

APPLIED RESEARCH



Planetary LEGO Blocks Take Shape

These LEGO blocks are not the familiar plastics bricks you may have pieced together as a kid or given to your children to play with. In fact, these blocks could one day form the foundations of habitats and infrastructure supporting astronauts on places like Mars, the Moon and other worlds.

Funded by a NASA Phase 1 STTR grant last year awarded in partnership with Honeybee Robotics, PISCES set out to research innovative designs for building blocks made from locally sourced volcanic basalt. The objective was to create a prototype planetary LEGO brick using local, raw materials that could be made robotically on other planets. The process, known as ISRU or in-situ resource utilization, could also be used to create sustainable building materials on Earth. Now, nearly one year since the

project began, the goal is nearly in sight.

After spending many long days in the lab experimenting with various thermal profiles and mold designs, PISCES Geology Technician Kyla Defore and Operations Manager Christian Andersen have finally created the full-size block design they intended. But this not-small achievement came with a few challenges.

Using only rock dust from Hawaii Island quarries and sustained heat, many of their early attempts were fraught with stress cracks and other imperfections, which compromised the structural integrity of the full-sized bricks. The problem seemed to lie in the initial mold designs, which were expanding during heating periods and contracting when cooling. *(Continued on page 5...)*

MESSAGE FROM THE PROGRAM DIRECTOR



Rodrigo Romo

Aloha Kakou,

Kilauea's eruption on the Island of Hawaii has dominated much of our attention during the last month. Seeing the power of an unstoppable force of nature is a humbling experience, and reminds me that we live on a dynamic, everchanging planet, and there is still much to learn.

I am thankful that no one from the PISCES ohana has been affected by this sudden and unexpected series of events. However, my heart goes out to all the people whose lives have been turned upside down by the continuing eruptions that are forever changing the landscape in lower Puna.

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OUTREACH & EDUCATION



AstroDay Brings Educational Fun to East Hawaii

SMA telescope operator and outreach specialist Mimi Fuchs entertained dozens of local youth with astronomy-themed coloring activities during AstroDay in Hilo on May 5, 2018.

Volcanic eruptions, volcanic ash and earthquakes were no deterrent for Hilo's annual AstroDay event held on May 5, which drew hundreds of local visitors for a day of science activities and educational fun at Prince Kuhio Plaza in Hilo.

"It was a crazy week and I wasn't certain what to expect—but it appeared the crowds were enthusiastic and appreciative," wrote Carolyn Kaichi, education/outreach specialist at UH Institute for Astronomy and a key organizer for the event.

More than 30 local science, technology and engineering organizations showed up to talk-story, share demonstrations and pass out various prizes and swag to kids and their families. PISCES brought its new UAV octocopter for show-and-tell and played space trivia.

Both adults and kids visited the various booths to earn stamps toward a collectible Maunakea coin themed on astronomy and Hawaiian culture. This year's winner of the Maunakea Coin Contest was 4th-grader Bailey Mattos of E.B. de Silva School. Bailey was recognized and awarded with an amateur telescope at the plaza's center stage. Students in all

grades are invited to create a design for the coin each year.

The Maunakea Observatories also brought popular activities like the portable StarLab planetarium, infrared camera demonstrations and poster images of galaxies and stars captured at the summit.

"For the most part I think everyone had fun and it was an impressive turnout," Kaichi wrote. "This couldn't have happened without the partnerships we all have, and support from the Maunakea Astronomy Outreach Committee, Maunakea Support Services, and the Office of Maunakea Management."



PISCES PIO Chris Yoakum poses a space trivia question to visitors at AstroDay.

PISCES SELECTS WINNER FOR UAV NAME CONTEST



PISCES PIO Chris Yoakum presented 7-year-old Michael with a "He'e Manu" prize pack during AstroDay.

Drones don't usually have the honor of receiving an appropriate Hawaiian name to characterize their robotic personalities. Fortunately for PISCES' new UAV, that is not the case.

The new octocopter—acquired for a project in partnership with the Hawaii Dept. of R&D—recently received a fitting name following a contest held during 'Imiloa Astronomy Center's birthday bash in March. "He'e Manu," meaning "Flying Octopus," was coined by UH Hilo IT specialist Norm Dionne. Norm thought the prize would be more appropriate for his younger family member and deferred the honor to 7-year-old Michael Blum. Michael was excited to receive a custom He'e Manu sticker pack and t-shirt commemorating the occasion.

