

SPACE RESOURCES HANDLING SYSTEMS FOR LUNAR, MARTIAN, AND SPACE MISSIONS



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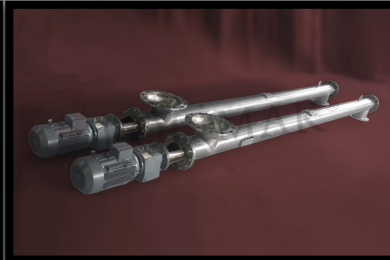
Bulk Material Handling Systems for Terrestrial and Celestial Applications



Excavation & Collection



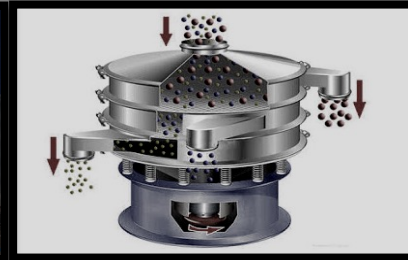
Transportation



Conveying & Feeding



Storage



Sieving, Size Separation



Image Credit: NASA

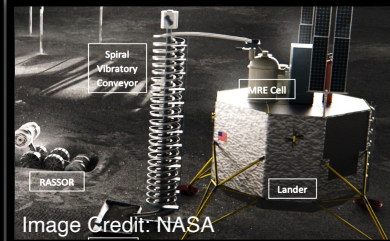
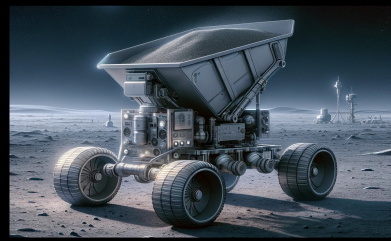


Image Credit: NASA



Image Credit: Beth Lomax

Others

Loading, Filling, Discharging, Crushing, Grinding, Dust collection, Mixing & Blending, Bagging & Packaging, Weighing & Dosing

Challenges in Regolith Handling

- Abrasive Nature of Regolith
- Temperature Extremes
- Dust Emission
- Static Electricity
- Site / Conveying Route Changes
- Limited Power Supply
- Launch Weight Limitation
- Low / Micro Gravity

About Polimak



Who

Polimak is an engineering and fabrication company specializing in bulk solids handling technologies across multiple industries.

Team

Over 110 highly skilled professionals.

Where

Türkiye, USA, Germany, UK, Ireland

Objective

To create comprehensive solutions for space resource handling, by leveraging current know-how from terrestrial applications.

ISRU Projects

Space Resource Handling:

Solutions for transport, conveying, and storage in lunar, Martian, and space environments

Regolith Processing:

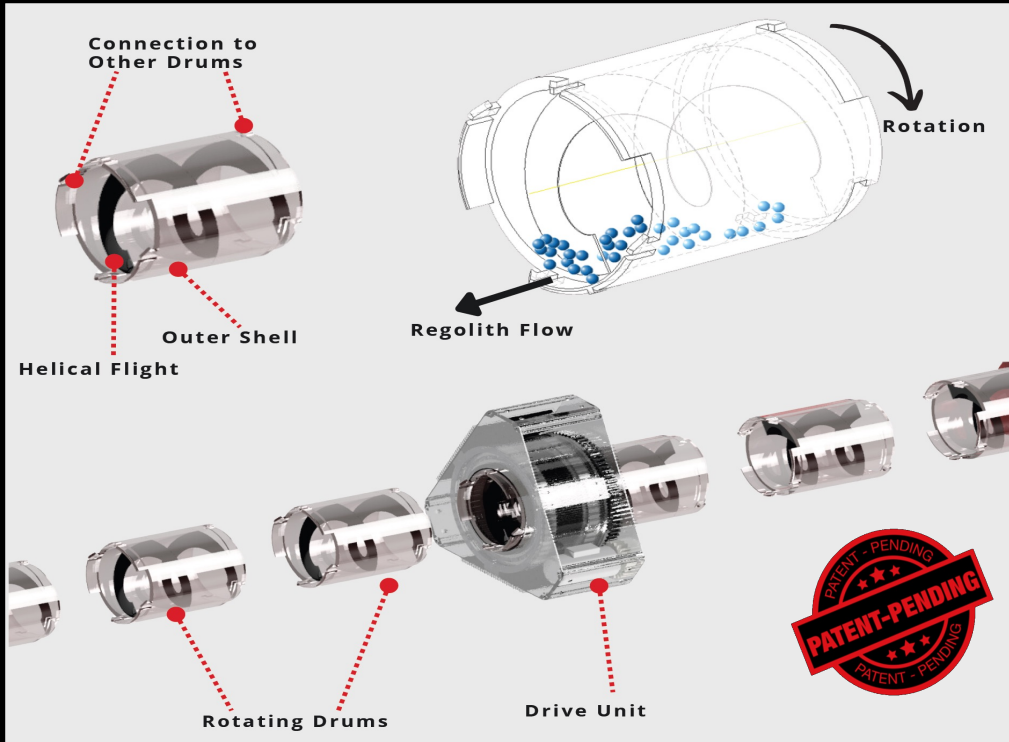
Systems for preconditioning and volatile extraction from lunar soil.

Integrated Lunar Solutions:

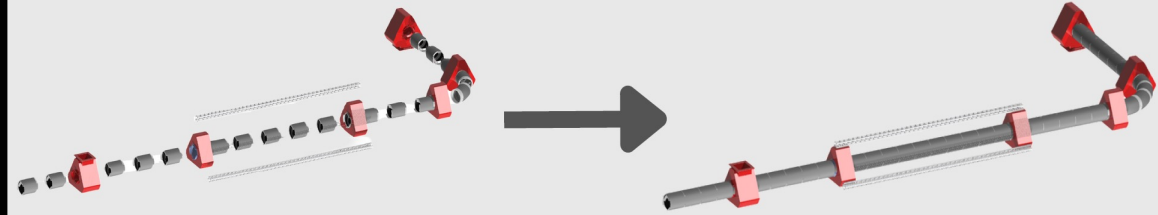
Tailored setups for lunar missions, focusing on construction and resource extraction.



