FINAL REPORT

Center for Innovation, Commercialization, and Entrepreneurship
UAF Office of Intellectual Property and Commercialization

January 31, 2022

PROJECT TITLE:	Alaska Center for Innovation, Commercialization, and Entrepreneurship
PERFORMANCE PERIOD:	July 1, 2018 - January 31, 2022
REPORTING PERIOD:	July 1, 2018 - January 31, 2022 (final report)
DATE OF REPORT:	January 31, 2022
RECIPIENT:	Alaska Center ICE: Alaska Center for Innovation, Commercialization, and Entrepreneurship University of Alaska Fairbanks PO Box 757265 Fairbanks, AK 99775
AWARD NUMBER:	N00014-17-1-2673
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Table of Contents

1. Executive Summary

This project entailed founding the Alaska Center for Innovation, Commercialization, and Entrepreneurship (Center ICE) as well as delivering some initial Center ICE programming. Center ICE is an innovation hub located at the University of Alaska Fairbanks that serves all of Alaska. Center ICE offers an increasing amount of programming, funding, and space to Alaska innovators and entrepreneurs as they develop solutions that are creating a more resilient United States presence in the Arctic.

This project is part of the Office of Naval Research's ARCTIC (Alaska Regional Collaboration for Technology Innovation and Commercialization) initiative, which includes four other Alaska partners: Alaska Center for Energy and Power, Renewable Energy Alaska Project, Launch Alaska, and the Center for Economic Development. By design and much to our satisfaction, the establishment of Center ICE has opened the door to other funding support for work outside the scope of what is discussed in this report. This report is almost exclusively limited to the work performed under this award, although success in achieving the broader intended benefits of Center ICE merits great recognition.

The foundational aspects of this project entailed laying the groundwork for Center ICE, including hiring staff, training, developing growth strategies, and building partnerships. Significant effort was put into building relationships with and between the Iceman Spark Innovation Cell at Eielson Air Force Base and UAFs Honors College. Center ICE launched its ICE Jam series to build community and transfer knowledge among Alaska's innovators and entrepreneurs. Early on in the project, we kicked off the launch of Center ICE with a three-day Lean Launch Workshop featuring many of Alaska's thought leaders in this space and facilitated by BMNT's Steve Weinstein.

The LaunchPad, which was later referred to as the Center ICE Seed Fund, formed the backbone of this project. These seed funds supported promising technologies and startup companies. All funded projects were required to submit a proposal and adhere to certain standards. One category of seed fund projects was supported on a rolling basis as the best opportunities arose. The other category of projects was solicited around particular opportunities or needs. These included: projects by researchers to pivot their expertise to serve the needs created by the initial onset of the Covid-19 pandemic, projects that aligned with the United Nations Sustainable Development Goals, and projects that contributed to the development of Alaska's blue economy.

Another major aspect of this project was creation and annual delivery of our Students Startups program. This program provides internships through which college students learn about innovation and entrepreneurialism and then apply this knowledge to gain experience and skills while working with an Alaska startup company.

Our project included two other aspects: We helped support and build momentum for maker spaces at the University of Alaska Fairbanks. Finally, we provided direct support for K-12 and undergraduate student innovations through collaboration with engineering senior design project classes and Alaska's Teaching Through Technology program.

2. Introduction

Alaska has strategic military importance and vast untapped potential. The University of Alaska (UA) is an integral part of Alaska's history and community. Alaska residents, and especially UA faculty and staff, represent the State's future - technologically, economically, and socially. The challenges faced in Alaska are unique and monumental; the opportunity is even greater.

In 2018, UAF's Gwen Holdmann and Mark Billingsley undertook the challenge of harnessing and directing the innovation and talent being produced in Alaska. To do this, they developed the concept of a unique innovation hub: the Center for Innovation, Commercialization, and Entrepreneurship, or Center ICE. Working closely with federal, state, community, and university stakeholders, this initiative was launched in 2018, with the Office of Naval Research as a major supporter.

The work performed under this award tracks the creation and evolution of Center ICE, which continues growing and pivoting to best serve Alaska and the United States. Looking back, it is difficult to imagine the state of innovation and entrepreneurialism at UA and in Alaska without Center ICE. The impact has been tremendous, yet Center ICE is still nascent, and the scope of its impact is just starting to be felt. The path to this point has ranged from exhilarating, disappointing, seemingly impossible at times, and inspirational.

Center ICE is a fixture in Alaska and still has immense room for growth and improvement. We are excited to be on this mission and thrilled to have the Office of Naval Research as a partner.

3. Groundwork

The foundational aspects of this project entailed laying the groundwork for Center ICE, including hiring staff, training, developing growth strategies, and building partnerships. Significant effort was put into building relationships with and between the Iceman Spark Innovation Cell at Eielson Air Force Base and UAFs Honors College. Center ICE launched its ICE Jam series to build community and transfer knowledge among Alaska's innovators and entrepreneurs. Early on in the project, we kicked off the launch of Center ICE with a three-day Lean Launch Workshop featuring many of Alaska's thought leaders in this space and facilitated by BMNT's Steve Weinstein.

3.1. Laying the Groundwork for a Stronger Innovation and Entrepreneurial Ecosystem

Talented and motivated people are core to Center ICE's success, and through this project we have been able to support and develop many people. Gwen Holdmann started off as Director of Center ICE with Mark Billingsley filling the primary support role. About one year ago, Billingsley took over as Director of Center ICE. Nigel Sharp joined the team for about two years as UK's first ever entrepreneur in residence, a position he successfully transitioned out of as he took the lead of a startup company with other Alaskans to develop and commercialize a UAF technology. Peter Webley, currently the Deputy Director of Center ICE, has played a key role in developing multiple Center ICE programs. Nickole Conley and Lesli Walls played important roles in keeping Center ICE in compliance with grant requirements and formulating a financial strategy for the project. Evelyn Jacome recently joined the team and, among other things, she is helping Alaskans build partnerships with federal agencies to develop their innovations.

Finally, this project has supported the development of multiple students who have joined Center ICE on a short-term basis to learn about our programs and assist in their delivery.

These people are the foundation upon which Center ICE has been built. As we gain momentum, their learning accelerates and we are attracting more people to our operations. They have created the vision for Center ICE. They've led its development and managed each of its programs. They work late into the night to meet deadlines and put their personal credibility on the line for Center ICE and its programs. Nearly four years in, they're building their careers around Center ICE. We are immensely grateful for and proud of their efforts.

This project also provided Center ICE with fundamental support by contributing to the buildup of the Center ICE space with some minor supplies' purchases.

3.2. Eielson and Honors

Community growth and building capacity of those at the University of Alaska and across the Interior of Alaska developed throughout the grant. In Year 2 then OIPC Faculty Ambassador and Center ICE collaborator and now Deputy director of OIPC Professor Peter Webley connected with the Innovation Cell at Eielson Airforce base (AFB) known as Iceman Spark. Working with UAF Honors Director Dr. Alex Hirsch, we built Iceman Spark challenges and needs into the Honors program. Interactions focused on building teams and selecting their challenge statement from the pool of AFB needs. Students came from across the university including those in nursing, physics, biochemistry, mathematics, and homeland security, Figure 1A.

Figure 1. (A) *UAF Honors students meet Col. Bishop and members of the Iceman Spark Innovation Cell at Eielson AFB on February 14, 2020. (Photo courtesy of Peter Webley). (B) Honors student Aksiin Storer, in blue coat, works with AFRL and Eielson AFB innovation team members on their EOD experiments (Photo from TSgt. Cavanaugh).*

In Year 2, students met with the Logistics Readiness Squadron to better comprehend why fuel truck valves are freezing and discuss previously applied solutions and the Security Forces Squadron to discuss procedures and solutions to Eielson's perimeter security challenges. In Year 3, Center ICE re-connected with the Iceman Spark team and their Director of Innovation, TSgt. Nicholas Cavanaugh, which led to another opportunity for the Honors students to work on the challenges and needs shared by the innovation team. Three teams formed focused on building engineering design, base connectedness, and the capacity of snow as a tool for explosive ordinance removal (EOD). The EOD project led to connections with Airforce Research

Laboratories (AFRL) who were supporting the Eielson team with their snow experiments. Spring 2021 experiments occurred with student Aksiin Storer supporting AFRL and Eielson, Figure 1B.

By Year 4, the collaborations had grown into a network of innovators where Eielson sees the opportunity that University of Alaska provides in expertise and capabilities while UA researchers work on local needs and real-world challenges to support USAF Arctic operations. The UAF Honors program has an Alaskan fellow working with their team on bringing in innovative projects for the students and integrating them into Makerspaces. This fellow leads the Honors connections with Iceman Spark and works directly with the students in the T3 Makerspace and Media space that was funded through a CISF award under our Makerspace RFP. This community collaboration between the University of Alaska and Eielson AFB will continue beyond the end of this award and demonstrates how support from ONR has built increased capacity in Alaska, developed student resilience and capabilities, and supported the DoD mission for Arctic operations.

