IDAHO GLOBAL ENTREPRENEURIAL MISSION

FY2020 ANNUAL REPORT

IGEM

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IGEM

The Idaho Global Entrepreneurial Mission (IGEM) is a unique program that invests public funds in advanced university research and capacity building to further economic development initiatives for the state. The IGEM grant program uses a three-pronged approach to support a statewide entrepreneurial and commercialization pipeline to bring to market advances in vital industries to the state's economy. In the first eight years of operation, IGEM has been successful in advancing important research projects, funding strategic research capacity investments, and propelling innovations that position Idaho industries in new and profitable markets.

This annual report provides a succinct update on the IGEM program, its funded projects, and successes over the past eight years.

IGEM Provides Three Distinct Funding Opportunities:

IGEM – COMMERCE

$1 MILLION

Managed by the Idaho Department of Commerce under the direction of the IGEM Council.

Funds research ventures where industry and university partnerships work together to bring viable products and technologies to market.

IGEM – HERC

$2 MILLION

Managed by the State Board of Education (SBOE) and administered by the Higher Education Research Council (HERC).

Invests funds to support infrastructure and advance key capacities at Idaho's research universities.

IGEM – CAES

$2 MILLION

Managed by the SBOE and administered by the Center for Advanced Energy Studies (CAES).

Leverages the partnerships between Boise State University, Idaho State University, University of Idaho, University of Wyoming, and the Idaho National Laboratory to fund advanced energy projects and initiatives.

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The IGEM-Commerce grant program funds research initiatives where university investigators and private sector business experts partner together to bring viable technologies to market. IGEM commercialization grants are a powerful economic development resource by funding university research that can advance private sector products and services produced in Idaho. Through its support of commercialization partnerships, IGEM makes an investment in developing new business ventures, creating new products and high-value jobs, while supporting the research capacity of Idaho's universities.

At the helm of the IGEM-Commerce program is the IGEM Council, a twelve-member body appointed by the Governor as prescribed in Idaho Code section 67-4726. The IGEM Council's diverse and experiential make-up consists of the brightest business, research, policy, strategy, and financial minds in the state.

The Council thoroughly vets IGEM grant proposals to mitigate risk and maximize the return on investment. The IGEM Council's fiscal stewardship and strategic direction advances IGEM's overall intended goal of economic prosperity through investments in technological advancements and innovation.

IGEM COUNCIL

The IGEM Council is a twelve-member council appointed by the Governor as prescribed in Idaho Code section 67-4726.

Membership of the IGEM Council includes:

- Four (4) representatives from the private sector;
- One (1) representative from the State Board of Education (SBOE);
- One (1) representative from the Idaho National Laboratory (INL) or the Center for Advanced Energy Studies (CAES);
- One (1) representative each from Boise State University (BSU), Idaho State University (ISU), and the University of Idaho (UI);
- One (1) representative from the Idaho Senate;
- One (1) representative from the Idaho House of Representatives; and the
- Director of the Idaho Department of Commerce.

FY2020 MEMBERS:

- **Dr. David Hill** – Chair, SBOE
- **Bill Gilbert** – Vice Chair, The CAPROCK Group
- **Von Hansen** – KONEXUS
- **Rick Stott** – Superior Farms
- **Dr. Noel Bakhtian** – CAES
- **Dr. Bradley Ritts** – University of Idaho
- **Dr. Harold Blackman** – Boise State University
- **Dr. Scott Snyder** – Idaho State University
- **Senator Kelly Anthon** – Idaho Senate
- **Representative Paul Amador** – Idaho House of Representatives
- **Tom Kealey** – Idaho Department of Commerce

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IGEM – Commerce Grant Program

With $1 million in annual funding, Idaho Commerce utilizes $50,000 for program administrative costs, leaving $950,000 for grant awards. To date, IGEM-Commerce has funded 36 projects, resulting in over $7.7 million invested in university and industry research partnerships.

YEAR	APPLICATIONS	FUNDED	REQUESTED	AWARDED
FY2013	18	7	$3,088,169	$844,093
FY2014	20	4	$3,506,145	$972,371*
FY2015	14	3	$3,044,732	$950,000
FY2016	18	6	$4,149,029	$1,104,830*
FY2017	14	4	$3,628,640	$979,569*
FY2018	14	3	$5,375,198	$950,000
FY2019	13	5	$3,626,955	$1,016,728*
FY2020	19	4	$4,991,353	$953,711
TOTAL	**130**	**36**	**$31,410,221**	**$7,771,302**

** Supplemental funding provided by Idaho Commerce*

To date, the program's largest grant award was $427,173 with the smallest being $46,146. Over the past eight years, the average grant request has almost reached a quarter of a million dollars.

YEAR	APPLICATIONS	AVERAGE REQUEST	AVERAGE AWARD
FY2013	18	$171,565	$120,585
FY2014	20	$175,307	$243,093
FY2015	14	$234,210	$316,667
FY2016	18	$230,502	$184,138
FY2017	14	$259,189	$244,892
FY2018	14	$383,943	$316,667
FY2019	13	$278,997	$203,346
FY2020	19	$262,703	$238,428
PROGRAM AVERAGES	**16 PER YEAR**	**$243,490**	**$215,870**

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Photo by BSU Novel Movement and Inspection System for Drones

FY2020 Grant Awards

DEVELOPMENT OF A SCALABLE MANUFACTURING PROCESS OF ON-CHIP COLOR TUNABLE LASER

Boise State University

Grant Amount: $242,114

Boise State University and industry partner, Iris Light Technologies, Inc., will continue development of a scalable manufacturing process for on-chip color tunable lasers. The research team has successfully optimized the conversion process of red phosphorous to black phosphorus and the nanomaterial ink formulation. This collaboration has secured a U.S. Air Force AFWERX Small Business Technology Transfer (STTR) Phase 1 award and investment for Iris Light from the Clean Energy Trust. Boise State and Iris Light are also in discussions with the National Research Council of Canada for potential future collaboration.

