

LUNAR OUTPOST

The Next Leap



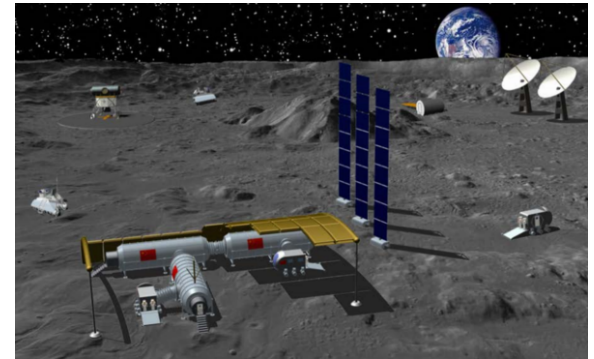
LUNAR OUTPOST MISSION:

Develop technology that enables a presence on the Lunar surface, while creating Earth analogs that drive innovation and have positive impact.

Importance - Space

Permanent US presence on Moon is both matter of scientific exploration and space economic development

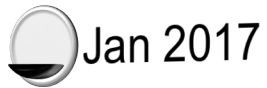
- [“Russia and China partner on new lunar exploration mission”](#) – Aerospace Technology, 3/2018
- [“China's Rover Sends Back Pictures From the Far Side of the Moon”](#) – Popular Mechanics, 1/2019
- **Variety of technological developments needed to make presence a reality**
 - Payload Mobility Services
 - Dust Monitoring & Mitigation
 - Resource Prospecting & Site Mapping
 - Habitat Infrastructure



Concept Chinese Lunar Base

<https://www.popsoci.com/china-russia-space-rocket#page-5>

Company History



Jan 2017

Lunar
Outpost
Founded



July 2017

Incorporated
& Capital
Raised



Feb 2018

Delivery of
commercial
product:
Canary AQ
Sensor



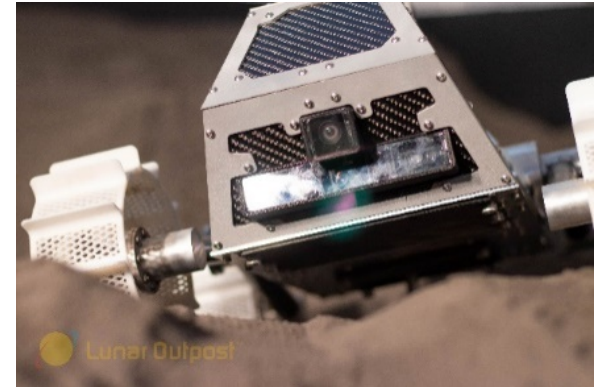
Nov 2018

Official
MAPP Rover
Debut



Q1 2021

MAPP
Delivery for
Lander
Integration



Company Capabilities

15 full-time/part-time executives and engineers with experience in: Aerospace, Biomed, Defense, Robotics

Primary Office: Boulder

Main Workforce Office: Golden

- Design, Build, Test for Components, Subsystems, and Systems
- Modelling and Analysis (ME, Thermal, Electrical)
- Agile Software Development, Testing, Deployment, and Support
- Prototyping and Small-Scale Manufacturing
- Specialized Machine, Manufacture, Test Equipment: Outside Facilities
 - Colorado School of Mines – **Lunar Testbed Facility**

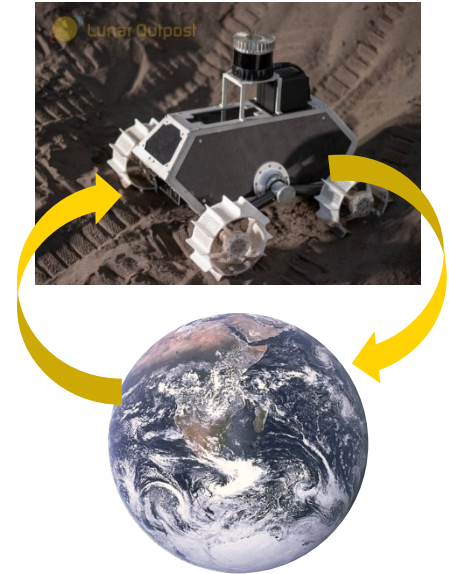


Company Strategy

Lunar Outpost develops high-potential, dual-use technologies for both space and scalable markets on Earth.