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WORKFORCE DEVELOPMENT



Pathway to Success: Blueprints for the 2018 Summer Internship Program

Former Materials Science intern Lily Leyva (L) and PISCES Geology Tech Kyla Defore collect data at a planetary analog test site in Summer 2017.

In just a few weeks, PISCES will welcome its latest team of student interns to work on several research programs in the field and in the lab.

Beginning June 18 and ending Aug. 14, the 10-week program will host one Akamai Workforce intern and two junior volunteers this year. The program will focus on applied research in Materials Science to create sintered basalt pavers for a vertical launch/landing pad and will be organized into three phases: 1) *Research and Field Work*, 2) *Lab Work* and 3) *Manufacturing*.

The *Research and Field Work* phase will teach participants about In-Situ Resource Utilization (ISRU), and how locally sourced, raw materials can be used to extract resources like oxygen, water and rocket propellant. Students will also learn how to identify various rock forms and soil compositions in the local terrain, while using remote sensing to locate potential planetary analog sites for sampling. Once identified, students will “ground-truth” these areas by visiting them in person with survey equipment to collect samples.

In the *Lab Work* phase, students will

analyze their samples using a range of testing methods. Using an EDXRF spectrometer, they will determine the chemical make-up of three to five samples collections. The students will also analyze the mineral composition of their samples using a binocular microscope, and measure for particle sizes, heat capacity, density and thermal conductivity.

Once all the data is recorded, students will enter the *Manufacturing* phase to fabricate their samples into usable products. This phase will involve sintering the samples at high heat in a mold for sustained periods of time and recording the results that yield the most durable and cohesive products.

The three program phases this year are designed to teach students how to conduct sound research, use remote sensing techniques to locate potential analog sites, characterize sites and choose the best samples. They will also learn to gather accurate data, conduct in-depth analysis, and use the results to create their own basalt paver tiles.

PROGRAM DIRECTOR'S MESSAGE ...

Volcanic eruptions aside, the month of May was a mix of bittersweet news for us at PISCES. Sadly, the legislative bills intended to support our Workforce Development and related initiatives did not pass. However, we were pleased to learn that PISCES will receive additional supplemental funds from the State of Hawaii in the coming year to bolster our work in Applied Research, Workforce Development and Economic Development. We also received funds to procure an official vehicle for PISCES staff thanks to DBEDT. A huge mahalo to DBEDT for making this possible!

I was also happy to receive some good news about World View, an Arizona-based aerospace company created by Jane Poynter (the focus of this month's guest spotlight article) and Taber MacCallum—two former biosphere scientists and dear friends of mine. World View secured funding to accelerate the development of a high-altitude balloon platform called a Stratollite which can be deployed quickly at low cost. This vehicle can maintain its position over a specific area of interest for sustained periods of time and carry a variety of Earth-observing instruments. My congratulations go out to both Jane and Taber. It is rewarding to see small private space companies making an impact in the global space exploration community.

(Continued on next page...)

*A Worldview strattolite prepares for launch in October 2017 in Tucson, AZ.
PC: Worldview*





GUEST SPOTLIGHT

Limitless: Beyond the Skies

Making the Stratosphere Accessible

Jane Poynter, Co-founder and CEO of World View

Jane Poynter & Taber MacCallum (pictured right and left, respectively) are the founders of Arizona-based aerospace company World View and are both former participants in Biosphere 2.

Jane Poynter is no stranger to big ideas. World View, the Tucson-based stratospheric flight and technology company, is just the latest game-changing venture for Poynter, the biospherian turned entrepreneur/CEO and humanitarian.

Most wouldn't describe Ms. Poynter's journey in life as ordinary. Quickly after primary school, Poynter developed an early and insatiable appetite for audacious projects. This gravitational force led her on an international trek of self-exploration and education that concluded with her earning a spot on the eight-person roster of Biosphere 2, a project widely regarded as the first large-scale, terrestrial space colonization experiment. Poynter would spend two full years enclosed inside the completely sealed 3.14-acre artificial ecosystem alongside seven other biospherians, including her now lifelong

partner and World View co-founder and CTO, Taber MacCallum. The scientific, engineering, and ecological contributions of Biosphere 2 remain immeasurable today, a whole 25 years after Poynter stepped out of Biosphere 2 and back into Biosphere 1 (planet Earth) with her nearly 7 billion new crewmates.

