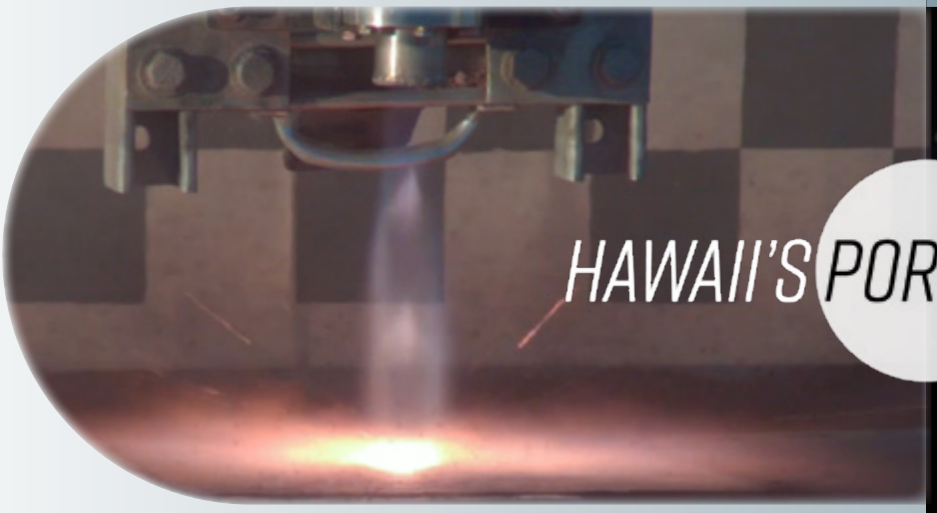
PISCES

PACIFIC INTERNATIONAL SPACE CENTER FOR EXPLORATION SYSTEMS

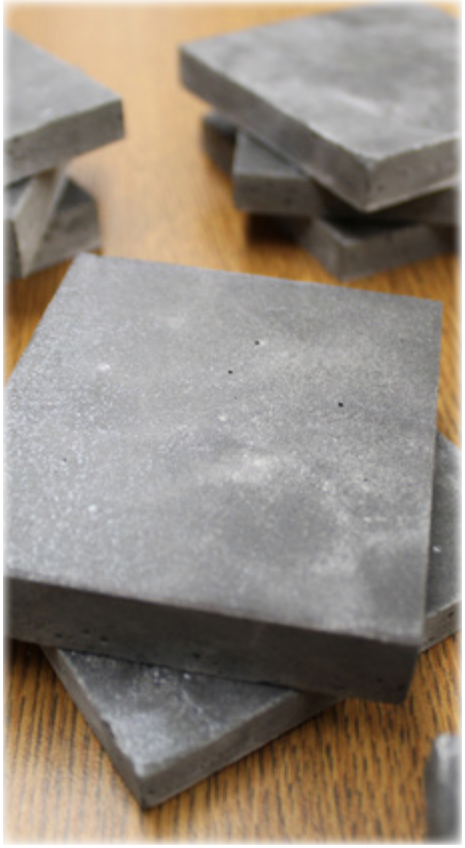


HAWAII'S PORTAL TO SPACE

FY20 ANNUAL REPORT

Hawaii Revised Statutes Section 201-80

PISCES Hawaii



The Pacific International Space Center for Exploration Systems (PISCES) is a state-funded Hawaiʻi aerospace agency under the Dept. of Business, Economic Development and Tourism (DBEDT). Based in Hilo, the agency is working to position the state as a leader in space exploration while developing sustainable products and technologies that benefit the State of Hawaiʻi. Through initiatives in Economic Development, Workforce Development and Applied Research, PISCES provides hands-on work experience to Hawaiʻi's future scientists, programmers and engineers, preparing them to meet the demands of a highly competitive industry while improving the local economy through job diversification, innovative products and new industries.

FY20 Annual Report

Contents

Letter from the Board Chair 4
Letter from the Program Director 5
Executive Summary. 6
Economic Development 8
- Launch Operations 8
- UAS Operations 10
- Dual-Use Technology R&D 11

Workforce Development 12
- Internships 12
- Women's STARS Program 13

Applied Research 14
- Sintered Basalt Research 14
- Research Grants 16
- Planetary Mission Simulation 17

Education & Outreach 18
- PISCES-RISE Robotics Club 19
- HI-SEARCh Robotics Competition 19

MOU Partnerships 20
Financial Report 21
Staff 22
Board of Directors 23

This report was compiled in accordance with Hawaii Revised Statutes Section 201-80.
*****Front and back cover images: static rocket fire photos courtesy of Masten Space Systems.***

Letter from the Board Chair

Henk Rogers

Greetings,

During difficult situations and unprecedented challenges, we are reminded of the importance of investing in diversifying Hawai'i's economy. I want to express my appreciation for everyone who has had the foresight to support PISCES all these years and help build the foundation for bringing the multi-billion-dollar aerospace industry to our community. We need it now more than ever.

As the economies of the world heat up in their post-COVID recoveries, so will the race to settle and explore the resources of the moon. The United States, China, Russia, India and even the United Arab Emirates are preparing for the next great wave of exploration and colonization, and Hawai'i is positioned to lead the way with aloha.

Hawai'i has every geological and geographical advantage necessary to become the center of space crew training and selection, just as it did during the Apollo missions over 50 years ago. This year, PISCES participated in a two-week lunar simulation at the Hawai'i Space Exploration Analog and Simulation (HI-SEAS) to research off-world living and basalt sintering at high altitude.

Additionally, as the closest state to the equator, Hawai'i's geographic location makes it the best spot in the country to launch payloads into orbit and to cooperate with Asian partners like Japan, Korea, India and China.