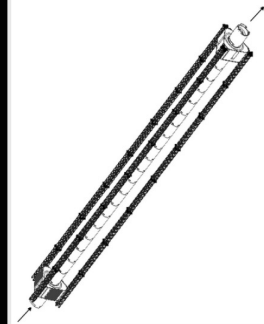
Systems in Development: Modular Drum Conveyor



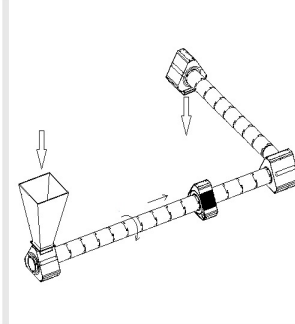
SMART ASSEMBLY



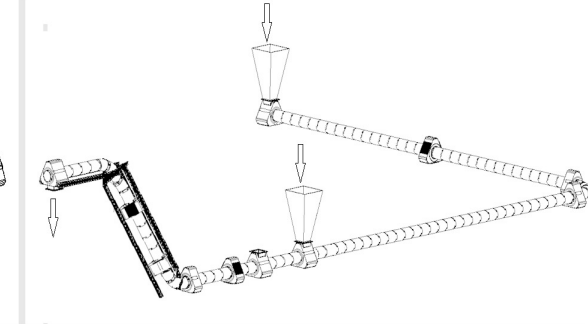
INFINITE CONFIGURATIONS



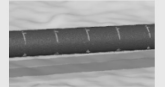
Inclined conveying
1 inlet, 1 outlet



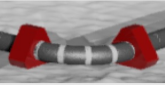
Horizontal conveying
1 inlet, 1 outlet



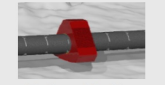
Horizontal & inclined conveying
2 inlets, 1 outlet



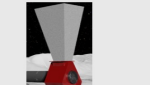
Linear Rotating Drum



Flexible Rotating Drum



Drive Unit



Inlet Unit

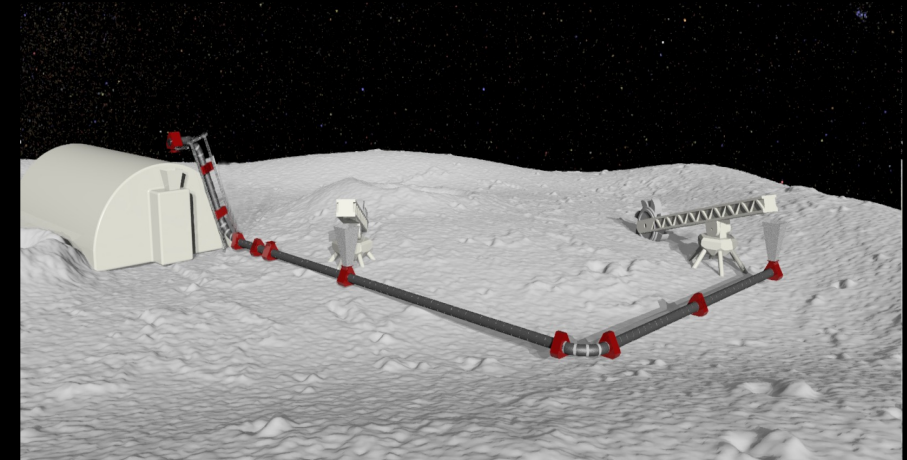


Outlet Unit

The modular drum conveyor facilitates the effective transport of space resources between excavation areas, construction sites, processing units, and lunar landers.