3.3. ICEJam Community Building and Knowledge Transfer

Following the 2020 Students Startups (S2S) program, Center ICE saw the need for a webinar series for anyone wanting to get involved in the startup community. A 1-hour social/networking/learning approach developed where entrepreneurs and innovators network and catch up with friends, learn about new opportunities, or hear from experts. The first event (Aug 2020) brought Brad Feld to talk about his Startup communities' book and how the Alaskan community could flourish and grow. Several ICEJam's were held during Techstars Startup Week Alaska in 2020 and 2021. One event to highlight from 2020 is the Impact Through Innovation event where changemakers from across Alaska spoke how their programs have made a social and environmental impact, with Launch Alaska talking about its Technology Deployment Track. Center ICE held a learning and networking event in Feb 2021 where attendees heard from Launch Alaska portfolio companies talk about their experiences, Figure 2A. Discussions focused on lessons learned and tips in building up their businesses and took questions on deploying startup technologies in Alaska.

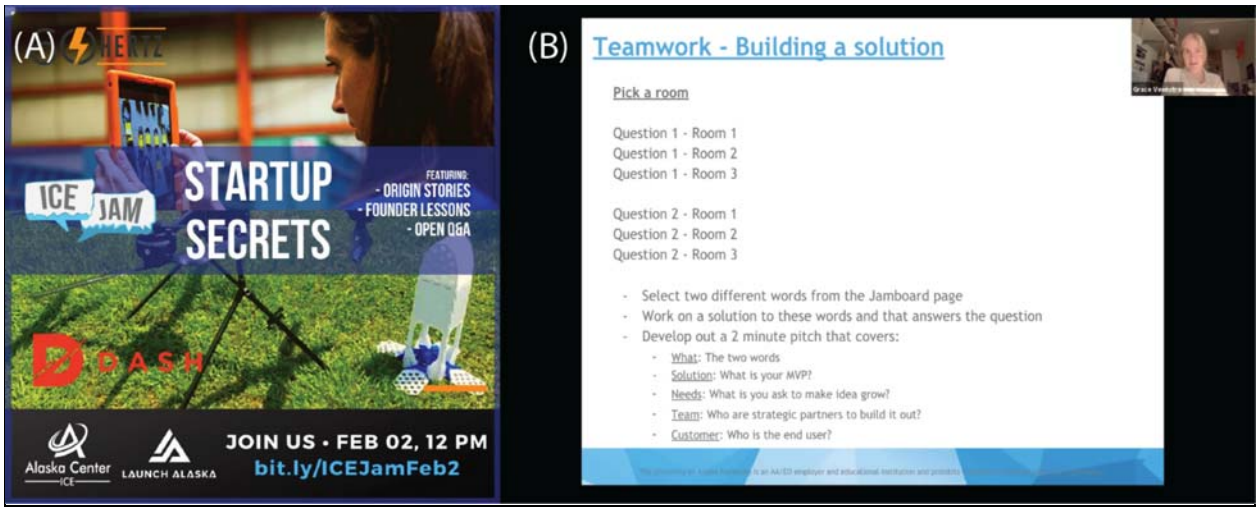

Figure 2. *(A) Feb 2021 ICEJam event flyer: Startup Secrets. (B) UAF Honors student Grace Veenstra presenting on her team's solution during a Nook Tank IceJam, September 2021.*

The ICEJam's continued in Year 4 with events on: building capacity and resilience (Figure 2B where UAF Honors students apply design thinking to build solutions to Alaskan problems in a fast paced environment); highlight entrepreneurs (women-owned Alaskan Businesses highlighted in Oct 2021 as part of Women's Entrepreneurship Week in collaboration with Montclair State University); and promote programs and opportunities to entrepreneurs (through Alaska Startup Week in Nov 2021) where Alaskan businesses spoke about how Center ICE, through this grant, provided them with growth opportunities, summer interns, and time to develop collaborations.

36 ICEJam events have been held so far where 630 attendees heard from a range of entrepreneurs and learnt more about programs and opportunities to support them on their journey. Over the series, 30 collaborators worked with Center ICE, with over 100 presenters. engaging events gave innovators the opportunity to hear from like-minded individuals and the ability to talk to others from the comfort of their home or office. The ICE Jams will continue beyond this award and have built a following of innovators and entrepreneurs. Alaskans will continue to hear from invited speakers on their experiences so that they can locally grow their business while the social and networking events support community growth and drive new connections that lead to business ventures, grant applications, and economic growth.

3.4. Lean Launch Workshop

Center ICE attracted significant interest early on through the delivery of Alaska's first ever Lean Launch Workshop. The workshop was facilitated by BMNT's Steve Weinstein and attracted multiple leading innovators and entrepreneurs from across Alaska. Over the course of three days, participants went through an ideation process, learned and applied the business model canvas and Steve Blank's lean launch process, performed customer discovery interviews, and pitched their ideas to their peers and a group of judges. This program represented a defining moment for Center ICE, was transformative for the University of Alaska, and was a milestone in the growth of Alaska's innovation ecosystem. Weinstein's authoritative status built energy and momentum and confidence in Alaska.

A second version of the Lean Launch Workshop was offered the following year. It featured BMNT's Phil Dillard and introduced the mission model canvas. Then Center ICE supported development of the first ever Hacking 4 Defense course by faculty member Robert Coker.

Center ICE continues iterating on these workshops and courses to keep up the momentum and deliver programming that meets Alaska innovators and entrepreneurs where they are while teaching industry-leading strategies and techniques.

Figure 3: *Photo of teams developing preparing to perform customer discovery under the instruction of BMNT's Steve Weinstein.*

4. LaunchPad / Center ICE Seed Fund

The LaunchPad, which was later referred to as the Center ICE Seed Fund, covers the largest category of activities in this project. These seed funds supported promising technologies and startup companies. All funded projects were required to submit a proposal and adhere to certain standards. One group of seed fund projects were supported on a rolling basis as the best opportunities arose. The other group of projects were solicited around particular opportunities or needs. These included: projects by researchers to pivot their expertise to serve the needs created by the initial onset of the Covid-19 pandemic, projects that aligned with the United Nations Sustainable Development Goals, and projects that contributed to the development of Alaska's blue economy.

4.1. LaunchPad / Center ICE Seed Fund: Accelerating Innovation

The LaunchPad, which was later referred to as the Center ICE Seed Fund, supported promising technologies and startup companies on a rolling basis as the best opportunities arose.

During its first year, Center ICE primarily supported five projects. One of the projects was led by Birgit Hagedorn. Hagedorn, an environmental geochemist and scientist with more than 25 years of research and field experiences in polar and temperate environments, proposed the idea to Far North Fungi's Gabe DeGange and Allison Dunbar at looking at mushrooms as a tool

for bioremediation. Gange and Dunbar, who had already thought about this, jumped at the opportunity to move the idea forward. Their project explored using mycoremediation to clean up petroleum hydrocarbons, such as gasoline and diesel. This can be especially helpful for the many locations in remote Alaska that rely on diesel for energy and where diesel spill remediation cannot be achieved with traditional methods. This team has gone on to form the Fungi Alliance, an Alaska-based community consisting of the stakeholders needed to make this technology a reality.

Other projects from year one included support for: development of an improved comet assay, a procedure regularly used to analyze damaged DNA; prototype construction and business development of an innovation using biological materials for packaging; business planning for the commercial use of waste skin from the world-leading Alaska pollock fishery; building a prototype for a non-invasive device to measure brain oxygenation in an animal model.

During year two, the Center ICE Seed Fund supported four students from the University of Alaska to travel to Missouri to participate in a Startup Weekend and work with its leaders to understand the program and bring it back to Alaska. Then the students hosted a Startup Weekend in Alaska. They gained invaluable training in entrepreneurialism not to mention leadership skills. And they shared their new-found knowledge with other students and community members in Alaska. Another project from year two supported the development of a medical solution for individuals who suffer traumatic ischemic events in remote locations and require significant transport time to reach proper medical care. This innovation is highly relevant in Alaska, for example, where an individual in a remote community who suffers a stroke could need to wait many hours before arriving at a location that can provide full medical care. This technology remains under development and has received multiple subsequent rounds of funding from a variety of sources.

During the second, third, and fourth years, Center ICE moved toward more often supporting specific areas of innovations, which are discussed in the next section. Nonetheless, Center ICE has continued supporting the best opportunities that arise on a rolling basis. One example project involved pairing a local raft manufacturer with students to design an oar saddle fit for Alaska rivers. The end result was a design that the manufacturer could bring to his factory for production.

4.2. Focused Opportunities

4.2.1. IICP

The COVID-19 pandemic is continuing to be a major disruption to us all. During Year 2 and into 3, Center ICE saw new opportunities for growth and innovation. Center ICE pivoted some of the ONR support to build a call for proposals: Immediate Innovation for Coronavirus Project (IICP). Center ICE selected six projects under the IICP call: one for University of Alaska-wide support for local needs, four faculty and staff-led R&D projects to develop new capabilities and solutions, and a student-led R&D engineering project. The four faculty and staff projects are summarized here.