Our work at PISCES has adapted and shifted priorities during the COVID-19 crisis. In response to the pandemic, our team joined a community coalition of STEM organizations, students and community members to produce personal protective equipment (PPE) for health care workers and first responders. We also raised funds from corporate sponsors and local nonprofits to fund our sixth-annual STARS program, which was recently recognized in a national STEM mentoring report.

We continue to work hard to provide our future aerospace engineers and scientists with the knowledge and resources necessary to succeed. In addition to the high school students who completed the STARS space and science camp, we also mentored five students in robotics and materials science projects related to aerospace in 2020.

The benefits and advantages for Hawai'i's lunar settlement and space exploration industry are endless, especially in a post-tourism economy. In terms of experience and credibility, we have what it takes to create a thriving aerospace industry in Hawai'i. And, we also have the invaluable culture of respect and aloha that will guide our journey. We could become the Cape Canaveral of moon base development, and we should embrace the possibilities.

Henk Rogers
Chairperson

Letter from the Program Manager

Rodrigo Romo

Aloha kākou,

The past year has been an unpreceented time for everyone. The coronavirus pandemic has wreaked havoc on the economy, education, travel and other aspects of what was considered "normal" in society. Hawaiʻi was particularly hard-hit because of our heavy dependency on tourism. This has exposed and highlighted the need to diversify our economy into other areas beyond tourism. We have been working closely with state legislators to identify opportunities in Aerospace that could diversify and bolster Hawaiʻi's economic recovery. They focus on three main areas: launch operations, Unmanned Aerial Systems (UAS) and planetary surface research and development. We believe each of these areas can provide strong economic opportunities for Hawaiʻi.

During the initial stages of the government-ordered lock downs, our staff primarily worked from home and joined a local grass roots coalition to produce needed personal protection equipment (PPE) for healthcare workers and first responders. The group, called Hawaiʻi STEM Community Care, was initiated by Hawaiʻi Science & Technology Museum and NexTech and included members of the astronomy community, local universities and PISCES. Working together, we have produced face mask tension relief straps, face shields, hands-free door openers and a UV sterilization unit for first responders to sterilize N95 masks.

Despite the lockdowns from the pandemic, the Aerospace industry is seeing rapid growth. This summer, we saw SpaceX launch American astronauts from U.S. soil to the International Space Station for the first time in nearly a decade. It was also the first time a commercial space company had sent humans to space. Private companies are leading the development of launch systems, lunar landers, surface mobility systems, small satellites and other technologies. With NASA's Artemis program aiming to return astronauts to the moon in a sustainable way, interest in analog field-testing and technologies for construction and survival on the lunar surface has grown. PISCES has been invited to collaborate on three grants to provide logistical support for analog field testing on Hawaiʻi Island. We are also leading two separate grants to develop a 3D-printing extruder capable of producing a composite made of basalt and a binder. These grants have been submitted and the status of their approval is pending.

Our launch and landing pad tiles made of volcanic basalt have also drawn interest from NASA and Masten Space Systems, and a collaborative project to test them for lunar applications is in the works.

In legislative news, I am pleased to say the bill we submitted this year with support from members of the House and Senate passed and is waiting to be signed into law by Gov. David Ige. Bill HB1912-HD1-SD1 establishes PISCES as a direct agency attached to DBEDT, makes minor changes to the structuring of our board of directors and adjusts our reporting requirements to better reflect our current work.

Without a doubt, the coming year will be difficult for many in Hawaiʻi and nationwide. Here at PISCES, we will be focused on providing guidance and support to aid Hawaiʻi's economic recovery while continuing our research and development in ISRU, robotics and workforce development.

Rodrigo Romo
Program Director

Executive Summary

Top left: A student rogramming a smart robot during the annual STARS program's robotics workshop. Bottom left: PISCES' planetary rover "Helelani" parked outside the HI-SEAS habitat on Mauna Loa. Right: A sintered basalt tile made using only an basalt aggregate and heat.

Diversifying Hawaii's Economy Through Aerospace Projects

Fiscal Year 2020 has been an exciting year for aerospace where private and public partnerships came together to achieve new goals in human spaceflight and exploration. NASA has a solid plan to return astronauts to the moon in the coming years under the Artemis program; commercial companies are designing and testing spacecrafts for crewed missions and landing systems to support the future of travel beyond Earth; space tourism is emerging as a new industry.

PISCES has been working diligently on projects in Economic Development, Workforce Development and Applied Research to realize a sustainable aerospace industry cluster in the State of Hawaiʻi that will meet the needs of the evolving Aerospace sector. This exciting new phase in aerospace brings numerous economic opportunities for development in Hawaiʻi where the geographic positioning of the islands is well-suited for launch operations, Unmanned Aerial Systems for communications networks, and continuing research and development on products and technologies that benefit both Hawaiʻi and the collective human effort of space exploration.

A launch operations site would

open the way to small launch vehicles providers interested in sending small satellites and similar payloads into low-Earth orbit. Unmanned Aerial Systems are among the new technologies that will provide the next generation of wireless communications globally. Through airborne networks of UAS aircraft, mobile data and communication services can be provided to the ground with increased coverage, benefiting those without connectivity as well as emergency response teams and scientific studies. One company is looking to Hawaiʻi to establish a base for UAS systems to provide such a system to users on the ground. In the realm of space tourism, a human spaceflight startup is considering Hawaiʻi as a possible launching point for its stratospheric balloon rides above Earth.

In research and development, PISCES has continued to forge a path in the realm of sintered basalt, studying Hawaiʻi's volcanic basalt as a medium to develop In-Situ Resource Utilization processes for lunar and Mars applications. With several durability tests completed, sintered basalt products show promise as a building material that can withstand unusually high temperatures and force. Companies are looking at PISCES' basalt tiles for commercial applications in construction, as well as for launch and landing pad materials.

