

The Lunar Surface Innovation Consortium is administered by the Johns Hopkins Applied Physics Laboratory, and operates in collaboration with the NASA Space Technology Mission Directorate under the Lunar Surface Innovation Initiative. Its purpose is to harness the creativity, energy, and resources of the nation to help NASA keep the United States at the forefront of lunar exploration. To find out more, sign up to participate, or access past additions of this newsletter, please visit lsic.jhuapl.edu.

Contents

<u>Director's Update</u>	1
<u>Focus Area Monthly Telecon Schedule</u>	1
<u>Funding Opportunities</u>	2
<u>Dust Mitigation Workshop Announcement</u>	2
<u>Member Feature</u> <i>Cislunar Space Development Company</i>	3
<u>NASA News</u>	4
<u>Community Bulletin Board</u>	5

Focus Area Monthly Telecon Schedule

Dust Mitigation

Third Thursdays at 12PM Eastern

Excavation & Construction

Last Friday at 3PM Eastern

Extreme Access

Second Thursdays at 3PM Eastern

Extreme Environments

Second Tuesdays at 3PM Eastern

In Situ Resource Utilization

Third Wednesdays at 3PM Eastern

Surface Power

Fourth Thursday at 11AM Eastern

If you'd like to participate in a focus area's monthly telecon, please sign up on the LSIC website here: lsic.jhuapl.edu/Events/survey.php

Director's Update

Happy New Year! I hope everyone managed to take a little time to recuperate after an exhausting year. We have a lot of exciting plans for 2021, but one that I am most excited about is developing our mentoring portal. While we initially looked at our mentoring directive as



a way to connect early career folks or younger companies with more established mentors, we've been thinking about other community needs. One of the key roles of LSIC is ensuring that the best technology is funded, built, and eventually available for use on the Moon, so how do we achieve that?

The first step is making sure that we connect Space Tech with the brilliant ideas that are out there. While this could just mean letting the community know what opportunities are available, we would also like to make sure that great concepts don't lose out because the proposers are inexperienced with how to respond to different types of proposals, challenges, etc. About 15 years ago, NASA Science Mission Directorate started offering a half day workshop which essentially introduced scientists to the grant writing process and taught what the reviewers look for. Over that time, the quality of proposals rose dramatically, and more and more new scientists started securing funding. Space Tech has a number of different types of calls, and it might benefit people from all types of institutions to understand what NASA and reviewers are looking for in each type of call.

We will be discussing ways that we serve the LSIC community in more detail at the Executive Committee meeting this month, but I have also put together a short survey with some initial ideas about the mentoring portal [here](#). It should only take a couple of minutes to fill out, and I would be extremely grateful for your feedback. Thank you, and I look forward to seeing you all again soon!

Rachel Klima

Director, Lunar Surface Innovation Consortium

SES-LSIC-Director@jhuapl.edu

Funding Opportunities

NASA SBIR & STTR Solicitations 2021 (<https://sbir.nasa.gov/solicitation-detail/66886>)

NASA's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs have a solicitation open to small businesses in the U.S. Participants can collaborate with universities and industry partners. The program has multiple focus areas that can be applied to for funding. Up to \$125,000 is available for Phase I, and up to \$750,000 is available for Phase II applicants.

Phase I Proposals Deadline: 08 January 2021



Watts on the Moon Centennial Challenge (<https://www.herox.com/WattsOnTheMoon>)

Teams will propose solutions for energy distribution, management, and/or storage that address NASA technology gaps and can progress toward flight readiness and future operation on the lunar surface. Such solutions may also have important synergies with terrestrial energy needs, and this Challenge is expected to help advance similar technologies for terrestrial application and commercialization.

Phase 1 Registration and Submission Deadline: 25 March 2021

Break the Ice Lunar Challenge (<https://breaktheicechallenge.com/>)

Design a system architecture to excavate icy regolith and deliver acquired resources in extreme lunar conditions. Up to \$500,000 in Phase I prizes is available. The Mission Scenario takes place in and around a permanently shadowed region (PSR) near the lunar South Pole. In this scenario, the mission will last 365 Earth days. The Challenge seeks solutions to maximize water delivery and minimize energy use and the mass of equipment required to be transported to the lunar surface.

Registration and System Architecture Submission Deadline: 18 June 2021

SAVE THE DATE! Dust Mitigation Workshop on 04 February 2021

Save the Date for the Lunar Surface Innovation Consortium Dust Mitigation Workshop scheduled for 04 February from 11:00 AM to 5:00 PM EST. The event's objectives will be to update the state of dust mitigation and identify technologies that are already available, define gaps in knowledge and research, get community perspectives, and gather input for future solicitations, including for the 2022 cycle. A summary report will be provided to NASA.