DEVELOPMENT OF AN ADVANCED GENOMIC SELECTION TOOL FOR THE U.S. SHEEP INDUSTRY

University of Idaho

Grant Amount: $251,114

The University of Idaho and Idaho industry partner, RILE Ag, will work together to advance a new genomic selection tool for the U.S. sheep industry.

The genome research will provide better tools and data for sheep ranchers and processors at a lower cost. By changing the genotyping assay platform to sequencing technology, as opposed to array technology, the project team can take advantage of the decreased cost to access genetic information for the U.S. sheep industry. In addition to being less expensive, sequencing platforms are very flexible which will allow easy updated markers.

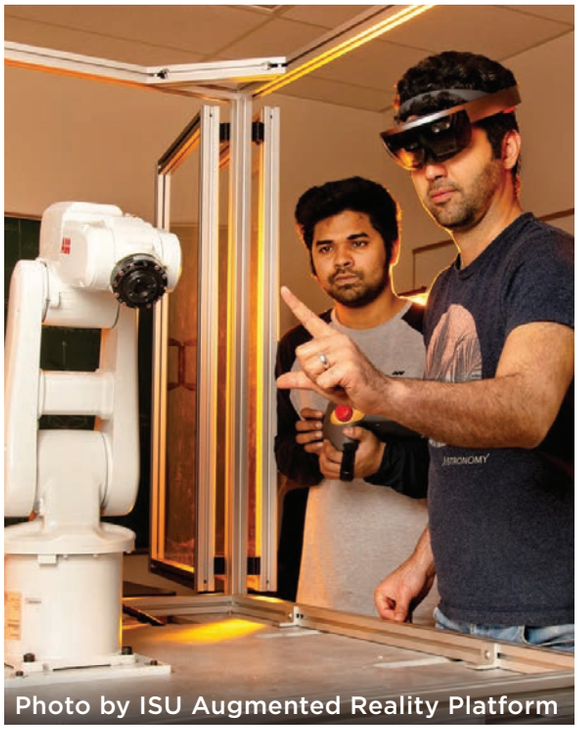

Photo by ISU Augmented Reality Platform

NOVEL MOVEMENT AND INSPECTION SYSTEM FOR DRONES

Boise State University

Grant Amount: $248,083

Boise State University with industry partner, Pitch Aeronautics LLC, will continue development of a new cyclorotor drone and the incorporation of a novel thermography sensor system. The research team is working on the thermography imaging data fusion algorithm development and has completed the temperature segmentation algorithm development. Work continues on the gradient-based thermal image segmentation, which directly leads to more accurate subsurface defect determination.

FREE TO FEED FOOD ALLERGEN TEST KIT FOR HUMAN MILK

University of Idaho

Grant Amount: $255,496

The University of Idaho and industry partner, Free to Feed Inc., will advance research and development in detecting food allergen proteins in human milk. This research will help to advance Free to Feed's patent-pending technology.

The project team has hired a temporary study coordinator to complete a literature review and work on details related to finalizing study design. In addition, the project team has begun to work on all the materials (e.g., informed consent, sample collection protocols, dietary intervention protocols) needed for gaining ethics approvals for the proposed clinical trial via the University of Idaho Institutional Review Board.

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IGEM – Commerce in Progress Projects

DESIGN AND DEVELOPMENT OF AN AUGMENTED REALITY PLATFORM FOR ROBOTIC SYSTEMS DESIGN AND INTERACTION

Idaho State University

FY2019 Grant Amount: $162,606

Idaho State University partnered with House of Design to develop an Augmented Reality (AR) robotics physics and communication engine to be used for industrial robot design, operation, and interaction. House of Design is a rapidly growing company whose main functionality is to integrate robots into industrial production lines. The project is structured in five milestones, including: identify and define input and output of system, have the AR system able to identify a robotic system, have system information displayed in AR app, develop robot interaction and training, and delivery of working prototype. A no cost extension was granted and milestones one to five have been completed. In addition, several Idaho State University students attended two three-day long training courses at House of Design during the summer of 2019 and spring 2020. Several graduate students completed their thesis and dissertation on topics related to the project.

TEST THE FUNCTIONALITY AND EFFICACY OF A PATENTED SANITIZING TOILET SEAT

Idaho State University

FY2019 Grant Amount: $82,792

The Mechanical Engineering and Chemistry Departments at Idaho State University have partnered with Fufuloo Products LLC., who has a patented toilet seat called the Washie. Washie allows the user to clean the seat with an all-natural cleaning solution before use. After activating a sensor, located on the right side of the seat, cleaning solution rises from the seat and is wiped down with toilet tissue to clean the seat. Having the user clean the seat is the major difference between Washie and other self-cleaning toilet seats on the market and is more affordable to businesses. The project team will also continue to document and study the effects of cleaning chemical on the seat after prolonged repetitive use. Lastly, work on a new formulation of the cleaning chemical is being conducted which will satisfy EPA regulations.

