



Pacific International Space Center for Exploration Systems



NEWSLETTER

APPLIED RESEARCH

MESSAGE FROM THE DIRECTOR



PISCES Submits NIAC Proposal for new ISRU Material

Above: The new material could help construct lunar bases like this concept using less energy than current additive manufacturing methods. Image credit: European Space Agency (ESA)

PISCES intends to launch a new research project in materials science that could help solve some of the challenges of building infrastructure on other planets. The agency will submit a grant proposal to the NASA Institute for Advanced Concepts (NIAC) Phase I program for a low energy, high strength basalt composite that could be sourced *in-situ*.

The proposal is seeking funding to research whether a specific binder composite of basalt regolith is suitable for use as a construction material on the moon and Mars. The binder uses minimal energy to cure and produces a highly durable composite material that can withstand high temperatures. The study will investigate the processes and energy required in a vacuum to synthesize this binder *in-situ* using only native resources found on the moon and Mars. The study also intends to

identify technologies and strategies needed to gather the necessary components used to synthesize the material as well as energy sources and inputs.

The composite would be useful in building launch and landing pads which need a high tolerance for heat from rocket exhaust plumes. It could also be used to: construct berms to deflect dust from launch and landing blasts; build habitats and shelters for equipment, personnel and assets; and pave roads and walkways.

“Currently, most construction designs depend on additive manufacturing methods with the most common feedstock for lunar and Mars applications being a mix of regolith and binders transported from Earth,” said PISCES Operations Manager Christian Andersen, who wrote the project proposal.

(Cont. on page 4...)



Rodrigo Romo

Aloha kākou,

This month Hilo lost a strong pillar of the community. Barry Taniguchi was much more than the CEO of KTA Superstores, he was a dedicated member of the community who gave back in countless ways. Barry’s actions demonstrated care and aloha for the youth of our community, and generosity in supporting education and those who are less fortunate. Barry was also a dedicated supporter of Astronomy who cared about the proper management of Maunakea and the respect of Hawaiian culture.

Barry’s passing leaves a deep void in our community and the PISCES ‘ohana extends their deepest sympathies to the Taniguchi family. He will be missed.

A hui hou,

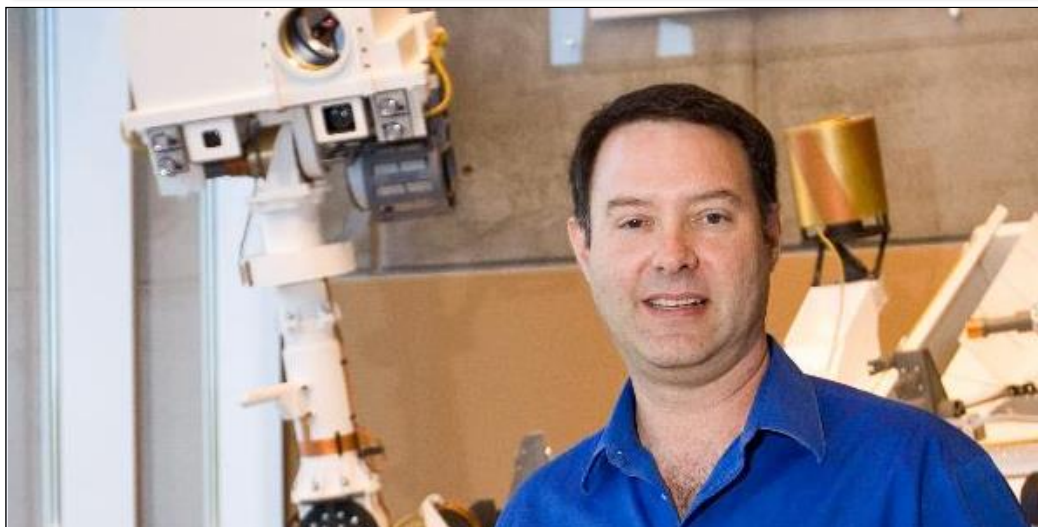
Rodrigo Romo
PISCES Program Director

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GUEST SPOTLIGHT



NASA's Mars 2020 Rover: Mapping Mars in 3D

By Dr. Jim Bell, Arizona State University

Above: Dr. Jim Bell is a professor and planetary scientist in the School of Earth & Space Exploration at Arizona State University, and the Principal Investigator for the Mars 2020 rover's Mastcam-Z imaging system. He is also an author of popular science books and has been heavily involved in the previous Spirit, Opportunity and Curiosity rover missions. Courtesy photo.

NASA's next Mars rover is scheduled to launch in mid-July next year and will land on the Red Planet in February 2021. Currently called "Mars 2020" (until it receives a proper name from the nationwide naming contest currently underway), the rover is made up of about 90% spare parts leftover from building the Curiosity rover. Despite looking outwardly similar to Curiosity, Mars 2020 has a very different science payload and mission. One of the new instruments is a color, stereo imaging system called Mastcam-Z. These cameras are similar in many ways to the color cameras called Mastcam on the Curiosity rover, but they have the added capability of zooming from wide angle to telephoto (hence the added "Z" for zoom).