There will be a round of lightning talks, and you are invited to present! Please submit one paragraph using the abstract portal on the event website by Friday, 15 January. It should outline your area of expertise, describe what you're working on, and identify the knowledge and technology gaps in dust mitigation that need to be addressed for you to move forward. For more information, please visit the event website [here](#).

Member Feature: Cislunar Space Development Company

In 2017, Dallas Bienhoff retired from his position as a Space Architect and Project Manager with Boeing and embarked on a mission to provide commercial transportation from low Earth orbit to the Moon's surface and all points in between by starting the Cislunar Space Development Company (CSDC). He was inspired to pursue the creation of such a system upon hearing comments made by Mike Griffin during his tenure as NASA Administrator that commercially provided propellant depots might be used by NASA for Constellation. CSDC's efforts are specifically trained on an overall transportation architecture that includes propellant depots, space tugs, and Moon shuttles, all working together to make the lunar surface more accessible for NASA and commercial industry.

Architecture Description

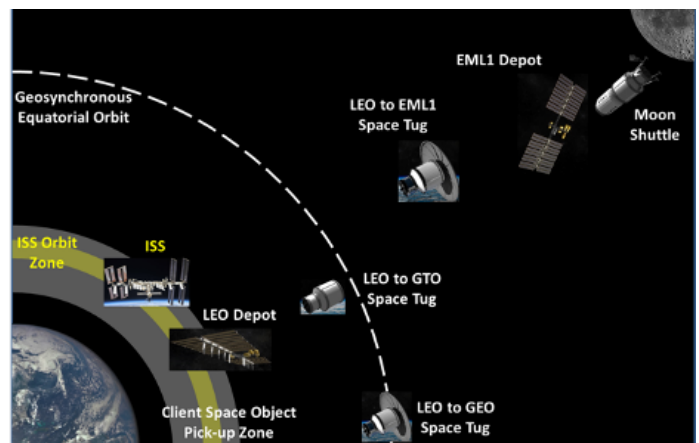
In the current proposed architecture, propulsive and aero-assisted space tugs facilitate geosynchronous transfer for orbit delivery to Earth and Earth-Moon Lagrange Point 1 (EML1). These tugs use liquid oxygen and liquid hydrogen as propellant and are refueled from Earth. A separate Moon shuttle operates in turn between EML1 and the Moon's surface. The infrastructure as currently designed is sized for satellites up to 4,000 kilograms. An example scenario for an operational satellite, launched on a rocket to low Earth orbit, would be picked up and moved to geosynchronous orbit. This transfer is faster than using solar electric propulsion, and at an anticipated reduced cost. CSDC's propellant depots will take advantage of in-situ resource development on the Moon and are designed to convert water into liquid hydrogen and liquid oxygen. While many required technologies, such as cryogenic fluid management and transfer, are ready to fly, one area that Bienhoff identifies as needing more development is smaller liquid oxygen and liquid hydrogen engines CSDC requires.

Current Objectives & Challenges

In September 2020, a CSDC established a Board of Advisors to evaluate and critique its system requirements documentation. Once that important task is accomplished, CSDC will begin looking for potential customers and funding. Target customers include human landing system contractors, sovereign space agencies, satellite providers and operators and Moon developers. Partnerships with launch service providers are also needed. Looking ahead, Bienhoff says that cost to orbit (not just propellant) is one of the biggest obstacles CSDC has to face, which currently is between \$2,000 and \$3,500 per kilogram for large launch vehicles. It also provides the pathway to a great opportunity, as CSDC's goal is to have their system provide a lower cost option for those operating in space around the Earth and the Moon.

Long-Term Planning & Opportunities

Looking ahead, Bienhoff specifically identifies geosynchronous satellite operators as an important market entry point. "Nobody puts satellites in geostationary orbit, the satellites themselves have to make that circularization burn. So this would be a design change, and breaking into the geostationary transfer orbit (GTO) path will build confidence that this architecture will work," Bienhoff says. He identified five key development stages for their transportation system and anticipates that each will take about five years to complete. The first is GTO capabilities,



CSDC's full capability architecture is shown in context with the International Space Station and the overall cislunar space environment

followed by geosynchronous capabilities, then propellant depots. After those three steps are accomplished, capabilities at Earth Moon L1 would then be followed by the Moon shuttle. These development stages move their system from minimum viability to full capability.

