SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Upper Stages, Space Transfer, Entry and Landing Systems (3)

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SUITABILITY OF REUSABILITY AND IN-SITU PROPELLANT PRODUCTION FOR A LUNAR TRANSPORTATION SYSTEM

Abstract

Only few years after the successful flight of Sputnik, and within only one decade a total of 18 soft Moon landings were performed successfully by spacecraft from the Soviet Union and the USA. This impressive result was driven by the Space Race between the USA and the Soviet Union. The main design driver was to be the first. It resulted in similar designs for all vehicles. They were expendable and based on storable hypergolic propellants carried from Earth. The spacecraft were also optimized for very specific missions, with limited considerations about a possible future permanent presence on the lunar surface. In the context of the beginning of the space exploration and the Space Race, such designs were the best answers to achieve the goals of that time.

Nowadays the design drivers are different. Costs and added-value for the society play now a central role. For this reason, long-term planning and sustainability considerations are very important aspects. In 60 years of astronautics, numerous technologies had time to mature to allow novel concepts. This is the case of cryogenic propulsion. Others, such as reusability of Earth-based systems, are currently arriving on the market. All of this making now concepts feasible for which the development of in-situ propellant production (ISPP) could also bring large benefits.

In the proposed paper different versions of a novel Lunar transportation concept based on a reusable lunar SSTO (single stage to orbit) vehicle called RLRV (Reusable Lunar Resupply Vehicle) and on a reusable transfer vehicle called RTLV (Reusable Trans-Lunar Vehicle) are presented. This concept makes use of ISPP, cryogenic propulsion LOx/LH2 (liquid oxygen and liquid hydrogen) for reusable transportation system elements. The versions differ by the origin of their propellant. It can come from the Moon for given legs in the Moon neighborhood, or even for all legs until LEO. Either only LOx is produced from Lunar regolith, or LOx and LH2 are both produced on the Moon by gathering and processing water ice. Collaboration between the vehicles is considered as well. An assessment of the influence of the rendezvous location for the RLRV and the RTLV is also proposed. In addition to the classic low Lunar orbit rendezvous, the Lagrange point L1 is also considered. In order to assess these transportation concepts they are compared to classic designs.