CONVERT AGRICULTURAL WASTE INTO AN EFFECTIVE NEMATODE SUPPRESSING FOOD AND FERTILIZER

University of Idaho

FY2019 Grant Amount: $241,667

The University of Idaho and industry partner California Safe Soils are combining mustard seed meal with a food hydrolysate product to develop an affordable new biopesticide that can combat roundworms while increasing yield and avoiding the negative environmental consequences of chemical pesticide use. Plant-feeding roundworms, or nematodes, are responsible for approximately 14%, or $100 billion, in overall annual agricultural yield loss. Using IGEM funding, experiments are underway to optimize the amounts and methods of pesticide application in the laboratory and greenhouse. Preliminary results show a synergy between the two materials and an impact on nematode populations and plant growth. Further refinement of application methods will continue through the winter months, followed by field verification during the growing season.

DEVELOPMENT OF A RIBONUCLEIC ACID (RNA) HOME TEST FOR EARLY HIV DETECTION

Boise State University

FY2019 Grant Amount: $255,496

Boise State University and industry partner, Molecular Testing Labs, are collaborating research efforts to commercialize a ribonucleic acid (RNA) home test for early HIV detection. RNA can also reveal a patient's response to drug treatment, diet, and other regimens. The research conducted in this project will advance efforts in bringing to market a home test where RNA can now be extracted from blood spots and provide HIV results in 7 to 10 days after infection, instead of 3 to 9 weeks.

Before the shutdown of the lab due to the pandemic, all biosafety protocols were approved at Boise State University and considering the pandemic, the research team added COVID-19 RNA testing to the protocols. A new graduate student has been hired and trained to work on the RNA-based HIV testing. The team was able to validate human RNA extraction and amplification of RNA P (RNA from RNA polymerase gene) from DBS samples and validate COVID-19 PCR testing (using DNA positive control).

A GENERAL-PURPOSE GONIOMETER

Boise State University

FY2018 Grant Amount: $368,772

Research on this project supports the design and development of a market ready general-purpose portable infrasound goniometer. The goniometer will be able to detect natural phenomena sounds as well as differentiating man-made sounds and their sources. Multiple systems have been built and are currently running successful tests in Boise and Utah.

Boise State and WMDTech have been able to continue to work on the project during the pandemic. The design and

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prototyping are well underway, and two prototypes of the latest iteration have been assembled. Field tests have been conducted to determine refinements to the sensors and firmware. After extensive effort, Boise State filed a patent application to protect novel aspects of the invention.

DEVELOPMENT IN OPTIMIZING LASER METAL DEPOSITION ADDITIVE MANUFACTURING TECHNIQUES

University of Idaho

FY2019 Grant Amount: $274,167

Through a collaboration with industry partner Premier Technology, Inc. (Premier), the University of Idaho, and Boise State University, this project team is optimizing a laser deposition-based additive manufacturing (3-D printing) technique to create innovative products for the industrial sectors such as energy, aerospace and food processing. This unique technique will allow users to quickly make large metallic parts with complex geometry and design flexibility under controlled atmospheric conditions. The project is not only creating key technical capability but is providing hands-on research experience to several students, supporting the development of the next generation technical workforce in the rapidly expanding area of additive manufacturing. The project will help position Premier as an industry leader by expanding their presence in the marketplace across Idaho and beyond while the universities gain valuable research expertise to attract further funding in this research area.

DEVELOPMENT OF A MAGNETIC SHAPE MEMORY (MSM) MICROPUMP

Boise State University

FY2018 Grant Amount: $343,330

This project further supports the development of a working Magnetic Shape Memory (MSM) Micro-pump prototype for volume production. The industry partner, Shaw Mountain Technology, LLC (SMT) is a Boise State University startup company founded in 2015 by Distinguished Professor and former Chair of the Materials Science and Engineering Department, Dr. Peter Müllner. The research and development of this project is focused on replacing the driving mechanism, currently an electromotor and permanent magnet assembly, with a more compact and energy efficient electromagnetic system. A new industry partner, House of Design, has been engaged to assist with production scalability. SMT has sold two pumps and three additional patents have been filed by Boise State University for further iterations and improvements to the pump technology manufacturer.

IGEM – Commerce Completed Projects

FLEXIBLE SENSORS ASSISTED MINIATURIZED AIR SCRUBBER FOR PROTECTING STORED POTATOES

Boise State University & Idaho State University

FY2017 Grant Amount: $413,681

This IGEM grant has led to a multi-institution effort to develop an integrated miniaturized air scrubber and cloud-enabled wireless distributed sensor network to monitor and control the storage environment for potatoes. The Boise State University team developed and tested temperature, gas, and humidity sensors in a laboratory environment. A web-based client application that provides interfaces for users to view the real-time readings of different sensors that are physically present in the storage facility has also been developed. ISU extensively tested the Idaho Hydro Tech (IHT) Humigator on its ability to remove mold spores, bacteria, and viruses from air. Analysis of the results and manuscript preparation is in final stages. The analysis indicates that the Humigator™ is effective in removing bacteria from air, although results were influenced by patterns of airflow in the test lab

This integrated solution should enable IHT, the industry partner, to increase their share of the potato storage market. While each component of the integrated system has unique capabilities, their integration marks an important advance in agricultural technologies.

