



ARCHITECTURAL DESIGN
NOVEMBER/DECEMBER 2014
PROFILE NO. 232
GUEST-EDITED BY NEIL LEACH

SPACE ARCHITECTURE

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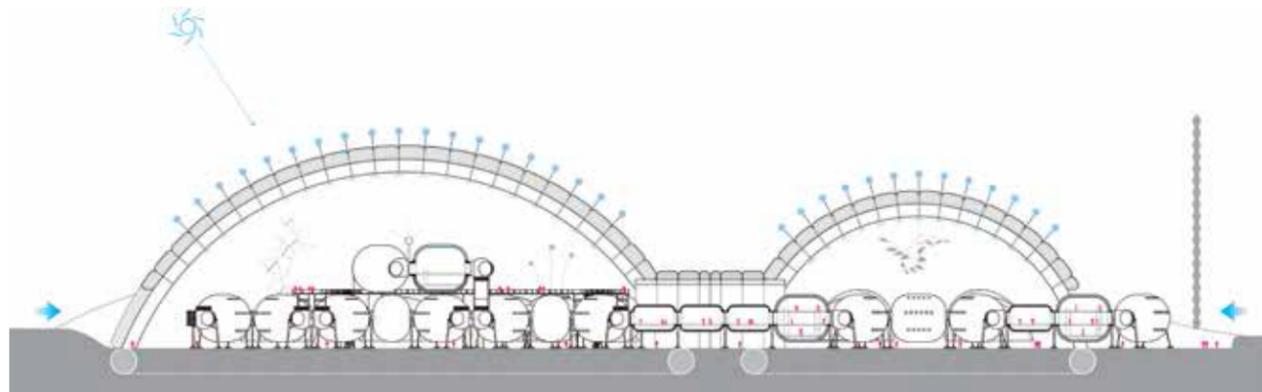
Architecture and Vision, MoonCapital, the Moon, 2010
The growing MoonCapital community with more interconnected domes.

Andreas Vogler

M O O N C A P I T A L

L I F E O N T H E M O O N 1 0 0 Y E A R S A F T E R A P O L L O

Munich-based architect **Andreas Vogler**, and co-founder of Architecture and Vision, here presents his speculative project MoonCapital, a proposal for habitation of the Moon in 2069, a century after the first lunar landing. Located in the most promising place on the planet for human settlement, the lunar south pole, MoonCapital accommodates 60 or so people in a series of modules, allowing for cellular growth.



Cross-section through the domes showing the interconnected inflatable modules inside standing on their own feet together with low-gravity sculptures to enrich the lunar landscape.

MoonCapital is a design proposal for a second-generation habitation located on the rim of Shackleton Crater at the lunar south pole in the year 2069, 100 years after the first man arrived on the Moon. Based on current and anticipated technology and scientific knowledge, it develops a realistic scenario of how 60 and more people may live on the Moon 55 years from now.

In 2009, Architecture and Vision worked on a series of extraterrestrial habitats, such as the MoonVille project, to develop an architectural vision of a settlement on the Moon 40 years after the first moon landing. MoonVille was based on the concept that the limited amount of energy and resources on the moon results in a defined size settlement, similar to a medieval town, that corresponds to the amount of available farmland. In contrast to this, MoonCapital is investigating the principle of cellular growth based on a series of modules. The ongoing architectural research on how humans can not only survive but also live in Space

is an important contribution to the scientific community.