1. Fill immediate needs
 - Establish Lunar presence
 - Value to commercial customers
2. Have a positive impact
3. Drive near-term growth

Ex: Leverage technology from MAPP for mining/extreme condition mobile platforms on Earth



Air Quality Technologies

From monitoring in space habitats to IOT Smart Cities

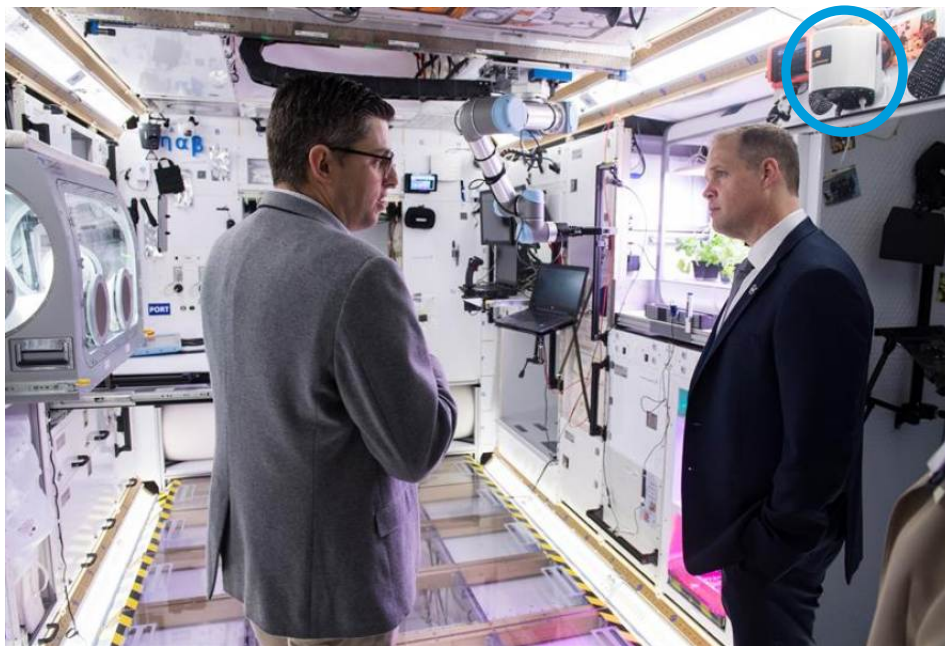
- **Defense and Spaceflight Platforms**
 - Space applications – Lunar Habitat
 - Remote detection – JPL MAIA
 - Air Force – Advanced Instrumentation
- **Commercial**
 - Municipalities, Communities/Individuals, Oil & Gas, Construction, Research Organizations
 - City and County of Denver won Bloomberg Initiative using Lunar Outpost Canary Air Quality Monitors

Custom monitor for Lockheed Martin's prototype habitat at KSC



Canary-S

LM Hab AQ Monitor



Bill Pratt (L), Lockheed Martin NextSTEP program manager gives NASA Administrator Jim Bridenstine a tour of the Lockheed Martin Gateway habitat prototype in the Space Station Processing Facility High Bay, after an event to discuss NASA's progress toward sending astronauts to the Moon and on to Mars, at Kennedy Space Center in Florida, USA, 11 March 2019. EPA-EFE/Aubrey Gemignani

