Autonomous Lunar Site Preparation and Logistics via a Cable-Driven Parallel Robot

Above is a 4-tower Lunar Deployment of Cable-Driven Parallel Robot (LCDPR) System showing the tool carriage above a completed landing site 100 meters in diameter.

Dictionary of Acronyms:

CLPS - Commercial Lunar Payload Services
ConOps - Concepts of Operations
GPR - ground penetrating radar
IaaS - Infrastructure-as-a-Service
ISRU - In-Situ Resource Utilization
LCDPR - Lunar Deployment of Cable-Driven Parallel Robot System
TCRS - Tensioned Cable Robotic System
Tool Carriage - A device that carries tools in a cable-driver system
TRL - Technology Readiness Level

Part 1: Identification and Significance of the Innovation

Proposed innovation: A cable-driven parallel robotic system for autonomous lunar site preparation, regolith construction and logistics

The proposed system would consist of multiple lightweight, anchored towers around the construction site. At the top of the towers, motorized cable spools connect to a payload where the cables intersect, called a tool carriage. By spooling the cables in a controlled manner, the payload can be moved in the volume created by the towers. The payload will consist of various interchangeable tools that can move rocks, fill craters, grade the regolith surface, excavate and move regolith, as well as function as a crane to move pallets or items within the volume of the towers. This allows site preparation, excavation, regolith construction, moving items / payloads like a crane, possibly a 3d printing system attachment and other applications after construction is complete (e.g. offloading payloads from landers or onto landers before take-off).

We propose to design a modular scalable system design that can be adjusted to the needs but use a HLS starship 100 m diameter landing pad as a design reference scenario. The study would design the system, determine mass and power requirements, determine anchoring forces and requirements, dynamic behavior of the cable and tower system, requirements for forces, power and control systems of the “tool carriage” and study requirements for sensors and controls for autonomy into the system. We will benchmark predicted performance against rovers and other site preparation methods. The team brings experience using a Lunar Cable-Driven Parallel Robotic (LCDPR) on Earth for construction, robotics experience and regolith, construction, testing, DTVAC testing, excavation, compaction and anchoring into this project.

Advantages

The proposed cable-driven parallel robotic system offers significant advantages over traditional lunar construction approaches. The system's towers, once anchored, create a large operational volume where the end effector can move in three dimensions with 6 degrees of freedom. Terran Robotics currently gets millimeter-level precision in terrestrial use, and without wind or tower foundations settling could get similar lunar results. This approach effectively decouples the construction area size from the system's mass, enabling the preparation of large landing pads.

This cable-driven approach is particularly well-suited to lunar operations due to its inherent dust mitigation properties. By suspending tools above the surface and controlling them remotely, we minimize dust disturbance compared to wheel-based systems that continuously interact with the regolith. The system's modularity allows for rapid adaptation to different mission requirements through interchangeable end effectors, enabling functionality ranging from regolith grading and compaction to rock removal and payload manipulation. Additionally, the redundant cable configuration ensures operational resilience - the system can continue functioning even if individual cables or motors experience issues, a critical consideration for remote lunar operations.

The towers used for constructing landing pad structures would typically range from 20 to 60 meters in height, making them ideal for installing navigation lighting, radar, or hazard cameras. Positioned above most of the rocket plume during landing and launch, they provide a strategic vantage point. Additionally, repairs to the central area of the landing pad could be conducted without rovers leaving wheel marks along the edges.

Beyond site preparation, the infrastructure can be repurposed for operational tasks, such as unloading cargo from landers, loading payloads, and refueling future reusable lunar landers. The tower, cabling, and tool carriage would remain unchanged, requiring only new tool attachments for different functions.

The technology builds upon Terran Robotics' Earth-based experience with cable-driven construction robots, adapting their AI-first approach to the lunar environment. Rather than relying on complex mechanical systems, our design emphasizes sophisticated control algorithms and computer vision to achieve precision with simplified hardware. This reduces mass requirements while increasing reliability - a crucial advantage for lunar missions where every kilogram matters.

