New Forms of Planetary Surface Exploration & Mobility using Hard Landers & Propulsive Hoppers. B.E. Cohanim[1], S. Slagowski[1], Shawn Murphy[1], J.A. Hoffman[2], and P.M. Cunio[2]

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Abstract: Since the early days of the Viking and Apollo missions to the Mars Exploration Rovers, we have visited the surface of several other planetary bodies in our solar system besides our own. This paper will discuss some of the technological history of those missions: what made those missions possible, new technologies that advanced the forefront of our ability to explore other planets, and the capabilities of those missions. Then, based off that heritage, we will describe the new sets of missions, new technologies, and new areas of research which will enable the near-term future surface exploration of other planetary bodies in our solar system.

Our current history has only seen two types of explorer vehicles: Landers and Rovers. These vehicles have served us well, delivering and transporting science payloads and humans across the surface of planets. We have landed these assets on the surface using both propulsive, air-braking, quasi-hard landing airbags, and the combination of all of the above. Future methods will undoubtedly still include these methods for emplacing payloads and people on the surface of another planet, but new methods being developed will enhance our capabilities of emplacing science and, maybe someday, people on the surface. Research is being done into a class of hard Landers, called penetrators, that would reduce the mass and cost and propellant of safely placing science payloads on the surface of another body. This technology is being developed to eliminate the need for braking or cushioning the landing of the payload, saving mass and costs by reducing the need for parachutes and propulsive elements that need to be carried all the way to the surface of the planet.

Once on the surface, we have only explored via the feet of man or by wheeled machine. Current research and development is developing a new type of surface mobility, Hoppers, which will enable a lander platform to propulsively lift off the surface and relocate to a new site kilometers away in a matter of minutes. This will also enable the capability to explore places that Rovers or humans have not been able to explore before, e.g., the bottoms of craters and the tops of cliffs. Someday this technology may even be used to transport humans over long, hazardous terrain.

Even more futuristic vehicles are being discussed for the exploration of other planets by using blimps and planes that can fly through the air of atmospheric bodies, drills and other submersibles which can explore beneath the surface, and docking vehicles which can gently interface with low gravity objects.

This paper will provide an overview of these topics and explore future possibilities being developed by Draper and MIT.

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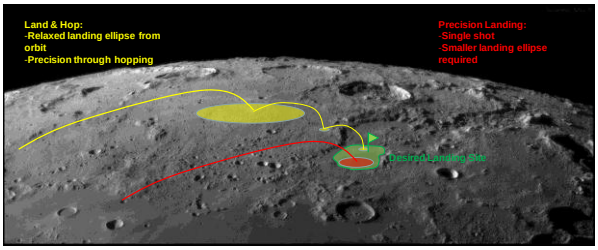
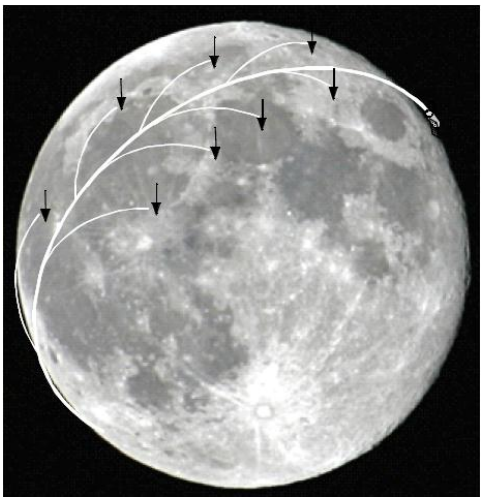




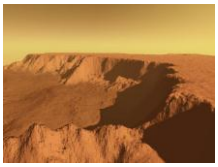
Rapid Regional Access

- Hoppers can cover more ground in less time than rovers have demonstrated

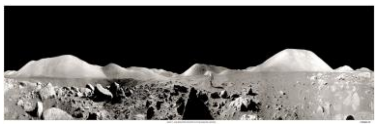
Mars Rovers = 13.5 km (5 yrs)

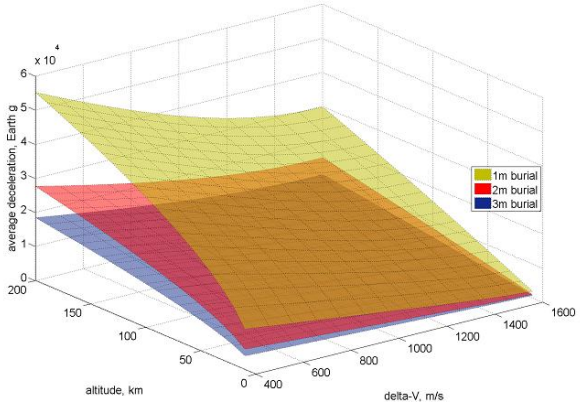
Hopper = 20 km (5 hops)

Scale Cliffs



Traverse over/into Hazardous Terrain





Landing Approach	Expected Deceleration
Powered descent	20 g
MPF/MER	< 50 g
Rough lander	500 to 2000 g
Hard lander	10,000+ g

S. W. Thurman*and T. P. Rivellini, ROUGH LANDER CONCEPT FORMARS EXPLORATION, 2002 Core Technologies for Space Systems Conference Colorado Springs, CO, USA