NASA SBIR 2006 Phase I Solicitation

X7.03  Surface Handling and Mobility, Transportation, and Operations Equipment (Lunar or Mars)

Lead Center: JSC

Participating Center(s): ARC, GRC, JPL, LaRC

The objective of this subtopic is to provide new capabilities for delivery, handling, transfer, construction and repackaging of Extra Vehicular Activity (EVA) equipment and preparation of site infrastructure for lunar operations. This includes access/handling and transportation equipment/carriers for delivery and deployment of materials, components, and infrastructure; surface systems for site clearing, pad construction, and regolith manipulation; and commodities distribution systems (including umbilicals) for routing to equipment and infrastructure. These new capabilities are required to make planetary surface missions more reliable, safer, and affordable.

Several vehicle features will be critical to surface operations: expanded mobility, range and duration, life support recharge, crew following, automated path planning, automated driving, and obstacle avoidance. Vehicles with life support recharge capabilities will extend useful EVA time. The ability of a vehicle to follow a crewmember will enable science and exploration support equipment to be carried for the astronaut as well as extend the traverse distances. While the utility of autonomy is easily recognized when the crew is not on the surface, these functions could also be advantageous to long traverses and rescue or emergency operations when crewmembers are present.

Proposals are sought which address the following technology needs:

- Highly reliable and durable surface systems for site preparation, pad construction, site sampling and prospecting are needed for planetary exploration. Sample collection may require excavating, picking, and physical manipulation of materials, as well as tagging and transport to an analysis site. Emphasis will be placed on proposals that address both manned and unmanned vehicle control operating capabilities of the surface system.

- Flexible and adaptive systems to deploy and emplace site infrastructure, such as beacons for communication, survey, navigation, etc. Emphasis should be placed on developing lightweight, power-efficient manipulation devices (dexterous and non-dexterous) that can be deployed on small rovers and that are appropriate for multiple tasks. Much of this activity can be performed with teleoperated and semi-autonomous robots controlled from ground. Some of this activity, however, will also require human presence at the site. In both cases, the effectiveness of Human-Robot interaction (HRI) will have a major impact on the efficiency and productivity of mission operations.
Access/handling and transportation equipment (including cargo carriers) for delivery and deployment of materials, components, and infrastructure. Vehicle systems that can self-deploy, that can function in rough and steep terrain, and that can be controlled at various levels of autonomy are of particular interest.

Commodities distribution systems (including umbilicals) for routing to equipment and infrastructure. Commodities distribution systems are necessary to interconnect distributed surface assets (e.g., access/handling and transportation equipment, launch and landing systems, communication relays, power plants) to support long-duration sorties and sequential mission architectures.

Vehicle control architectures that support on-board driving, teleoperation, and autonomous operations. Particular emphasis is placed on architectures that can flexibly support and adapt to multiple control modes, that include activity monitoring and operator intent prediction, and that can tolerate up to 10 seconds of time-delay.

Highly reliable, durable, and long-life systems (mechanical, electrical, software, power train, lubricants, etc). This includes design and implementation of integrated actuator, suspension and control avionics for surface vehicles and evaluation of test articles in field experiments (preferably in lunar analog environments).