**ASTROBOTIC'S PAYLOAD DELIVERY SERVICE ENABLES LUNAR SURFACE ACTIVITIES.** D. B. Hendrickson, Vice President of Business Development, J.M. Thornton, CEO, Astrobotic, 2515 Liberty Ave. Pittsburgh, PA 15222, dan.hendrickson@astrobotic.com.

**Introduction:** This paper describes Astrobotic's lunar payload delivery service, along with the latest program developments toward the company's first demonstration of service.

**Overview of Astrobotic's Service:** Astrobotic is a lunar logistics company that delivers payloads to the Moon for companies, governments, universities, and nonprofits using its Peregrine Lunar Lander. Peregrine is a modular spacecraft that delivers a collection of payloads to lunar orbit or surface on a single mission for the historic low price of $1.2 million per kg. The vehicle will serve as a product line for Astrobotic's first five delivery missions.

**Figure 1: An engineering mock-up of the Peregrine Lander at a lunar analogue site.**

Peregrine's first flight in 2019 will be a demonstration of service that carries 35 kg of customer payload to the lunar surface. Following this first mission, Peregrine will be capable of carrying up to 265 kg of payload optimizing the trajectory and increasing the quantity of propellant carried. Payloads are integrated onto either the top or bottom of Peregrine's payload decks using a standard bolt pattern.

For Peregrine's first mission, the vehicle will fly as a secondary payload on a United Launch Alliance (ULA) launch vehicle to either low Earth orbit or geosynchornous transfer orbit. After deployment in Earth orbit of ULA's primary payload, Peregrine will be propelled toward the Moon using the launch vehicle's upper stage. Peregrine then separates and its onboard propulsion system carries out course correction burns, lunar orbit insertion, and powered descent to the surface. Upon landing, Peregrine will commence an 8-Earth day surface mission, and provide payloads power (0.5 W per kg of payload) and communications bandwidth (2.8 kbps per kg) for the duration. The first mission will land at Lacus Mortis, a mid-latitude location at 45 degrees North, 25 degrees East. Future missions will be capable of landing at any latitude on the Moon, including the lunar poles.

**Peregrine for Surface Activities:** Peregrine is ideally suited to carry small (1-5 kg) to medium-sized (5-10 kg) science, exploration, and technology demonstration payloads to lunar orbit or the lunar surface on its first mission. CubeSats (from 1U to 6U), small rovers, resource instruments, seismometers, retroreflectors, and telescopes could all make use of this mission and advance the state of the art in lunar exploration for a fraction of the typical cost. As of this writing, Astrobotic has 11-deals in place, representing 6-nations for its first delivery mission.

Following a successful demonstration of low cost delivery service to the Moon, Peregrine will be ready to serve the landscape of lunar surface activities that are planned for the near term. To date, Astrobotic has 108 deals in its sales pipeline for Peregrine. This pipeline is indicative of space agency plans and private sector business cases that are enabled with foundational low cost lunar delivery. Peregrine's design will be ready to serve and compliment exploration architectures such as Orion and SLS, the Cislunar Gateway, or the ESA Lunar Village with regular large cargo shipments. Missions focused on resource prospecting, harvesting, and insitu resource utilization at the lunar poles will also be flown by Peregrine. Development of the technologies needed to land and operate at the poles (such as Terrain Relative Navigation) are well underway in Astrobotic's Future Mission and Technology Department, which has 23-past or ongoing NASA technology contracts to date.

**Laser Communications on the Surface:** At the Paris Air Show this past summer, Astrobotic announced that it had signed a payload agreement with ATLAS Space Operations to carry the first-ever laser communications terminal to the surface of the Moon. In addition to ATLAS carrying out a technology demonstration at the surface, this new terminal will be made available for Astrobotic's payload customers, providing them gigabit per second data bandwidth. This is a thousand-fold increase over radio communications from the Moon. Thanks to this new service offering, Astrobotic's payloads can now broadcast live streaming, high definition video, among other high speed data intensive activities. This service will be available for purchase by payloads as live bandwidth or data packages. Laser communication services on the Moon is indicative of the new era in lunar surface activities enabled by commercial lunar services like Astrobotic.