ALUMINUM CASK FOR USED FUEL COOLING

University of Idaho & Boise State University

FY2018 Grant Amount: $237,898

Researchers from the University of Idaho in Idaho Falls, the Center for Advanced Energy Studies research consortium, and Japan-based Sakae Casting, LLC used IGEM funding to perform criticality assessments of potential casks, develop mechanical and chemical means to dissolve boron compounds in molten aluminum, cast a prototype used fuel cask, and conduct experimental tests on that prototype used fuel cask to determine the maximum heat loading permitted. These tasks were conducted to develop and bring to market a borated aluminum cask for cooling used nuclear fuel. The cask will strengthen used fuel management at nuclear power plant sites around the world, as many reactor sites have limited space to store used fuel, which is often stored in large, deep water-cooled pools. The cask presents an intermediate, space saving storage option.

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EVALUATION OF THE ANKLE ROLL GUARD'S EFFECTIVENESS TO IMPROVE CLINICAL BENEFIT

Boise State University

FY2016 Grant Amount: $148,927

A new, innovative orthopedic product (Armor1) that prevents injury by limiting excessive inversion of the ankle has been developed by Ankle Roll Guard™. Boise State University quantified Armor1's effectiveness and compared its ability to prevent excessive ankle inversion with existing orthopedic products. The preliminary quantitative data demonstrated that Armor1 provides similar prevention of excessive inversion as existing orthopedic products but may allow the wearer more natural ankle motions and better physical performance. Using this data, Ankle Roll Guard™ has initiated negotiations with several medical device distributors.

HOPLITE SKATE ARMOR™ COMPARATIVE ANALYSIS

Idaho State University

FY2017 Grant Amount: $111,453

The central focus of the project was the testing of a hockey safety device called HOPlite Skate Armor™, developed by Fi-Ber Sports, that was to be worn over a standard hockey skate. HOPlite Skate Armor™ is a patented two-piece composite plastic foot protector intended to reduce foot related injuries for hockey players. The Idaho State University research team was charged with the development of a consistent delivery system capable of accelerating a hockey puck to 100 mph and recording the velocity of the puck prior to its impact with the protective device. The mission was to record impact data and video from the puck collisions with the HOPlite Skate Armor™ device for analysis. The research final report contained detailed information allowing for replication of the testing process. The puck launching system has applications for other safety devices as well and could accelerate a puck to 190mph. With the impact film data and high-speed video provided by the ISU research team, Fi-Ber Sports will be able to conduct an analysis of the reaction of the material used in the construction of HOPlite Skate Armor™. ISU administrators met with the HOPlite Skate Armor™ team in early 2019 to discuss the next steps. ISU volunteered the use of the necessary testing equipment so that HOPlite Skate Armor™ could pursue third party testing to verify the data. This new data, along with existing data provided by ISU, could allow for HOPlite Skate Armor™ to become the industry standard in foot safety equipment for hockey players.

TECHNOLOGY DEVELOPMENT FOR EFFICIENT PROVISION OF UAS PRODUCTS

University of Idaho

FY2016 Grant Amount: $161,524

The University of Idaho, along with assistance from Z Data Inc. has developed software tools to assist Empire Unmanned in handling enormous amounts of data acquired during unmanned aerial system (UAS) flights. The ability to process, visualize and disseminate large volumes of gathered data enables Empire Unmanned to expand its product offering.

TIME-OF-FLIGHT SPECTROSCOPIC REFLECTOMETER

Boise State University

FY2017 Grant Amount: $260,435

Boise State University has developed a spectroscopic time-of-flight reflectometer (STOFR) to assist the manufacturing and quality control process of a new revolutionary process which reduces and eliminates reflections from the end of an optical fiber (RARe Motheye Fiber™ process), developed by Fiberguide Industries, Inc. The instrument measures optical reflection from RARe Motheye Fiber™ over a wide range of wavelengths from near UV to near infrared. STOFR is capable of measuring reflections less than 0.1% and is insensitive to optical alignment (an important factor in the manufacturing environment). An instrument with such broadband capability and high sensitivity does not exist on the current commercial market. STOFR has been in field operation since July 2018. The revenue generated by RARe Motheye Fiber™ is expected to exceed $1 million annually.

DATA ANALYTICS FOR PRECISION AGRICULTURE

Boise State University

FY2015 Grant Amount: $343,072

Boise State University worked with the JR Simplot Company to develop a data analytics solution for agronomic decision making based on historic farm and crop yield data. The goal of this project was to leverage Simplot's existing data to give growers new tools and resources they need to optimize their yields. Researchers automated the process of matching the multi-spectral photosynthetic images for Simplot so they can be used to produce predictive models for their network of growers.

6,000 WATT SPLIT PHASED GALLIUM NITRIDE HIGH FREQUENCY INVERTER

University of Idaho

FY2016 Grant Amount: $178,178

The University of Idaho in collaboration with Inergy Solar, the industry partner, has engineered and manufactured a new 2,000-watt Split Phased Gallium Nitride High Frequency Inverter. With the success of this development, researchers designed and are closer to realizing a 6,000-watt capacity inverter. These inverters will augment Inergy Solar's current product offering by advancing development toward a complete home solar solution. A new front-panel design and advanced user-controlled features have also been added, including the ability to set the power output, receive light and temperature conditions, collect optional sensor data through a web-based app. In addition to the gallium nitride focus, this project's research has also included emphasis on network cybersecurity protection for

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this off-grid energy source. The project is continuing to refine the design for attaining increased power loads, enabling internet access to operate the product, advanced user features and displays, and better cybersecurity.