Rothman: An ultraviolet (UV) germicidal irradiation device was developed for N-95 filtered facial respirators to be safely reused, Figure 5A. Center ICE collaborated with the Geophysical Institute on this development with shared resources to support Rothman and his team, see article and

article. Rothman developed ten novel respirator disinfection units. Unlike other UV disinfection devices, the Rothman's is specifically optimized for decontaminating N95 respirators. Two disinfection units were distributed: one to the Fairbanks Pioneer Home (a State operated nursing home) and the other to the Fairbanks Correctional Facility.

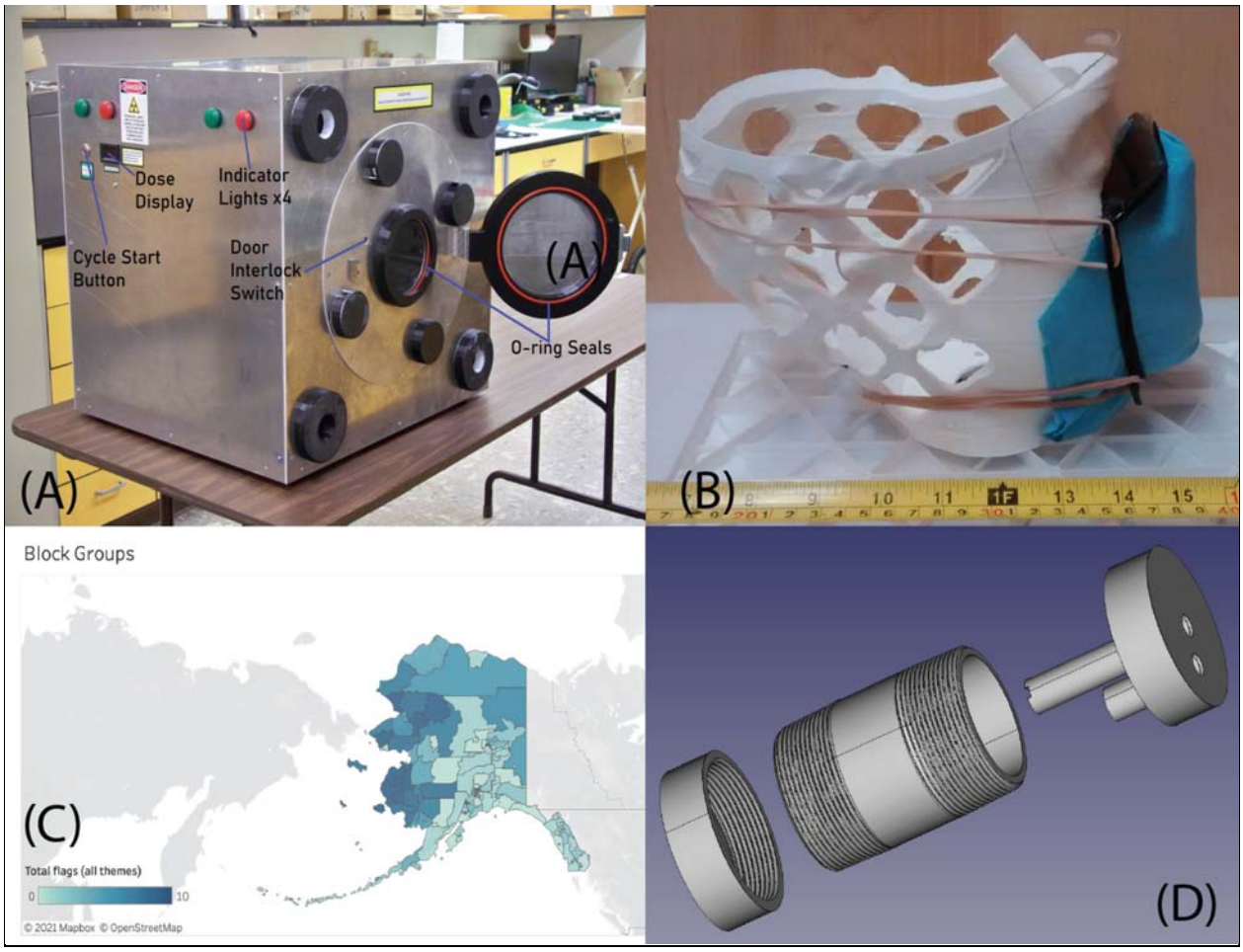

Figure 5. *(A) Side-view of the Rothman's disinfection unit highlighting the different parts that support the intake of the N-95 masks (Photo by Jeff Rothman), (B) Lawlor and team novel 3D printed "mask frame", the Alaska Micro Mask, (C) Harley's Statewide derived products from Harley's IICP research with Alaska SVI visualized by block group, and (D) Arnoult's exploded CAD view of their impinger, an optional component of the nebulizer system that reduced the number of aerosol particles reaching the filter.*

Lawlor: This rapid fabrication team designed and built personal protective equipment (PPE) for immediate use to slow the spread of COVID-19 in Fairbanks, see article. Several undergraduate students worked on PPEs for an enormous need by hospital staff, first responders, and the public. They gained experience working with an interdisciplinary team on a critically important real-world problem. In response to a request from Fairbanks Memorial Hospital to improve the fit of existing cloth masks, they developed a novel 3D printed "mask frame", the Alaska Micro Mask, that holds the cloth closer to the face, reducing leakage. This mask design is available here, Figure 5B. Dr. Orion Lawlor was inducted into the Alaska Innovators Hall of Fame as a member of their 2021 class that highlighted his work under this research as well as the funding

support provided by Center ICE under the grant from ONR. The Alaska Mask won the top prize for UAF's most commercially viable invention disclosure in FY 2020.

Harley: Used his skills to model the spatial distribution of at-risk populations in Alaska, see article. He saw a need, during the initial impact of the COVID-19 pandemic in Alaska, to quantify relative risk and vulnerable populations at the community level. Alaska census areas are often geographically larger than those in the contiguous U.S. so SVI scores are associated with areas equivalent to a U.S. state while the demographics of the population is diverse, so a community-level SVI is more applicable. Harley focused on building an online tableau based SVI tool to define SVI's at the Alaska community level, Figure 5C. Harley's interactive tool provides a new Alaska-specific methodology to classify the vulnerable communities across the State, see website. Harley's SVI product won the top prize for the most commercially viable invention disclosure from all UAS-based disclosures in FY 2020.

Arnoult: This team designed a system that would contain and filter the aerosol particles exhaled from a patient receiving nebulization therapy. One solution to this problem was devised by designing a nebulization system that would contain and filter the aerosol particles from the patient's exhaled breath with a mouthpiece that fits snuggly through a front port in a facemask and that allows for a more efficient transfer of the nebulized medication into the lungs by reducing contact with the wet surfaces in the mouth. An optional component of the solution's design is an impinger, Figure 5D, that can recapture some of the aerosol particles thereby reducing the number of particles that need to be filtered by an N95 filter. During the IICP project, Arnoult shifted from designing a complete nebulizer system to improving upon the Respirgard II Nebulizer System until this new product met the needs of the medical community.

Summary: These four projects showed how University of Alaska researchers were able to pivot their skills for a timely need. Leads for these projects came from a diverse range of backgrounds from across the academic system with infrasound engineers building the sterilization units, computer science faculty and engineering staff working with students on the PPE team, and a geoscience marine biologist applying their skills to vulnerability data science. This highlighted how the skills and capabilities of an academic environment can themselves be pivoted to support critical and timely challenges.

4.2.2. UN SDG

The IICP call for proposals had 30 submissions to support innovations from UA researchers in response to the COVID pandemic. This demonstrated that when we had a targeted opportunity then researchers across UA had great interest to propose their innovative approaches to build commercially viable solutions. In Year 3, Center ICE had a second targeted opportunity with the focus on the United Nations (UN) Sustainable Development Goals (SDG)'s. Three SDGs were chosen: #9 (Industry, Innovation, and Infrastructure), #11 (Sustainable Cities and communities), and #13 (Climate Action). Center ICE promoted a call, named Innovation for Climate Action and Sustainable Communities, see article. Proposal submissions came from across the UA system and two projects were selected for funding. The first is from Dr. Andrew McDonnell, UAF College of Fisheries and Ocean Sciences and the second project is from Dr. Brandon Briggs, UAA Department of Biological Sciences. McDonnell's research and commercialization approach focused on dispatchable heat pumps to enable balancing of renewable energy on the grid.

Briggs's project centered on developing Arctic Biotechnologies for Environmentally Sustainable Rare Earth Element Extraction (REE).