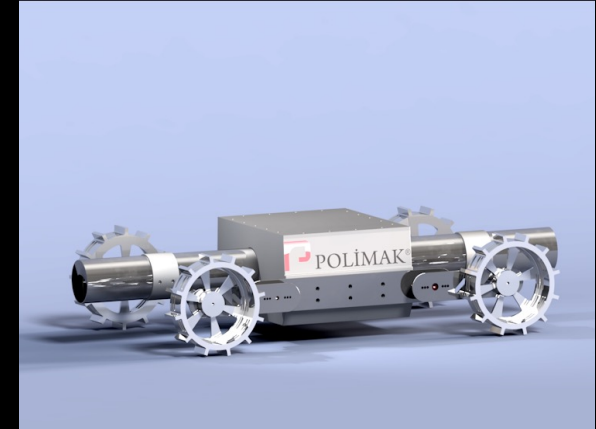
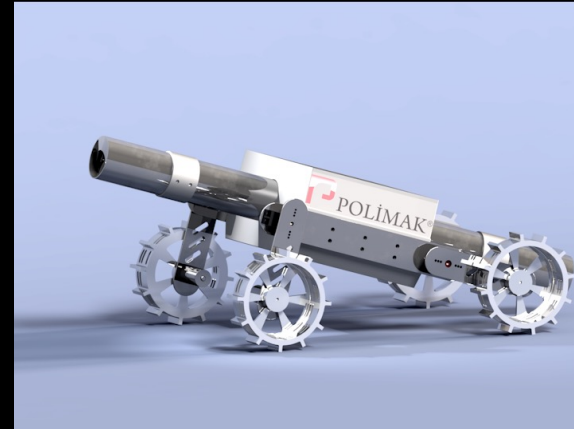
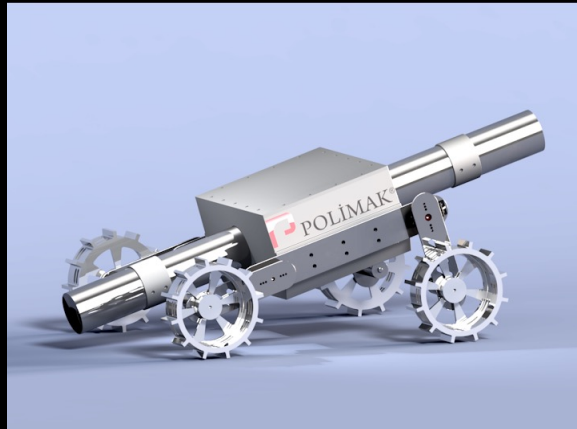
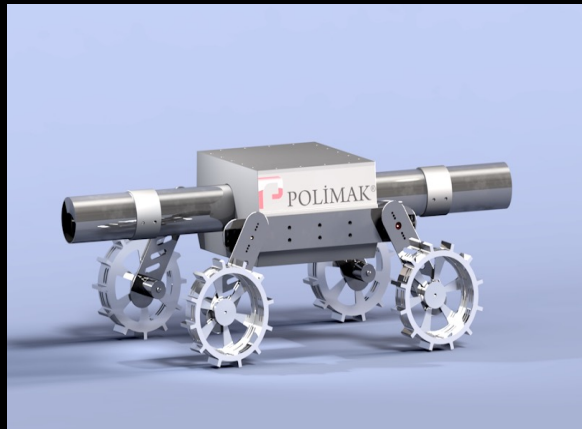
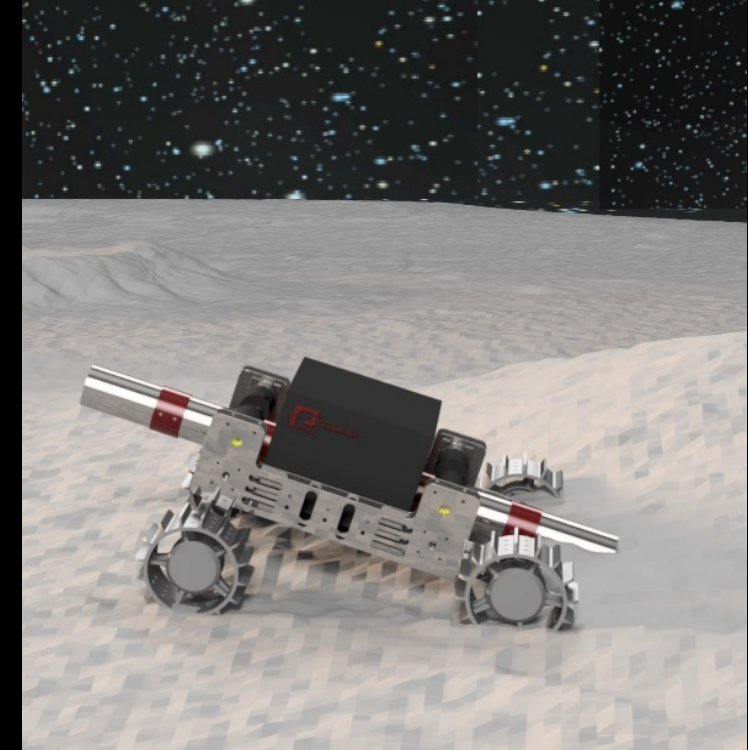
Key Features:

- Modular design for endless configurations, conveying routes and distances.
- Suitable to install on rovers for excavation and transportation
- Fully contained conveying minimizes dust emission and damage on mechanical parts.
- Minimized abrasion due to rolling of particles instead of forced sliding
- 50% of the parts can be built and sourced from local raw materials.



Systems in Development: Conveyor for Rover Platforms

- The modular drum conveyor concept is ideal for lunar rover platforms.
- The rotary drum excavates loose regolith and transfers it to the other end.
- Provides continuous excavation and transloading.
- The middle section of the rotary drum inside the rover body can have a larger diameter, providing higher payload capacity.
- Multiple rovers can operate sequentially, forming a continuous regolith conveying line.



Systems in Development : Regolith Feedstock Preparation

Essential Feedstock

Critical for future lunar construction and resource extraction.

Storage Method

Store as stockpiles in open areas for simplified handling.