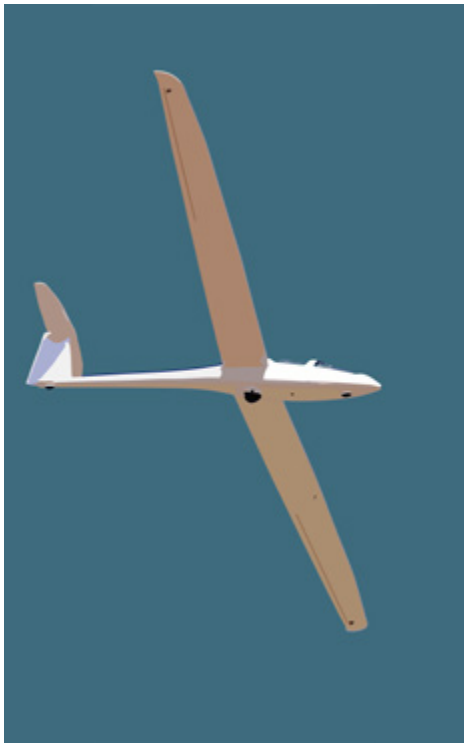
Bolstering these initiatives, PISCES worked diligently in FY20 to offer unique hands-on learning experiences to Hawaiʻi students as part of its Workforce Development objective. Offering aerospace projects in robotics and materials science, the staff mentored five undergraduate students through the summer months of 2019.

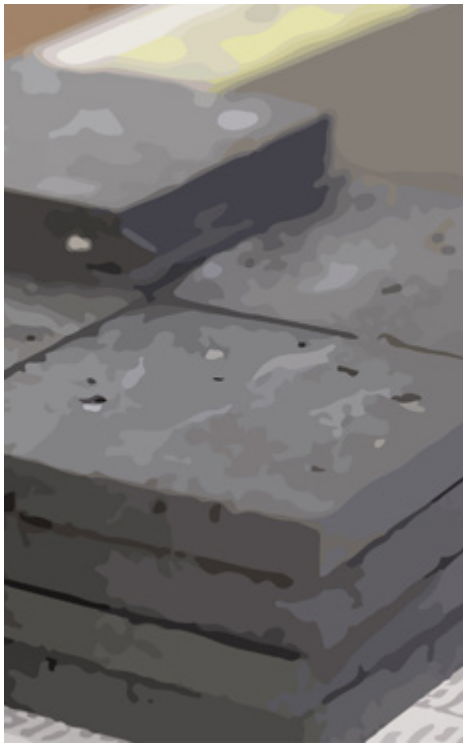
In outreach and education, PISCES adapted to the changing conditions brought by the COVID-19 pandemic, working with local STEM groups to provide virtual outreach and educational activities. Staff also continued to support the PISCES-RISE robotics club for elementary school youth, a program that began in 2018 with support from the University of Hawaiʻi at Hilo. In 2021, PISCES is planning an international robotic mining competition inspired by NASA's Lunabotics, an event that will bring more than 20 college teams from around the world to compete in the lunar-like analog terrain of Hawaiʻi's Big Island.

These projects all aim to align Hawaiʻi with the 21st century world of technology and exploration, creating new opportunities for youth to learn and grow while diversifying Hawaiʻi's local economy through sustainable

Below: PISCES staff and Summer 2019 interns who completed projects in robotics and materials science.

Economic Development





Aerospace Sector Opportunities for Hawaii

Hawaiʻi is well-suited for certain sectors of the Aerospace industry. The islands' unique geographic position and geological makeup present economic opportunities that can serve as strong foundational pillars for a new high-tech, high-paying Aerospace sector that would employ Hawaiʻi residents.These sectors include:

- *Small satellite manufacturing;*
- *Testing and on-orbit operations;*
- *Small vehicle orbital launch;*
- *Unmanned Aerial Vehicle Systems (UAS) testing, research and training;*
- *Planetary surface training & testing programs.*

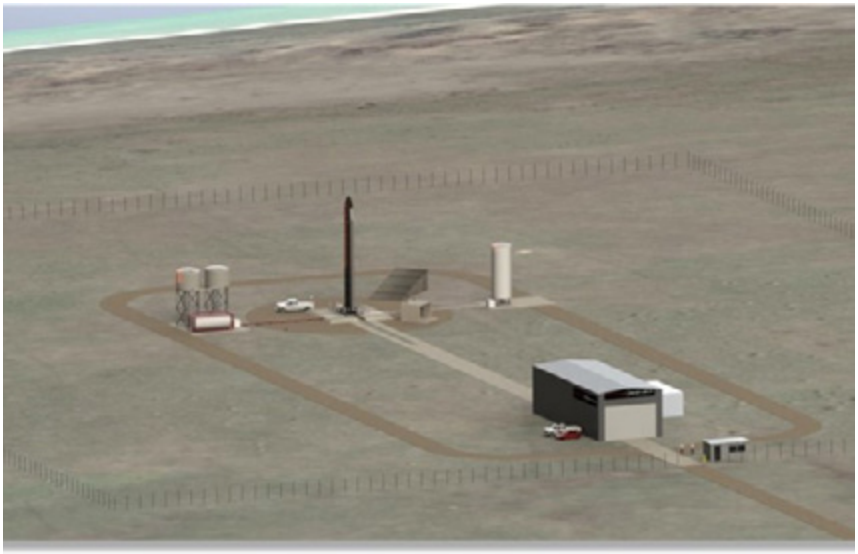
Together with the Hawaiʻi Space Flight Laboratory, PISCES has been looking at identifying opportunities in the Aerospace Industry that can be brought to Hawaiʻi. We are currently working with both Hawaiʻi lawmakers and private firms to find a way to establish the following projects.