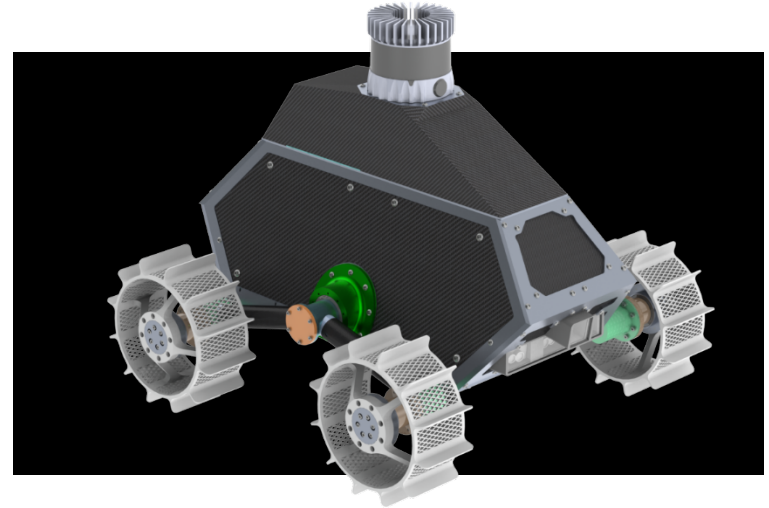


Mobile Autonomous Prospecting Platform (MAPP)

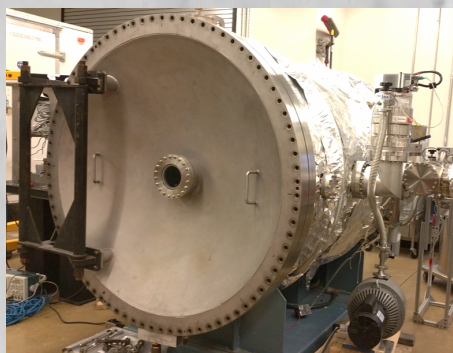
1st Commercial prospector debuted by US company

Requirements:

1. Characterize lunar resources
2. Provide hi-res surveys of key sites
3. Create resource & risk maps of lunar sites of interest



Vital next step in Lunar exploration and resource utilization



Space Resources Lab
(SRL)