Preparation

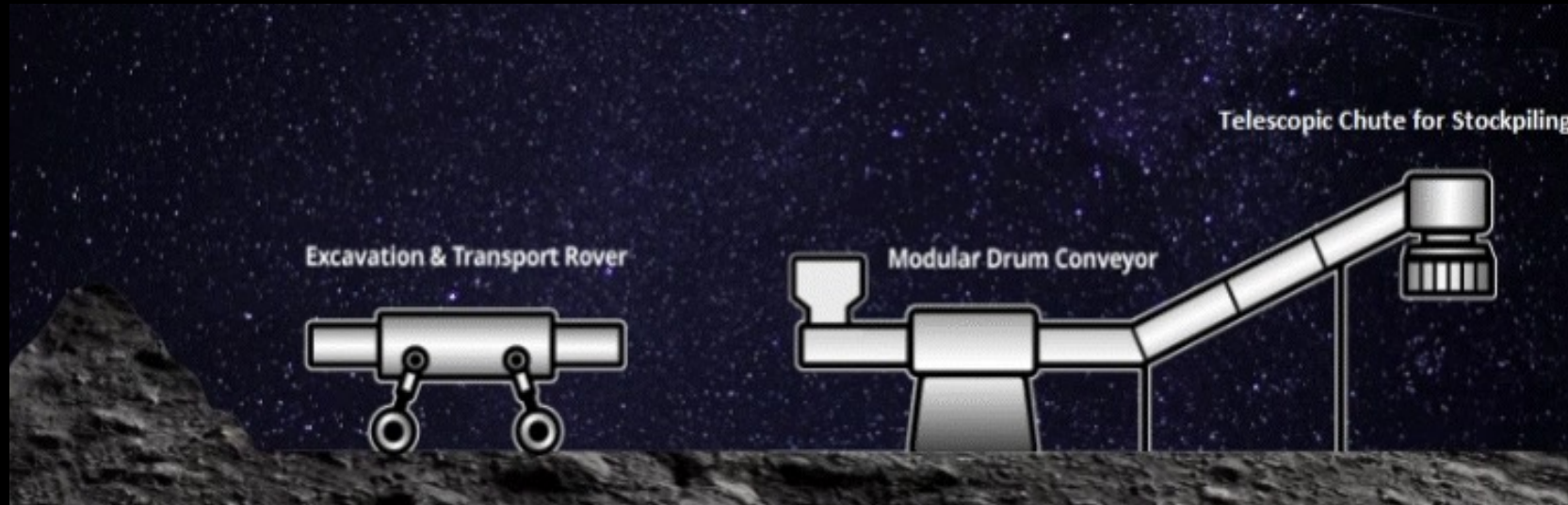
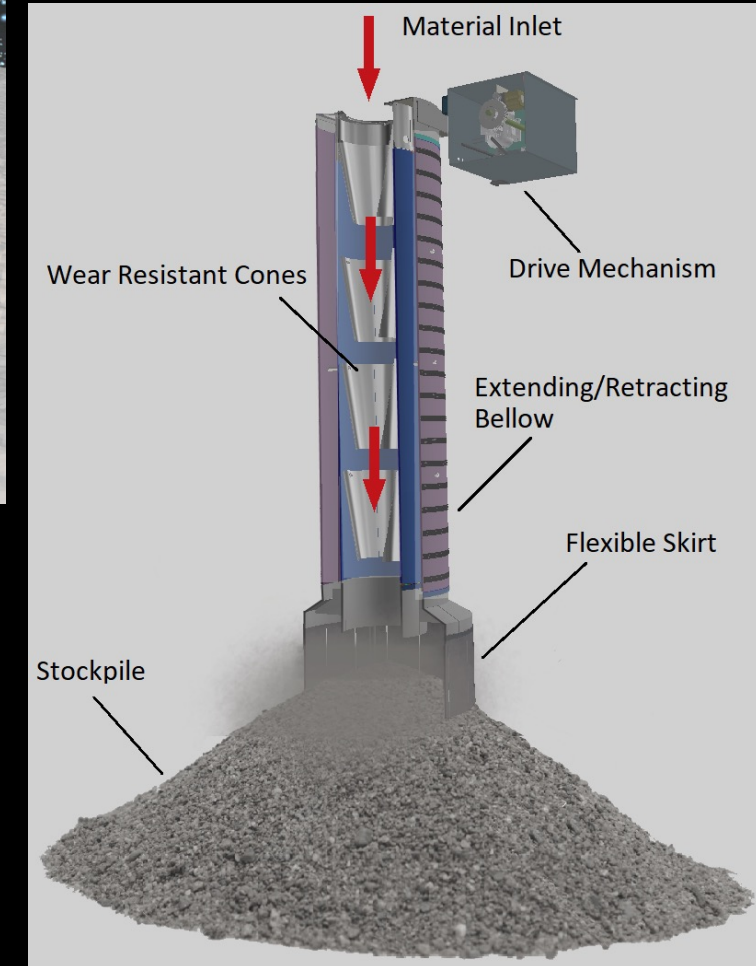
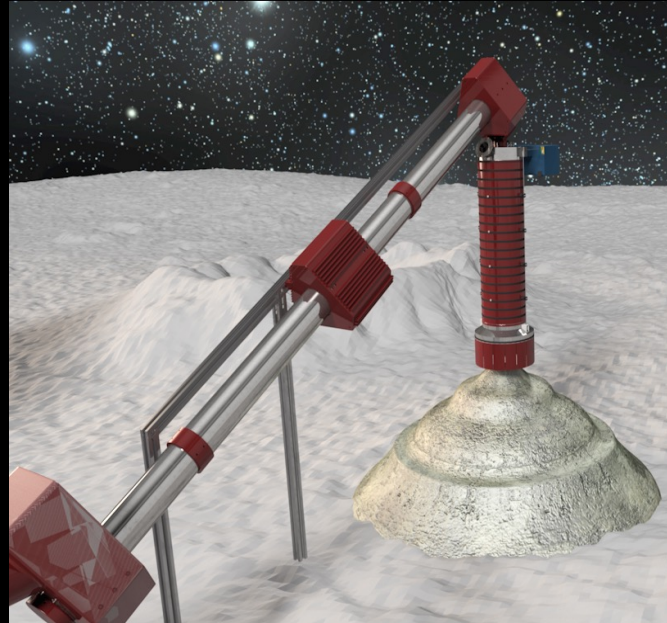
Move regolith to higher levels and drop by gravity.

Dust Mitigation

Use extendable and retractable chutes with flexible skirts to prevent particle spread.

Suggested Solution

Modular drum conveyor with attached telescopic chute



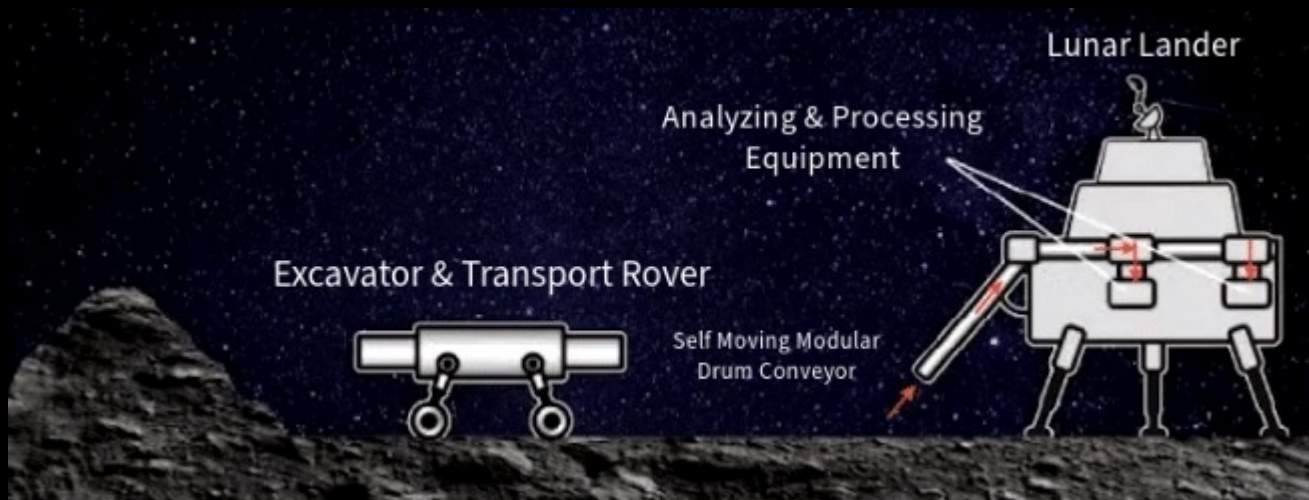
Systems in Development : Lunar Lander Regolith Delivery