Relevance to NASA's Needs

This innovation aligns with NASA's STTR Subtopic T7.04: Lunar Surface Site Preparation, which emphasizes the need for robotic systems capable of:

- Rock removal and site grading
- Surface compaction and dust mitigation
- High-resolution terrain mapping
- Autonomous infrastructure deployment

By leveraging a Lunar Cable-Driven Parallel Robot (LCDPR) instead of traditional rover-based methods, this system eliminates issues associated with tire tracks in leveled areas, excessive dust displacement, and unnecessary regolith disruption. This results in a more stable, long-lasting lunar landing pad.

Advancing the State of the Art

Most lunar surface preparation studies have focused on small-scale landing pads. The proposed system introduces several key advancements:

Scalability: Unlike conventional compacted landing zones, a cable-based system can clear and prepare much larger surfaces while maintaining precision.

Reduced Wear & Tear: Since only the working tool contacts the lunar surface, motors and actuators experience less exposure to abrasive lunar dust, extending system longevity.

Power Efficiency: By using cables instead of heavy rover locomotion, the system requires less energy than traditional excavation and grading methods.

Multi-Functional Tooling: The modular system enables a variety of attachments, including rock extraction tools, rakes, and vibratory compactors, allowing for diverse terrain manipulation techniques.

Infrastructure Reusability: After landing pad construction, the infrastructure can be repurposed for cargo unloading via cranes or even reconfigured for aerial gondola transport in the lunar highlands, reducing the reliance on regolith-damaging wheeled transport. The towers can also serve as mounting points for navigation aids, strategically positioned to avoid debris from rocket plumes during landing and launch.

Long-Term Impact

This approach also supports future lunar refueling operations, enabling lunar landers to achieve lander reusability. Additionally, techniques validated through this project can be adapted for Mars, where similar construction and operations principles would apply, expanding the potential impact of this technology across planetary exploration missions.

Part 2: Technical Objectives

The primary objective of this project is to develop and demonstrate an innovative, lightweight, and modular lunar surface preparation capability utilizing a Lunar Cable-Drive Parallel Robotic System (LCDRP), delivered by a Commercial Lunar Payload Services (CLPS)-compatible rover platform. The technical objectives specifically address the NASA STTR Subtopic T7.04 (Lunar Surface Site Preparation), supporting key lunar infrastructure needs for the Artemis program and future commercial lunar activities.

Our technical objectives are as follows:

1. Design of Lunar Cable-Driven Parallel Robot System (LCDPR):

- Design, prototype, and test anchoring methods for securely embedding support poles into lunar regolith, validated through vacuum chamber testing at Michigan Tech University.
- System analysis, conceptual design and trade studies at the system level.
- Analyze risk areas identified in section 3 Work Plan.
- Anchor point stability: measure anchoring force of different anchor methods to develop a model for foundation design
- Wire gauge selection: measure forces for excavation, determine gauge, and develop parameterized model of forces for control system to towers, foundation and anchors.
- Calculate Bending force on towers and to trade study of tower design options.
- Conduct study of thermal, dust, and electrical environment of towers, cables, carriage system

2. Modular Tool Attachment Interface:

- Develop a design of a modular interface system allowing easy exchange of diverse site preparation tools, ensuring power, data connectivity, and structural integrity.
- Design and test prototype tool attachments, excavation tools (buckets and rakes), vibratory compactors, and cargo handling attachments, in collaboration with Terran Robotics.

3. Comprehensive Regolith Manipulation and Surface Stabilization:

- Measure force for rock removal, regolith leveling as inputs for a physics model for ConOps planning of engineered surface features such as roads, pathways, and landing pads.

4. Robotic Operations and Autonomy:

- Develop operational strategies and requirements and conceptual designs for sensor-based autonomous systems capable of performing complex construction tasks with minimal human intervention.
- Model a rover capable of lunar site selection and characterization, for the purpose of Phase I ConOps planning.
- Create detailed Construction Concepts of Operations (ConOps), beginning with natural lunar terrain and concluding with engineered infrastructure meeting defined geotechnical criteria.
- Preliminary tool designs and ConOps plans

Part 3: Work Plan

The project work plan is designed to address key risk areas and establish feasibility through targeted analyses and testing. Multiple development paths will proceed in parallel to collect critical system metrics for modeling and risk reduction. The work will be conducted in defined phases, ensuring a structured approach to validating the system's design, performance, and integration requirements.