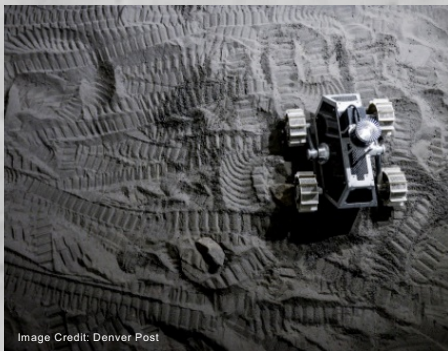


Image Credit: Denver Post

Earth Mechanics Institute &
Lunar Testbed Facility



M³ Robotics Lab

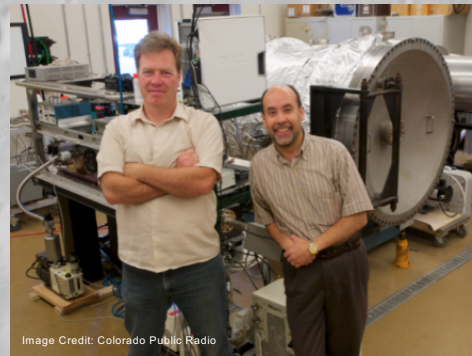
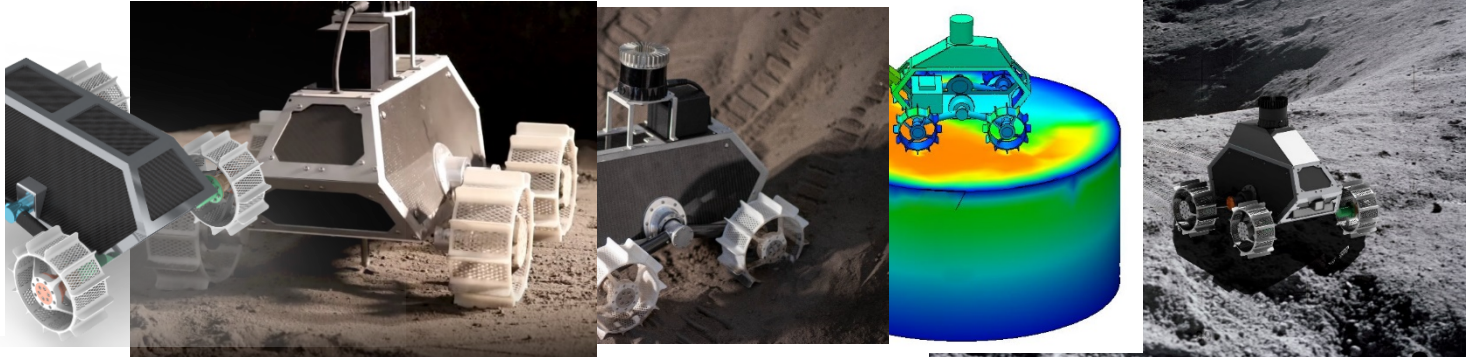
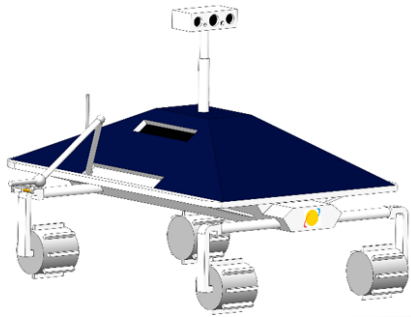
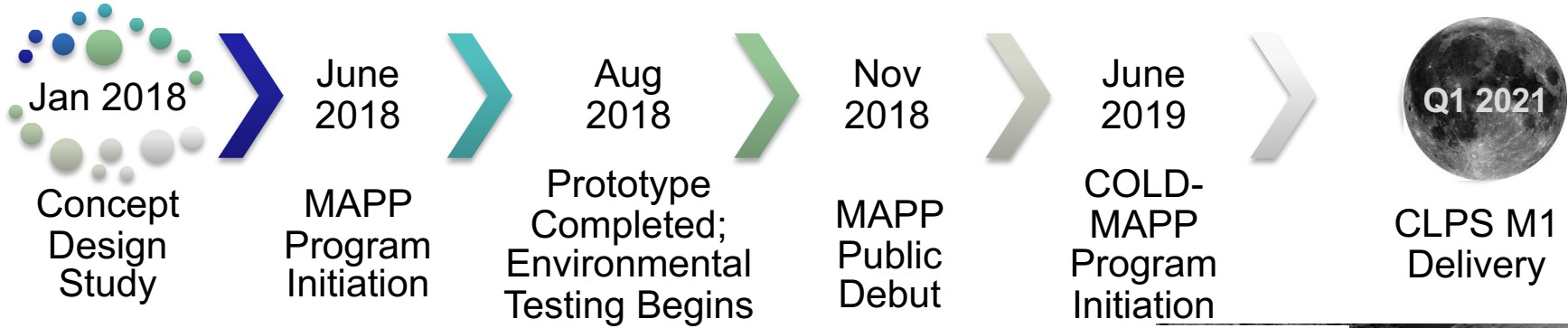


Image Credit: Colorado Public Radio

...and many more!

