PISCES HAWAI'I www.pacificspacecenter.com

Newsletter

7th Edition
JULY 2016

PISCES WELCOMES NEW INTERN!

HILO HIGH SCHOOL STUDENT JOINS PISCES FOR THE SUMMER

Meet Hawai'i Island high schooler Ara Uhr who will be helping PISCES with updating our robotic rover Helelani.

The Pacific International Space Center for Exploration Systems (PISCES) is pleased to announce we have a new intern for the summer.

Ara Uhr will be a junior at Hilo High School next year and will be working on some of our computer programming software before school begins in the fall. Ara is currently involved in the Hilo Viking Robotics team and is a Science Olympian at her high school.

In addition to interning with PISCES, Ara will also be attending our summer STARS program for high school females kicking off later this month (July 19-22).

Ara said she reached out to our staff in hopes of getting some real, hands-on experience with our team.

"I am very interested in the field of STEM, and feel like PISCES is an ideal location to learn about this," she said.

Currently, Ara is working with Teddy DeRego on programming our robotic rover Helelani. This summer they'll be working to improve its overall effectiveness and efficiency.

Throughout the years PISCES has had many interns who have completed successful internships that have helped pave the way for their future careers. Best of luck, Ara!

LETTER FROM PISCES DIRECTOR ROB KELSO

IT IS *NOT* BUSINESS AS USUAL AT PISCES...

Over the last 3-1/2 years, PISCES has accomplished some spectacular milestones through the combination of a dedicated and skilled workforce, innovation, and creative collaboration partnerships.

Through key strategic partnerships with both federal government and private sector organizations, PISCES has accomplished what many only dream about - performing actual applied science test programs on-location in sites similar to both the Moon and Mars. These innovative projects strengthened the PISCES brand and brought enviable recognition to the state's space organization.

Over the last few years, the state has introduced legislative language indicating a strong desire to diversify the state's economy base beyond tourism, agriculture, the service industry and military. Aerospace has been touted as one of those emerging sectors to help diversify the portfolio. Continue reading on pg. 2

Letter from Director Continued...

Further, key legislators have indicated that PISCES should be more directly focused on economic development and business development rather than applied research.

Years ago, I was a guest lecturer for many organizations on the topic of leadership. The title was "Why Winners Win." This lecture discussed key attributes found within individuals and organizations that ultimately made them a "Winner." One of those characteristics was "you can change without growing, but you cannot grow without change."

Winners want growth, even if it becomes uncomfortable by introducing the difficult reality of CHANGE. History has clearly shown that those organizations that do not adapt and change are doomed to failure.

This is no different for PISCES. PISCES finds itself in a position where it must "change" to survive in the current state environment. As Director, I strongly believe that this state needs high-tech job infusion, and attraction of an industry-base into the state. Just as the state of Hawai'i must adapt and change in order to diversify its economic-base, so must PISCES change. While PISCES has enjoyed great success and admiration for its innovative work in applied research in planetary technology, the state has greater interest in job-creation and growth in new technology industries. We must all make this transition if we are to establish new technology jobs for future generations of Hawaiian keiki (children).

It is within this context that both PISCES and its Board of Directors are evaluating and implementing options for new directions within PISCES. While PISCES will maintain a low-level of applied research for future engineering projects, the primary focus within PISCES in the coming months will be to better assist our state in aerospace economic development. It is within this new area that I believe PISCES can make its larger contribution to the needs of the state. These results will take time to create new markets and aerospace opportunities within Hawai'i. But it is a road I believe will best serve the larger needs of all Hawai'i residents.

Stay tuned for more exciting announcements in this area in the coming months. Until next time….
"Achievement Through Excellence"

PISCES Executive Director Rob Kelso is seen here networking with area partners during a testing of our Vertical Take-off/Vertical landing pad. Photo Credit: Ena Media Hawai'i

3D PAVER ANALYSIS

By Christian Andersen
PISCES Operations Manager

As part of a PISCES-NASA Kennedy project to robotically build a Vertical Take-off/Vertical landing (VTVL) pad, PISCES developed and matured a process for making pavers/bricks only using rock quarry waste (fine rock dust and sands). This process requires no added binders (like cement) and can be manufactured using excess and/or off-peak energy.

Prior to completion of the VTVL pad, the center paver was sent to NASA Kennedy and 3D scanned.

Upon completion of the firing of the solid rocket motor (~1000 lb thrust), the center paver was again sent for 3D scanning for comparison.

By aligning and overlaying the two scans (seen below) it was determined that despite exposure to temperatures far in excess of basalt's melting point, there was minimal volumetric loss. The area directly impinged by the rocket plume showed a maximum loss of .100 inches and a maximum nominal loss of .005 inches (blue areas in scan). The scans also revealed an annular increase in materials with a maximum increase of .100 inches and a maximum nominal increase of .005 inches (yellow and orange in scan).