McDonnell's team first developed a numerical model to evaluate the operation and performance of a fleet of dispatchable air source heat pump (ASHP) systems on the grid. The model allowed them to calculate the economic and environmental benefits of this hybrid dispatchable ASHP system. Their results indicated that with approximately 1000 customer ASHP installations powered by 5MW of wind capacity, customers could meet about one third of their heating demand with the ASHP yielding inexpensive and emissions free heat at an equivalent oil cost of $1.62 per gallon, saving each customer on average $1,200 per year. This approach would offer a viable commercialization pathway given the significant benefits to the utility and ASHP user. Next, they focused on interviewing Alaska's electric utility companies and independent power producers and pitching their concept to them. Early on in their market research they realized that there was a distinct lack of renewable energy development in Alaska, a fact that would limit the concept's ability to deploy ASHP as a regulating resource. In early 2021, they spun off a new company from the Seed Fund research, Alaska Renewables LLC and set about early-stage renewable energy project development work. The PI of this Seed Fund grant Andrew McDonnell continues to work with the company as Vice President. Through collaborations with a local installer of heat pumps, McDonnell chose a Mitsubishi ASHP with cold weather capabilities and multiple indoor units as an ideal test unit. The heat pump system will form the basis for several different control implementations and experiments, Figure 6A.

Briggs working with Michael Martinez started to analyze feedstock samples from four different mines [Alaska, Utah, Wyoming, and Arizona] with the aim to develop a non-acidic method that liberates REE ions in water using microbes that perform bio-weathering processes. They scaled up their extraction process from 50 to 250ml as well as transitioning from bottle sized batch cultures to bioreactors to provide continuous monitoring and nutrient additions. Briggs made a pivot during the research to focus on more efficient methods if anthraquinone-2, 6-disulfonate (AQDS) was removed from the process. Briggs working with Michael Martinez started to analyze feedstock samples from four different mines [Alaska, Utah, Wyoming, and Arizona] with the aim to develop a non-acidic method that liberates REE ions in water using microbes that perform bio-weathering processes.

Briggs's scaled up their extraction process from 50 to 250ml as well as transition from bottle sized batch cultures to bioreactors to provide continuous monitoring and nutrient additions, Figure 6B. Briggs made a pivot during the research to focus on more efficient methods if anthraquinone-2, 6-disulfonate (AQDS) was removed from the process. Briggs' team found that different feedstocks can have variable amounts of REE, and this impacts the total REE that can be recovered. A 10-fold scale up of their process saw a slight increase in percent recovery, which is promising for future scale-up experiments. Another promising aspect of using the bioreactor is that they were able to cut the time down to 3 weeks instead of the typical 5-6 weeks. This will reduce the cost to make it even more economical.

The funding provided to McDonnell and Briggs allowed them to make great strides towards scaling up their research to produce outcomes of their respective industry sectors. For McDonnell and his team, the seed funding was critical to allow them to explore several innovative opportunities on the topic of renewable energy, heating, and demand response technologies, see article. The founded a new renewable energy company that is developing new

utility scale renewable energy projects in Alaska and established partnerships with multiple electric utilities, software companies, local HVAC installers, UAF researchers, national laboratories, and other organizations to allow them to work on the next phase of the concept.

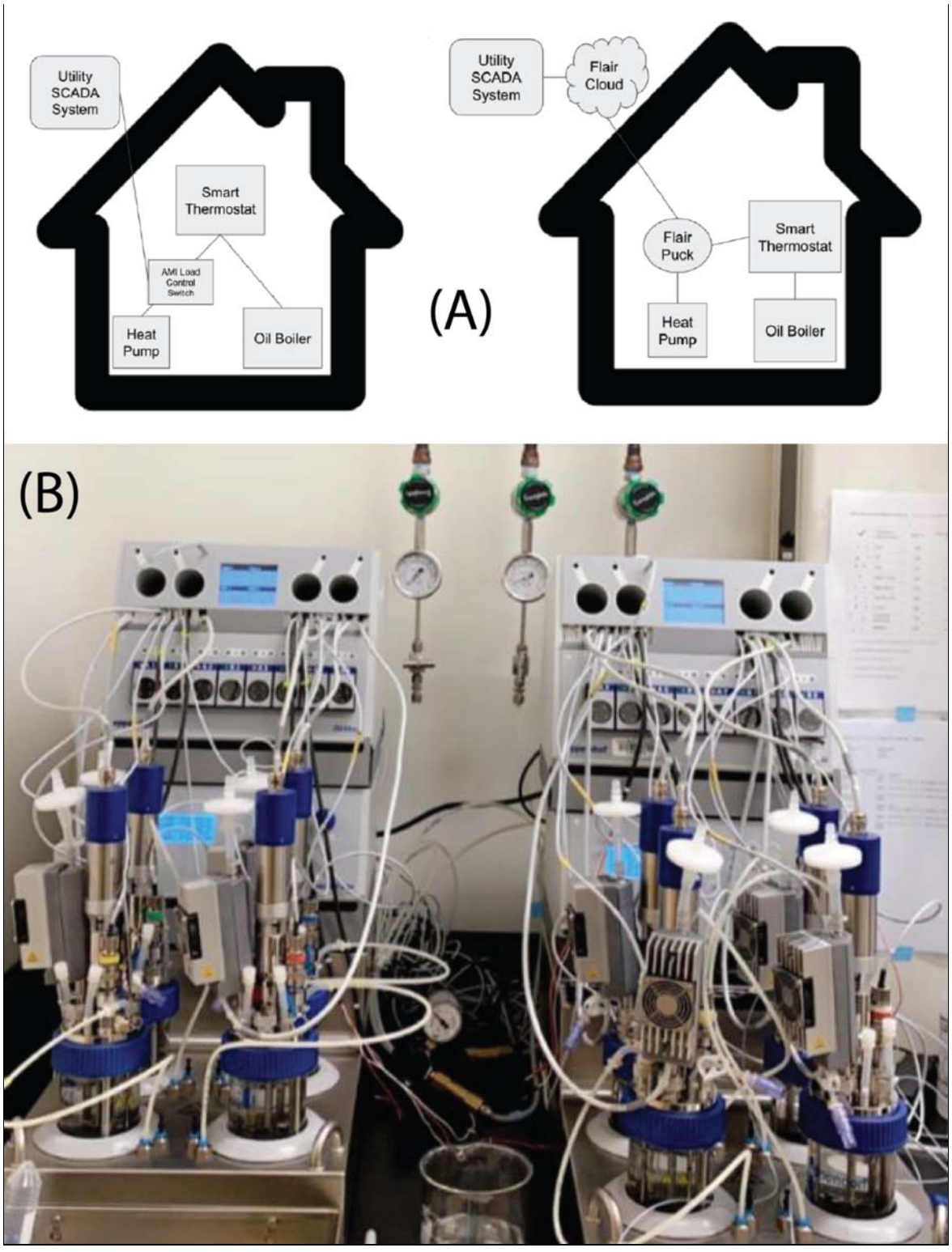

Figure 6 *(A) Two different system configurations tested under McDonnell Seed Funding research to demonstrate the feasibility of dispatchable ASHP hybrid heating systems (B) Bioreactors running some coal samples from Wyoming from REE Seed Funded research.*

For Briggs and his team, they showed potential for increasing the amount of recovered REE through using new processing workflows and that the production can be scaled up using bioreactors. The seed funding allowed them to derive new results to support the team to further their R&D to increase recovery percentages from the REE feedstock and scale up to production levels. This UN SDG request for proposals showed how specialized tracks for funding requests can harness the UA research capabilities and drive R&D to build commercial ventures.

4.2.3. Blue Economy

The success of the proposals submitted, and projects supported under the IICP RFP at Center ICE then saw another opportunity for a Seed fund track, this time focused on the Alaska Blue Economy and in collaboration with the Alaska Blue Economy Center (ABEC). This RFP occurred in Fall 2021 with support focusing on projects with three month long innovative research, development, and commercialization plans. The collaboration with ABEC provided an opportunity to integrate more ocean and fisheries scientists with the ONR funded grant as well as drive new commercial products that will benefit the Blue and Ocean Economy in Alaska and the U.S. Arctic. Two proposals were funded, one centering in the application of Blockchain technology for Alaska's seafood industry and the second building out community capacity in the kelp mariculture industry through new site suitability assessment kits or SAT's.

The blockchain funded research brought together Justin Sternberg, the Director of ABEC with deep learning, artificial intelligence, cryptography, and blockchain expert Jody Edmondson. The funding allowed them to work together and bring Jody's expertise to Alaska, which can kickstart new opportunities. The project work focused on the application of how blockchain (the distributed ledger technology that serves as the foundation for cryptocurrency networks) could digitally transform the current seafood supply chain in Alaska. The CISF support through this ONR grant allowed them to understand how blockchain can provide better traceability from ocean to table products while at the same time rewarding stewardship and sustainable practices by those in the industry. The teams research found five potential improvements that blockchain can provide for seafood chain of custody management: enhanced traceability and trackability of product; reduction of supply chain execution errors and disruption; enablement of frictionless operationally efficient transactions; greater global visibility of network state among participants; and Increased security and safety of assets. As researchers Sternberg and Edmondson highlight: academia and the private sector should now join forces to experiment with various blockchain platforms to develop pilot projects.