SMART RAISED PAVEMENT MARKINGS (RPM) INTEGRATION WITH TRAFFIC SIGNAL CONTROL SYSTEMS

University of Idaho

FY2016 Grant Amount: $299,651

The University of Idaho and its National Institute for Advanced Transportation Technology (NIATT) have validated the safety benefits of EMI's Smart Pavement Markers in different applications. A multidisciplinary team of UI researchers improved the functionality of these markers by adding wireless communication capabilities to them, opening the door for several real-time adaptive on-pavement warning systems to improve traffic safety in different roadway segments. Through a partnership with Idaho-based Evolutionary Markings Inc., UI produced innovative, real-time communication and data exchange between RPM devices and different traffic control systems, connected vehicles, and autonomous vehicles. A test installation of the technology was featured in a journal for the Washington State Institute of Transportation Engineers. Using EMI's pavement markers, a UI team of students were finalists in the U.S. Department of Transportation's Traffic Control Device Competition to reduce wrong entry crashes on high-speed roads. In addition, the Idaho Transportation Department installed EMI markers in different segments of its two-lane rural highway systems to improve safety.

COMMERCIALIZATION OF NEW AQUATIC ANIMAL HEALTH PRODUCT

University of Idaho

FY2013 Grant Amount: $124,021
FY2016 Grant Amount: $105,452

This project was an inaugural recipient of IGEM funding in FY13. Since the initial investment, this project has successfully progressed toward the commercialization of a fish vaccine to combat Cold Water Disease (CWD). Idaho is the national leader in trout production, accounting for over 70% of all commercial (food fish) rainbow trout. Commercial aquaculture production contributes over $110 million to Idaho's economy. Due to this secondary round of funding, an exclusive license has been successfully negotiated and executed. The University of Idaho continues to work directly with the company sponsor to gain final U.S. Department of Agriculture (USDA) regulatory approval for this vaccine. The process has steadily moved forward, and initial laboratory safety trials have recently been completed and submitted to USDA for review. Upcoming laboratory efficacy and field safety trials remain to be completed. Once results are reviewed and approved, full vaccine licensing approval is expected from USDA, which is required prior to commercialization, marketing, and product launch.

SENSOR ADAPTER FOR MACHINE-TO-MACHINE (M2M) MARKET

Boise State University

FY2016 Grant Amount: $211,098

With IGEM funding, Boise State University and industry partner, Marshall GIS, developed a sensor device to improve the collection, modification, and delivery of remotely-sensed GPS, vehicle diagnostics, and other related data. The sensor adapter fills a critical gap in the delivery of data from diverse sensors to the growing internet Platform as a Service (PaaS) marketplace, allowing sensor agnostic and carrier agnostic delivery of data to the cloud for use by a wide variety of applications.

REMOTE SENSING OF ALFALFA CROP BLOOM

Boise State University

FY2017 Grant Amount: $194,000

This project allows Boise State University's Department of Geosciences to apply its experience and expertise in remote sensing data collection and analysis to provide protocols and prediction models to the industry partner, Kairosys, Inc., that will form an important part of the suite of solutions it is developing for managed pollination. Boise State is using imaging technology based on spectroscopy science for monitoring alfalfa as it progresses through its flowering cycle. Based on the success of the project, S&W Seed Company has joined as a new industry partner. In partnership with S&W, sensors were deployed in several alfalfa fields and a predictive model is under development. S&W has provided additional data to the project and along with the founders of Kairosys, are actively engaged on the product development of the predictive model.

2E-HEXENAL FUNGICIDE

University of Idaho

FY2014 Grant Amount: $296,917

At the University of Idaho, researchers tested an organic compound called 2E-Hexenal as a fungicide for stored potatoes. Converted to and applied in a gaseous state, this new approach to eradicate fungi would be industry changing. UI partnered with several companies to study the effectiveness of this fungicide in post-harvest tubers. The project shifted from large-scale potato trials to smaller-scale trials, which incurred cost savings. Those savings were utilized to conduct additional research on the use of 2E-Hexenal in onion storage facilities, where it has successfully demonstrated a dramatic reduction in crop losses due to postharvest pathogens. The product is now patented. UI licensed the fungicide with one of the partnering companies, which is pursuing EPA registration and will attempt to bring this technology to market by 2023. Researchers in Wisconsin, Michigan and Idaho carried out further testing of 2E-Hexenal in large-scale trials last winter. Initial results are good, and trials will expand during storage season to collect more data for EPA registration.

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RISE ANALYTICS
Idaho State University
FY2014 Grant Amount: $300,000

Idaho State University partnered with ON Semiconductor for analytical research in the development and improvement of semiconductor products. The Commerce IGEM award allowed for the acquisition and installation of Scanning Electron Microscope and Energy Dispersive Spectroscopy (SEM/EDAX) equipment. The equipment is in the Eames Advanced Technical Education and Innovation Complex, in the newly remodeled Material Analysis and Microscopy Laboratory (MAML). The equipment positioned in MAML has fostered collaboration between ISU and multiple industry partners as well as numerous governmental agencies. In FY2019, work was completed on infrastructure to support the MAML lab; chillers and UPS units were installed and located in a separate room from the microscopes themselves to enhance user experience in these labs. Large vacuum pumps were emplaced for potential implementation of a future central vacuum system, to further reduce noise and vibration levels in the microscopy lab. The JEOL FX2000 TEM was serviced and the electron source was upgraded from a Tungsten filament to LaB6 crystal which will yield increased brightness imaging and improve beam stability over its useful life.

