TRL 5 Testing Results and Design Advancements for the Mason Suite of Construction Tools

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Introduction: A long-term human presence on the Moon and Mars will require infrastructure to support landing and launches, exploration of the lunar surface, and sustainable operations. In-situ resource utilization (ISRU) will be crucial for building the infrastructure needed to support these activities. For example, landing pads constructed from locally available regolith mitigate ejecta from landings that would otherwise present risk of damage to hardware, infrastructure, and personnel as well as degradation of science and potential for inflamation of geopolitical relations. Redwire's Mason technology is a tool suite which converts regolith into critical infrastructure such as landing pads, roads, berms and foundations.

Technology Overview: The Mason tool suite currently consists of three platform-agnostic tools: BASE, PACT, and M3LT. BASE (Blade for Autonomously Surfacing Environments) is a grader that pushes away rocks, fills in craters, and levels the regolith surface; PACT (Planetary Automated Compaction Tool) densifies the loose regolith; and M3LT (Microwave Melter of Martian and Lunar Terrain) uses microwave energy to fuse the dusty regolith material into a solid material with properties similar to high strength concrete.

TRL 5 Testing: TRL 5 testing for all three tools was completed successfully. A brief summary of testing for each tool is provided below. Additional conclusions and planned design updates for each tool will be presented.

Grader Testing: The BASE tool's performance was evaluated under a range of different regolith densities and cut depths, in addition to demonstrating rock removal operations. Surface preparation methods were devised to generate low density, medium density, and high density regolith for testing. A predictive model of grader performance was developed and general agreement was demonstrated between test results and predicted behavior. Testing revealed that cut depth and regolith density have a significant impact on measured loads.

Compactor Testing: PACT utilized two methods of compaction for testing, "Spot" and "Raster". The Spot compaction method consists of applying a static vertical load to the tool while vibratory motion is induced. The Raster compaction method consists of submerging PACT 1-5 mm below the surface grade of the regolith and moving it horizontally while vibration is applied.Testing revealed the PACT system to be capable of consistently achieving 80% relative density in regolith when vibratory motors were used.

Microwave Emitter Testing: The M3LT tool successfully sintered lunar regolith simulant into solid samples under relevant vacuum conditions. The process was controlled using noncontact sensors in both stationary trials as well trials with motion of the M3LT tool relative to the regolith surface. Sample properties and process efficiency improved as parameters were tuned, with best metrics to date including 5.3 kWh/kg energy efficiency, 1.2 kg sample mass, 79 mm sample thickness, and 66 MPa compressive strength.

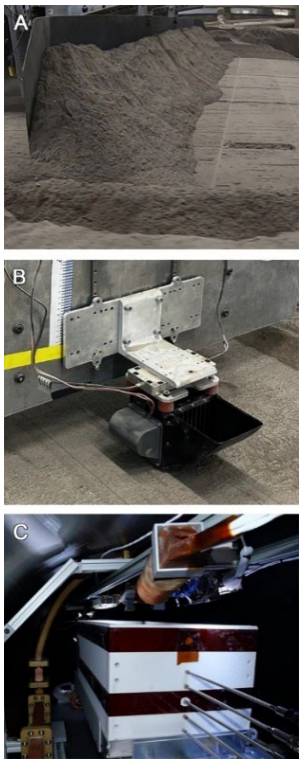

Figure 1: Mason construction tools undergoing TRL 5 testing. (A) BASE, (B) PACT, and (C) M3LT.