ASSEMBLY AND INSTALLATION CONCEPT FOR A COMPLEX PLANETARY SURFACE HABITAT AND INDUSTRIAL MODULE. T. P. Varga[1], I. Szilágyi[1], K. R. Varga[2], Sz. Bérczi[3], [1]VTPatent Kft. H-1111 Budapest, Bertalan L. u. 20. Hungary, (info@vtpatent.hu), [2]Eötvös József High School, H-2890 Tata, Tanoda tér 5. Hungary, (vargakingareka@gmail.com), [3]Eötvös University, Institute of Physics, Dept. Materials Physics. H-1117, Budapest, Pázmány P. s. 1/a. Hungary (bercziszani@ludens.elte.hu)

Introduction In our previous abstracts we discussed in detail the practical and theoretical questions regarding the configuration and implementation of planetary surface modules suitable for human habitat and industrial activities on the Lunar or Martian surface.[1,2,3,4,5]

Background: Surface modules of this type are unavoidable for the planned future Lunar and Mars missions. During these missions the suitable circumstances for human habitation and for surface activities have to be sustained for a sufficiently long time in sheltered surface habitats and other sheltered surface modules.

The requirements for prolonged human stay in space has become been extensively studied since the 1970's and it by today it has become a routine for astronauts to stay on the International Space Station for several months, providing a continuous human presence on the ISS. Launching instruments and payloads form the Earth's surface to orbit and returning these instruments safely to the ground has also become a routine operation. Most constraints thus arise form the side of the available funding for the particular mission, than from technological and engineering difficulties.

The next step is the determination of the optimal method of sending larger instruments and research personnel to the vicinity and to the surface of another planetary body.

Aims: The module has to be in a fully working condition for human habitat and industrial applications immediately after surface touchdown. It is sufficient if the module is shielded against cosmic radiation and micrometeorites. For long term usage the module has to equipped with extra protection: The surface materials, rocks and regolith may be used in a layer with a depth of 30 – 50 – 100 cm, or in othe rcases may be placed in a valley or canyon. [4,5]. The module also has to be shielded against cosmic radiation, micrometeorite impacts, and from the large surface temperature fluctuations of the Lunar day-night cycle.

The essence of our proposal:

- The assembly of a complex surface module, assembly in space, in low orbit around the Earth or the Moon.

- Transfer for the vicinity of the target body e.g.: the Moon or Mars, and descent and installation to the surface of the planetary body.

- The transfer for the target body may be done over a longer time period thus allowing the usage of energy-optimised transfer orbits, and the usage of low thrust transfer engines. All assembly, test and correction can be carried out before transfer in Low Earth Orbit.

- The main advantages of this is that the microgravity environment and the lack of any external material (e.g. regolith) which may impede the assembly process. It is also possible to utilize existing experience and technological knowledge regarding orbital assembly and construction.

- Surface touchdown and landing on the Moon or Mars. Sufficient number of rocket engines may be used for breaking. The entire module can be landed in one piece to the chosen base site,

Question of the construction: The main support for the landed module should be provided by 3 or 4 landing legs or support points. A supporting structure of 3 legs provide a configuration which is stable in all but the most uneven landscape, however provide less protection from the tipping of the structure upon touchdown. Also the triangular base layout provides less compatibility with rectangular inner spaces.

A 4 support leg design enables a quasi-pyramidal layout for the surface module. The module should be of a flatter design to prevent tipping over upon descent and touchdown, as well as to provide a smaller cross section.

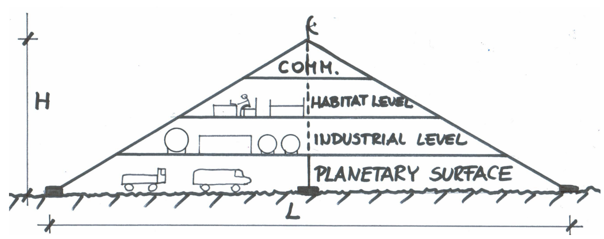

Fig.1 *Cross section of a possible realization of a surface module assembled in orbit.*

Feasibility study: The assembly process can most easily be done in space, in low orbit around the Earth, thus it is possible to utilize the already existing proficiencies in orbital construction and assembnly. The individual sub-modules and building blocks can be launched individually and they can be assembled using existing methods used in for example in the construction of the International Space Station.