HIGH SPEED DIGITAL PACKAGE MEASUREMENT & MODELING FOR NEXT GENERATION MEMORY MODULES
University of Idaho
FY2013 Grant Amount: $150,000

Partnering with Micron, this project allowed for the speedier development and design on next-generation memory modules with the acquisition of the Vector Network Analyzer. The acquisition of the Vector Network Analyzer not only helped Micron, but it also prepares UI students with hands-on education on the latest industry equipment. Additionally, the Micron Foundation gifted $1 million to UI to fund an endowed professorship in microelectronics in the College of Engineering. This gift has helped UI's efforts to better position itself as a leader in microelectronics education and research.

AUTOMATED QUANTITATIVE DETECTION OF E.COLI O157:H7 AT BEEF PROCESSING FACILITIES
University of Idaho
FY2013 Grant Amount: $78,076

The project examined if there was a better process to detect and determine the strains of E. coli within the beef processing system. While the project was successful in decreasing the detection time, the new process was not sufficient for commercial use at a beef processing plant. The process did recognize six strains that are considered adulterants in fresh ground beef products. Additionally, beef trim contaminated with E. coli O157:H7 could be identified in approximately 18 hours, which is about 24 hours faster than other generic methods.

EXPANDING PRECISION AGRICULTURE MARKET OPPORTUNITIES WITH UNMANNED AIRCRAFT SYSTEM SENSORS
Idaho State University
FY2015 Grant Amount: $179,755

This project utilizes hyperspectral imaging mounted on Unmanned Aircraft Systems (UAS) to advance precision agriculture. ISU and the Idaho-based JR Simplot Company worked together to advance remote sensing applications in the evaluation of multi-platform data collection using UAS. Researchers have discovered a detection methodology that identifies the Potato Virus Y (PVY). The detection of PVY is critical for potato growers to prevent yield losses. The project team secured additional grant funding through the Idaho Specialty Crop Grant program from 2018 – 2020 and 2020 – 2021. New field trails in the 2019 and 2020 growing season provided additional data to refine the approach to detect the PVY crop threat and develop customized sensors. ISU successfully submitted a full patent application in 2018 for this technology. Dr. Donna Delparte, the principal investigator, created a new Idaho registered startup business, I2I Geo LLC, to market this technology.

N-E-W TECH™: INNOVATION AT THE NUTRIENT, ENERGY, WATER NEXUS
University of Idaho
FY2015 Grant Amount: $427,173

This project validated and brought to scale a new reactive filtration water treatment platform. USPTO patent No. 10,366,468 "Biochar Water Treatment" was issued in July 2019 and a similar EU patent is pending. The potentially carbon-negative advanced water treatment technology can clean and sterilize contaminated wastewaters while recovering critical phosphorus and clean water for reuse. The process can remove biological and chemical contaminants in the water using treated Biochar charcoal made from agricultural or forestry waste, as well as through a catalytic oxidation process that destroys most compounds of concern, such as hormones and pharmaceuticals. The system has been successfully trialed at municipal water treatment plants in Moscow and Troy, Idaho, at an agricultural drainage canal near Parma, Idaho, and in Idaho's Magic Valley to address water challenges of the dairy processing industry.

The GreenTech BlueWave biomimicry water technology, advanced separations project (a subset of the IGEM grant) was funded this summer by the U.S. Environmental Protection Agency and the U.S. Department of Agriculture with awards totaling $2 million dollars.

CONDUCT PRECLINICAL STUDIES ON POTENTIAL ANTICANCER AGENTS
Boise State University
FY2013 Grant Amount: $80,986

The project focused on the analogs of doxorubicin and mitomycin C, two compounds that have an important role in the treatment of a variety of cancer types. Use of these two

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compounds has declined due to side effects, including myelosuppression and the onset of irreversible acute cardiotoxicity. Research efforts to gain knowledge on doxorubicin and mitomycin C's mechanism of toxicity have provided tangible results. Researchers discovered favorable results from one of the analogs, GPX-160. They found it to be a more stable analog and a patent has been submitted on GPX-160, with two initial manuscripts following 1) synthesis and anticancer activity and 2) mechanic studies. Gem Pharmaceuticals has contributed over $100,000 in sponsored research toward this partnership.

CANINE HIP IMPLANT
Boise State University
FY2014 Grant Amount: $110,454

A new implant, the Bionic Hip System™, was developed by MWI to improve the standard of care for treating hip osteoarthritis by reducing cost, improving canine mobility, and lowering complications. Boise State University characterized the mechanical performance of the implant. MWI has submitted a utility patent on the technology and West Vet is currently developing instruments to use with the bionic hip implants in canines. The bionic hip implant successfully completed over a million cycles of wear testing, and these findings were published in the Journal of Orthopaedic Research. This study also led to the development of a new technique to measure abrasive wear in hip implants, which was published in the Wear Journal. The undergraduate working on this project was awarded an NSF graduate fellowship and is now completing her PhD at Boise State. The next step for this project is to implant these devices in a small sample size of canines.

NANOFABRICATION INFRASTRUCTURE SUPPORT
Idaho State University
FY2013 Grant Amount: $250,000

The project allowed for the acquisition of a Dualbeam-Nanomachine Center. The Dualbeam system provides both high resolution imaging and nano-machining capabilities in a single component. This tool enables ISU to provide ultra-precise machining and nanofabrication capabilities that meet the needs of its industry, educational, and research partners. The machinery is also located in the Material Analysis and Microscopy Laboratory (MAML) in the Eames Complex. The equipment positioned in MAML has fostered collaboration between ISU and multiple industry partners as well as numerous governmental agencies. The Dualbeam system is currently installed in the MAML microscopy suite and is connected to air, chiller and vacuum services. Once the service maintenance is completed on the Dualbeam system, it will be back into full operational specification and the instrumentation will be ready to resume collaborative research and contractual services on an on-demand basis.

