Armstrong UMV Concept for Lunar Surface Construction

09 June 2023 at Space Resources Roundtable

Presented by John Suh, VP & Founder of Hyundai New Horizons Studio

Hyundai-Kia America Technical Center, Inc. (HATCI) | R&D Division
Hyundai Motor Group

Outline

UMV size categories: Micro- and Mini-UMV

Roboticized suspension [or **a**daptive, **h**igh **r**ange-of-**m**otion **s**uspension]

Robotized chassis

Ideas about UMVs in lunar construction

Lunar Outpost collaboration

Types of UMVs_Micro and Mini

Summary

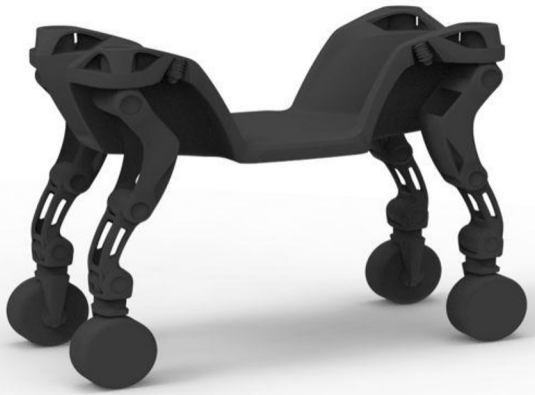
There are two platforms under development: Micro-UMVs and Mini-UMVs

- **Micro** UMVs are uncrewed. The X-1-A is a Micro UMV currently in development
- Mini UMV is crewed vehicle that is targeted to carry a driver and a passenger

For both Micro UMVs and Mini UMVs, the long-term vision is that they are **collaborative mobile autonomous vehicles** which help people accomplish their jobs and work

Micro UMV > X-1-A

Uncrewed
Curb weight (without payload): <100 kg



Mini UMV > X-2 without body

Crewed
Curb weight (without payload): 400 kg to 800 kg

Average Adult Male

H: 1754 mm
Mass: 90 kg

X-2 scale AHROMS on test stand (video)

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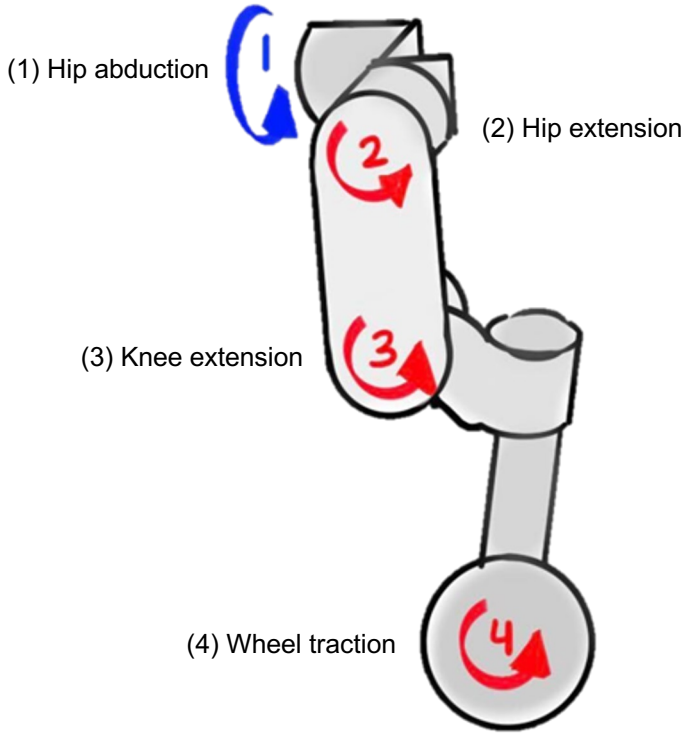
Adaptive, High Range-of-Motion Suspension (AHROMS)

- AHROMS is the distinguishing feature of UMVs
- AHROMS is a “robotized” suspension
- The suspension function is replaced by a combination of motion control devices and passive mechanical elements
- A suspension with motion control devices can be programmed to give a vehicle increased mobility and deliberate traction
- Increased mobility: Travel over terrain previously insurmountable with traditional suspensions
- Deliberate traction: Wheeled locomotion done in an intentional way