Excavation and other forces will be measured in MTU's existing Excavation Force Measurement Test bed and the anchoring forces determination will leverage an already ongoing internal MTU anchoring project which includes an anchoring testbed for measuring installation and anchoring forces both inside and outside the dusty thermal vacuum chamber. A DEM anchoring model is being developed and will be refined and validated with the data from testing in regolith simulant.

Risk Areas Addressed

- Anchor point stability
- Wire gauge selection
- Bending forces on towers
- Thermal effects on towers
- Dust and wear considerations (Phase II focus)

1 Design of Lunar Cable-Driven Parallel Robot System (LCDPR)

1.1 System analysis, ConOps, Conceptual design and trade studies at the system level

1.1.1 Develop a ConOps plan assuming CLPS-sized lunar landers.
1.1.2 Formulate a ConOps plan for rover surveys using GPR and tower/wire construction (installation and assembly).
1.1.3 Develop a ConOps plan for lunar site preparation, including rock removal and regolith leveling for an HLS-sized landing area.
1.1.4 Create a structural physics model and simulation to analyze construction and site preparation time and power requirements.
1.1.5 Integrate structural physics models into simulation platforms such as Gazebo, Blender, or Unity for additional ConOps scenario simulations.
1.1.6 Conduct time and power estimations for survey, assembly, and operations and compare with rover-based systems.
1.1.7 Calculate mass, timeline, and power requirements for constructing an HLS landing site.

1.2 Wire gauge selection: Measure forces for excavation, determine gauge, and develop parameterized model of forces for control system to towers, foundation and anchors.

1.2.1 Measure forces exerted on tools for regolith and rock removal using MTU excavation force measurement test bed.
1.2.2 Calculate the total wire length required for the system.
1.2.3 Develop a parameterized model of forces and control through the system, including cable connections to the tower, foundation, and anchors.

1.3 Calculate bending for on tower and trade study of tower design options

- **1.3.1** Conduct a trade-off study for tower design and anchoring options.
- **1.3.2** Calculate forces, material properties, and component sizes.
- **1.3.3** Conduct a trade study on the structural integrity of towers under bending forces.
- **1.3.4** Compare structural implications of three-tower versus four-tower configurations.

1.4 Anchor point stability

- **1.4.1** Measure anchoring force of different anchor methods in ambient conditions
- **1.4.2** Measure anchoring force of different anchor methods in vacuum conditions
- **1.4.3** Develop a DEM model for anchoring design

1.5 Conduct study of thermal, dust and electrical environment of towers, cables, carriage system

- **1.5.1** Perform evaluation of rocket plume (dust) effects on tower.
- **1.5.2** Perform evaluation of electrical effects on cables (Kevlar vs aluminum), carriage electronics.
- **1.5.3** Perform thermal evaluation on tower design, cables, and carriage.

2 Modular Tool Attachment Interface

- **2.1** Explore standard tools and tool attachment interfaces and evaluate for potential use
- **2.2** Develop a robust design of a modular interface system allowing easy exchange of diverse site preparation tools
- **2.3** Design concepts for sensors, power, data connectivity, and structural integrity of tool connector.
- **2.4** Design and test prototype tool attachments, focus on excavation tools (buckets and rakes), vibratory compactors, and cargo handling attachments, in collaboration with Terran Robotics.

3 Regolith Manipulation and Surface Stabilization Methods

- **3.1** Literature review of excavation and other models for cable controlled systems
- **3.2** Initial measurements of force for excavation, rock removal and regolith leveling at MTU testbed