SURFACTANT SOLUTIONS
Boise State University
FY2014 Grant Amount: $265,000

Boise State University partnered with BHS Specialty Chemical Products to create renewable chemicals by converting oils into surfactants for use in products marketed to industrial food processing, personal care, and petroleum industries. Researchers were successful in creating surfactants from pure oil feedstocks, as well as developing a method to make surfactants from high grade vegetable oil waste. Likewise, researchers were able to use low grade vegetable oils from food production facilities as feedstock for surfactant synthesis. BHS was bought out by DuBois Chemicals in 2017 and further development of this technology was terminated.

INNOVATIVE PESTICIDE APPLICATION TECHNOLOGY SYSTEM
University of Idaho
FY2013 Grant Amount: $46,146

The project allowed for field tests to be conducted to quantify the effectiveness of a new pesticide spraying technology compared to conventional spraying. GenZ Technology, the industry partner, learned from field tests that the new spraying technology performed better than existing technology. This new pesticide application system has been used for strawberry and lettuce crops. This project has raised $2 million in capital for the industry partner from angel funds and has also hired 8 new employees. GenZ Technology was also a Regional Winner of the 1776 Challenge Cup and invited to compete at the Global 1776 Challenge Cup competition.

DETERMINE COMMERCIAL VIABILITY OF MICROBIAL INDUCED CALCITE PRECIPITATION (MICP)
University of Idaho
FY2013 Grant Amount: $114,864

The project allowed an assessment to be made on the viability of MICP, a process that uses microorganisms already present in the soil to form calcite. A new Idaho company BioCement Technologies, Inc. has been created as a result of this new product and a license of this technology has been negotiated with the University of Idaho. In addition to receiving IGEM grant funds, this project has also received National Institute of Health (NIH) Small Business Investment Research (SBIR) funding.

The SBIR Phase 1 grant awarded $53,968 for a 6-month study to reduce the mobility of lead (Pb) in soils at sites in and near Kellogg, Idaho. This technology has been patented in the US, New Zealand, Australia, and Canada. BioCement Technologies has 12 road stabilization pilot projects resulting in company revenue. BioCement continues to market and test the technology in various locations, and for several use cases.

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IGEM – HERC

IGEM – HIGHER EDUCATION RESEARCH COUNCIL (HERC)

IGEM-HERC funds are used to support Idaho public institutions of higher education research and development of projects that foster expertise, products, and services resulting in state economic growth. Priority is granted to those proposals that can show a strong collaborative effort among institutions as well as the private sector or exhibit high potential for near term technology transfer to the private sector. IGEM-HERC funded projects may receive funding for up to three years, contingent on annual review and satisfactory progress toward approved performance measures.

The institutions report to HERC each year on the status of their projects, including progress toward key objectives, budget expenditures, economic impact and commercialization potential. The awards granted in FY2020 included the second year of a potential three-year award to the University of Idaho for **Sustaining the Competitiveness of the Food Industry in Southern Idaho: Integrate Water, Energy and Waste Management**, the second year of a potential three-year award to Boise State University for **Nucleic Acid Memory**, the first year of a potential three-year award to Idaho State University for **A Disaster Response Complex for Emergency Responders in Idaho**, and the first year of a potential three-year award to the University of Idaho for **Cellulosic 3D Printing of Modular Building Assemblies.**

IGEM - HERC awards are granted through a competitive process that is open to each of Idaho's three public research institutions. The process incorporates an independent review of proposals and an evaluation component for identifying the project success and economic benefit to the state.

University of Idaho – Security Management of Cyber Physical Control Systems (Sustaining the Competitiveness of the Food Industry in Southern Idaho: Integrate Water, Energy, and Waste Management ($700,000)

Food production and processing are vital to the social and economic integrity of the Eastern Snake River Plain. However, in some areas, there are limits on both existing operations and growth due to water supply and water quality limits. Additionally, food processing companies are on the front line of rapidly increasing consumer expectations for sustainability in both their operations and supply chain. Reducing the energy/water/waste footprint of Idaho producers/processors will enhance their market competitiveness. Recovery of valuable products from waste will generate economic value and improve the environment. Reduced resource use allows more stakeholders to sustainably maintain their operations, including producers, processors, and communities.

The objective of this project is to build capacity and partnerships among our three research institutions to assist Idaho food producers and processors in reducing water, energy, and waste footprints. Specific outcomes include:

Recovery of energy, nutrients, water and bioproducts from waste streams: bench to place-based pilot projects. Bench-scale bioreactor operations continue to be operated and evaluated. Bench-scale EBPR operations are ongoing, with a focus on ascertaining the effects of key process operational criteria on maximal P recovery. Another current focus is on achieving stable nitritation in an activated sludge wastewater treatment system achieving carbon, ammonia-N, nitrite-N, and phosphorus removal. Complementing the nitritation research are efforts to understand and better characterize denitritation, with the aim to further optimize the EBPR process for energy efficient nutrient recovery. One PhD student conducted intense evaluations of the dairy based PHA pilot in Y1/Y2, with very successful results.

Algal cultivars continue to be used for routine experimental deployment. On-going experiments are focused on cultivation at both bench and pilot scales employing wastewaters from multiple sources to maximize nutrient capture and algal biomass production. Both pilot systems were made fully operational in Y1, with operations extended into Y2. The research team was fully trained on systems operation. One PhD student has been working on extracting and isolating pure PHA bioplastic generated from eight trials on the pilot plant over 84 days of operation. An initial Stakeholder Advisory Group (SAG) meeting was held at the University of Idaho Water Center in Boise, Idaho. A primary component of the SAG feedback for the Task A team was to focus on demonstration of commercialize-able product production.