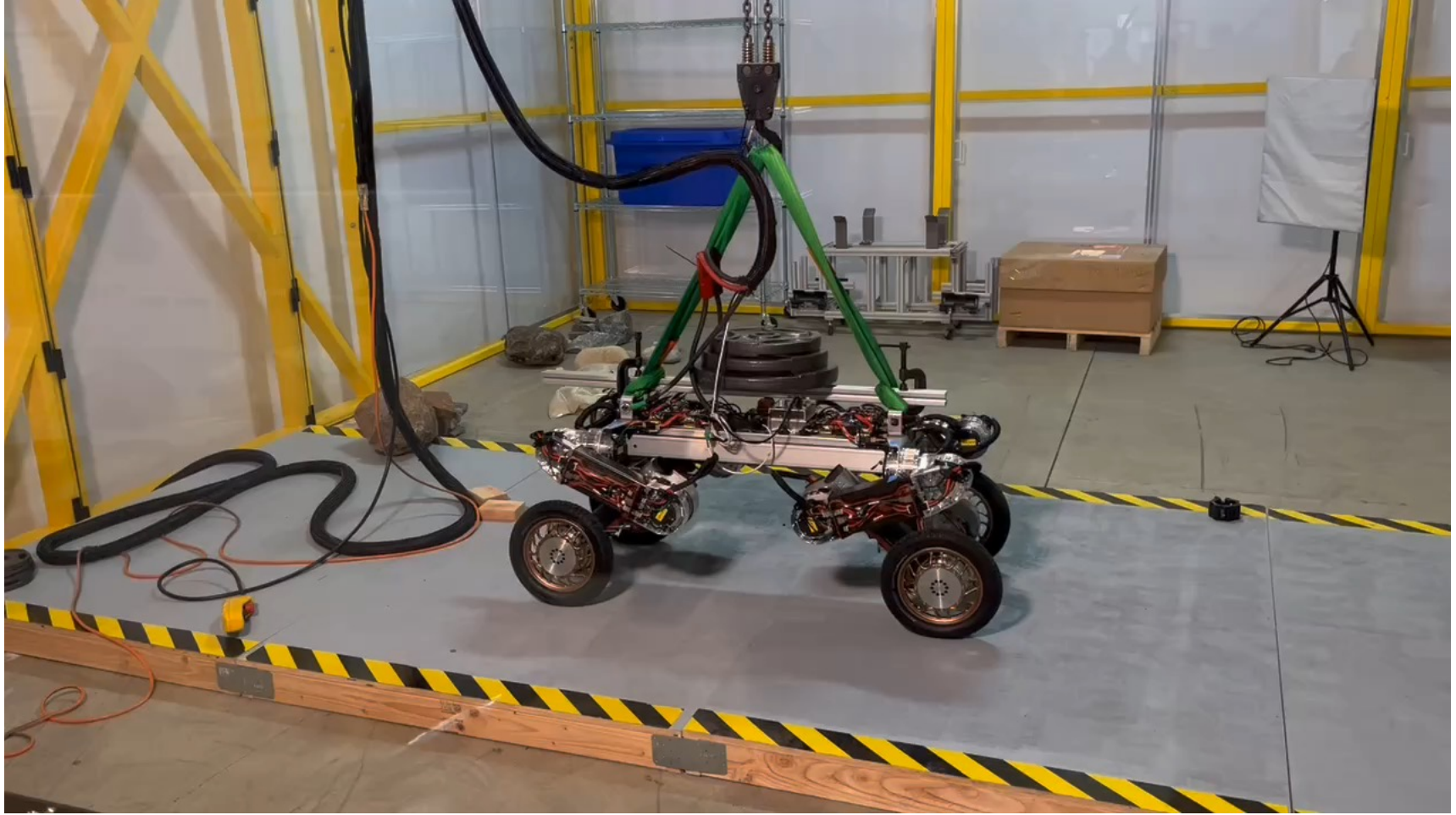
Mini-UMV_X-1-A Mk 1 [in testing]

- Architecture was selected to prioritize walking performance
- AHROMS moves in 3D space
- Skid steering