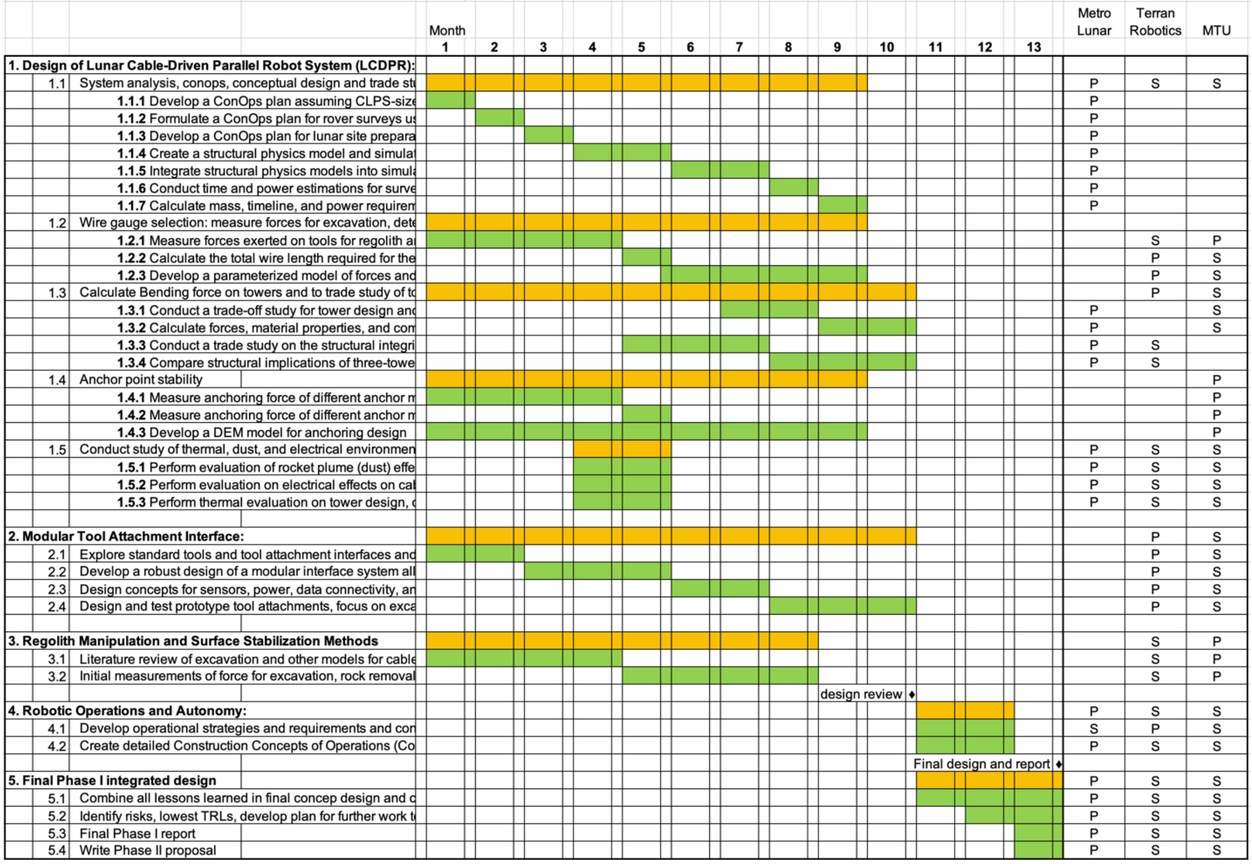
4 Robotic Operations and Autonomy

- **4.1** Develop operational strategies and requirements and conceptual designs for sensor-based autonomous systems capable of performing complex construction tasks with minimal human intervention.
- **4.2** Create detailed Construction Concepts of Operations (ConOps), beginning with natural lunar terrain and concluding with engineered infrastructure meeting defined geotechnical criteria.

5 Final Phase I integrated design

- **5.1** Combine all lessons learned in final concept design and ConOps
- **5.2** Identify risks, lowest TRLs, and develop plan for further work to address risks
- **5.3** Final Phase I Report
- **5.4** Write Phase II Proposal

The image below shows the work plan's schedule and resource allocation for the tasks. **"P"** means "primary" task owner, and **"S"** means "secondary" task owner. The green section in the chart shows the month a specific task is scheduled to be completed in the 13-month schedule.