The annular buildup of material and the central losses indicate that the central paver material was melted and pushed out from the central plume impingement rather than ablated away.

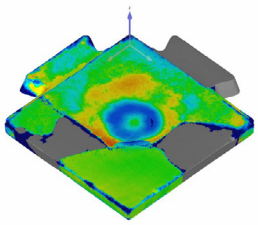

Image and information by: NASA

The 7th Joint Meeting of the Space Resources Roundtable and the Planetary & Terrestrial Mining Sciences Symposium

By John Hamilton, PISCES Logistics and EPO Manager

This symposium (consisting of mining industry, federal space agencies and various university and commercial new space companies) was held on the campus of the Colorado School of Mines in Golden Colorado. This is the premier conference on ISRU (in-situ resource utilization) for the space community.

As expected, NASA's Journey to Mars program took front and center stage with multiple presentations

Cont. page 3...

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on the new landing site paradigm of Exploration Zones. Following the October workshop on Human Landing Site/ Exploration Zones (HLS2), it has been clear that regardless of the specific Mars landing site, the area must have reclaimable water so that ISRU technologies can flourish. Water reclamation from regolith or glacial ice will allow production of breathing oxygen and propellant (rocket fuel) in the form of methane. Methane and oxygen can be manufactured and stored on the surface prior to the eventual arrival of the exploration astronauts.

Site selection for ISRU locations for future Mars expeditions is currently underway. PISCES/University of Hawai'i at Hilo submitted two candidate sites at the workshop. The selection will be made after the satellite imagery and spectral data from the Mars Reconnaissance Orbiter are available.

The concentration on ISRU technologies bodes well for Hawai'i as opportunities in short and long-term analogue testing will be increasing. PISCES and NASA conducted the only ISRU field tests in 2008, 2010 and 2012. A long-term testing regime will be needed to flight qualify the various schemes and systems.

Coupled to the ISRU regolith processing is the use for the material post-volatile recovery. This is when the regolith is extracted and changed. After the change, the material is better suited for construction use in bricks and structures as well as landing pads, such as the recent PISCES/KSC Swampworks demonstration performed here.

Additionally, the use of the Moon and Near-Earth Asteroids (NEA) for preparation, training and testing for a Mars mission is now being openly discussed as the most logical path forward. The same ISRU technologies proposed for Mars can also be used on the Lunar Surface, perhaps by commercial companies. Propellant for the Mars Transfer ship will likely come, not from Earth, but from lunar dust and also (perhaps) NEAs via optical mining techniques. A lunar orbiting fuel depot ("gas station") is consistent with NASA's desire to contract services from the private sector. This activity can be accomplished via robotic and human-robotic systems. The upcoming Resource Prospector mission to the lunar South Pole (based on the RESOLVE program tested here with PISCES) will be the precursor mission.

Various Google Lunar X-Prize Teams have similar goals. Perhaps the innovative MoonRIDERS project of PISCES, which unites public (NASA), private (GLXP teams) and education (High Schools), will be the enabling model for accelerating collaborative and cost-effective demonstration missions.

Next year, the symposium moves to Toronto Canada in conjunction with the Canadian Institute of Mining mega-conference.

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for more information

HELELANI DESIGN REFERENCE MISSION

By Rodrigo Romo, PISCES Program Manager

After successfully completing the construction of the Vertical Take-Off/Vertical Landing (VTVL) Pad project in collaboration with NASA's SwampWorks team, Honeybee Robotics, ODG and Hawai'i County Research and Development, PISCES' planetary rover Helelani was scheduled for a major overhaul of its control systems.

Helelani's second generation of control systems was based on an Arduino systems architecture. While the Arduino boards provided enough capability to perform the tasks required for the VTVL project, it was determined that in order to perform more advanced operations involving advanced imaging processing, Disturbance Tolerant Network Operations, Time Delay Emulation, and semi autonomous navigation, a more powerful on board computer system would be required.

Under guidance of Teddy DeRego, PISCES robotic technician, and with help from Casey Pearring (former PISCES robotic technician) and Karlin Yeh (former PISCES intern) a complete overhaul took place during the spring of 2016. All Arduino boards were removed and replaced with an on board computer.

This upgrade required new coding to be written for the Graphic User Interfaces (GUI) and for the data management from the sensors and end effectors. In addition to the control systems, Helelani's power systems were also upgraded and modified to have three independent power buses: a main bus for the rover's mechanical systems (motors), a 12V bus for all electronics involved in command, control, data, sensors, communications and imaging systems and a 12/24V bus for third party payload systems.