MAPP Development

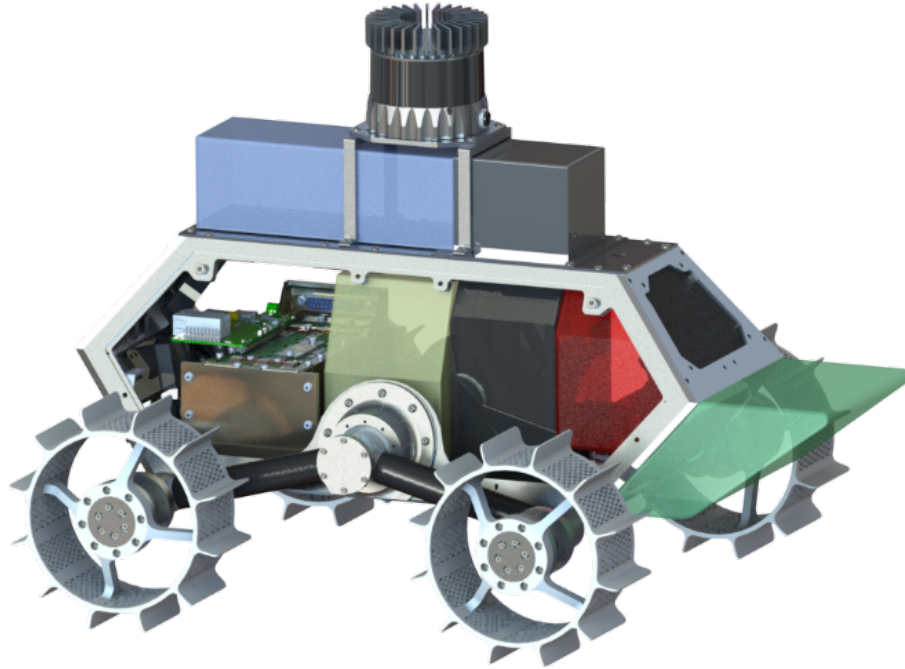


High TRL Subsystems

Component	TRL	Description
Battery	9	15 flight batteries delivered; flown on 4 missions; manned spaceflight qualification underway
Drive Motors	8	Used as actuators on prior orbital missions.
Navigation Camera	8	Optical Navigation Camera for current flight systems.
Solar Cells	7	Flown on multiple spaceflight missions.
CPU/Control Electronics	7	Radiation Tested, Hardened Versions Available
Chassis/Suspension	5	Prototype testing underway in relevant environments
MAPP Overall TRL	5	Mission-critical subsystems currently qualified and integrated; verification of lower-TRL subsystems initiated