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	1.1.2 Formulate a ConOps plan for rover surveys us		🟩												P		
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	1.1.4 Create a structural physics model and simulat				🟩	🟩									P		
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	1.1.7 Calculate mass, timeline, and power requirem									🟩					P		
1.2	Wire gauge selection: measure forces for excavation, dete	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨							
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1.3	Calculate Bending force on towers and to trade study of to	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨					P	S
	1.3.1 Conduct a trade-off study for tower design and							🟩	🟩						P		S
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1.4	Anchor point stability	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨							P
	1.4.1 Measure anchoring force of different anchor m	🟩	🟩	🟩	🟩												P
	1.4.2 Measure anchoring force of different anchor m					🟩											P
	1.4.3 Develop a DEM model for anchoring design	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩							P
1.5	Conduct study of thermal, dust, and electrical environmen				🟨	🟨									P	S	S
	1.5.1 Perform evaluation of rocket plume (dust) effe				🟩	🟩									P	S	S
	1.5.2 Perform evaluation on electrical effects on cab				🟩	🟩									P	S	S
	1.5.3 Perform thermal evaluation on tower design, c				🟩	🟩									P	S	S
2. Modular Tool Attachment Interface:		🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨					P	S
2.1	Explore standard tools and tool attachment interfaces and	🟩	🟩													P	S
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2.3	Design concepts for sensors, power, data connectivity, an						🟩	🟩								P	S
2.4	Design and test prototype tool attachments, focus on exca								🟩	🟩	🟩					P	S
3. Regolith Manipulation and Surface Stabilization Methods		🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨							S	P
3.1	Literature review of excavation and other models for cable	🟩	🟩	🟩	🟩											S	P
3.2	Initial measurements of force for excavation, rock removal					🟩	🟩	🟩	🟩							S	P
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4. Robotic Operations and Autonomy:												🟨	🟨		P	S	S
4.1	Develop operational strategies and requirements and con											🟩	🟩		S	P	S
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5. Final Phase I integrated design												🟨	🟨	🟨	P	S	S
5.1	Combine all lessons learned in final concep design and c											🟩	🟩	🟩	P	S	S
5.2	Identify risks, lowest TRLs, develop plan for further work t												🟩	🟩	P	S	S
5.3	Final Phase I report													🟩	P	S	S
5.4	Write Phase II proposal													🟩	P	S	S

Part 4: Related R&D

Michigan Technological University (MTU) is actively involved in lunar site preparation research, collaborating with NASA's ASPECT (Autonomous Site Preparation: Excavation, Compaction, and Testing) project alongside the Colorado School of Mines. MTU's Planetary Surface Technology team specializes in compaction mechanisms and modeling to analyze and validate lunar landing pad designs.

Key Organizations and Research Initiatives

- **Astroport Space Technologies** is developing **regolith solidification technologies** to create lunar bricks for landing pads using 3D printing and autonomous robotics. They collaborate with the University of Texas at San Antonio and have received NASA funding.
- **ICON Technologies Inc.** was awarded $57.2 million by NASA to explore 3D printing for lunar infrastructure using regolith. Their Project Olympus focuses on constructing landing pads.
- **Redwire Space** is advancing in-situ microwave sintering of lunar regolith for landing pad construction.
- **NASA Kennedy Space Center & Sidus Space** developed an interlocking paver system using lunar regolith, designed for robotic assembly of stable landing pads. This innovation is detailed in NASA Patent - KSC-TOPS-89, Lunar Landing Pads
- **Ethos Space Resources** has worked on transforming regolith into landing pads using the Astrolabs rover.
- **NASA Kennedy SwampWorks Labs** developed the RASSOR 2.0 rover, designed for excavating and leveling lunar regolith using modular tool attachments. The IPEx (a smaller version of RASSOR 2.0) is also focused on regolith manipulation. This technology is detailed in NASA Patent - KSC-TOPS-7, RASSOR Excavator

University Research

Several universities are involved in lunar infrastructure research:

- **University of Central Florida**
- **Imperial College London**
- **Auburn University**
- **Colorado School of Mines**
- **Michigan Technological University**

Additionally, up to 50 universities per year participate in NASA's Lunabotics competition, which challenges teams to design and build autonomous excavators and construction robots for lunar applications.

These combined efforts are driving advancements in lunar site preparation, regolith utilization, and robotic construction methods, all essential for sustainable Moon-based infrastructure.

Part 5: Key Personnel and Bibliography of Directly Related Work

Alan Snyder - MetroLunar

Alan Snyder is the founder of MetroLunar, a company focused on developing autonomous assembly solutions for space and lunar surface operations. Prior to founding MetroLunar, he contributed to NASA's VIPER Lunar Rover project, where he worked on telemetry and ground software systems. His expertise also includes hyperspectral satellite imagery processing, overseeing end-to-end data pipelines—from raw satellite data acquisition to secure product delivery for commercial and national security applications in AWS cloud environments.