Challenges

- Delivering regolith to ISRU reactors and analysis devices in lunar missions. [1-3]
- Devices need to be either placed on the ground after landing or have regolith moved up to them.
- Necessity to distribute regolith to several devices
- Regolith samples must be transported from various locations, or alternatively, devices need to be mounted on lunar rovers.

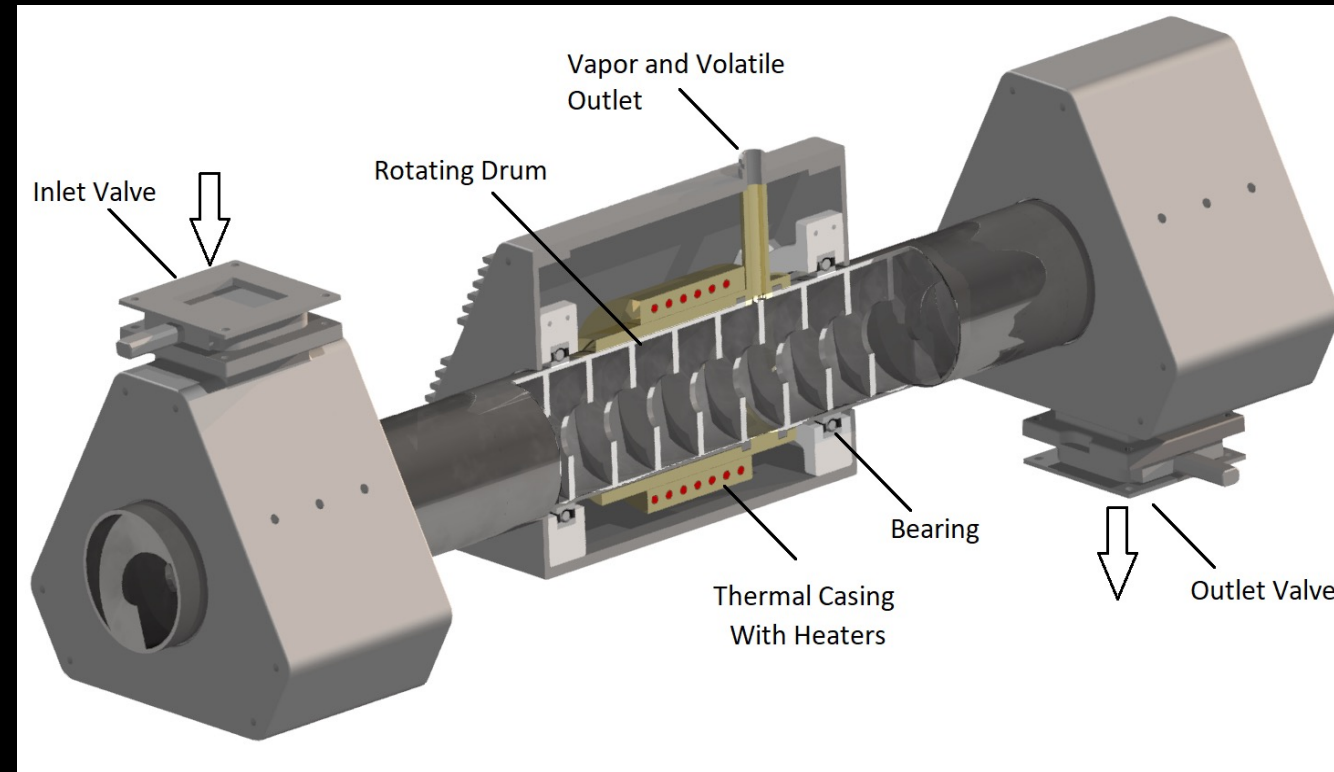
Suggested Solution

- Lander-Based Devices: Keep ISRU reactors and analysers on the lander.
- Conveyor System: Use conveyors to collect regolith from the ground and distribute it to devices on the lander.
- Rover Integration: Employ lunar rovers to transport regolith from distant locations to the conveyor system.



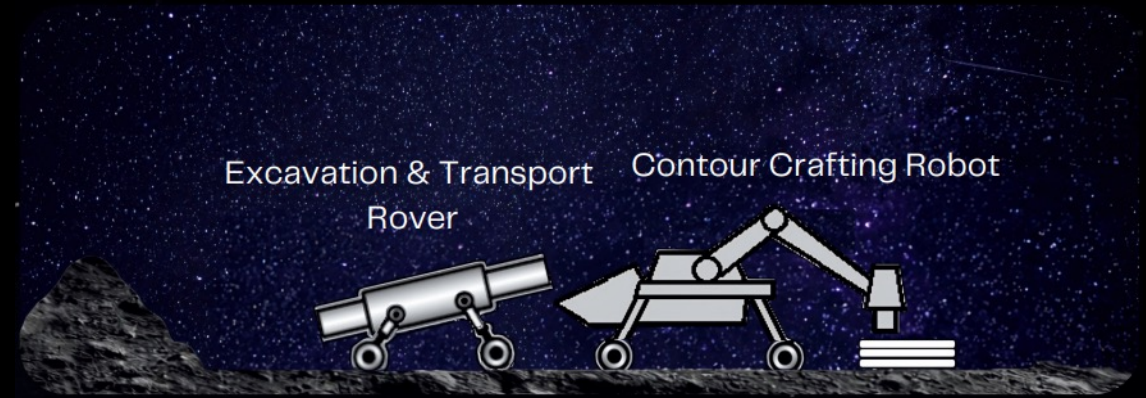
Systems in Development : Regolith Preconditioning System