But Poynter hasn't slowed down since leaving Biosphere 2. In fact, she's built upon the many successes, hardships, and learnings of that project to bring new visions and ideas to life. Poynter and MacCallum have, together, embarked on many bold entrepreneurial pursuits, including the formation of Paragon Space Development Corporation, a life-support technology company which has grown into one of the premier Environmental Control and Life Support System companies on Earth. Paragon designs and produces critical technology needed to sustain life in hazardous environments like the International Space Station and Boeing's new CST-100 Crew Space Transportation spacecraft. Under Poynter's leadership, Paragon also successfully completed project StratEx, an experimental program that designed, built, and flew a system for human stratospheric exploration via high-altitude balloon. Project StratEx and pilot Alan Eustace now hold the world record for the highest human balloon flight in history, coming in at 135,908 feet.

(Continued on next page...)



Poynter harvests sweet potatoes inside Biosphere 2. PC: World View



Photo courtesy of World View.

PROGRAM DIRECTOR'S MESSAGE ...

This month, PISCES is preparing to welcome a new team of student interns to work on our Applied Research projects this summer. We are also gearing up to launch our 2018 STARS Program in July which will offer a truly unique and inspiring experience to participating high school women.

On a final note, the PISCES ohana and I wish to congratulate our former robotics interns Jack Andersen and Andrew Hasegawa who just graduated with honors from Hawaii Community College. May you both be successful in your future endeavors!

A hui hou,

R. Romo

Rodrigo Romo

PISCES Program Director



Former interns Jack (L) and Andrew in the field with Helelani.

Beyond the Skies *continued...*

If Biosphere 2, Paragon, and StratEx weren't enough, Poynter has since embarked on perhaps her most audacious project yet—pioneering an entirely new economy in the stratosphere. Beginning in 2013, Poynter's focus shifted towards building and growing World View, which is now widely regarded as the world's leading stratospheric flight and technology company. What began as a novel and unique approach to human space exploration has grown into a company uniquely positioned to tap into the value of a layer of Earth's atmosphere that has been widely ignored for decades—the stratosphere.

As co-founder and CEO, Poynter is leading World View in the development of new technologies that leverage the natural advantages of the stratosphere to solve critical, real world problems. Principally among those technologies is the Stratollite, a stratospheric vehicle that offers customers breakthrough navigation, control, and station-keeping capabilities for long-duration missions. In short, the Stratollite combines many of the benefits of geo-stationary satellites, LEO satellites, and high-altitude drones, all at a fraction of the

cost of those technologies. Sustained, controlled flight in the stratosphere has remained technically out of reach until Ms. Poynter's team took on the challenge. The Stratollite is already serving a myriad of applications that have been traditionally served by satellites and aerial platforms, and it's positioned to unlock unprecedented new use-cases that were never feasible. World View has gone through several successful financing rounds and is now backed by some of the most notable Silicon Valley investment firms, including early adopters in Facebook, Dropbox, DJI, and others. Today, World View designs, manufactures, and launches its own stratospheric balloons and Stratollites for a variety of customers (including NASA) from World View's new 142,000-square-foot global HQ located in Tucson, Arizona—the world's first purpose-built stratospheric ballooning facility.

After years of successful development and growth, Poynter still views the great progress at World View as just a fruitful beginning. In her pursuit to open the stratosphere for commerce and science alike, for Poynter, the sky was never the limit.



Planetary LEGOS *cont...*

After adding insulation materials to prevent varying temperature gradients (or temperature changes at different places along the brick) and adjusting the mold design to secure the basalt, they found a winning technique that created a usable Planetary LEGO block free from defects.

The final step in the project will be stressful—for the LEGOS. To determine how they measure up to conventional building materials and how they might withstand harsh environments, the LEGOs will undergo flexural and compressive strength tests. If previous efforts are any indication, the blocks will likely perform well.

During a robotic launch and landing pad project conducted in 2016, PISCES sintered a series of basalt pavers tiles that exceeded the strength of residential and specialty concrete. Planetary LEGO blocks are the latest incarnation of this research, and the next step in their evolution will involve the production of more samples to begin building various structures that can be tested and shared with the ISRU community.

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