Launch Operations

1. Land-based Operations (East Hawaiʻi Space Port Complex) — Two private-sector space companies are currently interested in launching payloads into space from East Hawaiʻi at a frequency of roughly 10 to 15 launches per year.

2. Glider Launch Operations — The DoD Joint Capability Technology Demonstration Program has allocated $25M to $50M towards development of a glider launch concept and has enabled foreign investment and development. The concept is fully designed but not yet built. Hawai'i's geographic isolation makes it an ideal base location for an air-launch vehicle. DoD and foreign investment could be used to help defray development costs. Sources of revenue for Hawai'i would include: (1) a share of the IP value for the glider system estimated at $660M when fully functioning; (2) operational costs for the launch areas; (3) increased high-tech companies/jobs related to orbital and planetary missions; and (4) U.S. Air Force support for six U.S. small rockets that can be adapted to launch from the glider. After three to four years, a success glider operation is estimated to be worth $1B.

3. Space Tourism Operations: A new spaceflight startup called The Space Perspective aims to provide high altitude flight experiences (100,000 feet) to paying customers aboard a custom built capsule carried by a stratospheric balloon. While operations will be focused on paying customers who wish to experience the view from the stratosphere, the company also intends to support scientific research and education-related projects. The company anticipates each capsule will complete about 50 flights per year, and each launch site will conduct 100 flights per year. The first unmanned test flights are set to begin in 2021 with fully commercial operations launching in four to five years. The company is currently seeking locations to establish flight center operations, headquarters and manufacturing facilities, and has expressed interest in Hawai'i. They anticipate a combined workforce for their space flight operations center and manufacturing facility to be 200 employees with average salaries over $60,000 per year.



Artist rendering of a small rocket launch facility. Source: Alaska Aerospace/Pacific Spaceport Complex Hawai'i.

Economic Development

Above: Artist rendering of HAPSMobile's HAWK30 aircraft in flight. Source: HAPSMobile.

Unmanned Aerial Systems (UAS) Operations

1. HAPSMobile Hub on Lanai — HAPS (High Altitude Platform Station) Mobile has expressed interest in establishing an operations center on the island of Lanai. The company is developing an airborne network of solar-powered stations that would fly in the stratosphere and provide on-ground telecommunications services for smart phones and other devices. A 300-foot tent hangar has been purchased for the site on Lanai and the project is awaiting land-use rezoning permits to proceed. HAPSMobile intends to use Lanai as the launch point for 1,000 HAWK30 aircraft.

2. HAPSMobile Maintenance & Refurbishing Center — HAPSMobile is also interseted in building an assembly facility in Hawai'i where its drones could be assembled for deployment to other parts of the world. The company would have to recover three planes per day to keep the fleet in the air, and the average maintenance cycle might be 30 days. Ninety planes would be in various states of repair at the maintenance center on a continual basis. Such a facility is expected to create 200+ high-tech workforce jobs to maintain and keep the aircraft in flight.

3. UH/OSU/NASA EPSCoR Collaborative Plan — With the slowdown of the air travel industry resulting from COVID-19, the HAPSMobile UAS project may allow retraining for pilots and aircraft mechanics to support the project's flight and maintenance operations.

4. Remote Sensing Operations — Various groups from NASA and the U.S. Forest Service are asking for high resolution coverage. The HAPSMobile project could bring $7M to $10M per year in research funds for projects that have already been identified.

Dual-Use Technology R&D

Research & Development for dual-use technologies can bring in federal research funding through grants to develop novel materials, technologies or processes that can be utilized in space exploration while potentially creating spin-off industries in Hawai'i. These include the sintered basalt research developed at PISCES which could be used for high quality tile in commercial applications. Research & Development also includes workforce development and outreach.

Summary

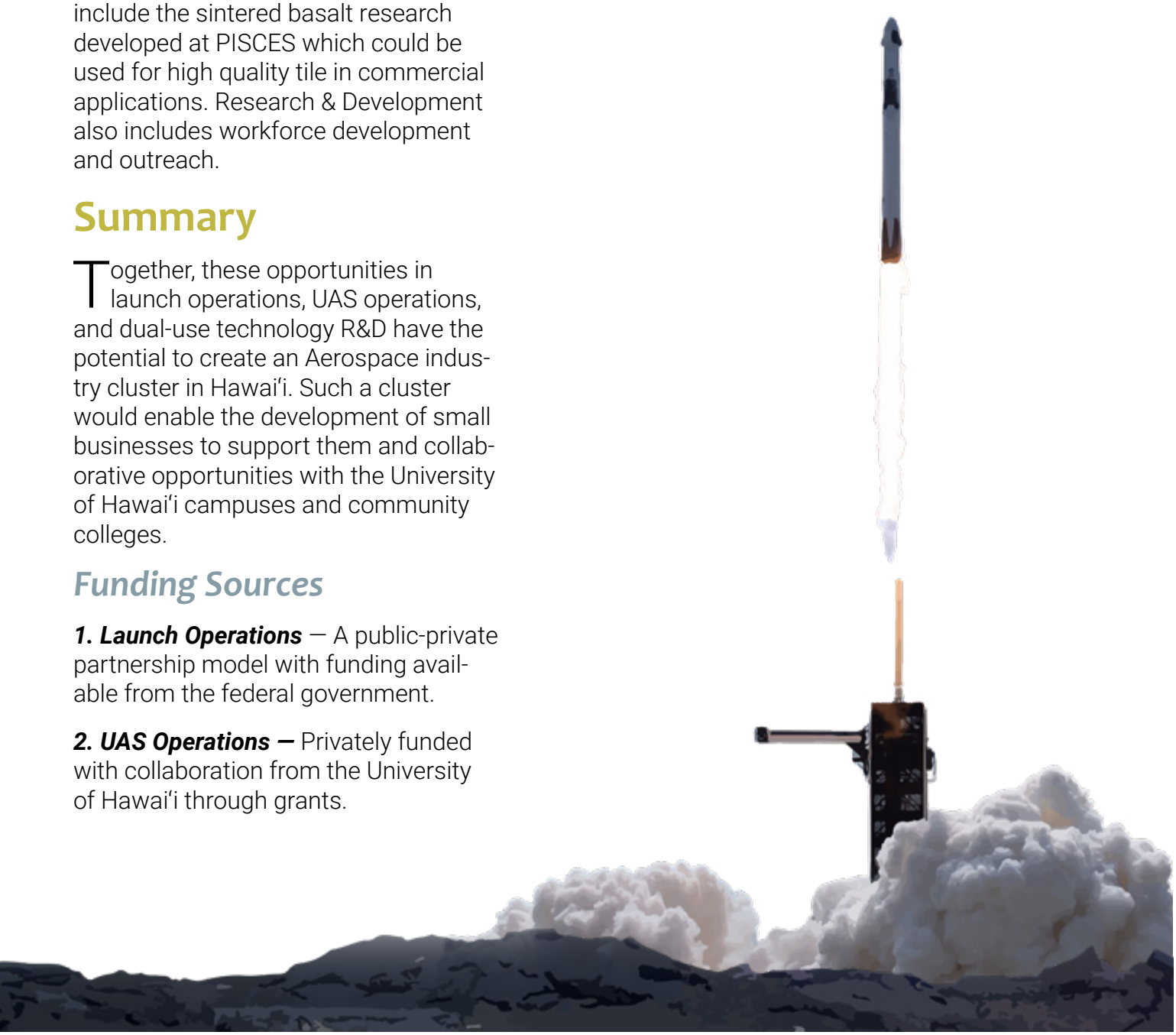
Together, these opportunities in launch operations, UAS operations, and dual-use technology R&D have the potential to create an Aerospace industry cluster in Hawai'i. Such a cluster would enable the development of small businesses to support them and collaborative opportunities with the University of Hawai'i campuses and community colleges.