- Preconditioning of regolith by sufficient heating to remove deleterious contaminants such as sulfur in preparation for subsequent O₂ and metal extraction processing or other uses, based upon discussions with LSII (pers. Comm. with C. A. Hibbitts).
- The preconditioning system design, analogous to but independently developed from NASA's Auger Dryer system [1], focuses primarily on preconditioning for O₂ extraction rather than water ice removal.
- System incorporates modular drum conveyor which is equipped with a built-in thermal casing.
- As the drum rotates, regolith is conveyed into the thermal extraction unit.
- Slide gate valves at the inlet and outlet sections are closed to create an enclosed environment.
- The thermal casing heats the regolith inside the rotary drum.
- Water vapor and other volatiles are collected through the top outlet.
- After thermal processing, the inlet and outlet slide gate valves are opened, allowing new material to enter and processed regolith to be transferred to downstream equipment.

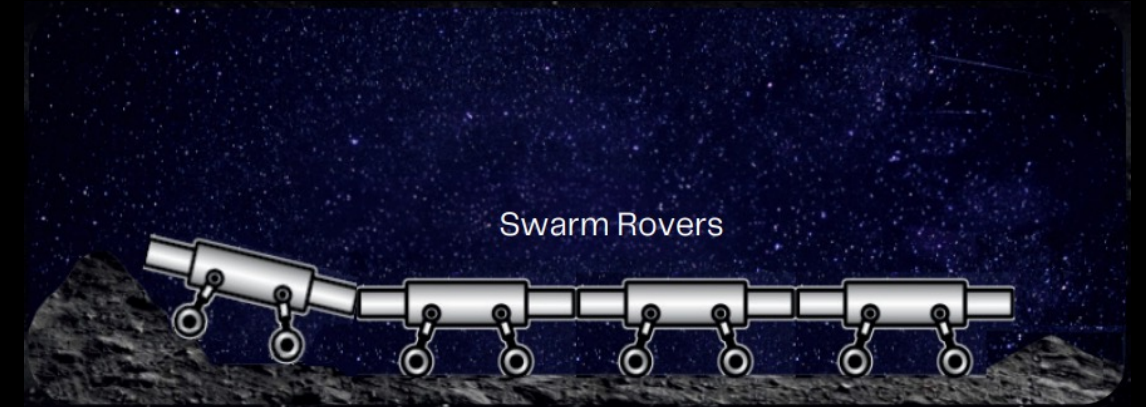


Other Scenarios

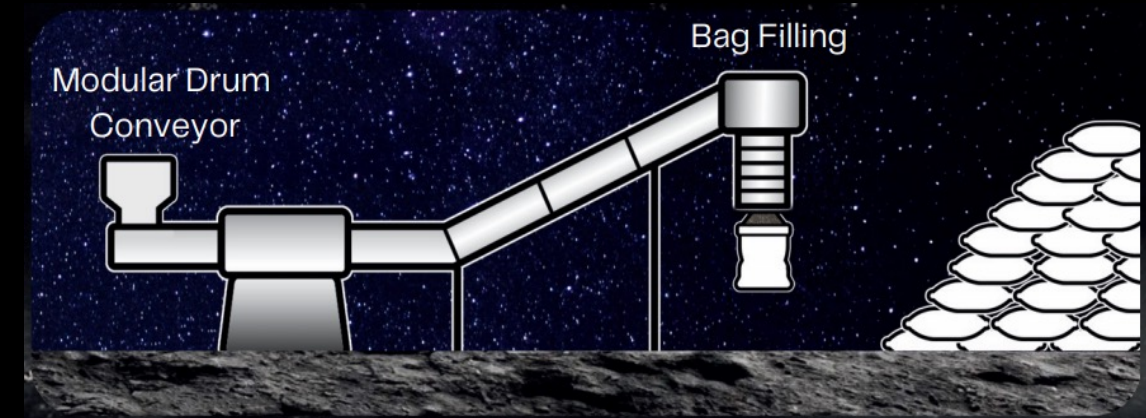
Feeding Regolith to lunar construction machinery



Utilizing swarm rovers to form flexible conveying routes between various endpoints.



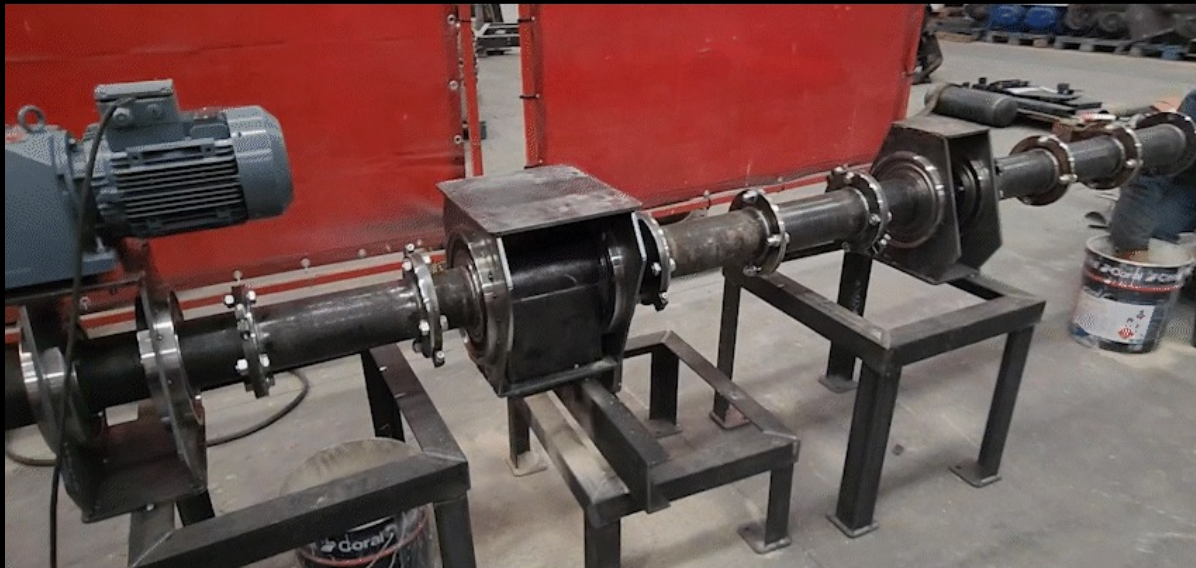
Filling flexible fabrics and inflatable structures for lunar base construction