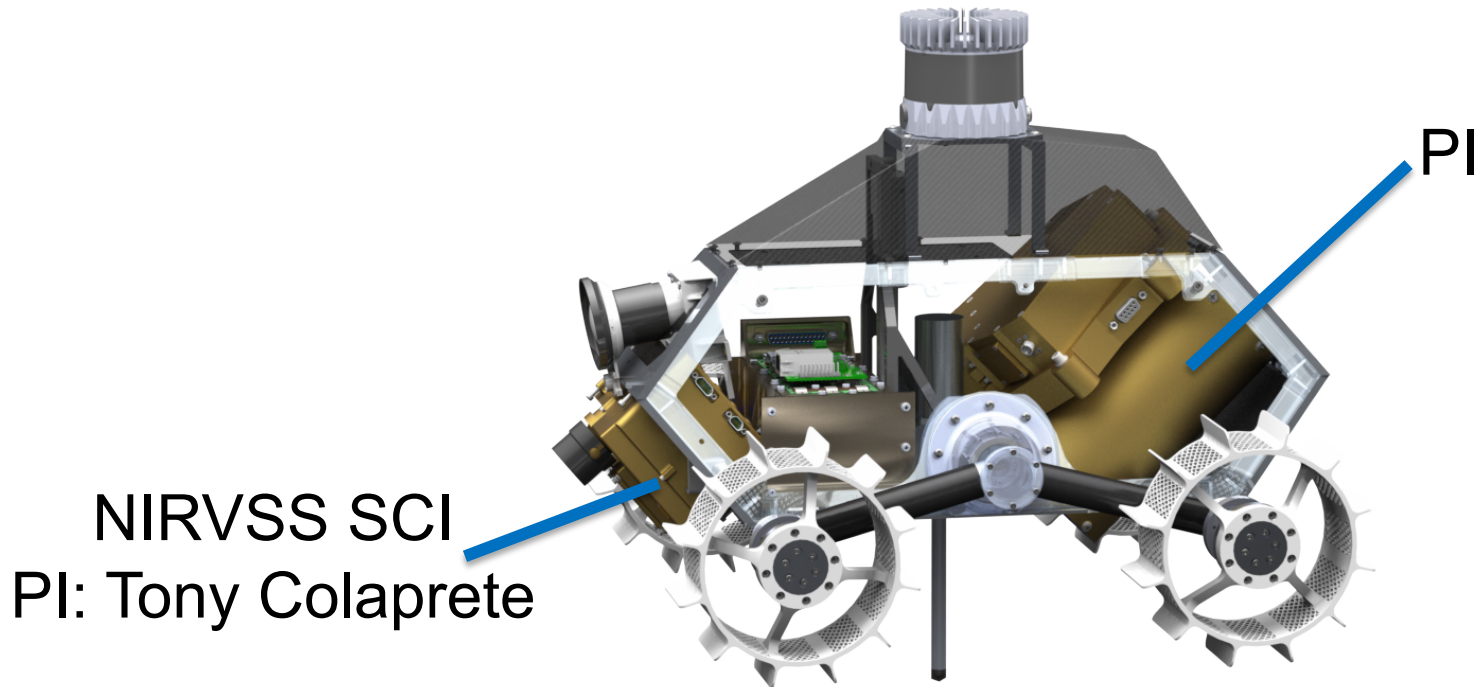
SWaP & Payload

- L: 45 cm
- W: 38 cm
- H: 40 cm
- 5.2 kg
- 44 W



Combined payload volume: 4,640 cm³

SWaP & Payload



NIRVSS SCI
PI: Tony Colaprete

NIRSpec
PI: Dave Landis

- +3.9 kg
- +38 W

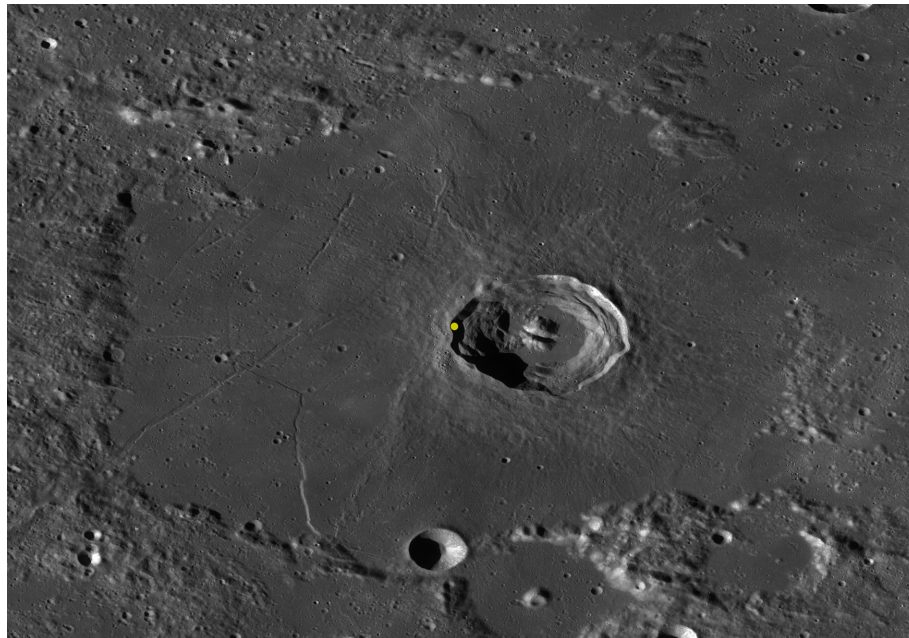
Total

- 9.1 kg
- 82 W

M1 Science/Prospecting Configuration