“We’d be a commercial trucking company operating in cislunar space,” Bienhoff adds. “We want to haul things and people in space. I would love to have permission to use Deep Purple’s ‘Space Truckin’ that came out in the 70s.” After CSDC’s Board of Advisor review finishes in 2021, it will be exciting to see this company continue to grow and meet its goals – and watch them ‘rock the Milky Way’. For more information about the Cislunar Space Development Company please contact Dallas Bienhoff at dallas.bienhoff@csdc.space or visit the website, www.csdc.space.

NASA News

New NASA Partnerships to Mature Commercial Space Technologies, Capabilities

21 December 2020 (Release 20-134) – In 2020, NASA made significant progress on America’s Moon to Mars exploration strategy, met mission objectives for the Artemis program, achieved significant scientific advancements to benefit humanity, and returned human spaceflight capabilities to the United States, all while agency teams acted quickly to assist the national COVID-19 response. [Click here](#) to read more.

NASA, Canadian Space Agency Formalize Gateway Partnership for Artemis Program

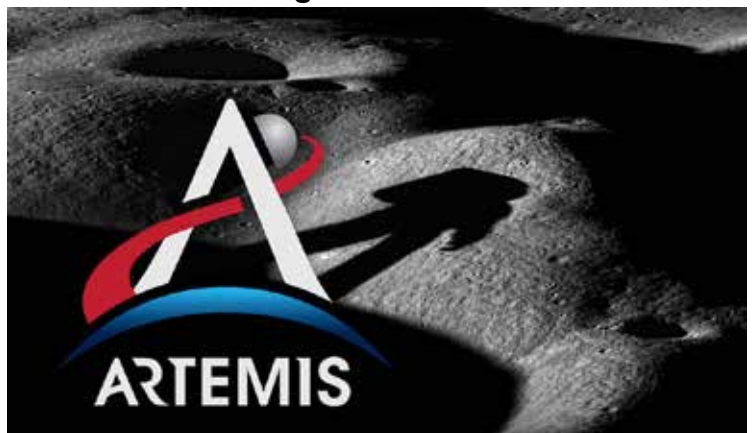
16 December 2020 (Release 20-132) – NASA and the Canadian Space Agency (CSA) finalized an agreement between the United States and Canada to collaborate on the Gateway, an outpost orbiting the Moon that will provide vital support for a sustainable, long-term return of astronauts to the lunar surface as part of NASA’s Artemis program. This Gateway agreement further solidifies the broad effort by the United States to engage international partners in sustainable lunar exploration as part of the Artemis program and to demonstrate technologies needed for human missions to Mars. [Click here](#) to read more.

NASA Names Artemis Team of Astronauts Eligible for Early Moon Missions

09 December 2020 (Release 20-128) – NASA has selected 18 astronauts from its corps to form the Artemis Team and help pave the way for the next astronaut missions on and around the Moon as part of the Artemis program. [Click here](#) to read more.

NASA Defines Science Priorities for First Crewed Artemis Landing on Moon

07 December 2020 (Release 20-121) – NASA has identified the agency’s science priorities for the Artemis III mission, which will launch the first woman and next man to the Moon in 2024. The priorities and a candidate set of activities are included in a new report. The Artemis III Science Definition Team, which comprises federal employees and consultants with expertise in lunar science, began meeting in September to define compelling and achievable science objectives for all aspects of the Artemis III mission, including sampling strategies, field surveys, and deployable experiments. [Click here](#) to read more.



NASA Selects Companies to Collect Lunar Resources for Artemis Demonstrations

03 December 2020 (Release 20-118) – NASA has selected four companies to collect space resources and transfer ownership to the agency: Lunar Outpost of Golden, Colorado; Masten Space Systems of Mojave, California; ispace Europe of Luxembourg; and ispace Japan of Tokyo. Overall, the new NASA contracts with these companies totals \$25,001. [Click here](#) to read more.

Community Bulletin Board

Astrobotic's CubeRover Completes Successful Mobility Testing

Submitted by Alivia Chapla, Astrobotic

Astrobotic's CubeRover successfully completed more than 150 mobility tests inside a 120-ton enclosure designed to mimic the surface of the Moon. These tests will further inform the final wheel design of all three sizes of the scalable CubeRover line. [Click here](#) to read more.

Lunar Base Camp 2030+ Now On Steam!