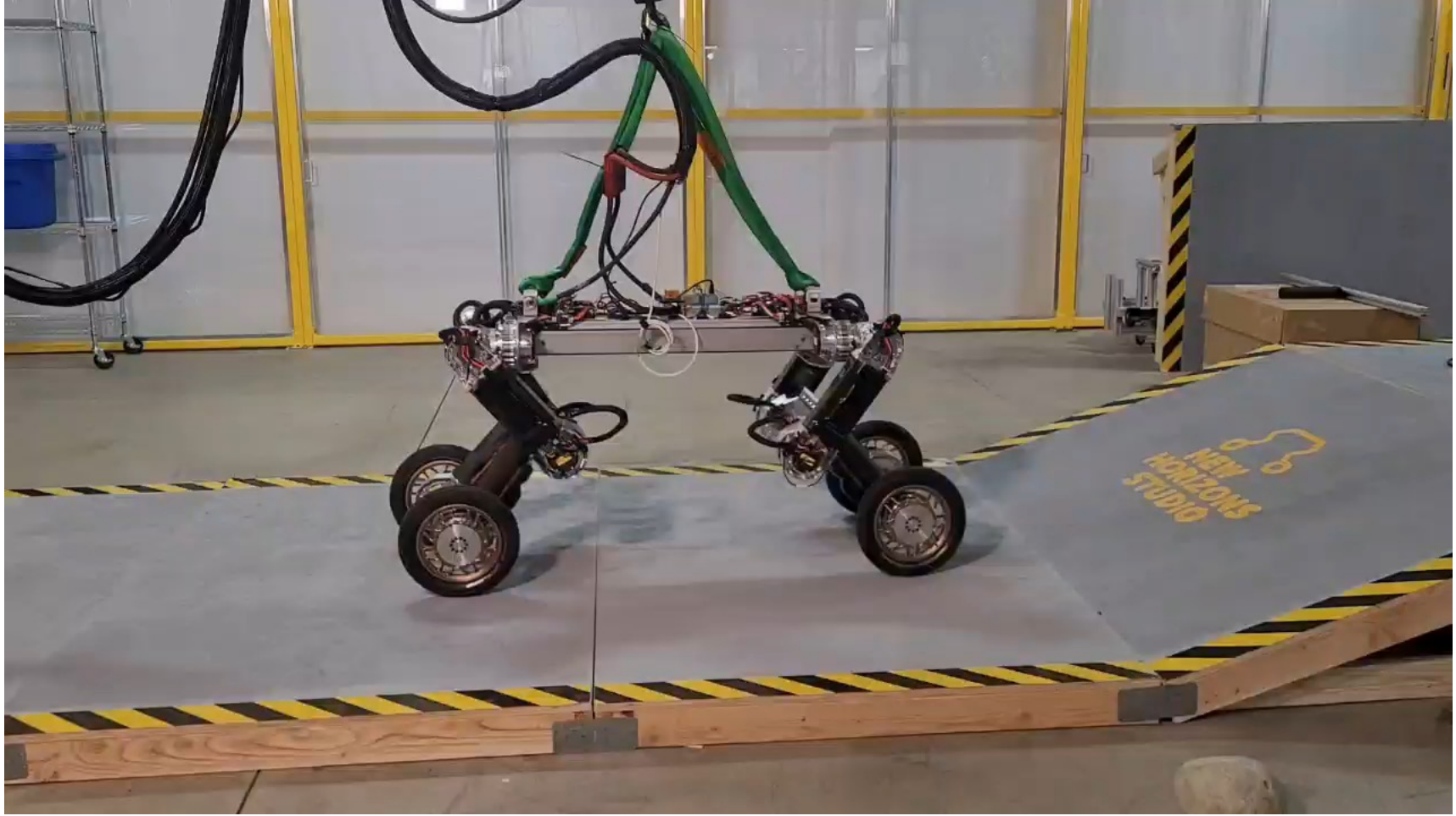
AHROMS architecture



Micro UMV X-1-A Mk 1 Prototype

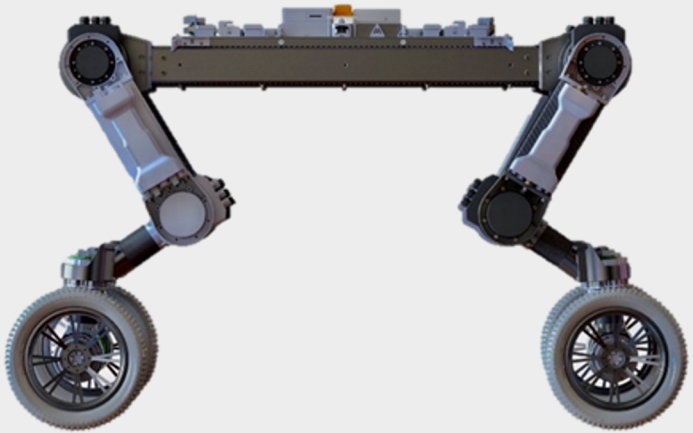


Micro UMV, X-1-A Mk 1, squat lift, 105 lbs. (video)



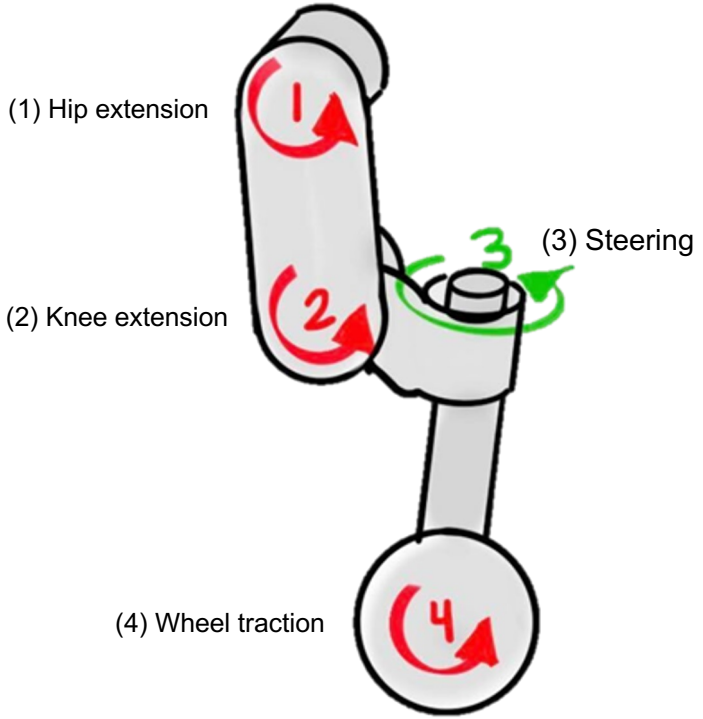
Micro UMV, X-1-A Mk 1, driving up ramp (video)