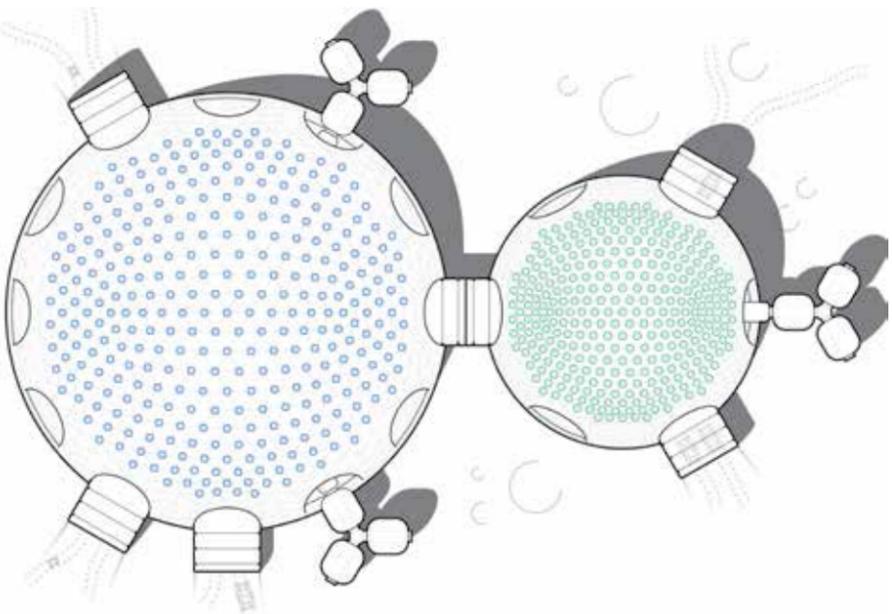
The lunar south pole is the most promising location for a human settlement, since there are peaks of eternal light, breaking the lunar day/night cycle, which last 28 earth days. On the other hand, a cable lift leading down into the Shackleton Crater would allow the establishment of an astronomical research station with a large, deep-space telescope with absolutely no light pollution – a big step forward in the exploration of our universe. The impact of micrometeorites in the south pole is also less, and moonquakes, though there is not yet enough research on them in this location, are another issue to consider.

A Modular Community with Low-Gravity Sports and Sculpture
Radiation is posing one of the most severe problems of human space flight, and this has led to a proliferation of proposals for underground lunar habitations. The MoonCapital project, however, proposes the building of domes covered with lunar soil (regolith) as a controllable engineering

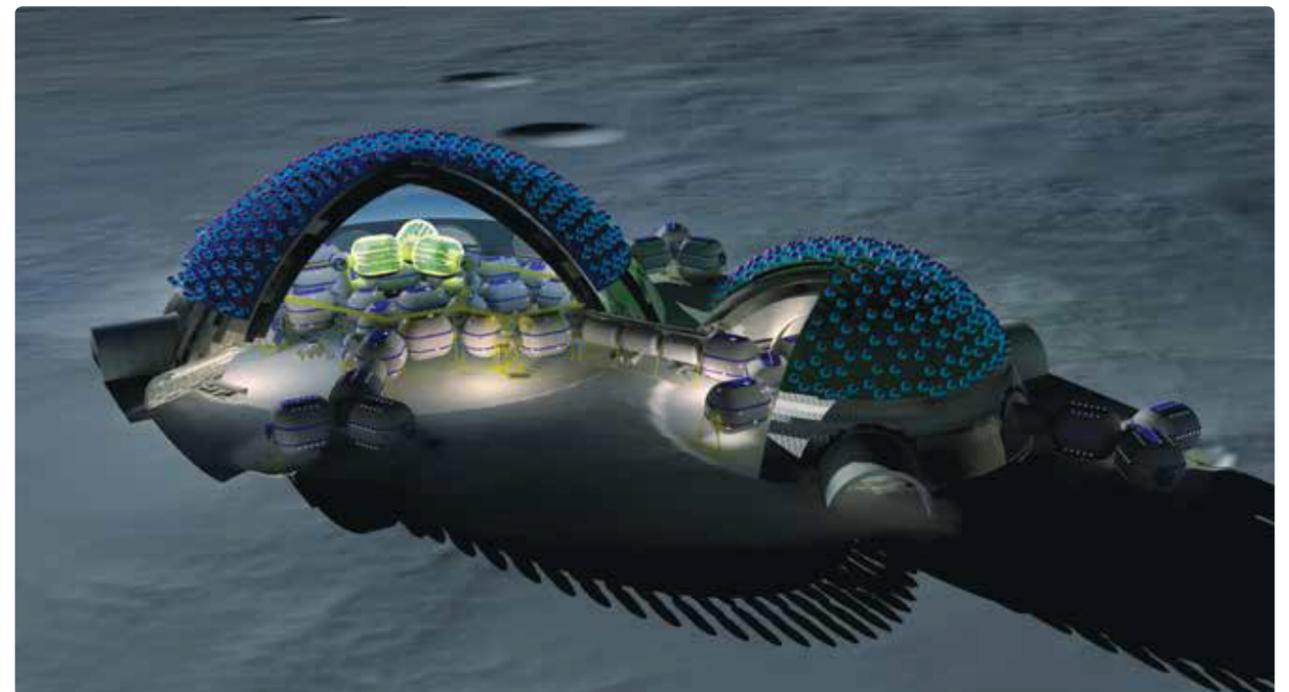
solution that also allows humans a feeling of protected openness on the Moon's surface. The domes, over inflatable modules, form an intelligent skin, protecting from radiation and micrometeorites and allowing sunlight through a daylight-direction system inside. They are also a visible architectural testimony of human presence on the Moon. Built using inflatable and self-hardening concrete technologies, they are covered by a 3-metre (10-foot) thick layer of small regolith-filled sandbags, filled and mounted by small swarm robots, which also clear the site. Inflatable light receptors collect sunlight and direct it into the domes, where it can be used to translate the 28-day lunar day/night cycle into a 24-hour terrestrial day/night cycle. A digital projection allows artificial simulation of the Earth's skies on the surface of the domes, and can also play movies.