Funding Sources

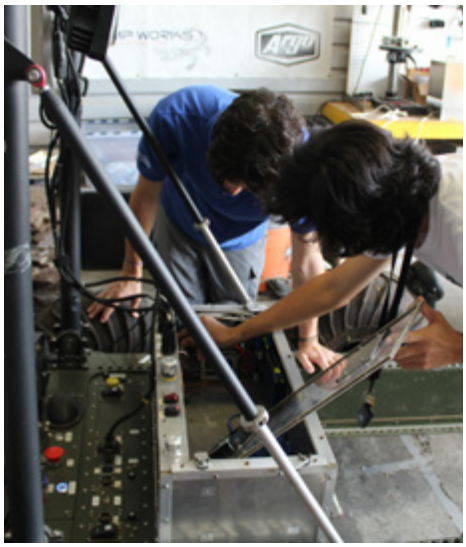
1. Launch Operations — A public-private partnership model with funding available from the federal government.

2. UAS Operations — Privately funded with collaboration from the University of Hawai'i through grants.

3. Dual-Use Technology R&D — Planetary surface research conducted by PISCES is currently being conducted. Such work requires baseline funding from the State of Hawai'i's general funds with supplemental funding raised through research grants and private contracts.



Workforce Development



Above: PISCES interns work on aerospace-related projects in materials science research and robotics development.

STEM Learning Experiences for Students

STEM jobs will lead Hawai'i's economy in growth, adding more than 3,000 new jobs between 2011 and 2021 (DBEDT, EMSI). Together with local STEM businesses and organizations, PISCES is working to help prepare Hawai'i youth for STEM-related careers through paid internships, summer vocational programs and volunteer opportunities.

Paid & Credit-based Internships

PISCES offers internships to undergraduate students based in Hawai'i with an interest in aerospace-related STEM projects. Students may work for salary or college credit in one of two tracks: Robotics and Materials Science. PISCES partners with Akamai Workforce Initiative and PIPES (Pacific Internship Programs for Exploring Sciences) to offer these projects. Students who participate apply their classroom learning and develop professional skills while making connections in aerospace and related industries through the projects they engage in. Since 2013, PISCES has mentored 49 college students.

Robotics

Students in the robotics track develop skills in electronics technology, software programming and hardware engineering using a planetary analog rover as a learning platform. Upon completion of the projects they design and implement with the rover, students test their work during a Design Reference Mission at a planetary analog test site. Since 2014, 19 students have worked on the rover (dubbed "Helelani," or Heavenly Travels), upgrading its software and hardware systems, communication capabilities, imaging and mechanical

systems, graphic user interfaces and sensors. Former robotics interns have gone on to work for companies like Google, Microsoft and NASA's Jet Propulsion Laboratory.

Materials Science

Students in the materials science track learn and apply principles of geology, volcanology and planetary science for basalt research for in-situ resource utilization (ISRU). Students gain experience in field testing, chemical and mineral analysis, and lab and field safety. They also develop skills in scientific writing and have the opportunity to co-author a scientific research paper outlining their work. Former materials science interns have gone on to intern with NASA and work for subsidiaries of Apple.

Women's STARS Program

STARS is a successful summer space and science camp for Hawai'i high school girls. Inspired by a NASA program for young women, PISCES began STARS in 2014 to encourage more young women to pursue careers in aerospace and STEM fields. The program accepts 12 students each year from anywhere in the State of Hawai'i and includes meals, accommodations and transportation through the support of corporate and nonprofit sponsorships and grants. In 2019, the program was recognized in Million Women Mentors' *State of the States World Report*.