Stereo imaging for these robotics vehicles is a critical element of mission operations. Stereo photos are used inside the rover's computer system and on the ground to create 3D "Digital Terrain Models" or DTMs. The rover's

onboard software uses these DTMs to navigate between commanded waypoints, helping to identify obstacles that the rover should avoid. DTMs are also used by ground controllers (the engineers who drive the rover) to navigate the rover to places the science team wants to explore, and to place the robotic arm and instruments on rock and soil targets along the surface. Finally, DTMs are also used by the science team to understand the topography and geology of the region the rover is traversing through.

Processing these images requires specialized software that has undergone a lot of development using Earth-based systems.

Right: Engineers test imaging cameras mounted on the mast and front chassis of the Mars 2020 rover during Summer 2019 at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California.

Credit: NASA/JPL-Caltech

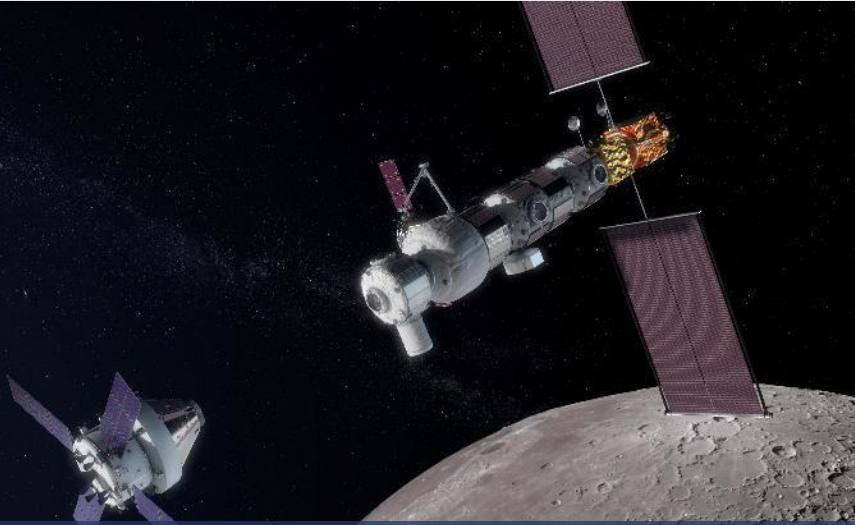


These include specially designed imaging systems like those developed at the aerospace agency PISCES in Hilo, Hawaii. PISCES and similar programs around the world address the latest hardware and software problems in planetary robotics, providing solutions to NASA and other space agencies.

On the Mars 2020 rover, Mastcam-Z will help infer the composition of Martian surface materials and guide decisions on where to drill and take measurements using the rover's instruments. Unlike Curiosity, Mars 2020 is outfitted with a coring drill to collect samples of rock and soil and store them in small "cache" tubes. A major goal of the Mars 2020 mission is to place these tubes where a future rover can fetch them, launch them into Mars orbit using a special ascent rocket, and transfer them to an orbiter for return to Earth. As such, the Mars 2020 rover is the first step in a planned robotic Mars Sample Return program that NASA is planning to conduct in the 2020s. Detailed analysis of these samples back on Earth will provide important clues about the past habitability of the planet, as well as important engineering information needed to successfully plan human missions to Mars—hopefully in the 2030s.

Learn more about NASA's Mars 2020 rover and its mission to the Red Planet at: mars.nasa.gov/mars2020.

AEROSPACE NEWS



NASA on Track to Return Humans to Moon by 2024

Above: An artist rendering shows the Orion spacecraft (left) approaching the orbital lunar gateway station—two key components in NASA's new plan to return humans to the moon. **Below:** Phase I of the Artemis program from 2022-2024. Credits: NASA/CisLunar and Gateway Overview

NASA's new Artemis program is probably the most ambitious space exploration effort to date and is on track to return humans to the lunar surface for the first time in a half century.

Unlike its predecessor, Apollo, the objectives of Artemis stretch far beyond visiting and researching the moon. While the Apollo missions accomplished six human landings between 1969 and 1972, Artemis aims to send humans back for good, establishing a base in unexplored territory and an orbiting lunar gateway. NASA has pinned 2024 as its target date for the next human landing, marking the beginning of a multi-phase project that will build up infrastructure, life support systems and gather important scientific data to help humans better understand how to live and work beyond Earth. The landing site will be the moon's South Pole, a region with pockets of water ice in permanently shadowed craters. With refinement, the water would provide valuable resources like drinking water, oxygen and rocket fuel.