Alan holds a degree in Engineering Physics and has been awarded multiple patents from Intel and Macrovision, in addition to self-owned patents spanning various technical domains.

Professor Paul van Susante - Michigan Technological University

Dr. van Susante is an Assistant Professor in Mechanical Engineering at Michigan Technological University (MTU) where he founded the Planetary Surface Technology Development Lab (PSTDL). He received his PhD in engineering systems on the topic of soil-machine interaction modeling and experimentation for Earth and Lunar applications, MS in engineering systems on the topic of human-aided construction of a large lunar telescope and a MS and BS in Civil Engineering with an emphasis on structural/building engineering. Dr. van Susante has over 100 conference and journal publications. He participated in several in-situ resource utilization, excavation and construction technology development and modeling projects for NASA via the SBIR/STTR program in collaboration with several small companies such as Honeybee Robotics, Lunar Outpost and universities such as University of Central Florida and Colorado School of Mines. Dr. van Susante was a NASA ESMD Faculty Fellow via the National Space Grant Program and spent a summer at NASA KSC working with the surface systems office on ISRU technology development including a landing pad technology testbed. He was the PI on a NASA STTR phase I grant to develop landing pad technology using in-situ rock, a Co-PI on a 3 year NASA Early Stage Innovation grant to develop technology for water extraction from Mars gypsum rock, and a Co-I on a 3.5 year NASA NextSTEP 2 BAA grant to develop water mining technology from buried glaciers on Mars. He was PI on a just concluded NASA LuSTR20 grant to develop and test a percussive hot cone penetrometer in combination with ground penetrating radar to detect volatiles and determine geotechnical properties of lunar regolith. He is a Co-I on a LuSTR21 grant to develop and demonstrate an autonomous rover for lunar landing pad site preparation and is in charge of the system for vibratory compaction of lunar regolith. He is the PI of a NASA STTR project for the development of a tool to help design regowork structures, including development of construction and use requirements, depending on available construction vehicles. He was the team lead of the MTU-PSTDL team selected as finalists in the NASA Watts on the Moon Challenge Phase 2, Level 3 and the NASA Break the Ice Challenge Phase 2, Level 3.

Zach Dwiel - Terran Robots

Zach Dwiel is the founder and CEO of Terran Robotics, a pioneering construction technology company specializing in cable-driven parallel robotic systems. Under his leadership, Terran Robotics has developed innovative AI-first approaches that emphasize sophisticated control algorithms and computer vision to achieve precision with simplified hardware.

Mr. Dwiel brings extensive expertise in the design and operation of tensioned cable robotic systems (TCRS), with particular focus on the control systems required for precise manipulation across large operational volumes. His work has demonstrated the effectiveness of cable-driven systems for efficient construction applications on Earth—principles that translate directly to the proposed lunar implementation.

Prior to founding Terran Robotics, Dwiel worked in advanced robotics and machine learning, publishing in top Robotics and machine learning venues. He holds a background in computer science, with expertise in control systems and the integration of AI with physical systems.

Part 6: The Market Opportunity

Our short-term market strategy (2025 to mid-2030s) focuses on securing contracts with NASA, DARPA, and the Space Development Agency (SDA) to develop critical lunar surface infrastructure. The initial objective is to obtain a Phase III contract to demonstrate small-scale construction capabilities on the lunar surface, establishing a foundation for future commercial and governmental projects. Early success in this phase is expected to position us for larger contracts related to lunar base construction, either directly awarded by NASA or through subcontracting with prime contractors.

As lunar activities scale beyond the mid-2030s, our business model will transition into an Infrastructure-as-a-Service (IaaS) approach, supporting the growing demand for In-Situ Resource Utilization (ISRU) and lunar mining operations. Key services will include:

- **Lunar Infrastructure Operations –** Providing, maintaining, and managing essential surface infrastructure for NASA and commercial space enterprises.
- **Landing Pad Development and Operations –** Establishing "Stage-Zero" facilities, where customers pay for landing services, cargo unloading via automated crane systems, and spacecraft refueling.
- **Lunar Roadway Construction and Maintenance –** Building and maintaining lunar roads based on demand, with a toll-based revenue model for sustained operations.
- **Solar Power Infrastructure –** Deploying solar panel fields with integrated battery storage, offering a reliable energy supply for lunar habitats and commercial mining operations.