The STARS schedule varies from year to year but generally includes the following activities:

- *Tours at Hawai'i's leading scientific research and education facilities including HI-SEAS, Maunakea Observatories and USGS Hawaiian Volcano Observatory;*
- *Group project assignments;*
- *Interactive presentations and activities with leading women in STEM;*
- *Hands-on workshops in robotics, rocketry and engineering;*
- *Connections with internship opportunities like Akamai, the Maunakea Scholars program and others.*

STARS is largely made possible through support from volunteers and local organizations working in STEM.

Due to COVID-19, the 2020 program was postponed. However, sponsorship funding was secured through Caterpillar, Inc. and Microsoft.

Above: Students pose in the barren volcanic terrain of Mauna Loa outside the HI-SEAS (Hawai'i Space Exploration and Analog Simulation) habitat during the 2019 STARS program.

Applied Research

Above left: Masten Space Systems conducts a static rocket fire test of a sintered basalt landing pad tile made at PISCES. Source: Masten Space Systems. Right: Sintered basalt tiles created using only Hawaiian basalt aggregate and heat.

Research to Benefit Earth & Space Exploration

Applied research is a core objective of PISCES' mission to bolster the aerospace industry in Hawaiʻi. These projects focus on innovative technologies that can benefit the State of Hawaiʻi and space exploration. Through partnerships with academic, public and private organizations, PISCES' applied research projects are an ongoing source of funding that support Hawaiʻi's economy. Funding sources include the Small Business Innovation and Research (SBIR) program, NASA's PSTARS program, NASA's NIAC program, NASA's Broad Agency Announcements (BAA) and others.

Sintered Basalt Research

Hawaiʻi's basalt has the unique characteristic of being chemically similar to the regolith (surface dirt) found on the moon and Mars. As a result, it makes an excellent medium for testing and proving potential In-Situ Resource Utilization (ISRU) proccesses here on Earth. Since 2015, PISCES has been refining and perfecting sintered basalt products using Hawaiian basalt. Taking basalt fines sourced from Hawaiʻi Island quarries, the materials science team has painstakingly found the ideal thermal profile to sinter (or bake) Hawaiʻi basalt into a construction material that is more durable than concrete. The process requires no additives, only heat. Sintered basalt products have

applications for Earth and space as a high-grade construction material that can withstand extreme temperatures, force and corrosion. PISCES is working with several outside agencies and companies to test the materials for applications on the surface of the moon and Mars.

Basalt Launchpad Tile Testing

Launch and landing pad tiles are among the many uses for sintered basalt products. PISCES has been developing sintered tiles since 2015 when it led a robotically built launch and landing pad project together with NASA SwampWorks and Honeybee Robotics. The latest tile designs are highly durable and have undergone preliminary testing for launch and landing pad applications.

In February 2020, Masten Space Systems conducted a static rocket fire test using a 12" x 12" x 1" basalt tile. The tile was subjected to a two-second rocket burst fueled by liquid oxygen and liquid methane. Positioned 20 cm from the tile, the burn produced 100 pounds of thrust at 2,550 K. The tile's surface glassed over and was impressed with a large indentation separated by a diagonal crack that ran corner to corner. Despite the crack, the results showed promise. Cracking could be prevented in future tests by developing a thicker tile.

Basalt Commercial Tile Testing

Since early 2020, PISCES has been working with Quest Unlimited to manufacture a durable kitchen tile on a large scale. The project began with the creation of 20 3" x 3" x .5" tiles and five 5" x 5" x .5" tiles that were subjected to a number of tests to determine their viability as a commercial product. These included: water absorbency, breaking strength, modulus rupture, dynamic friction and freeze thaw testing.

All of the tests returned positive results. Some of the tiles showed properties five times more durable than ceramic tile. As a result, basalt tiles may be useful for culinary, household and Earth-bound construction applications. The next step will be to perfect the sintering process to increase the quantity of tiles that can be produced in a given time. PISCES' materials science team is working on a stacking process to achieve this goal.

Sieving

Larger sieves were required to meet a growing demand for basalt and composite materials in FY20. Sieves are used to sort basalt fines into uniform grain sizes and achieve a cohesive sintered product. Particles sizes make a significant difference in the outcome of sintering. During Winter 2019, PISCES built a large set of 2' x 2' sieves that are mechanically operated. Previously, all sieving was done by hand. A set of six sieves starting at 800μm with gradations down to 75μm along with a shaker table were completed in late Spring 2020.

Applied Research

Above: Sintered basalt tiles.

Basalt Binders

To utilize basalt materials on planetary surfaces, it is critical to minimize energy usage and maximize the use of planetary resources. Using basalt materials terrestrially within the State of Hawaiʻi, these same considerations are just as important. But there is the added requirement of minimizing environmental impacts and ensuring the products they replace or supplement are equivalent or greater in cost. Due to high temperature and energy requirements, and the susceptibility of high temperature ceramics to damage during the sintering and fusing of basalt regolith, PISCES assessed the use of additives mixed with basalt regolith to facilitate low-temperature concretion to supplant the need for molds and possibly reduce binding temperatures.

In 2019, PISCES successfully tested a low-cost binder that not only binds basalt regolith at room temperature, but also binds in a vacuum (as found on the moon and other planetary bodies). The binder can also be sintered and strengthened further at a lower temperature than the pure basalt regolith. It is also inexpensive and abundantly found on Earth, but may be synthesizable directly from basalt. PISCES is continuing to pursue this research both internally and through numerous grant proposals.

Research Grants

Beginning in September 2019, PISCES submitted four grant proposals related to basalt-based binders and structural materials for ISRU. Due to fiscal impacts created by COVID-19, one grant opportunity was retracted by the issuer and two were disqualified due to PISCES' ineligibility under the requirements of the call. The remaining proposal awardees are expected to be announced in September 2020.