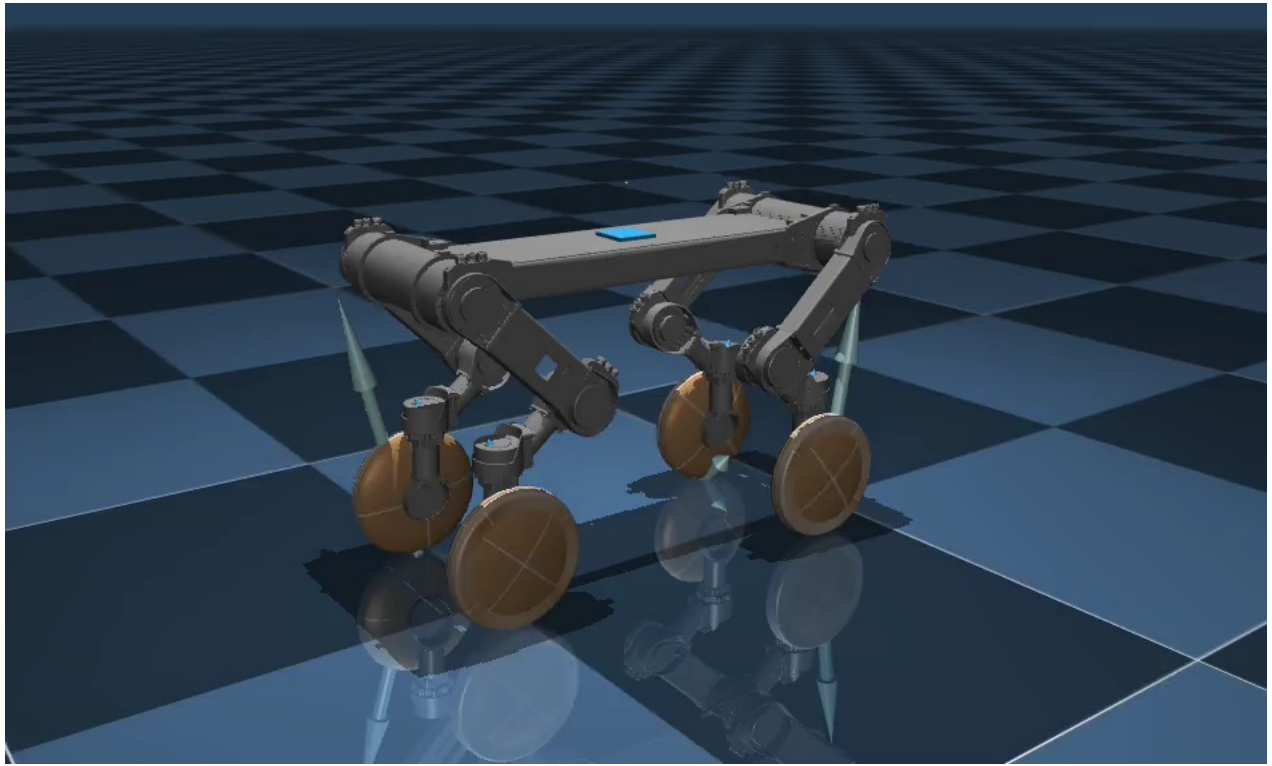
Mini-UMV_X-1-A Mk 2 [in design]



- Architecture was selected to prioritize driving performance
- AHROMS moves in 2D space
- Dual Ackerman steering

AHROMS architecture





Micro UMV, X-1-A Mk 2 in driving simulation (video)