Submitted by Chris Shove, Regional Scientists LLC

Lunar Base Camp 2030+ is based on NASA plans and technologies for astronauts living on the Moon, the Artemis Mission. It simulates different activities on the moon. You must find and mine resources such as ice for oxygen to breathe and hydrogen for rocket fuel, and minerals to sell to Earth. In year 2030+ there will be different nations, businesses and enemies you must defend against. You must use shuttle diplomacy to keep peace according to NASA Artemis Accords. The purpose of this simulation is to introduce STEM education to youth who may become real astronauts going to the Moon and Mars. [Click here](#) to read more.

Spacewaves Video: "Space: Our Next 'Last Mile' – Keynote with Mark Wiese of NASA" Now Available

Submitted by Tammy Long, Gateway Deep Space Logistics

Mark Wiese, Deep Space Logistics, Gateway Program, NASA, gives his keynote talk followed by a live Q&A. Additional guests include Maxwell Briggs, Acting NASA ITech Program Executive and Mark McDonald, Chief Architect, Space Technology Mission Directorate, NASA. Hosted by Dooner and The Dude at FreightWaves. Watch it now on Vimeo: <https://vimeo.com/486873139>

Aerospace Corporation at TechCrunch Space in December

Submitted by Andre Doumitt, The Aerospace Corporation

Aerospace Corporation hosted three showcases at the TechCrunch's TC Session: Space 2020 in December, which LSIC members may have attended. Among the most popular events was the university showcase moderated by the Aerospace Corporation, which included:

- USC – multi-sensor image fusion to get a constant visual point-cloud of anything in space at any time, novel end-effect control systems using robotics and electro-adhesion and gecko adhesives to transfer shear force to move an object
- CalTECH – Lunar Trailblazer mission and smallsat for detection of lunar water and for lunar surface geography
- UCLA – Space weather beyond the geo belt, including impact and severity of space weather events
- MIT – the use of AI and Light Curves to track space objects, forecasting large constellation maneuvers, Lasercom crosslink with mems pointing and in-space robotic assembly
- ASU – LunaH-Map program for detecting hydrogen in *Screenshot from TC Session: Space 2020*

the Moon's permanently shaded regions using a 6U cubesat and compact neutron spectrometer. The session also highlighted a range of gaming, Artificial Intelligence and Machine Learning, AR/VR, and novel space robotics and propulsion technologies in development.

Lunar Instrument Testing for PlanetVac and Ejecta Storm on Masten's Xodiac Rocket

Submitted by Matthew Kuhns, Masten Space Systems

Honeybee Robotics and the University of Central Florida recently reached important testing milestones for their lunar instruments currently under development. PlanetVac (Honeybee) and Ejecta Storm (UCF) were flown on Masten's Xodiac rocket. More information about Honeybee Robotics' PlanetVac is available here: <https://honeybeerobotics.com/portfolio/planetvac/>, and you can read more about the test and Ejecta Storm on UCF's website here: <https://www-ucf-edu.cdn.ampproject.org/c/s/www.ucf.edu/news/ucf-developed-sensor-passes-first-test-on-track-for-future-moon-missions/?amp>.



Photo of the PlanetVac and Ejecta Storm test

New Dusty Thermal Vacuum Chamber for the Planetary Surface Technology Development Lab at Michigan Technological University

Submitted by Paul van Susante, Michigan Technological University



Photo of the new dusty thermal vacuum chamber

The Planetary Surface Technology Development Lab at Michigan Technological University welcomes a 50 inch x 50 inch x 70 inch dusty thermal vacuum chamber. The chamber will be fully operational in January 2021 with LN2, power hooked up and 1500 kg (icy) lunar regolith simulant and 10^{-4} (to 10^{-6}) torr vacuum. We also have a 14ft x 6ft x 1ft lunar regolith sandbox with gravity off-loading capability and slope testing filled with lunar regolith for your testing projects. We specialize in ISRU research and planetary surface robotics and technology development. Please contact Dr. Paul van Susante (pjvansus@mtu.edu or 906-487-3253) for more information and/or inquiries

regarding partnering or testing. [Click here](#) to access the Husky Works Planetary Surface Technology Development lab website.

NASA Receives First Lunar CubeRover from Astrobotic

Submitted by Alivia Chapla, Astrobotic

After three years of intensive engineering work, Astrobotic's CubeRover is on its way to NASA's Kennedy Space Center in Florida. The CubeRover is designed to provide an affordable mobile outlet for scientific instruments and other payloads to operate on the surface of the Moon. This occasion marks the first time Astrobotic's Planetary Mobility department has delivered rover hardware to an outside entity. [Click here](#) to read more.