The second project, led by Dr. Schery Umanzor, centered on designing, assembling, and testing a toolkit (known as the Site Assessment Toolkit or SAT) for the kelp farming industry in Alaska. Their SAT kits were developed to assess transparency, temperature, salinity, nutrient concentration, and currents in the water column as key environmental parameters to assess potential sites suitable for kelp farming, particularly in Alaska. Through rigorous testing, Schery and collaborator Melissa Good developed a final SAT, Figure 7, and worked with the Native Conservancy on the kit's versatility and effectiveness in the field to collect observations. During the project work, Melissa gave a webinar on the SAT's and their capabilities that led to one of

the largest seaweed companies in Alaska reaching out to potentially secure the license for distribution of the kits. Already as their research was wrapping up, they had a potential transition of university innovations into commercial products and applications in the industry.

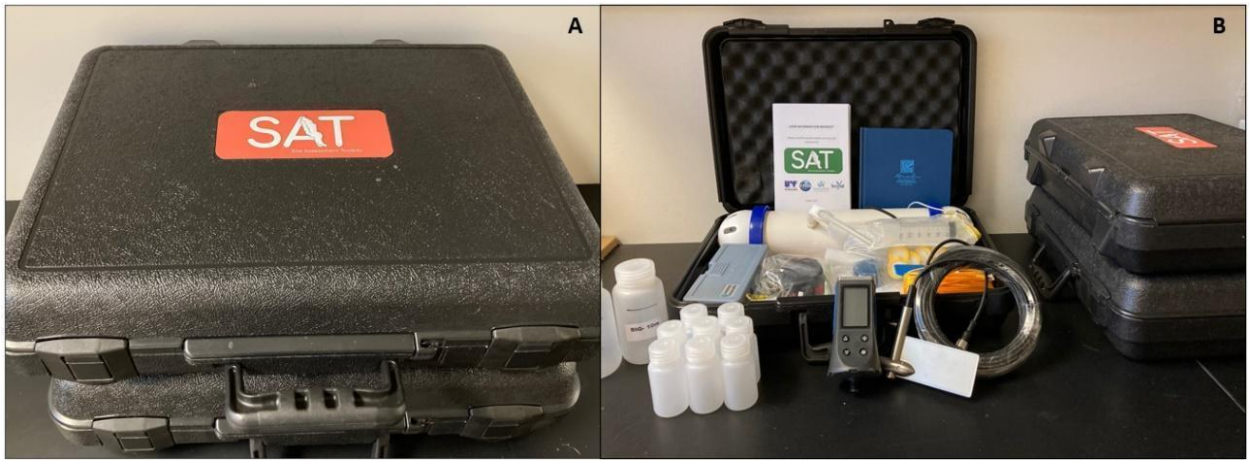

Figure 7: *External (A) and internal (B) view of final Site Assessment Toolkits.*

The two supported projects demonstrated the breadth of research occurring at the University of Alaska in the Blue Economy that can transition from the academic environment into community solutions and products for direct use and application by the industry. Center ICE will be continuing to connect with ABEC beyond the end of this grant and through UA's technology transfer office, OIPC, our team will continue to support Dr. Umanzor on the commercialization of the SAT's. There is a growing ocean/blue economy in Alaska and the research at University of Alaska has the potential to make significant strides to support economic growth and build solutions for direct application in Alaska and the U.S. Arctic.

5. Students Startups

Another major aspect of this project was creation and annual delivery of our Students Startups program. This program provides internships through which college students learn about innovation and entrepreneurialism and then apply this knowledge to gain experience and skills while working with an Alaska startup company.

Overview

In 2018, David Schweigert, a senior majoring in Civil Engineering, spent the Summer and Fall working for Coupi, a UA spinoff company. David worked in the Center ICE space on UAFs campus and worked closely with Coupi founder Jerry Johnson. Through this experience, David gained technical experience as well as exposure to the business startup process. This approach drove then Center ICE lead Nigel Sharp to build out the program that would become Students to Startups (S2S). The first S2S track occurred in the summer of 2019 focusing on sponsoring students to intern at startup companies or with faculty working on commercializable innovations. The program developed a structured format where students came together in a mixer event with startup companies. In 2019, 25 students interacted with 9 companies through "speed dating" sessions. Companies and students interested in working together were required

to assemble an internship work plan over the following days and apply for a Center ICE-sponsored internship.

Their internships entailed more than daily work for the startup company. A structured program was overlaid on their internship that brings them together weekly as a cohort to form community, network, teach innovation and entrepreneurial methodologies, share experiences, and more. Likewise, the recipient startup companies had obligations and contributed to the student's experience and education in a formal manner as well as to the S2S program itself. This first iteration of the S2S program laid the groundwork for the Year 2 and 3 cohorts in 2020 and 2021, with more details on these below.

An example from the 2019 summer cohort is highlighted in the opportunity provided to Gerald Montuya with Barati Medical LLC, Figure 8A. Gerald was mentored by Dr. Pourrezaei, Ardy, and Kel along with Dr. Barati and was given the entrepreneurial tools and resources to succeed. The S2S community helped Gerald whenever he was in need. In being a part of a startup, it showed to him how important it is to foster a community. S2S highlighted to Gerald the importance of creating meaningful connections to be better prepared for the opportunities ahead and to think innovatively in all aspects of his research and entrepreneurial activity.

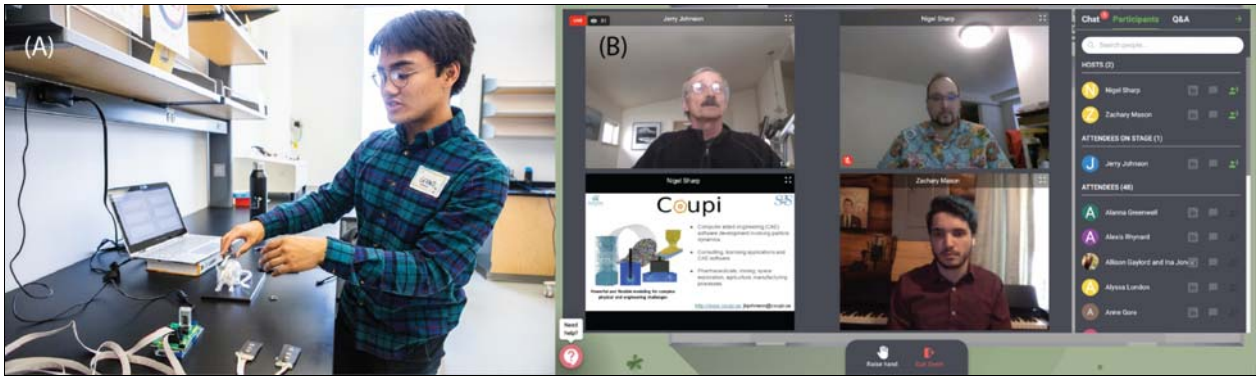

Figure 8. *(A) S2S summer 2019 cohort student, Gerald Montuya, at work for Barati Medical, LLC in the Center ICE co-working space. Photo by J R Ancheta. (B) Coupi CEO pitching the internship experience with his company in Remo for the 2020 summer cohort.*

Year 2 for S2S started in early Spring 2020 with a virtual meet-and-greet to a suite of startup companies. The COVID-19 pandemic meant that the program moved virtual, for all student-startup pairing and the summer programming. Center ICE used the Remo online platform, Figure 8B, to facilitate the early interactions to provide the startups with the opportunity to pitch their company and plans for the internship. The students moved around virtual tables, as they would do in person, so that they could meet the company and learn more about the experience that they would undertake together. For 2020, Center ICE supported as many potential applications for the program and was flexible so that more than one student could work with a specific startup company and so that the students could also pitch their own company idea to work on as part of the 2nd S2S cohort. This more than doubled the number of students supported by S2S for the summer of 2020 and highlighted the difference that the support from ONR, through this project, provided to Alaskan innovators and entrepreneurs and especially to the youth who will become the leaders of tomorrow.

The 2nd S2S cohort used the Remo-based virtual office where they could access virtual-desks to work with their startups as well as have multi-person meetings in the larger rooms. Center ICE hosted S2S-wide meetings to provide the resources for the students to increase their startup and entrepreneurial capacity. This virtual office setup was spun up because of COVID-19 and was an amazing opportunity to build the cohort and have them connect with each other and their companies when face to face interactions are limited and social distancing is in effect. Remo changed their platform and by the summer of 2021 did not have the same setup that S2S could use and therefore, Center ICE developed a Discord Server for the students to communicate with each other and used Zoom for all presentations and guest speakers.

The third cohort of S2S interns started in May 2021. This cohort was made up of nine interns supporting six companies. Center ICE had seen the benefit of multiple interns working with the same startup during the second cohort and therefore it was an option for startups in the third cohort. There was an almost even split between interns from UAF and UAA for this third cohort, while the companies mainly come from Anchorage. Notably, several of the companies in 2021 have connections to other ONR supported programs in Alaska, with The Launch Company, Quagga, and Remora each having at least one intern. We also note that Karta Solutions who had 2.5 interns became a member of the Launch Alaska program in Fall 2021. Additionally, many of the companies and some of the interns have gone through the Center ICE NSF I-Corps customer discovery programming, thus demonstrating the connectedness of the Alaskan ecosystem and added value from the ONR support to Center ICE for the past three years.