Recent Progress

Achieved successful production and testing of various scales of modular drum conveyors, proving capability for long-distance, multi-directional bulk material conveyance.

Designed a rover equipped with a drum conveyor for effective surface excavation and material transport, enhanced by a compact conveyor model for efficient regolith feeding.



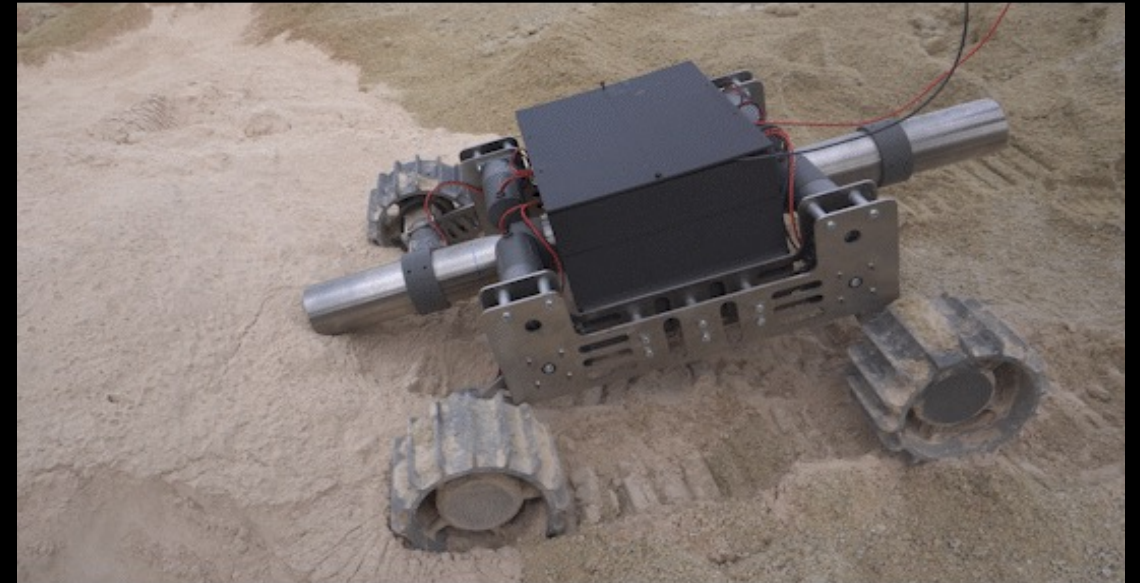
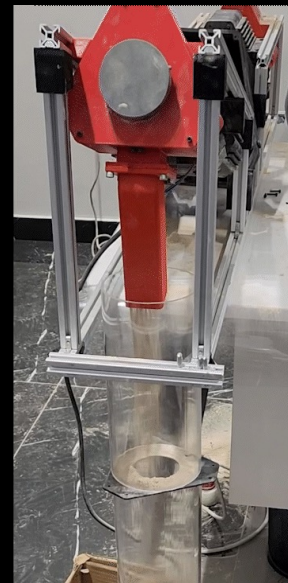
Recent Progress

Currently testing rover and conveyor systems in PTS Space's lunar testbed.

Showcasing end-to-end regolith handling capabilities from excavation to feeding of downstream systems.

Successfully tested horizontal and inclined conveying of regolith simulants.

Working for further scientific studies with academy and space tech companies.



Pilot Plant – End to End Testbed Services

Polimak, PTS Space, and Spacebackend companies have started a new mutual business to provide simpler form of pilot plant services for R&D projects.

End users will be able to attach their regolith processing systems on lunar lander mockup in PTS Space Rostock testbed.

Polimak's rover and conveyor system will provide regolith feed.

Spacebackend will provide remote control and communication services.