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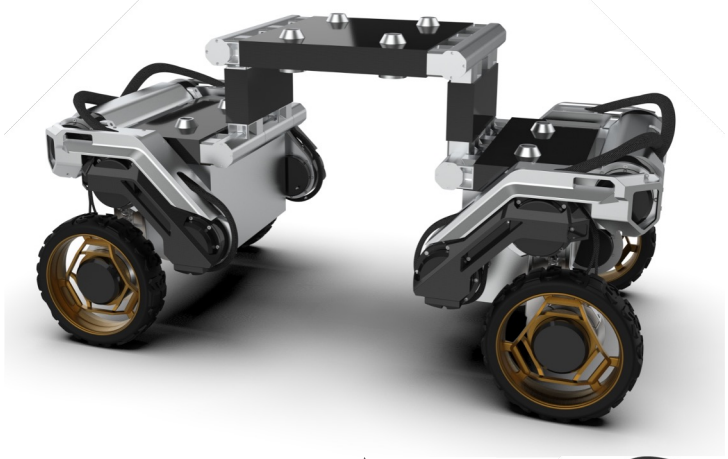
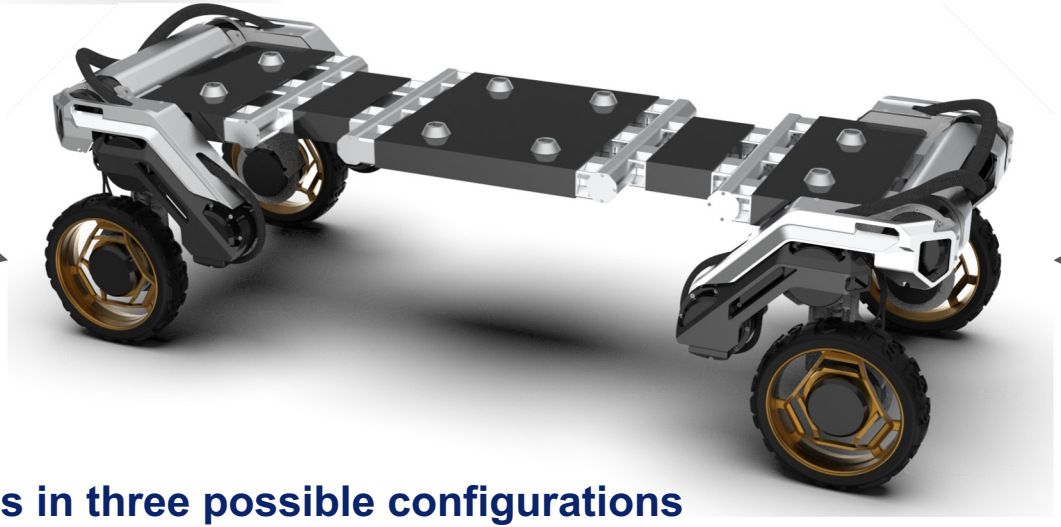
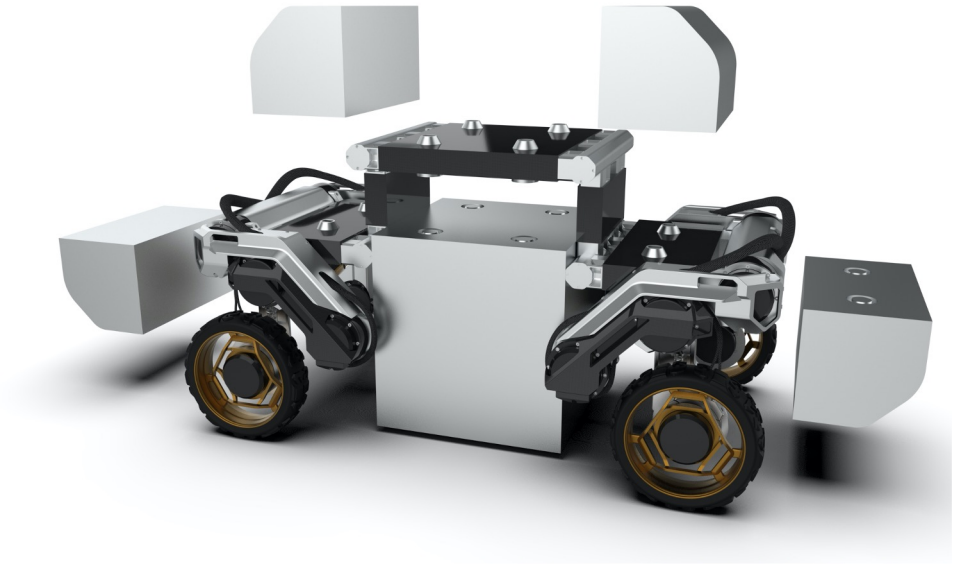
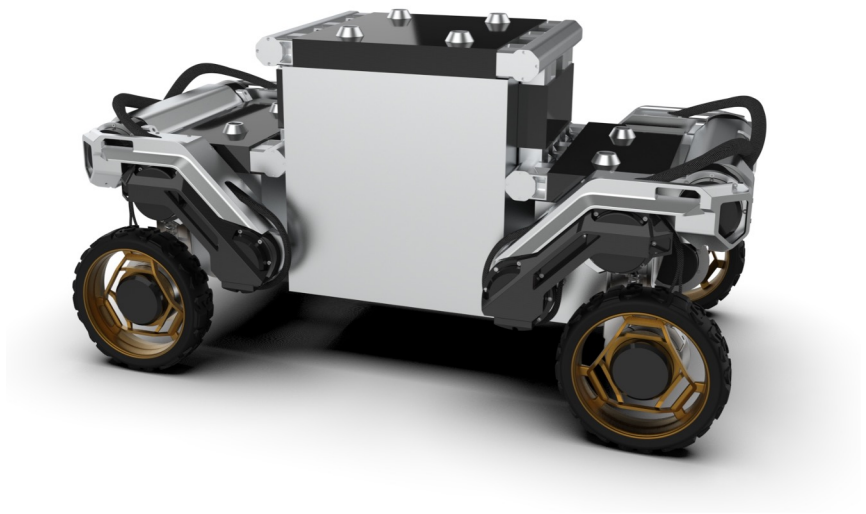




Micro-UMV chassis in three possible configurations

Micro-UMV with chassis in “tub” configuration





Micro-UMV with chassis in “arch” configuration

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► Ideas about UMVs in lunar construction

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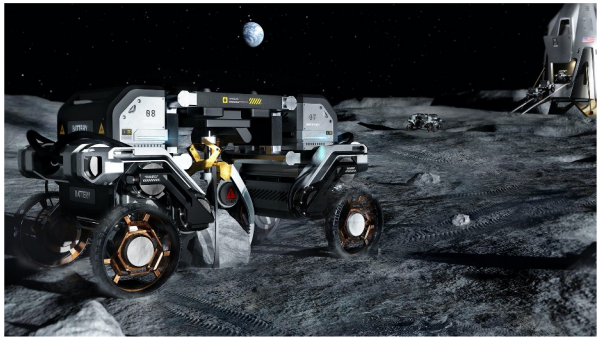
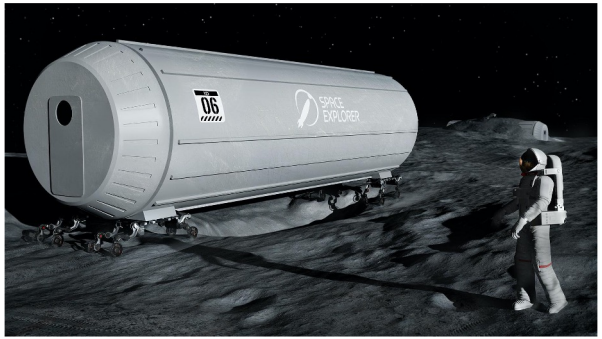
UMV Applications_Lunar construction and space resource development