As with the past two cohorts, the students and startups met via a mixer event to build connections and to support networking so that together an intern and a startup can build the summer project work. In addition, students partake in two learning events a week (Figure 9A) including topics such as customer discovery, intellectual property, LeanLaunchpad business development, and startup funding 101. The students also worked in small teams with a focused topic to understand the value of shared research and development. Here, the students worked on their team projects in three-week sprints and shared their progress with the second team, Figure 9B. The second team then spent the next three weeks on their own sprint to move forward the R&D already completed by the first team. The current progress was re-shared between the two teams and another three-week sprint kicked-off. At the end of the summer, the original teams presented on the work completed, the potential solution defined, and how they would use follow funding to build out their innovation.

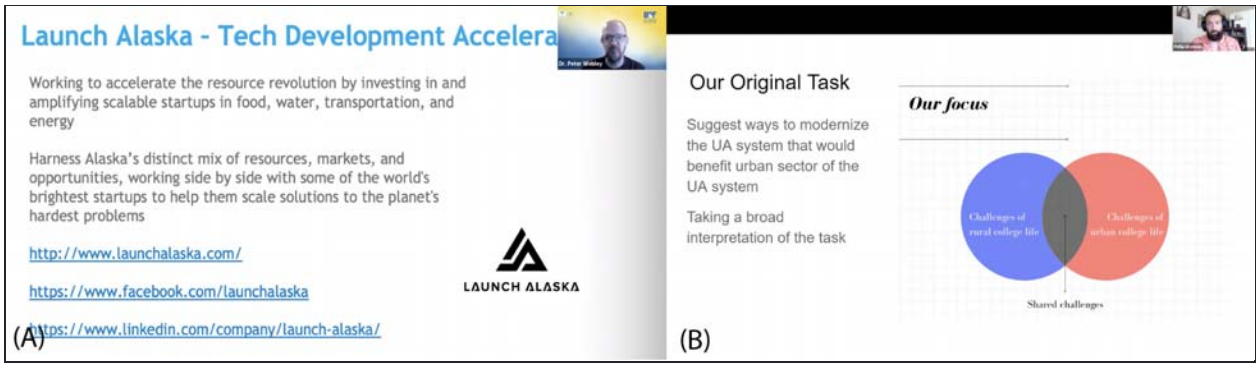

Figure 9. *(A) Learning event: Dr. Webley presenting on AK Ecosystem and the Launch Alaska Technology Development Track and (B) Team presentation by S2S Intern Phillip Drennan on their team project, topic: Modernize Student Experience - Urban Environments.*

For the third cohort, 2020 intern Solomon Himelbloom supported Prof. Webley. Solomon worked with 907 Financial during his internship and in the summer of 2020 transitioned to support Center ICE as a student employee. Solomon maintained the Discord Server that allows the cohort to communicate during their programming and bringing in the speakers to talk to the interns. The third cohort of students concluded in August 2021 with final presentations from the interns on their lessons learned, final project work, and insights into the Alaska entrepreneurial ecosystem. For the 2021 cohort, one of the companies increased its workforce by a quarter in having access to three interns. This makes a massive difference in the new opportunities that the startup can pursue while also giving the students a truly immersive experiential experience that would not be possible with a larger-side business.

Highlights

Several important highlights from the 2020 summer cohort included the entrepreneurial journeys of interns and staff members. Zach Mason left Center ICE in August 2020 with an opportunity to work with Remo, who Center ICE had been working with for the online platform for its virtual office environment. In the end, Zach saw an opportunity and a need for virtual tutoring services and formed North Star Tutors, see article and article. His time at Center ICE, supported by ONR, gave him essential skills to pursue his own entrepreneurial pursuits as well as built connections to the Alaska-wide entrepreneurial community. Zach and North Star Tutors made it to the final of the 2021 Alaska Angel Conference and won crowd favorite on the final pitch day. The second follow-on connection is with an intern from 2020, Heather Jensen, see article. Heather worked with AK Seeds of Change in S2S 2020 and after her summer experience she decided to start her own company, Events on the Run. Heather saw the local need for an organization to help support Alaskan's wanting to promote, develop, and run a race. Finding a reliable race director and event coordinator is essential to build a following and community of race goers and supports. Heather's experiences under Center ICE gave her the grounding and understanding of what it takes to start a company.

In 2021, there were several success stories involving the students in the program and the startups themselves. Firstly, intern Joshua MacEachern worked with Aquagga and their PFAS startup development. Here, Joshua got first-hand experience working with the Quagga team, talking with, and meeting stakeholders, and developing new engineering designs. Joshua continues to work with Quagga as he completes his Master while he also connected a fellow student, Louis Bastille to the Quagga team and Louis ended starting work with Quagga on their Department of Energy SBIR work with Idaho National Laboratory. S2S gave Joshua the experience of working with a startup as it looks to scale while working on SBIR grants and provided Quagga with intern talent and access to the UA student network for future employees. The second story centers on Intern Jessica Huezo, who worked with Karta Solutions during the 2021 cohort. S2S provided her with an insight into the SaaS startup ecosystem and while she did not continue to work with Karta Solutions beyond the summer, Jessica is working as an intern with WebbRes, winners of the 2021 AAC. They came to the spring 2021 mixer and while they

did not get an intern, they made an impression and Jessica wanted to continue her work in the startup environment because of S2S.

Continuing the stories involving Karta Solutions, we highlight the difference that the interns working with CEO Jay Byam gave for the company and its growth. The two full-time and one part-time interns increased the capacity within the company and allowed others in Karta to focus on other developments for the business. Karta subsequently applied for and was accepted into the gBETA Anchorage accelerator and received investment following this program that was matched by the 49th SAF. The final success story from 2021 is with Elevated Oats. S2S intern Corey Giddings worked with their team across the summer on several different projects for them. He spent time in their facility and learned how they developed new products. He spent time out at farmers markets and bazaar's promoting their products and interacting with customers and stakeholders. This summer partnership continued beyond the end of the internship as Corey continues to work for Elevated Oats and supports them as they grow the business and continue their entrepreneurial journey.

Summary

S2S spun out of a need to provide a mechanism to support students willing to work with startups and those businesses with a specific need that could give students the experience of working outside the academic environment. The highlighted success stories are just a few examples that demonstrate how the S2S program supported startups in Alaska, provided them with access to talented interns, and gave them the ability to grow. S2S also supported the students to learn more about the entrepreneurial journey, build new capabilities to be resilient members of the Alaskan community as they graduate, and drive new economic opportunities for Alaska. Over the three years of S2S, 17 startups [10M, 7F as lead] gained access to at least one intern. 30 students [15M/15F; 6 UAA/24 UAF] were supported to work with the startups as well as gain new understanding of the Alaskan Startup community and the journey's that a startup will go through as it looks to grow, adapts to the market needs, and ideates/pivots to user needs. Several of these interns have gone onto work in Alaska startups while several of the businesses supported have gained follow-on funding because of the connections made from being a part of the S2S network. Providing students with experiential learning programs like S2S allows academic institutions like UA and innovation hubs like Center ICE to develop resilient innovators who can go onto form the next startup and/or be prepared for the startup and small business working environment. Startups supported under programs like S2S gain access to talented and passionate innovators who can become employees of the future and allow the businesses to pursue new ideas and opportunities.

6. ICE Maker Space

In Year 3, Center ICE added in a track focused on Makerspaces. Four projects were funded under a Spring 2021 request for proposals: two focused on the K – 12 environments using UA facilities while two provided spaces at UA for students, faculty, and staff to work together. With the K – 12 age range, the two funded projects were the Visual Art Academy (VAA) and the T3 Makerspace. Under the VAA, the support benefited the students to gain access to cutting-edge technology and skilled instructors to facilitate their hands-on learning experiences where students gained familiarity with digital drawing and 3D modeling using laptop computers and a

virtual reality headset. For the T3 Makerspace (Figure 10A), the Center ICE funds fostered the development of a healthy makerspace community by building a recording area, an asynchronous online training program for both faculty and students, and a website to share short videos and written descriptions of the research initiatives taking place in their T3 Alliance STEAM Makerspace. Students can now share the stories behind their research projects.

For the other two projects, Center ICE supported The Well and the AK Media Lab. The Well has been the venue for teaching on the Science and Practice of Happiness and Wellbeing and how this makes a direct impact on students and their research focus and ability to adapt. Funds from the Center ICE support was a game changer after a year+ of COVID-19 remote learning. NSF sees places like the Well, Figure 10B as aspects of academic innovative broader impacts, where maker spaces in research proposals could result in the tipping point between proposals being funded. The support for the AK Media lab was instrumental in a re-energization of their Makerspace and gave them the capacity to leverage additional funding support from within the UA environment. The Center ICE funded work fostered new ways of developing infrastructure internally including support to develop their Massive Collaborative Animation Projects which the labs students have been working on under Professor Aoki and Molly of Denali with Professor Salganek.