In addition to basalt research grant proposals, PISCES also teamed up with the University of Hawaiʻi at Mānoa and NASA Langley on two different proposals. In these proposals, PISCES is facilitating and managing logistics, and providing a planetary analog rover platform for analog field testing in Hawaiʻi. These proposals reflect a renewed and grow-

ing need for analog field testing with NASA, space agencies and planetary surface system companies. PISCES is currently working with Motiv Space Systems on another analog field test grant proposal expected in July 2020.

Crewed Planetary Mission Simulation

In early 2020, PISCES participated in the EuroMoonMars IMA Hi-SEAS missions, a two-week lunar/Mars simulation led by the European Space Agency (ESA) at the Hawai'i Space Exploration and Analog Simulation (HI-SEAS) habitat on Mauna Loa. The mission was part of a series to support studies that will help humans explore and utilize the moon and Mars in a safe, efficient and inspiring way.

From Jan. 18 to Feb. 1, PISCES Geologist Kyla Edison participated in Mission III as a science and communications officer. She also researched the effects of basalt sintering at high altitude and the possible implications for sintering in a vacuum. Her research tested the basalt sintering process under the constraints of living in an isolated habitat at 8,200 feet. Samples were collected around the habitat during scheduled Extra-Vehicular Activities (EVAs) and then crushed by hand using a walnut cracker. They were analyzed via a portable X-Ray Diffraction (XRD) machine, a type of x-ray that determines a weight percentage of crystals bound within a rock. The samples were then sintered by a miniature kiln at 2,100 F to determine if the lunar analog samples could create suitable construction tiles for ISRU applications.

Above: PISCES geologist Kyla Edison descends into a lava tube on the lower slope of Mauna Loa during an EVA (Extra Vehicular Activity) as part of a simulated lunar mission led by the European Space Agency last month. Credit: EMMIHSIII/HI-SEAS.

PISCES' planetary rover Helelani was used during the mission as a platform for setting up and controlling a complex machine under constrained conditions with limited tools and supplies. The crew worked together to operate the rover from a simulated mission control inside the habitat and test the rover's range

Mission III proved that two weeks is too limited a time period to conduct experiments and conclude meaningful scientific results. However, it was beneficial to test how time constraints, limited accessibility and resources must be balanced to achieve collective goals under stress.

Outreach & Education

Above: PISCES geology technician Kyla Edison shares her basalt research in ISRU during a classroom visit at a West Hawai'i high school.

Engaging Youth and the Big Island Community

PISCES is committed to inspiring and educating the next generation of scientists, programmers and engineers to ensure they are equipped with the skills and experience necessary to compete in the competitive 21st century job market. Every year, we support some 40 community outreach events island-wide including Journey Through the Universe, Ellison Onizuka Science Day, the Hawai'i Science and Engineering Fair, AstroDay and many more. We actively participate in the Maunakea Astronomy Outreach Committee and collaborate with NASA's education and public outreach programs to support outreach specialists visiting Hawai'i.

Due to lockdowns and social distancing guidelines implemented during the COVID-19 outbreak that began in March 2020, outreach activities were severely limited. Though many events were postponed or cancelled, we provided support for the Maunkea @Home outreach campaign on social media. In addition, we also offered STEM activities for students staying at home through our website, including educational games, books and activities.

PISCES-RISE Robotics Club

In 2018, PISCES partnered with PUEO's (Perpetuating Unique Education Opportunities) RISE program in Keaukaha to bring an after-school robotics program to elementary students. With a grant from Hawaiʻi Community Foundation to purchase VexIQ robotics kits, the PISCES-RISE Robotics Club was born.

Keaukaha students responded enthusiastically to the program and excelled in their building and programming skills. The team is supported by student mentors from University of Hawaiʻi at Hilo. The program is intended to be a long-term initiative with old students becoming mentors for newer students.

HI-SEARCh International Robotics Competition

In partnership with a major heavy equipment manufacturer, PISCES is planning an international college robotic mining competition inspired by NASA's Lunabotics event. Called Hawaiʻi Space Exploration And Robotics Challenge (HI-SEARCh), the event was originally slated for Fall 2020 at NELHA's Hawaiʻi Ocean Science and Technology Park in Kailua-Kona, but had to be postponed. HI-SEARCh will invite college teams from around the world—including Hawaiʻi—to test and challenge robot designs in the volcanic terrain of Hawaiʻi's Big Island. Hawaiʻi's basalt is highly similar to the regolith found on the moon, and provides a realistic environment for field testing.

HI-SEARCh is intended as an educational and inspirational event to draw visitors, challenge students and ignite interest among youth with robotics, programming and space exploration. The event will also showcase local students and schools who excel in building, programming and competing with robotics.

The inaugural HI-SEARCh event is expected to host up to 21 teams. PISCES is seeking corporate and local sponsorships and anticipates the event will bring $500,000 in revenue to the state.

MOU Partnerships

Memoranda of Understanding (MOU)

PISCES holds active Memoranda of Understanding (MOUs) with 16 organizations, institutions and companies from around the world to collaborate on mutually beneficial research and development projects. MOUs are formal written agreements defining roles and responsibilities within a project. These agreements allow us to create partnerships and gain access to outside expertise and technical support.