UMV is a mobility platform that can be adaptive to multiple applications
Application requirements determine the whole vehicle design as well as the number of UMVs in operation

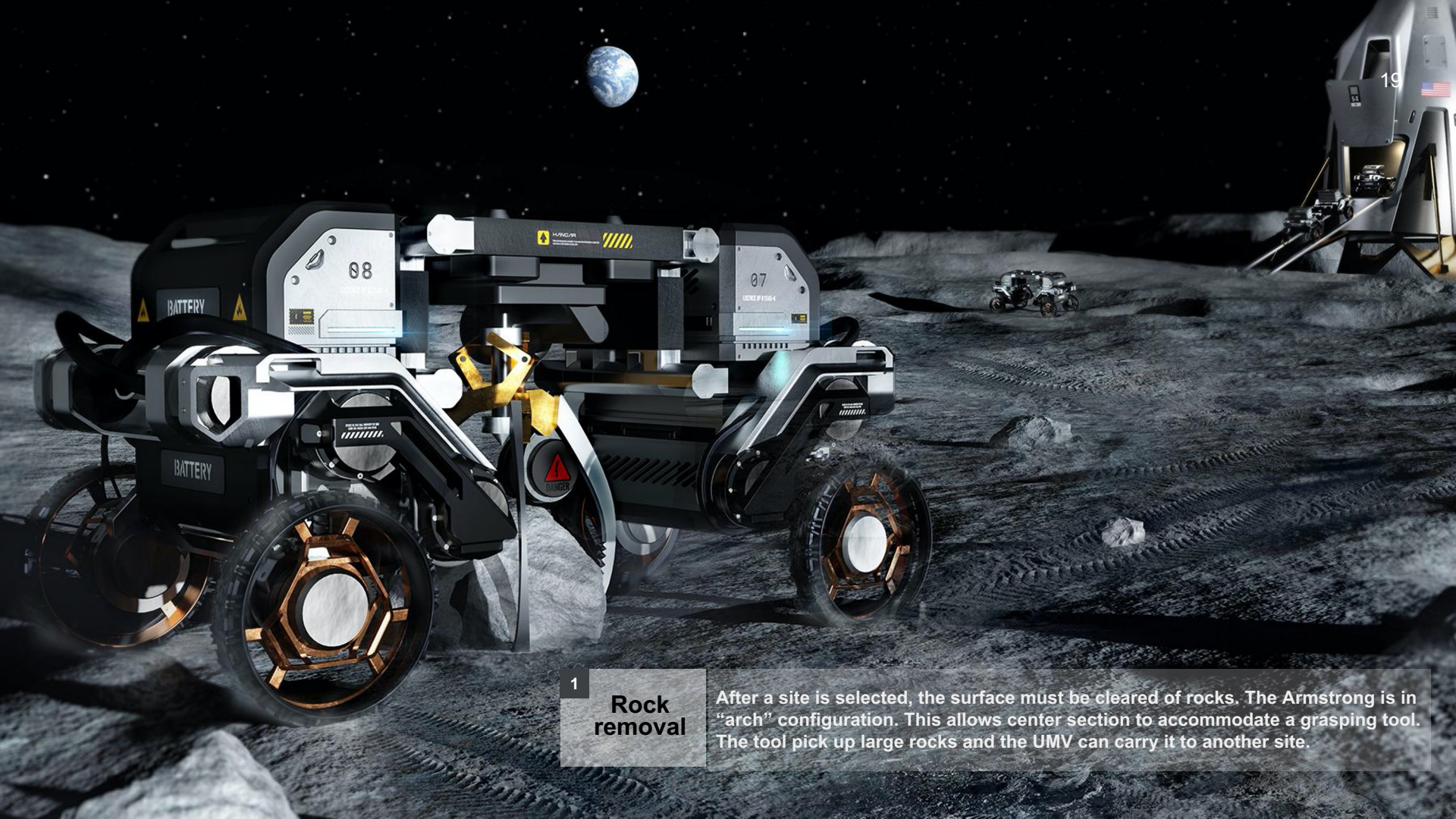


Surface Science
UMVs could be used as a rover for surface science.



Lunar Construction
UMVs can be used for building infrastructure and longer-term habitats for crews.