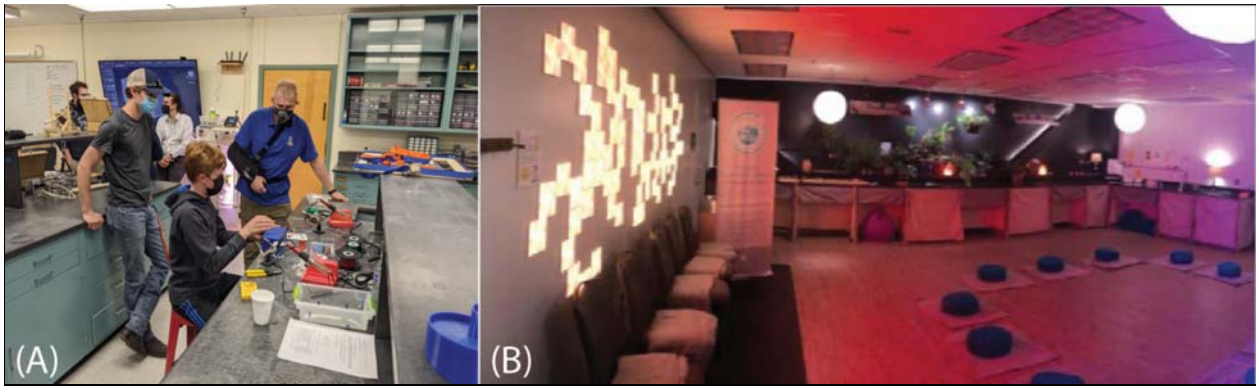

Figure 10. *(A) The T3 space at UAF showing CEM Dean Schnabel learning from Tommy Tillbury, a student in the F193: Introduction to T3 Alliance Makerspace class. Standing in the background is Tate Barhaug, an employee for the Makerspace. (B) The Well Makerspace where supplies supported the lead PI, Prof. Wooller to build a space for contemplation and a safe environment for students to think and reflect and then focus on their academic pursuits*

The funds to sustain and grow these Makerspaces will have a significant long-lasting impact on the innovation culture at UA. Each space will support building capacity within UA students and provide spaces for design thinking programming and innovative research. UA is continuing to build a MakerSpace community and these spaces will be integral parts of this community. The T3 space is already being used by the Honors students for their problem sets with the Eielson AFB, another innovative collaboration developed through support under this grant.

7. STE(A)M Education

Under this ONR grant, Center ICE built new programming to support undergraduate research as well as innovative programs in the K – 12 age range. This next generation was given an insight into the entrepreneurial journey and learned new skills on how to ideate and build solutions to real-world problems and community needs. This track developed significantly over the grant

timeline as more teams were supported and as Center ICE developed its network in the K-UG community. In Year 1 of the award, Center ICE talked with UAF mechanical engineering design class students who were looking for a project. Student Riley Bickford and his team members took up the challenge and connected with industry partner and Alaskan Ray Huot, Figure 11A. Throughout the project, Center ICE provided mentorship toward market viability. The students disclosed the technology to UA. Ultimately, the team won the 2019 Young Innovator Award for best student innovation. This was the first step towards integrating more real-world problem sets into the student experience and how the Center ICE funds through this award made a significant difference as the students developed their solutions.

Year 2 focused on unmanned aircraft systems, Vertical Take-off and Landing Design senior design project by Brian Holst, and Consumer Sterilization – Technology with Gerald Montuya. Holst's project centered on re-designing the power system of a fixed-wing aircraft for vertical take-off and landing. The team developed a marketable upgrade to the fixed-wing system that can be utilized by the unmanned aircraft systems industry. Gerald Montuya's team focused on consumer sterilization technology. The COVID-19 pandemic disrupted the weekly grocery run and Montuya's team looked to develop a new startup company. The ONR support allowed them to perform more discovery and evaluate the current market.

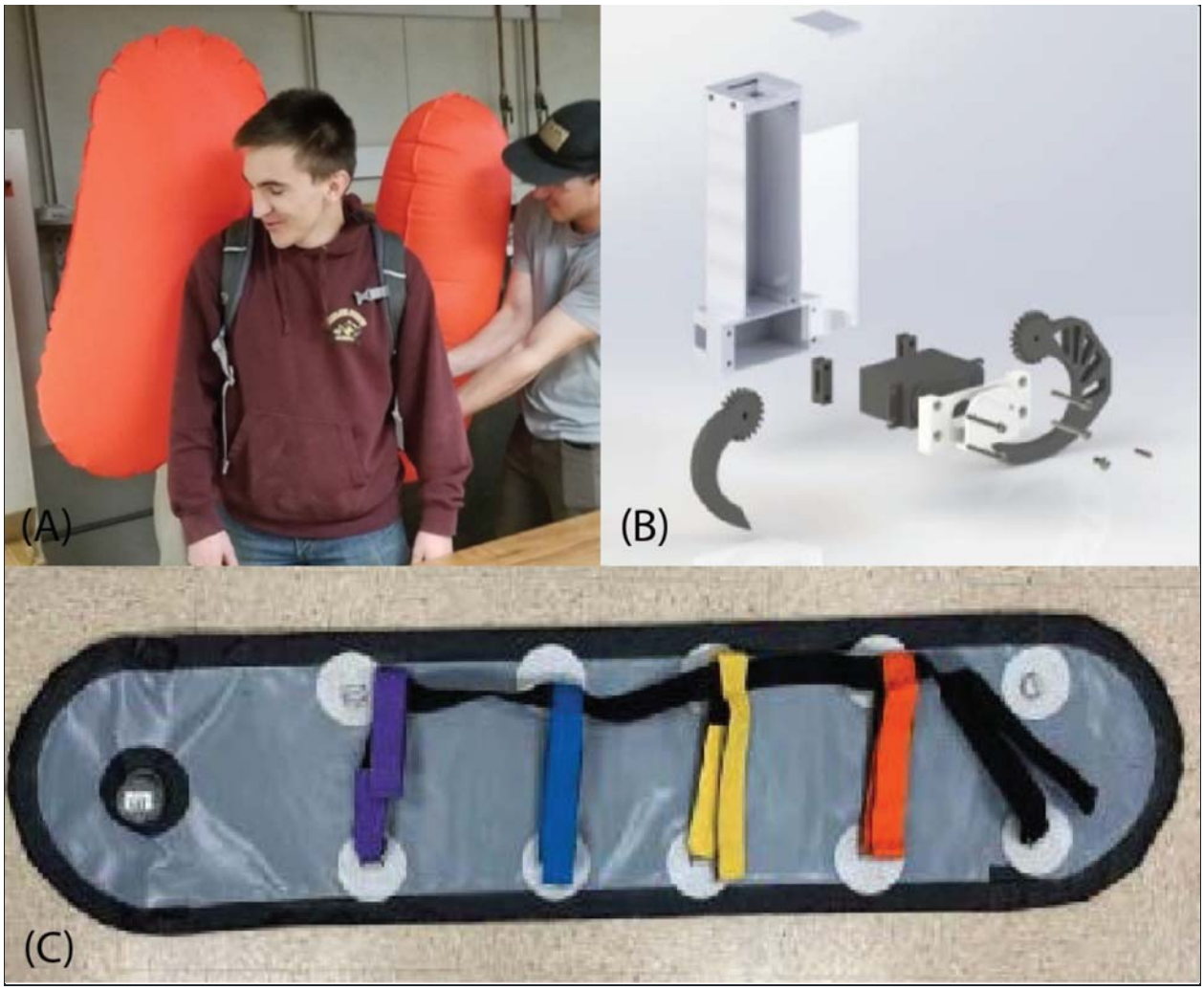

Figure 11. *(A) UG team test their prototype for the AvyPouch system, (B) Exploded view of the FAAST teams' claw design using a single servo to drive a double gear that holds a 5 kg payload*, and (C) *Final prototype strap system for a collapsible search and rescue board.*

By Year 3, there were more direct interactions with the engineering students that resulted in four projects supported from the mechanical engineering (ME) and civil engineering (CE) programs. The first ME student team focused on a Fully Automated Aerial Systems Tether (FAAST) for unmanned aircraft systems. Their design centered on a lightweight delivery mechanism to support integration into a small UAS aircraft, Figure 11B. Their remotely operated claw tethered precision winch can lift and deliver a payload of up to 5 kg (11 lbs.) with integration to the industry standard UAS payload rails and on-board autopilot. The second ME group formed the Adventure Board Team focusing on providing a lightweight, compact, and reliable safety technology for first responders or medical personnel in backcountry situations. This team's solution provides rigid spinal immobilization that can also easily be tucked into a backpack when not in use, Figure 11C. Two other projects funded were: the Hot Pocket unmanned aerial vehicle (UAV) enclosure team who developed a design for an insulated enclosure for UAVs for use in rural locations around Alaska which provided ease of use and the ability to operate in a range of environmental conditions and a CE project, Arctic Connections Engineering, who focused on building a solution for dynamic arctic wastewater lines that

accommodates movement resulting from settlement and subsidence. Three invention disclosures were declared from the work thus recognizing the student inventors for their developed solutions and to assist in evaluating their potential for commercialization and licensing. Three of the teams went through Center ICE's customer discovery programming in summer 2021 and one of the FAAST team members was a summer 2021 S2S intern with a Launch Alaska portfolio company, Quagga.