The smallest community and initial phase consists of two domes: a large one for the habitation and working modules, and a smaller one for the agriculture modules to produce food, and to recycle air and water. The modular system allows growth and

top: View of the two base domes showing the rover ports and inflatable daylight collection system on top.

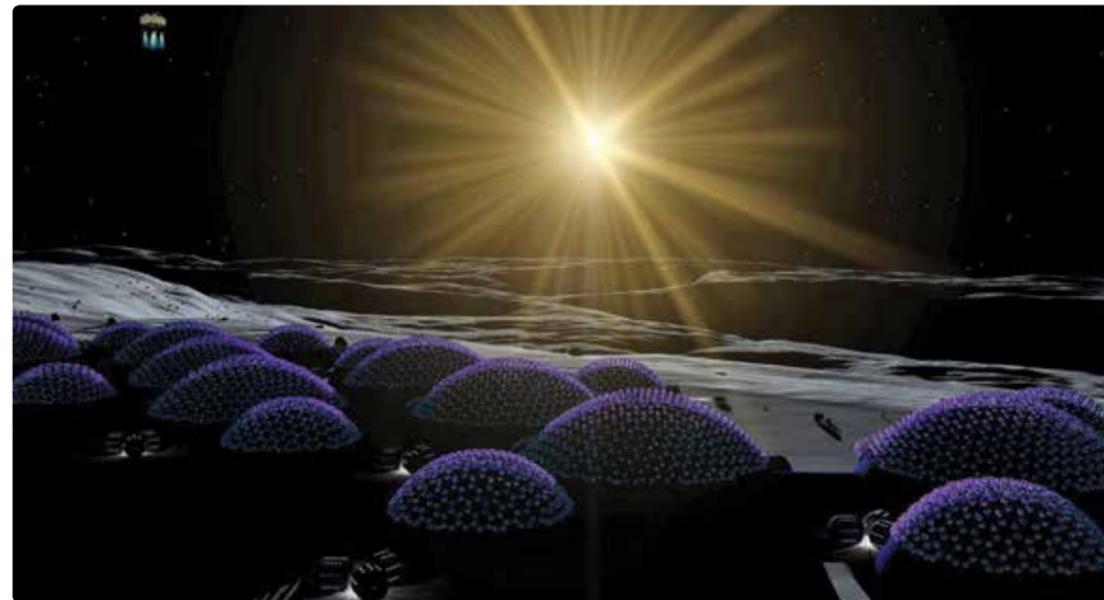


bottom: Cut-out rendering of the two base domes with the inflatable modules inside, and the three 'Paradise Modules' inside the large habitation dome.