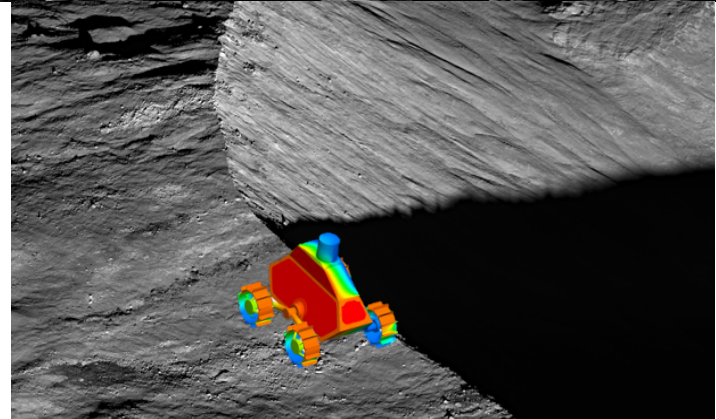
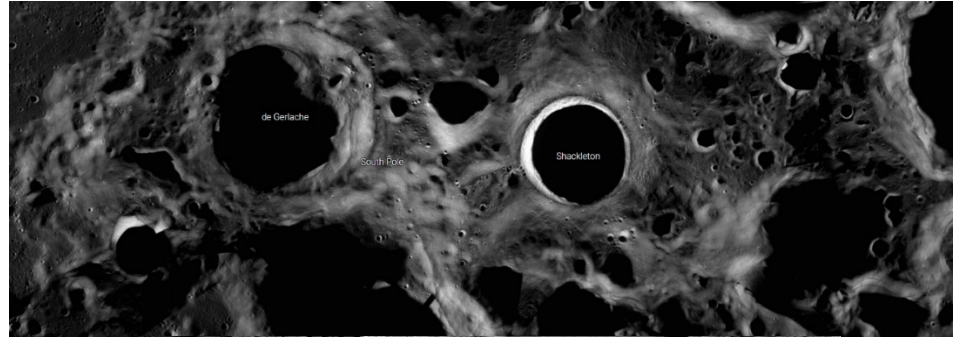
MAPP Baseline Mission

- Lunar Surface Instrument & Technology Payloads (LSITP)
- Lacus Mortis
 - 44 N 25 E
- -60 C to +130 C
- Mission Duration: 7-14 days
- Fully sunlit

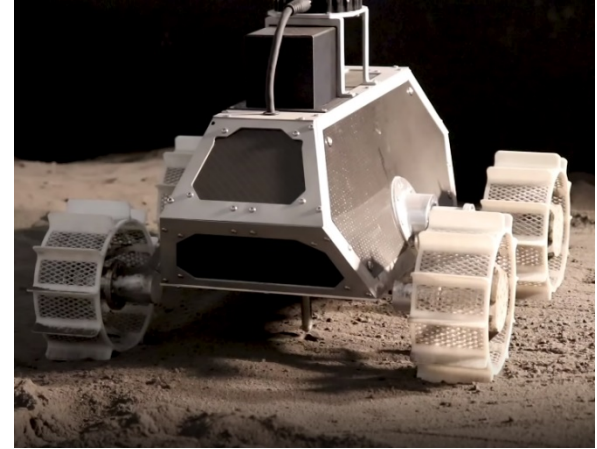
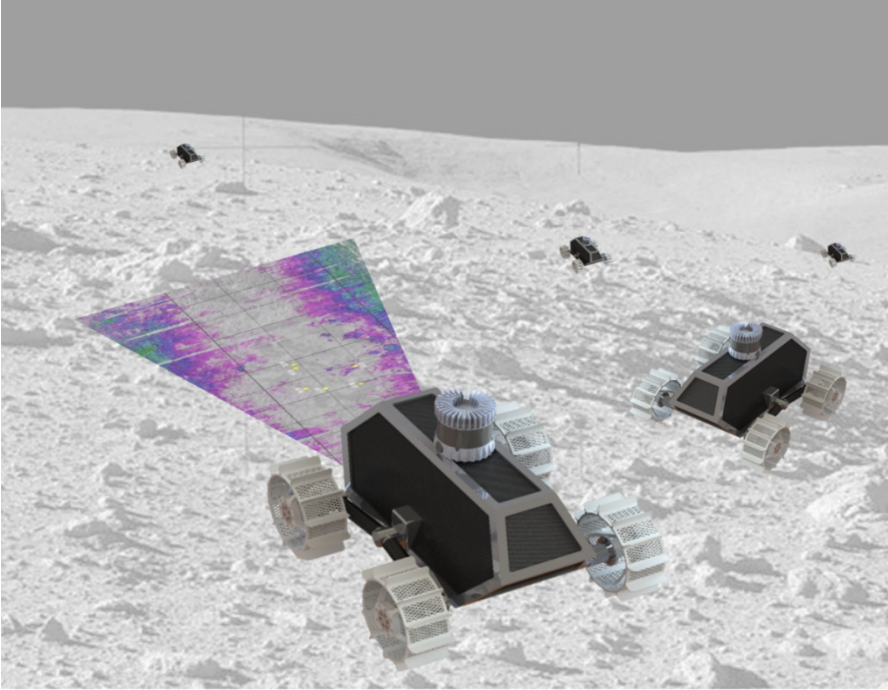