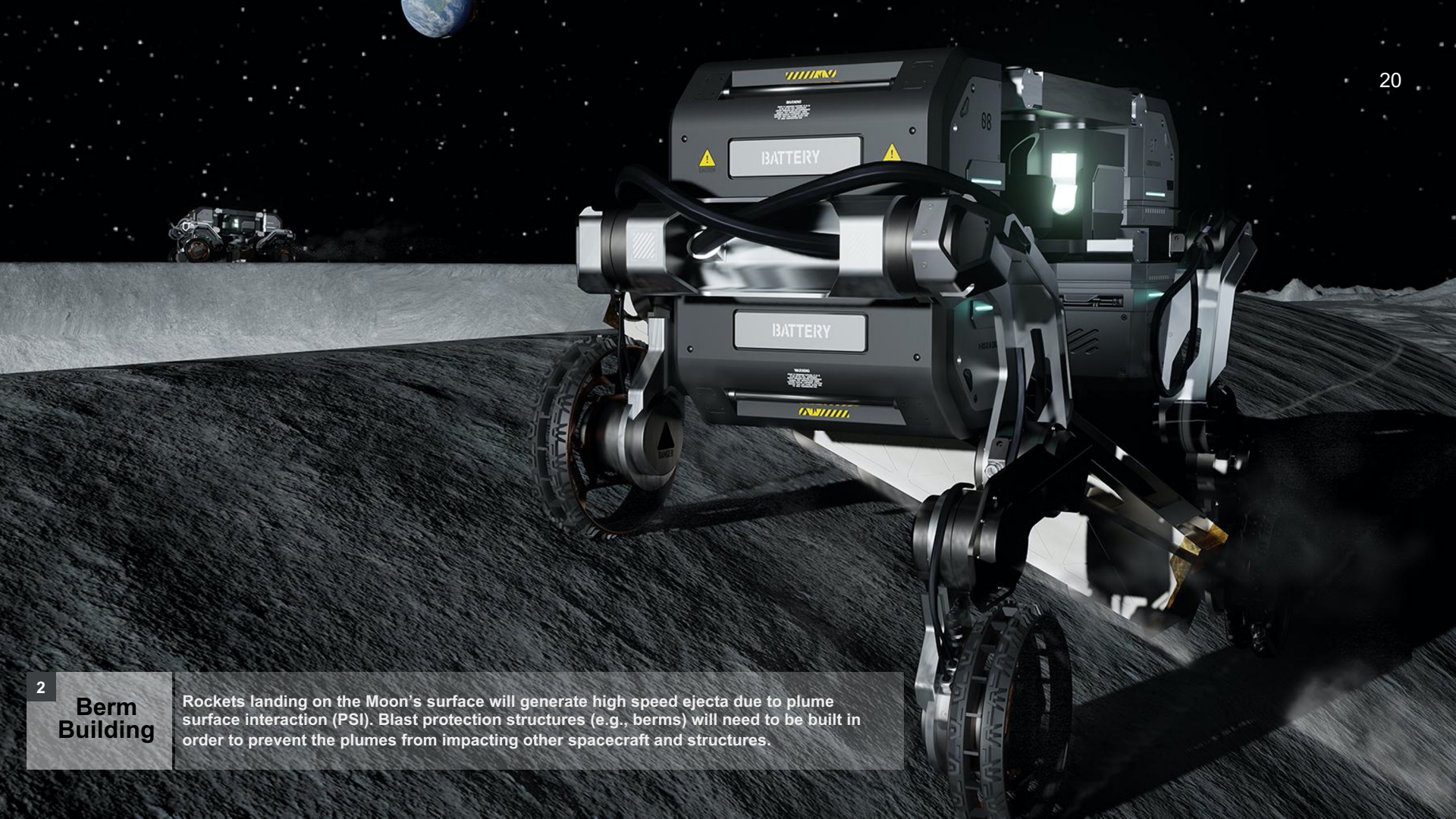
Astronaut Support Vehicle
UMVs can assist crews with tasks through autonomous operation or by collaborative human-robot teams.



1

Rock removal

After a site is selected, the surface must be cleared of rocks. The Armstrong is in “arch” configuration. This allows center section to accommodate a grasping tool. The tool pick up large rocks and the UMV can carry it to another site.



2

Berm Building

Rockets landing on the Moon's surface will generate high speed ejecta due to plume surface interaction (PSI). Blast protection structures (e.g., berms) will need to be built in order to prevent the plumes from impacting other spacecraft and structures.