In Year 3, Center ICE supported two programs building a growth mindset and design thinking into K – 12 education. OneTree Alaska worked with a group of educators and their students to develop their capacity in documenting scientific observations that drive inquiry exploration. With the UB/T3 program, Center ICE supported Director Adam Low to provide mini grants for project proposals with an innovation focus to support students in their ten communities. With OneTree Alaska, their team worked with teachers to understand how to use the Grinnell notebook protocol to document observations of winter seedling inquiry exploration, Figure 12A. Center ICE's K-12 support through this ONR grant allowed OneTree to build its work with the Grinnell Journals to the next level. With the UB/T3 communities, students submitted mini grant proposals for support for supplies to develop out a solution to a local community need. At the Seward Makerspace students improved upon hydroponic grow towers to incorporate 3D printed joints, Figure 12B, to connect the PVC pieces for the hexagonal frame. Also, T3 Alliance student Brain Mitchell designed a Raspberry Pi computer enclosure, Figure 12C, that could be cut out of clear acrylic with a laser cutter. The enclosure was first designed to ensure that it could support the mini-computer before the laser cutter was used to produce the final solution.

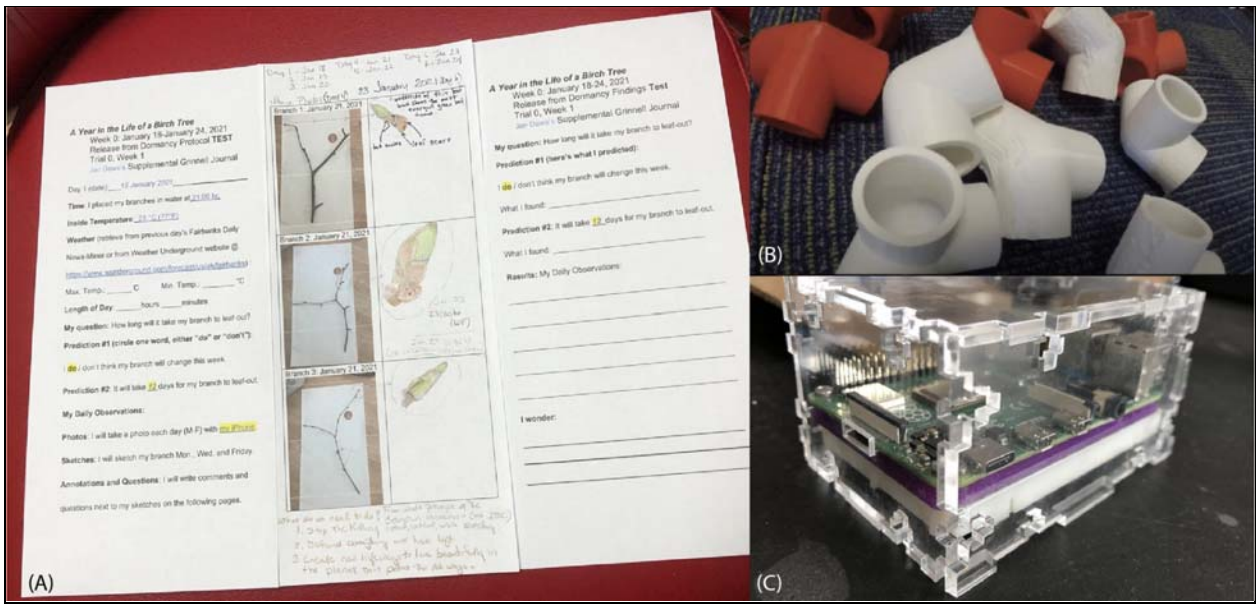

Figure 12. ***(****A) Grinnell notebook used by the OneTree Alaska students and teachers to document their observations and inquiry-based exploration of the birch trees used in the tapping process. (B) Seward Makerspace UB/T3 work showing the 3D joints for the grow tower and (C) the Raspberry Pi enclosure designed under a Center ICE mini grant.*

Under this track, undergraduate students were supported to further develop their innovative solution to a specific entrepreneur's need, industry topics, or a community request. Students were exposed to the first steps of the innovation journey and saw how their developed designs

had real-world applications. Several of the UG teams built new opportunities to engage with the statewide entrepreneurial ecosystem and work directly with a fast-growing startup business. Several of the projects furthered their understanding of the industry needs through Center ICE's customer discovery training. Outcomes from these discoveries will support the next iteration on the designs as they are tailored to the needs of the industry. For the K – 12 projects, these programs transitioned design thinking and ideation practices to teachers and students. One specific example is under the T3 support where opportunities were made available to a more diverse group of students while the skills developed by these students in their proposal writing and solution driven inquiry are applicable to future T3 projects and as they continue through their educational experience and transition to the University academic environment. The support under these STE(A)M projects increased the capabilities of the students and teachers in these programs and several of those funded are continuing to engage with the innovation ecosystem, either as employees of Startup companies or now undergraduates at UA using Makerspaces and build new solutions to today's challenges.

8. Conclusion/Outcomes

It is difficult for us to imagine what the state of innovation and entrepreneurialism would be like at the University of Alaska, in Fairbanks, and across Alaska without Center ICE. With the Office of Naval Research's support, we were able to establish Center ICE and get it up and running. Now we're gaining momentum, finding new partners and funding sources, and most importantly improving resilience in the arctic. We are supporting technologies, innovators, startup companies, and industry partners that are going to dwarf the impact of Center ICE – and this is most welcome.

The journey has not been easy, and we still have a long way to go. We've made a lot of mistakes and are trying to maximize these as learning opportunities. While there are other sources, the University of Alaska is the hub of innovation in the State of Alaska. UA performs amazing research, but the impact of that research on society and the economy has yet to be fully unleashed. Center ICE is now gearing its operations to move innovations through a procured but customizable set of steps. This will be introduced on February 1, 2022, as the Center ICE Innovation Accelerator (IA). The IA focuses more on the technology than on the inventor - a recognition that some researchers are not interested in furthering their innovation. This frees up the invention to be advanced by other people and places a focus on the research product itself. The Innovation Accelerator will consist of 9 modules ranging from the ideation stage, through development, and ultimately achieving commercial adoption. Progression through the in many cases also will follow progression through the TRL (Technology Readiness Level) stages. Importantly, however, the IA has steps to ensure the innovation is aligned with industry needs.

The Innovation Accelerator represents the next big phase of Center ICE. Surely the Innovation Accelerator will require iteration and will improve over time. And Center ICE will continue growing other aspects of its operations as well.

We are grateful for the Office of Naval Research's support for this project, and we look forward to continuing this partnership going forward.

REPORT DOCUMENTATION PAGE

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED	
		START DATE	END DATE
31-01-2022	final	01-07-2018	31-01-2022

4. TITLE AND SUBTITLE

Alaska Center for Innovation, Commercialization, and Entrepreneurship

5a. CONTRACT NUMBER	5b. GRANT NUMBER	5c. PROGRAM ELEMENT NUMBER
N/A	N00014-17-1-2673	N/A
5d. PROJECT NUMBER	**5e. TASK NUMBER**	**5f. WORK UNIT NUMBER**
N/A	N/A	N/A

6. AUTHOR(S)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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Fairbanks, AK 99775

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Office of Naval Research
875 N. Randolph Street, Suite 1425
Arlington, VA 22203-1995

10. SPONSOR/MONITOR'S ACRONYM(S)

ONR

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for Public Release; Distribution is Unlimited.

13. SUPPLEMENTARY NOTES

None

14. ABSTRACT

This project entailed founding the Alaska Center for Innovation, Commercialization, and Entrepreneurship (Center ICE) as well as delivering some initial Center ICE programming. Center ICE is an innovation hub located at the University of Alaska Fairbanks that serves all of Alaska. Center ICE offers an increasing amount of programming, funding, and space to Alaska innovators and entrepreneurs as they develop solutions that are creating a more resilient United States presence in the Arctic.

15. SUBJECT TERMS

Arctic, innovation, commercialization, entrepreneurialism, "Alaska Center ICE"

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES
a. REPORT	b. ABSTRACT	C. THIS PAGE	UU	25

19a. NAME OF RESPONSIBLE PERSON	19b. PHONE NUMBER *(Include area code)*
Gwen Holdmann	907-474-5402

PREVIOUS EDITION IS OBSOLETE.

STANDARD FORM 298 (REV. 5/2020)
Prescribed by ANSI Std. Z39.18