Partners

- AI Space Factory
- Hawai'i Community College
- Hawai'i Space Exploration and Analog Simulation
- Hawai'i Science & Technology Museum
- Honeybee Robotics
- UH Institute for Astronomy
- Made In Space
- The Makery
- Natural Energy Laboratory of Hawai'i Authority
- National Oceanic and Atmospheric Administration
- Canadensys
- Shark Wheel
- NASA SwampWorks
- RedWorks
- Caterpillar, Inc.
- Hawai'i Basalt Company, LLC

Financial Report

Overview: FY20 State of Hawaii Funding

FY20 Budget Operations Request	$550K
FY20 Operations Funds Appropriated	$550K
FY20 Operations Funds Allocated	$453K

Source of State Funds for FY20 Operations

FY20 Funds Allocated	$453.4K
FY19 State Funds Carried into FY20	$297.3K
Total Funds Available	$750.7K

Operating Costs in FY20

Description	General Operations	
Cost Category	Amount	% of Total
Labor	$410.4K	81.3%
Facilities	$50.2K	9.9%
Other	$44.4K	8.8%
Total Costs	$505K	100%

Meet Our Staff

Rodrigo Romo, Program Director

Rodrigo supervises day-to-day operations at PISCES including projects, personnel, budget and finance. He has 24 years of experience in project management for projects involving biological and technical systems, research and development, and robotics and ISRU. Originally from Guadalajara, Mexico, he earned his Bachelor's in Chemical Engineering at ITESO University and later obtained an MBA at the University of Arizona. Romo is a former Biosphere II crewmember.

Polly Roth, Administrator

Polly serves the primary role in accounting, human resources, finance and correspondence with DBEDT and the Research Corporation of the University of Hawai'i (RCUH). She specializes in nonprofit administration and accounting and has worked in the Astronomy industry in Hawai'i for more than 20 years. Polly earned her Bachelor's from the University of Wisconsin-Madison in Nutritional Science and the equivalent of a Bachelor's in Accounting from the University of Minnesota.

Christian Andersen, Operations Manager

Christian leads all additive manufacturing and construction projects, as well as logistics for analog field testing. He started his career conducting research in inertial confinement fusion at Lawrence Livermore National Laboratory, Ecole Polytechnique and Rutherford Appleton Laboratories. He has worked on a variety of projects transitioning aerospace technologies to terrestrial applications. Christian earned a B.S. in Physics from San Jose State University and a M.S. in Engineering from U.C. Davis.

Kyla Edison, Geology & Materials Science Technician

Kyla leads research in ISRU for terrestrial and space applications, seeking various methods for creating usable construction materials using volcanic basalt through sintering and casting techniques. Originally from Kauai, she earned a Bachelor's in Geology at UH Hilo and interned with PISCES before joining the staff. In 2016, she assisted a team of international scientists during NASA's BASALT research project on Hawai'i Island to develop protocols for a human mission to the surface of Mars.

Chris Yoakum, Public Information & Outreach Officer

Chris creates and manages public communications from PISCES including the monthly newsletter, press releases, photo and video, website and social media posts. He also coordinates outreach and education activities, including the STARS program, an annual space and science summer camp for high school girls. Born and raised in Hawai'i, Chris earned a Bachelor's in Communications from the University of Hawai'i at Hilo. He has previous experience as a journalist and copywriter.

Meet our Board of Directors

Henk Rogers, Chair
Entrepreneur & Founder of Blue Planet Foundation
Senate Nominee
Term: 2014 – 2022

David De Luz, Jr.
VP of David S. De Luz, Sr. Enterprises
Governor Nominee
Term: 2020 – 2021

Luke Flynn
Director of Hawai'i Space Flight Lab & Hawai'i Space Grant Consortium
Governor Nominee
Term: 2016 – 2023

Dennis Gibson
Senior VP of Booz Allen Hamilton
House Nominee
Term: 2018 – 2022

David Lassner
President of University of Hawai'i
Governor Nominee
Term: 2013 – 2022

Designated Alternate

Donald Straney
Vice President for Academic Planning and Policy at University of Hawai'i at Hilo

Mike McCartney
Director of the Dept. of Business, Economic Development and Tourism (DBEDT)
Ex-Officio
Term: 2015 – 2022

Designated Alternate

Chung Chang
Deputy Director of DBEDT

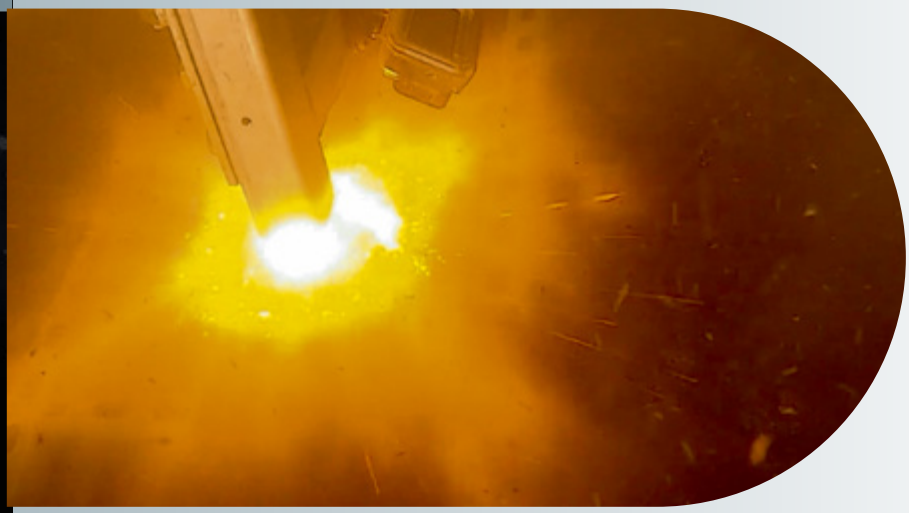
Kim Binsted
Professor of Computer Science at University of Hawai'i at Mānoa
Senate Nominee
Term: 2016 – 2024

Rachel Solemsaas
Chancellor of Hawai'i Community College
House Nominee
Term: 2018 – 2022

Vacant Seat
Executive Director of PISCES
Ex-Officio

PISCES

99 Aupuni St.
Ste 212-213
Hilo, HI 96720
(808) 935-8270
dbedt.pisces@hawaii.gov



www.pacificspacecenter.com

DBEDT