Pilot plant will be available in Q4, 2024



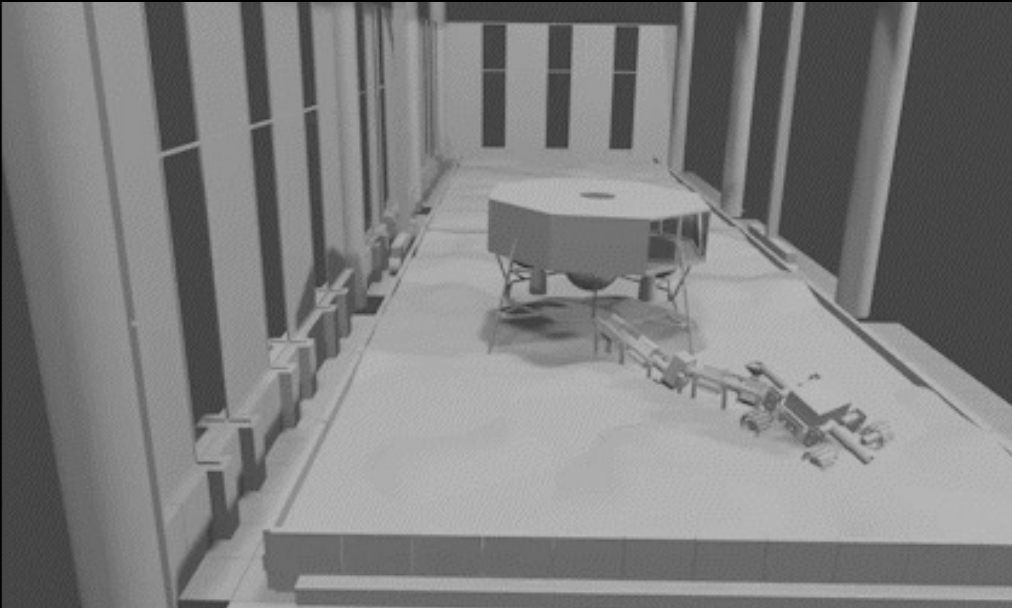
www.pts.space

Spacebackend

www.openmoon.space

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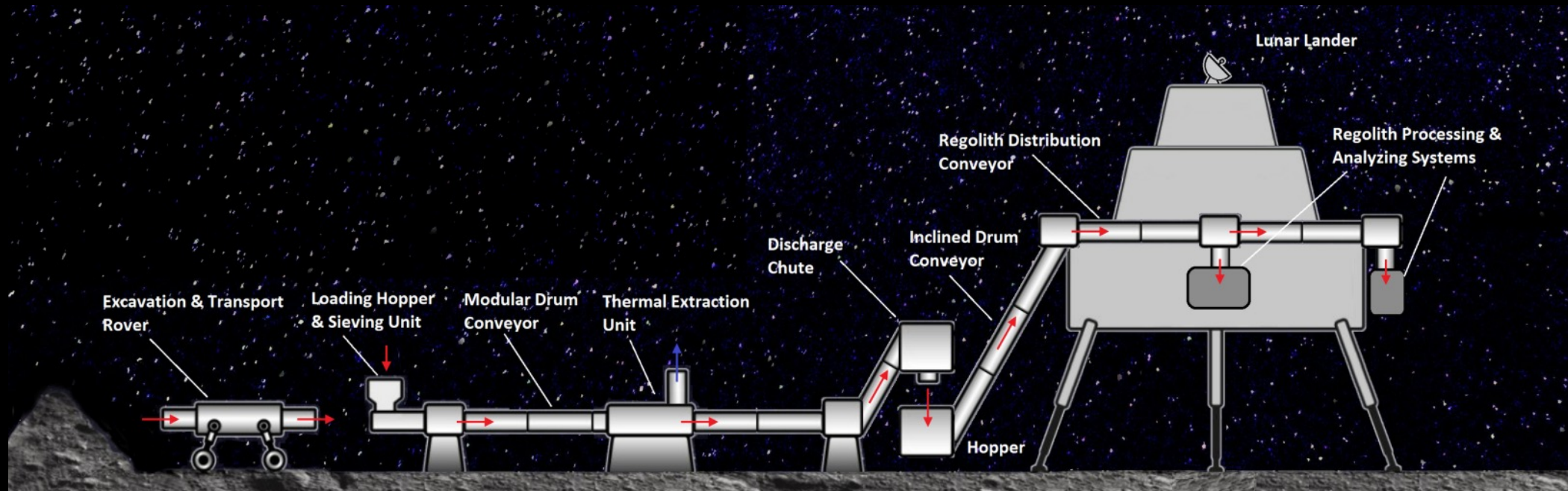
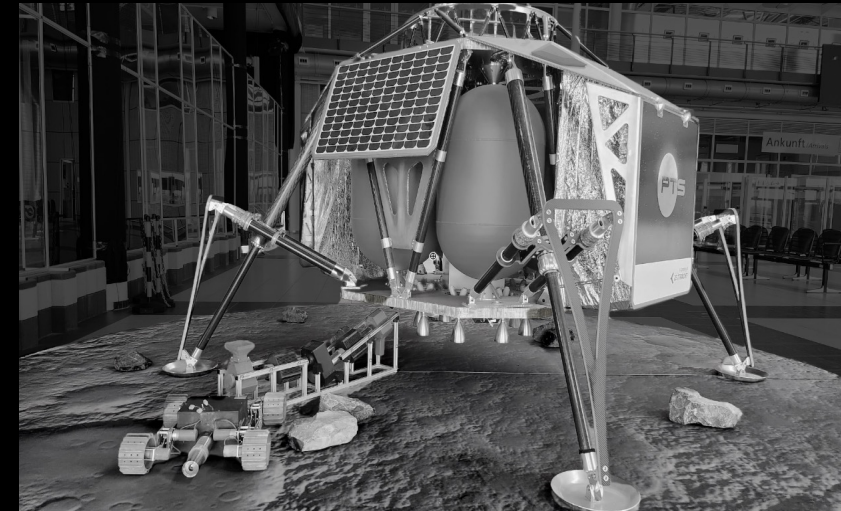


Future Work

Considering future needs and applications for space resource handling, and to avoid reliance on a single technology, two novel conveyor systems are currently in development.

Further scientific studies will be initiated in collaboration with academic institutions and research organizations.

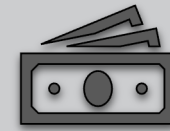
Aiming to develop comprehensive end-to-end solutions, including excavation, conveying, sieving, preconditioning, and feeding regolith to ISRU systems. These systems include reactors on lunar landers and lunar infrastructure construction systems.



Challenges



Multiple Development Topics:
Identifying and prioritizing key areas for development.



Research Activities: Increasing
scientific studies and securing
necessary funding.



Collaboration Opportunities: Exploring
partnerships for commercial projects.



Dependence on Complementary
Technologies and Services: Requires
reliable power supply, lunar-grade
components, payload delivery services,
and advanced remote control systems.

Thank You

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