PLANETARY SURFACE MOBILITY AT HONEYBEE ROBOTICS: A FAMILY OF ROVERS FOR SOLAR SYTEM EXPLORATION. I. R. King[1], J. D. Lawrence[1], and the Honeybee Robotics team. [1]Honeybee Robotics (iking2@blueorigin.com), Altadena, CA 91001

Introduction: Honeybee Robotics is developing a family of rovers to provide surface mobility capabilities for planetary science and exploration missions (Figure 1). Current programs are for human and robotic exploration of the Moon, but the rover subsystems are modular and adaptable for Mars and other bodies such as Ceres. Our design principle is to develop modular and scalable rover subsystems that can be wrapped around a specific instrument or payload suite, rather than constraining payloads to fit into standardized volumes. This abstract provides an overview of our current rover classes, upcoming developments, and ride share opportunities. The rover classes are defined by order of magnitude integrated vehicle masses.

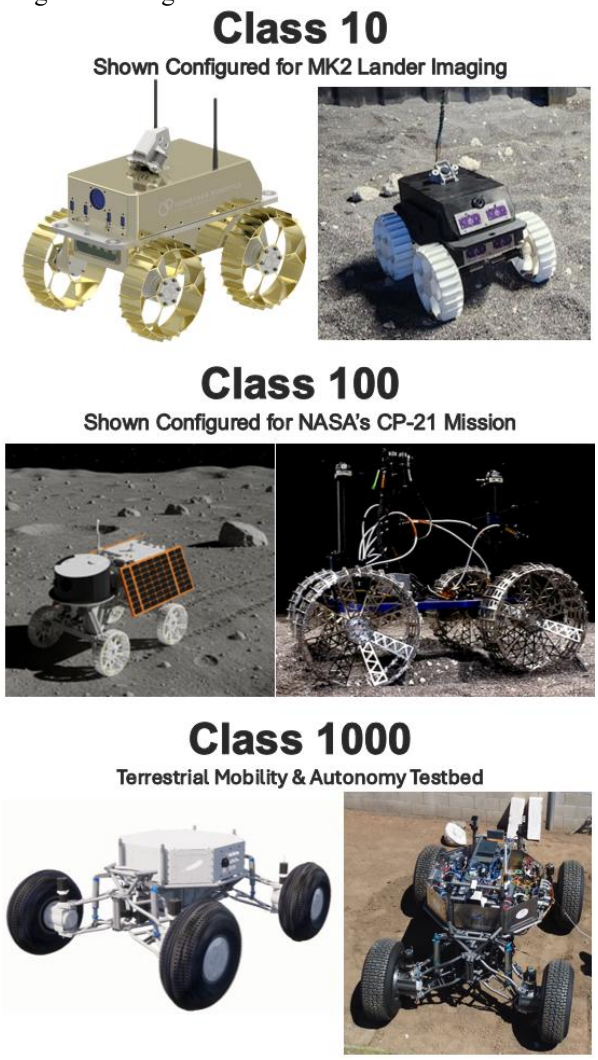

Figure 1: Honeybee Robotics is developing three classes of rovers, categorized by their mass in kg.

Class 10: The Class 10 rover is a compact, cost effective ~5-25 kg platform designed for local survey and inspection missions, carrying ~1 kg of payloads. The current point design is for use with the Blue Origin MK2 lunar lander where it will take high resolution video and still imagery of the lander's ascent from the lunar surface. The smallest variant of this rover is designed for tethered lander survey and inspection missions followed by a short, ~100 meter traverse on battery power. Larger variants are equipped with solar panels and direct to Earth communications for longer range and duration operations.

Class 100: The Class 100 rover is a ~100 kg solar- and battery-powered autonomous platform designed to carry ~10s of kg payloads for multiple kilometers during single lunar day missions. This rover class is intended as a CLPS-class workhorse for near term lunar science and exploration missions.

Our first 100 kg class rover is in development for NASA's 2028 CP-21 CLPS mission to the Gruithuisen Domes (~36° N, lunar near-side). The CP-21 rover is a skid steer vehicle with four independently actuated wheels with ~1 kph top speed. The rover communicates with Earth over lander or orbital S-Band relay. For CP-21, the rover will carry the 15 kg Lunar-VISE instrument suite with a Gamma Ray and Neutron Spectrometer (LV-GRNS) and the Visible/Infrared Multiband Suite (LV-VIMS).

Class 1000: The Class 1000 rover is a ~1000 kg platform designed for ~100s of kg payloads and lunar exploration, infrastructure, and resource utilization missions. In 2023, Honeybee Robotics built a 700 kg terrestrial mobility testbed named 'Haika' to develop flight requirements for these higher speed autonomous Class 1000 rovers.

Haika is a four wheel vehicle with independent steering, drive, and ride height actuation at each wheel, as well as compliant tires and shocks for passive suspension. Haika is designed to operate at up to 15 kph and has multiple steering modes including skid, Ackerman, crab/strafe, and turn-in-place. Haika is a highly modular platform to enable rapid iteration for testing a variety of mission concepts, payload operations, and sensor suites including high speed autonomous exploration, cargo offloading and transportation, construction, and regolith manipulation.

We use Haika to evaluate different mobility and sensing architectures, as well as different payloads. This allows us to test different mission and payload functions

and operations while varying ranges of motion and degrees of freedom, for example limiting steering to skid steer, adjusting ground clearance, or locking out suspension – such that we can use the testbed to determine the minimum level of capability for a specific mission, function, and rover point design.

Test Facilities: Honeybee maintains dedicated mobility test infrastructure at its Altadena, CA campus. This includes an 80 m² outdoor 'Moon Yard' with 1 m deep crushed garnet fill for drive, steering, suspension, and autonomous navigation development as well as the 'Moon Box' indoor analog facility with 12 tons of LHS-1 simulant and rocks. Honeybee also has multiple dirty TVAC chambers for environmental testing, including a 1 m x 1 m x 3 m chamber.

Conclusions: Honeybee's three classes of mobility systems are designed to cover a range of planetary surface mobility use cases. Within each class, existing point designs can be scaled to accommodate specific payload needs. The Class 10 rover will fly first with the Blue Origin MK2 lander, the Class 100 rover will fly first on Firefly's Blue Ghost Mission 3 in 2028, and the Class 1000 Haika testbed is informing requirements for future large-scale surface infrastructure operations through Blue Origin's NASA Appendix R Artemis Logistics Study. Each class is supported by extensive ground testing in Honeybee's dedicated analog facilities.