock-up

The iterative process of functions allocation within the module and its overall architecture have been guided by the principle of human-centred design. The different mission constraints led to the development of an adaptive system, able to change according to the astronauts' needs and provided with a combination of rigid pre-integrated elements and deployable spaces through pressurization.
The implementation of LADE's functionality into the Artemis mission architecture enables the shift from early exploration phases to a continuous human presence on the lunar surface.

After the completion of the research and design activities, a physical mock-up was built through additive manufacturing, as a proof-of-concept of the project's output. The mock-up has been developed through a process of digital fabrication design that has seen the virtual model transformed to be 3D printed in a detail scale of 1:20 through a process of laser sintering and subsequently refined to be presented at the conference.
In conclusion, LADE results in a complex and multidisciplinary project that fits adequately within the frameworks of the present and future human exploration of the Moon and, ultimately, the space. We believe that our work, at least as far as it concerns the holistic methodology exploit to develop all the aspects related to the design of a habitable, efficient, and safe module for the exploration of the Moon's surface, will serve as a starting point for future research and real outputs in this sector.



Team LADE at IAC Paris 2022 paper Presentation