What Do We Build First? The Initial Infrastructure of a Lunar Base

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The lunar environment already poses a challenging setting for a permanent base, which is only exacerbated by the high transportation cost and size constraints of transporting equipment and material to the site. Thus, it is paramount to address these challenges not in any manner but rather in a practical way, so that the infrastructure is suitable for exactly the requirements it faces.

Current approaches start with an initial robotic phase during which suitable infrastructure is established, so that, once humans arrive, the requirements for a permanent habitation are already fulfilled. However, these robotic systems and machines already require some infrastructure themselves. Inspired by the extensively used approach on earth not to equip every piece of equipment with individual protection for every environment it could face, we propose that the most relevant infrastructure needed is a temporary shelter and permanent habitat for mobile and respectively stationary systems. This would allow them to be constructed using less shielding from the environmental conditions such as temperature, radiation as well as impact from debris. Furthermore, such a shelter enables tailored design approaches for mobile systems, which do not need to function during all conditions encountered on the Moon. Due to the extreme scarcity of materials and equipment these initial structures should be constructed to fit the equipment and robotic systems they serve and not necessarily be designed for human use. However, once the initial infrastructure is established, the habitat/shelter should be adaptable so that further equipment sent to a later phase finds place. When the time comes, astronauts should be able to use them in conjunction with the robots. One approach to this end is to construct the habitat/shelter from a modular system.

Based on these constraints and observations this talk will discuss a minimum requirement for an initial lunar infrastructure, which at first would only serve robotic systems and equipment. Later it should be able to be expanded and adapted to human use as well. Additionally structural concepts which could achieve suitable conditions will be presented and compared.

One heavily used concept throughout will be In-situ resource utilisation (ISRU), presenting a holistic approach to the lightweighting challenges posed. Particularly when considering not just an initial short-term habitat/shelter but instead the desired long-term infrastructure, even the most extremely lightweight structures will be heavier than transporting just the equipment necessary for ISRU. Thus, the weight of the final structure will be higher but the relevant weight of materials and equipment needing to be transported will be lower.

Further this talk will focus on the often overlooked phase between an initial establishment of a lunar base and the desired outcome of a permanent lunar “city”. This phase is of particular concern because it needs to transform the entire operation from just deploying what has been delivered and set up by robotic systems to a self-sufficient infrastructure that can be expanded and support all the critical operations itself. Especially during this phase, the use of ISRU will be of the highest importance.