The surface module can be assembled completely to a fully working state in orbit, and it's operation can also be tested.

In the planning of a Lunar surface mission it is an imperative that the modules should be in a fully working order immediately after surface touchdown, and that it does not require a long multi mission preparation or surface assembly process. The preparation of the module should not require several manned precursor surface missions, and it should be in a fully working state immediately after landing. This is a priority since the development of the logistics and technology required for a manned surface assembly mission would require extensive on-site testing.

A solution for this problem is the construction and assembly of a surface module in orbit (preferably around the Earth) to a fully working order. The small mass and low surface gravity of the Moon enables the landing of larger compact objects from low Lunar orbit to the Lunar surface with reasonable efficiency.

The components of the proposed surface module may be launched with existing launch methods and hardware to low earth orbit and be assembled with existing capabilities and training. Since launching large constructs to low Earth orbit in a single piece is not efficient with current launch capabilities, the modular launch and orbital assembly method is already utilized for building space stations.

Detailed questions of the realization: The assembly of the components is thus possible either in orbit or at the surface, however a surface assembly provides several major difficulties:

- First of all, the individual transfer of the components, the assembly equipments and the workforce to the planetary surface is a much greater task as opposed to the assembly in low Earth orbit. Construction and servicing in low Earth orbit has an already existing logistical and technological basis developed for the construction of the ISS and other space stations as well for the servicing of the Hubble space telescope and Skylab.

- The Lunar surface and its low gravity environment provides a unique task for the engineering and logistics of the surface assembly. All machine and human activities must be planned and practiced with the low surface gravity in mind. The training of the personnel responsible for the in-situ surface assembly process is also a task which can be done on the Earth only to a limited extent (underwater tests) and would require in-situ practice. It is also important to consider that all activities should be properly tested and rehearsed beforehand. A prime example for this is the Apollo 10 mission which carried out a complete rehersalof the lunar landing, save the landing itself.

In the case of the Moon the presence of the surface regolith dust provides a hazard and thus the engineering of any surface equipment and module must aim to counter these effects. With regards to the rotating-moving parts in any assembly and construction equipment the nanometer scale dust my enter any gap, joint or opening causing malfunctions in the equipment. The regolith is also a major concern for humans, since it is toxic and thus a dedicated instrument is required to clean spacesuits and equipment, and to filter out regolith from the habitat module. This gives a very strong constraint on the extent of outside human activity during any surface construction.

The fine regolith grains also act as an electrostatically charged dust, which may impede some surface activity. Electrostaticaly charged regolith may form a fog, which can cause problems in visibility, and also deposit on intruments and hinder the performance of electronic and mechanical equipment.

- In the case of surface assembly it is also apparent that building components and submodules must be transferred and landed before they are functional. These components and submodules must be assembled via surface operations. The cost and complexity of the transfer can be greatly reduced if the entire module is transferred to the surface in one piece which is already operational and ready to support a human crew.

Advantages, preferred embodiments: In the preferable embodiment an internal structure is possible where the internal submodules are fixed on a chassis, and the outer shell of the construct is fixed to a secondary chassis. This configuration has the advantage that the internal gap betveen the submodules and the outer shell serves as a heat insulating vacuum layer. This configuration is preferable to having separate modules on the Lunar surface as each module would be directly exposed to the outside conditions and would require individual heating and cooling. The walls of the internal submodules are thus not the outer walls exposed to the lunar surface, but there is an extra outside wall offering additional heat insulation, radiation shielding and mechanical protection

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