As part of PISCES' summer intern program, two interns joined the robotic team to work on Helelani. Aaron Roth, currently enrolled in Arizona State University (ASU) will be working in collaboration with Dr. Jim Bell from ASU and Dr. Matt Deans from NASA Ames in the development of a stereoscopic imaging system (SIS) for Helelani.

Ara Uhr, a student at Hilo High School and member of the Hilo Viking Robotics team has been working under Teddy DeRego's supervision developing the GUI for the new SIS.

Following the installation of these systems, a Design Reference Mission (DRM) is planned and scheduled to take place in late July. For this DRM, detailed test objectives (DTO's) have been designed to fully characterize the capabilities of the new systems.

In addition to the characterization of the upgraded and new systems on Helelani, two additional tests involving remote teleoperation of the rover will be conducted. ***Continue pg. 4.***

PISCES 2016 HIGHLIGHTS

Here are some of PISCES accomplishments in 2016

APPLIED RESEARCH

PISCES spearheaded a Vertical Take-Off/Vertical Landing Pad (VTVL) experiment involving the use of pure Hawaiian basalt that was melted and compacted into pavers. The pavers were later set in place robotically. PISCES operated that same robot to level and compact the site where the pavers were interlocked into a bulls-eye pad. NASA Kennedy Space Center's ability to remotely install the pavers from their headquarters in Florida was another major milestone in the project. PISCES later tested the pad with a rocket engine firing that was recorded and analyzed for data purposes.

PISCES conducted a follow-up study of a sidewalk installation that was developed in Hilo during Fiscal Year 2015. Our scientists later gathered and analyzed data to review the durability of the three different basalt materials used in the project.

PISCES participated in the BASALT (Biologic Analog Science Associated with Lava Terrains) project that conducts scientific fieldwork in Idaho and Hawai'i Island to better understand the habitability of terrestrial volcanic terrains as analog environments for future missions to Mars.

WORKFORCE TRAINING & STEM EDUCATION

During the past year, PISCES employed and mentored 12 interns and student workers in paid or volunteer positions. The students were able to work on real-life engineering and science-related projects.

Each year PISCES hosts a workshop for young high school females called "STARS." This year the attendance almost tripled from FY 2015.

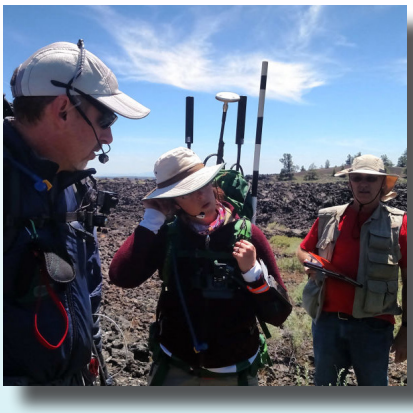
PISCES also continued a program titled MoonRIDERS that coordinates a partnership with students of two Hawai'i High Schools and NASA in the development of an electrostatic dust removal system for use on the Moon or Mars. PISCES obtained grants for $35,000 to support the effort to put the experiment on the moon in 2017.

This year PISCES acquired a space shuttle flight deck mock-up and mentored Kea'au High School and Hawai'i Community College students to restore the life-sized model to pristine condition.

PISCES participated in 30 events, speaking engagements, classroom and school club visits to encourage interest or mentor involvement in STEM activities.

LONG-TERM ECONOMIC DEVELOPMENT

PISCES procured and oversaw two engineering studies (geologic and telecommunications) at a Mauna Loa location that shows promise as one of the possible sites for a future NASA Laser Communication Ground Station.



PISCES' John Hamilton with the BASALT team in Idaho. This past month John, along with University of Hawai'i at Hilo student Colin Milovsoroff, joined the team of scientists, engineers, and astronauts to test time-delay simulation techniques that will help predict how astronauts may communicate on Mars.

PISCES interns are seen here working on the stereostopic system for the robotic rover...

HELELANI CONTINUED...

A Mission Control Center (MCC) will be set at PISCES' headquarters in Hilo and remote teleoperation, both in real time and in lunar time delay mode, will be conducted from there while Helelani is at the selected test site over 40 kilometers away.

NASA Ames will also be testing teleoperations from their facility in California. They will be testing real time and time delay operations as part of their training for future lunar rover operations. The NASA Ames test will also involve the use of the stereoscopic imaging system, data capture, download and processing remotely.

PISCES, through its robotic program, continues to provide invaluable job training skills to Hawai'i's future aerospace generation and to collaborate with NASA and other higher learning institutions in the advancement and development of space exploration technologies.