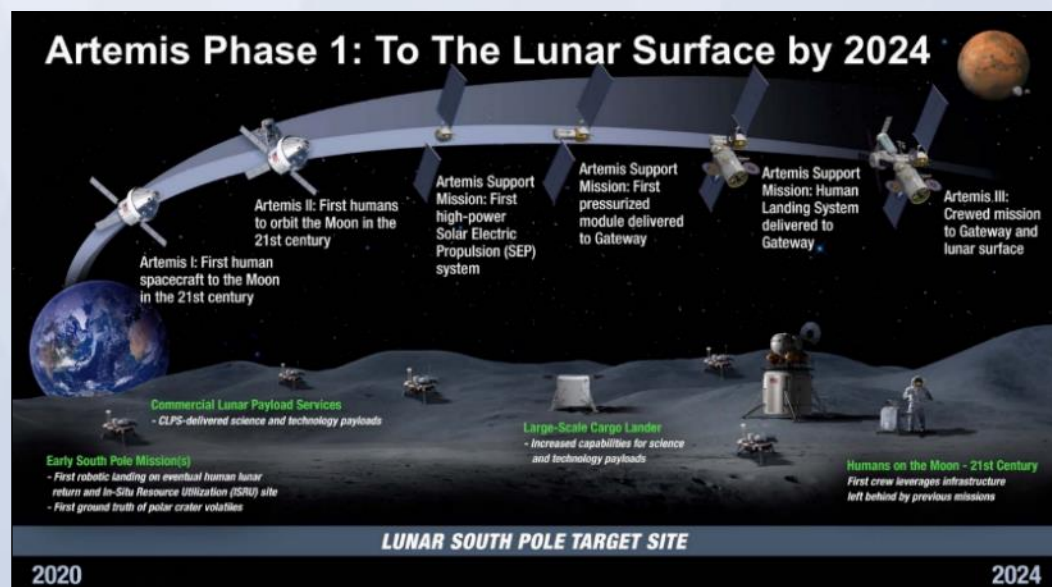
Artemis is planned in three phases, including an initial launch of instruments and technologies to the moon to prepare for human arrivals, followed by an uncrewed Orion spacecraft test run and the first of many crewed missions. Astronauts will largely rely on an orbiting lunar gateway station, which will provide a transfer point between Earth and the moon, as well as a base for communications and research. NASA says it will have sustainable human

missions in place by 2028.

In May, the agency selected three companies to furnish landers and services to the moon under the Commercial Lunar Payload Services (CLPS) contracts. These instruments will aid in pinpointing lander sites, measure radiation in the lunar environment, support navigation, and assess the impacts of robotic and human activity on the moon.

NASA is also leveraging partnerships with other countries to achieve its goals. The agency met with Japan's space agency JAXA earlier this year to discuss collaborating on the lunar gateway. Last month, The Australian Space Agency made a formal commitment to NASA and will triple its budget to support the Artemis program.

Ultimately, NASA's new program will prove new technologies and capabilities to make a human mission to Mars successful. With the moon only three days away from Earth (compared with up to three years round-trip to Mars), astronauts can take another small step for mankind before attempting the next giant leap.



OUTREACH & EDUCATION



PISCES Challenges Young Minds During East Hawai'i STEM Workshop

Above: Twenty students from eight schools participated in a hands-on STEM class organized by The Success Factory featuring PISCES' geology technician, Kyla Edison (pictured at center, wearing a lei). Credit: Gail Takaki/The Success Factory, creators of NexTech STEM programs.

PISCES teamed up with The Success Factory last month to engage local youth with a hands-on educational workshop focused on STEM problem solving.

Kyla Edison, Geology and Materials Science Technician at PISCES, led a three-hour class introducing PISCES' research projects and educating students about Earth-based geology. The students put their thinking caps on during a "Mars match" activity, comparing geological features between Earth and Mars to discover differences and similarities between the two.

Twenty students—grades sixth through twelve—attended the workshop at Engineering Partners,

LLC, in Hilo. One student, Kyra Bockrath of St. Joseph High School, was a 2019 PISCES STARS (STEM Aerospace Research Scholars) program alumna.

The event was organized by Gail Takaki, president of The Success Factory. The Factory is an economic development initiative focused on STEM education for underserved youth on Hawai'i Island. It organizes project-based learning events including multi-day NexTech camps engaging students in STEM industry exploration. These include hands-on activities with drones, CAD, 3D printing, problem solving, career exploration and essential career skills.



NIAC Proposal for ISRU Cont...

"These methods are either very energy intensive or extremely expensive," Andersen said.

The proposed composite could make construction on other planets more efficient and financially feasible while solving one of many challenges inherent in space settlement: building up infrastructure millions of miles from Earth with limited resources.

The NIAC program funds potential breakthrough technologies in early development for potential use in future space missions. The program provides up to \$125,000 for nine-month studies and funds about 12 to 18 projects each year. NIAC Phase I awardees will be announced in April 2020.



Left: Students examine Earth and Mars satellite images to compare their geological features during the workshop on Sept. 21 in Hilo. **Above right:** Following her visual presentation, Edison explains to a student the points of interest on a Martian satellite image. Credits: Gail Takaki/The Success Factory, creators of NexTech STEM Programs