COLD-MAPP Mission

- CLPS TO3
- Lunar South Pole
- -230 C to +100 C
- Mission Duration: 75 days
- Survive 4 days without sunlight
- 20 km drive distance
- 2 km from lander

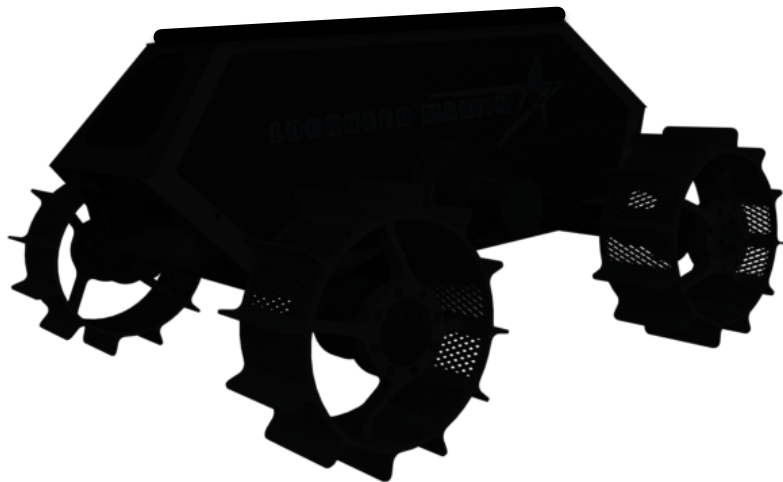
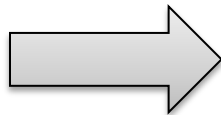
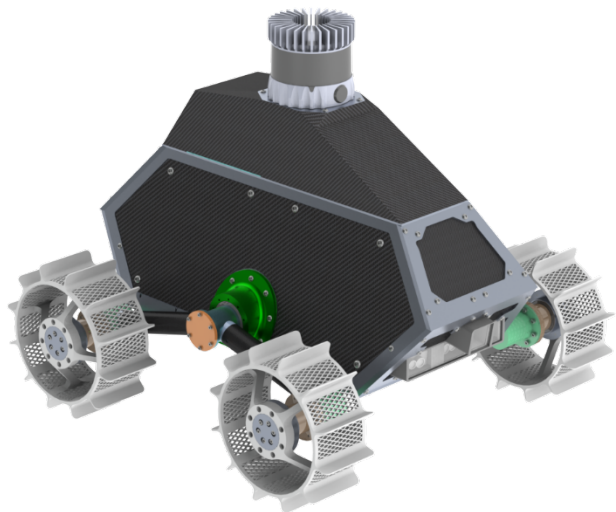


Swarm Surveying & Prospecting



- Cooperative path planning
- Intelligent sampling
- Seismometer
- Magnetometer

Design for Scalability



- Vision-based navigation
- Resource data overlay
- EPS & power optimization
- Microelectronic sensors

- 40 kg payload
- 85W payload power
- 325 kg launch mass
- 1.5m x 1.3m x 1.3m

Moving Forward

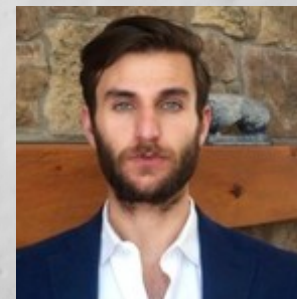
- Establish new paradigm of continuous rover deliveries
 - Human & Robotic Cooperation
- In Space Manufacturing & Assembly (ISMA)
 - Surface habitats
 - Comms & power cable laying
- Payload Manifests & Instrument Catalogs
 - Tech demonstration testbed
 - Drills & Spectrometers
 - Power Systems
 - Commercial Payloads
 - Data Customers





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