top: Interior view of one of the large domes showing the interconnected working and habitation modules and the Paradise Modules above.

bottom: Evening atmosphere at the MoonCapital after a long lunar day, which lasts 14 earth days.



MOONCAPITAL'S DIRECTIVE IS HUMAN-CENTERED: THE INTERIOR PLANNING OF THE MODULES IS DEFINED BY SAFETY, SOCIAL BEHAVIOUR AND PSYCHOLOGICAL NEEDS.

extension as the new lunar society develops. MoonCapital contains facilities for research, production and leisure, and a small hotel for visitors. Spaces inside the domes not occupied by pressurised modules are used for rover docking and maintenance, radiation-protected surface science, and low-gravity spacesuit sports like moon soccer and moon tennis. Sculptures will be installed in the vacuum environment to fulfil inhabitants' desire for culture, but also to aesthetically explore this fascinating environment.

The inflatable modules are designed to fit into a 6-metre (20-foot) diameter rocket fairing, leaving many options open for future launch capabilities. They have a deployed diameter of 11 metres (36 feet) and three levels. Main circulation is on level -1, from where level -1 below and +1 above can be accessed. The modules are connected by rigid carbon-fibre nodes that allow three horizontal and two vertical connections, and also contain noisy equipment such as life support. The modules have windows to allow views outside into the dome, and virtual windows that allow a radiation-protected view onto the lunar landscape.

Vertical circulation is realised by muscle-powered lifts and staircases. Ceiling height is kept between 2.4 and 2.6 metres (7.9 and 8.5 feet), and uses soft padding as it is easy to reach this height by jumping in one-sixth of the Earth's gravity. For the rather compact spaces, a low ceiling height is

beneficial for the perceived spatial proportions and keeps the pressurised volume low as well as the environmentally controlled volume. However, the arrangement also provides large spaces for gymnastics, reaching up to 6 metres (20 feet) ceiling height, in which to enjoy and explore the low gravity.

A Stimulating Interior in a Monotonous Exterior

MoonCapital's directive is human-centered: the interior planning of the modules is defined by safety, social behaviour and psychological needs. However, in reality a moon habitation is more a machine than a living environment as we know it on Earth, and space architects therefore need to consider human needs even more carefully. MoonCapital creates and respects private, semi-private, semi-public and public spaces to allow individuals maximum personal freedom in a confined environment. Sensory deprivation is also a main concern where the sky is always black and going out to 'breathe some fresh air' is impossible: environmental control (temperature, humidity, pressure, illumination, olfactory), communication, audio systems and food are all employed as stimulating countermeasures to this. A combination of sensors and algorithms can individually react on the people and expose them to the unexpected. Surfaces, decor, artwork and interactive devices such as electronic sculptures can further enrich daily life on the Moon.

Module Eden: the Lunar Paradise

In the larger habitation and working dome of MoonCapital's initial phase, three 'Paradise Modules', or Module Eden One to Three, have a normal earth atmosphere and contain aeroponic plants such as strawberries and apples that are in blossom over the year and bear sweet fruits and berries. These modules differ from the purely food-producing, robot-controlled agricultural modules: butterflies and birds fill them with movement and natural sounds, tables and benches allow people to meet there, to relax or just look at the plants, hear the birds and smell the air, creating a public park for the lunar inhabitants. The transparent skins also illuminate the dome and can be seen from the windows of other modules. Module Eden forms the green heart of the MoonCapital and a connection with home, the planet Earth, casting its blue light into the black Moon sky. ▾