This market strategy leverages early government-backed contracts to establish technological and operational leadership in lunar infrastructure development. By aligning with NASA’s long-term goals for sustained lunar exploration and commercial activity, we ensure a scalable, self-sustaining business model that will support the expansion of lunar industry and human presence on the Moon.

Terran Robotics' cable-driven construction systems are directly addressing the global housing crisis by dramatically reducing construction costs and timelines while improving quality and sustainability. Their innovative approach allows for rapid deployment of affordable housing with reduced labor requirements and minimal environmental impact. By automating key construction processes, Terran's technology helps bridge the growing gap between housing demand and traditional construction capacity, making quality housing more accessible to underserved communities. This STTR project presents a unique opportunity for bidirectional technology transfer: while adapting Terran's systems for lunar use, the extreme constraints of space applications will drive innovations in mass efficiency, power optimization, and autonomous operation that can be implemented in their Earth-based systems. These improvements will further reduce costs and increase deployment speed of affordable housing solutions. Additionally, NASA association provides credibility and visibility that can accelerate commercial adoption of Terran's technologies, potentially attracting new investment to scale their impact on the housing crisis while establishing their construction methodology as the foundation for both terrestrial and extraterrestrial infrastructure development.

Part 7: Facilities/Equipment

Michigan Technical University

Dusty Thermal Vacuum Chamber (DTVAC)

https://huskyworks.space/facilities/dtvac

The Dusty Thermal Vacuum Chamber (DTVAC) is a facility used to simulate extreme extraplanetary environments such as Lunar PSRs and the Martian surface. The DTVAC is customized for rapid servicing of meter-class payloads via removable sandbox carts capable of holding icy regolith.

Lunar Simulant Sandbox (1.8x4.2x3 meters) with gravity off-loading(IRGO)

https://huskyworks.space/facilities/sandbox

The Sandbox is an environmental facility used for enclosed atmospheric testing of mobility systems in lunar simulants. Various terrains are simulated with the inclusion of obstacles and adjustable inclines.

Regolith Freezing & Heating Containers with excavation force measurement test bed

https://huskyworks.space/facilities/containers

The regolith freezing and heating containers are utilized for the preparation, testing, and desiccation of large mixed icy regolith simulant samples. Capable of mixing and desiccating regolith simulant in the order of tens of thousands of kilograms for larger test beds.

Terran Robotics

Has a 10,000 square foot testing facility for its terrestrial-base robotic system near Bloomington, Indiana. The facility allows for indoor testing of cable driven robot configurations with a 15mx15m working area and up to 8m tall. Running large scale cable driven robot configurations indoors allows for comparing theoretical physical models to actual physical models in a controlled environment.

Part 8: Subcontractors and Consultants

Subcontactor

Professor Paul van Susante of **Michigan Technical University** will be the research institution (RI) for Phase I and Phase II of the STTR. He is the PI for the Planetary Surface Technology Development Lab (PSTDL), and has participated in many other STTR and SBIR projects for Sysrand Corporation, Energid, HoneyBee Robotics, Lunar Outpost, SpaceFactory, Astrobotic and others. And has participated on research projects for many customers including Lockheed Martin, Northrop Grumman, SpaceX, TransAstra, DARPA, NASA KSC, JPL, Bechtel, Caterpillar, NCHRP, NSF and others.

The expertise in regolith handling, construction, robotics and the lunar environment, as well as facilities at MTU will help with design of the system, testing prototypes, measuring the anchoring force of different anchoring methods. MTU will also measure the force on a wire system for removing regolith and rocks with different tools.

Subcontractor

Zach Dwiel is the CEO of **Terran Robots** and will serve as a consultant for Phase I and Phase II of the STTR. Terran Robotics is a construction startup company using cable Tensioned Cable Robotic System to build environmentally friendly buildings. Terran Robotics will be involved in the analysis of adapting cabled robotics systems into a lunar environment, and it is likely the control software used on a lunar environment could be very similar to the terrestrial version. In addition there is going to be an effort to design a connector to allow switching between tool sets in the lunar version of the cable robotic system.

Part 9: Related, Essentially Equivalent and Duplicate Proposals and Awards

MetroLunar has no prior, current or pending proposals or awards that involve substantially the same work involved in the proposal.