3 Surface Sintering

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5

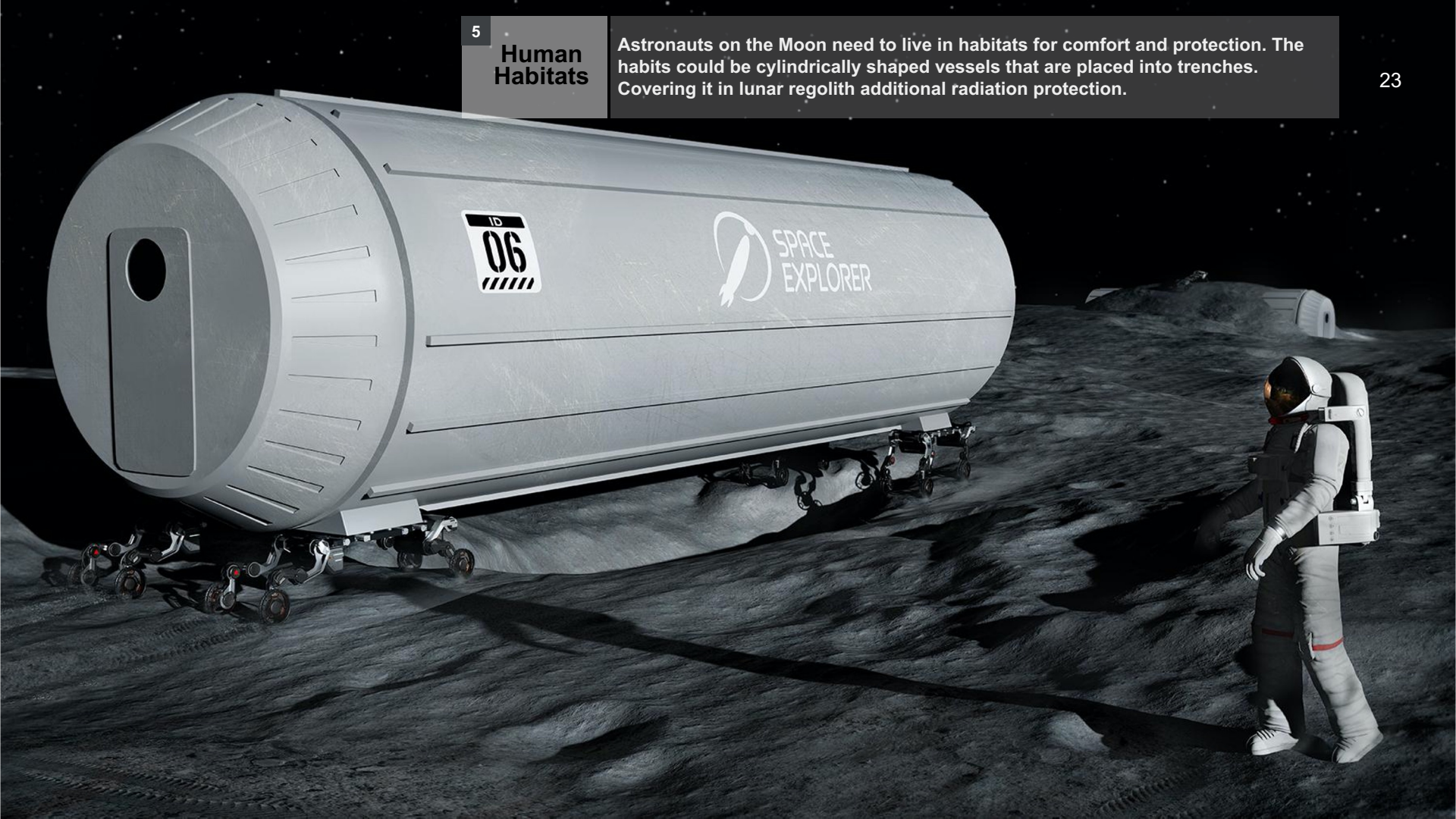
Ground Logistics

A permanent settlement will require supply from the Earth. Moving materials and goods from the lunar landers to the worksite or settlement will be facilitated by a fleet of surface vehicles. UMVs can be configured for good delivery or surface preparation tasks.

5

Human Habitats

Astronauts on the Moon need to live in habitats for comfort and protection. The habits could be cylindrically shaped vessels that are placed into trenches. Covering it in lunar regolith additional radiation protection.



6 Electric Grid

An electric grid will be needed to distribute the electricity from the generator to the point of consumption. At the middle top of this picture, Armstrong is in “flat” configuration to carry a solar panel. In the bottom, Armstrong is in “tub” mode to dispense cable from a spool.

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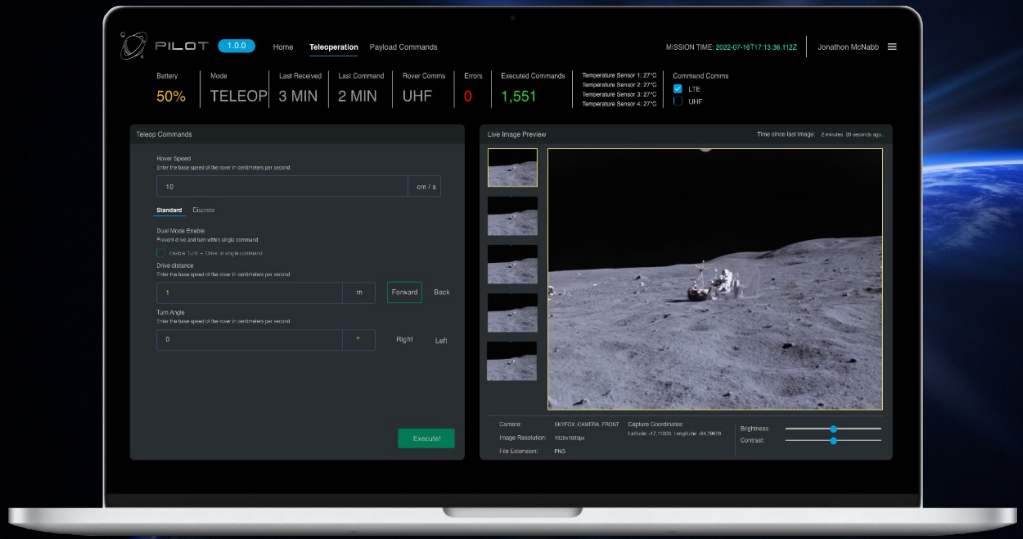
STARGATE

Robotics mission control platform enabling informed operator decisions for robotic system control and commercial payloads

Lunar Outpost™

- Command and control of robotic systems
- Customer data access for rover telemetry, payload systems, and scientific observations
- Enabling live camera/sensor feeds from remote locations
- Modern cloud-based infrastructure
- Security by design



Used by:

- Hyundai UMV [WIP]
- Lunar Voyage 1 – Nokia, MIT
- Lunar Voyage 2 – JHU APL, NASA
- Lockheed Martin LTV

Stargate Applications:

PILOT

MOONSIGHT

FORGE

ZEBCHAT

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