Decision-support tools for industry and community leaders to quantify and visualize trade-offs among water, energy, land use, and municipal growth. These tools improved the existing model of water supply/use to better incorporate the specific data needs and what options can be used for conservation scenarios given the existing data types. The team developed a new graphical user interface based on the newly added Stella Architect modeling platform developed in Y1. The team held a meeting with the Idaho Department of Water Resources (IDWR) regarding their newest ESPAM model version and updated data needs. The team began exploring management options to incorporate into the model, such as managed aquifer recharge (MAR) option which is the most active management option led by IDWR. The team evaluated the feedback from IDWR and the Surface Water User's Association at the stakeholder meetings in May 2019 and Dec 2019 and examined how the model could be more useful for stakeholders. Analysis began of energy use data associated with irrigation obtained from IDWR in Y1. The team further collaborated with experts from Idaho Power on energy use in irrigation in order to further analyze energy use data. The team evaluated spatial patterns in energy use for irrigation in the ESPA and controlling factors in order to identify key variables

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to relate water and energy use in irrigation (i.e., crop type, irrigation system characteristics, water source, etc.). The updated Stella Architect model on water use/supply was readied to accept modifications relating water use to energy use.

Technical innovations/sensing systems to reduce water/energy/nutrient use in targeted production systems. The team developed a decision support online tool prototype for sustainable agriculture decisions making: ***https://avalanche.geology.isu.edu/i2i/osgood.html.*** This decision support tool was developed by working with stakeholders and our Advisory Board member (Brandon Vining, ProGro) to provide remote sensing data/tools to aid decision making that is relevant to business decision making and operations. Stakeholders are excited about the potential of the tool to improve ROI, reduce fertilizer inputs and improve precision farming techniques for sustainable agriculture. The team conducted remote sensing analysis to forecast yield for potato growers based on a growing season of high-resolution satellite imagery (submitted for publication in 2019 to ASPRS Pecora Conference Proceedings by master's student). The team conducted thermal camera surveys of irrigated cropland using UAS in the 2019 growing season irrigation to assess efficiency and support water reduction efforts. Data was collected and an analysis is in progress. Hyperspectral camera data collection during the 2019 growing season of potato crops was used to detect crop threats. A PhD student conducted experiments to determine essential spectral signatures required to detect individual unhealthy plants in a grower's field that leverages machine learning of hyperspectral imagery, thus offering the opportunity to reduce inputs for control and mitigation of disease. The team launched a new Idaho based spin-off company (I2IGeo) to provide growers with technological innovations and decision support to assist their operations, leveraging the research outcomes from this grant.

Engage the present and future workforce in the adoption of new technologies. The team engaged with the Idaho Department of Environmental Quality (IDEQ) who approached the project team about workforce development needs and added a representative to the Stakeholder Advisory Board. The team hosted a hands-on education program known as "Idaho Drone League (iDrone)" to promote STEM pipelines in the Treasure Valley and skills important to the Idaho food industry in the future.

Project Management/Stakeholder Engagement. The team held a second Stakeholder Advisory Board Meeting and conducted considerable outreach to the dairy industry in both Idaho and Utah. A cloud file storage space has been established and shared with SAB members.

Boise State University – Nucleic Acid Memory ($666,500)

The vision of this project is to pioneer a digital data storage paradigm in Idaho by designing, building, and testing accessible, editable, and non-volatile nucleic acid memory (NAM) technologies that are inspired by DNA circuits and made possible by innovations in DNA nanotechnology. With support from IGEM-HERC, BSU researchers are creating a Nucleic Acid Memory Institute to meet critical innovation, economic, and workforce-development needs in Idaho. To expedite their vision of Idaho becoming a global leader in NAM, five tasks will be met over the life of the IGEM-HERC supported project. Below the tasks are summarized and progress on these tasks is reported.

Create efficient algorithms for coding information into data strands. The team designed an information encoding/decoding algorithm that combines fountain codes with a custom error detection scheme for dNAM. Fountain codes are intended for transmission of data over noisy channels and have great potential to generate a limitless sequence of encoding packets (called "droplets") from a single source message. Droplets can be received in any order and still be decoded to retrieve a message, regardless of the exact distribution of the droplets collected. With our error correction scheme, decoding of individual origami (each origami encodes a single droplet, plus indexing and error-correction information) is robustly achieved even in the presence of high noise by determining the minimum number of operations required to resolve the errors detected by the error detecting code (i.e. minimum edit distance). Combined with the redundancy provided by the fountain code, this leads to recovery of the entire data file with high reliability. To test the dNAM data storage protocol, the team synthesized fifteen unique 6 x 8 grid DNA-origami structures with the encoded random-access message 'Data is in our DNA!\n'. Each of the memory blocks contained a 4-bit binary index (0000 - 1110), a 16-bit data droplet, 20 bits for parity checks, 4 bits for checksums, and 4 bits acting as orientation markers. To rapidly recover the message encoded in the blocks, the team used DNA-PAINT to optically image a mixture of the dNAM blocks—below the diffraction limit of light—in a single recording. Once DNA-PAINT had been used to identify the positions of all data strands in the 512 x 512 pixel field of view, a custom image processing algorithm was used to rotate and fit the data strands to a 6 x 8 grid and translate the signal detected at each grid location to a 48 bit binary string for error correction, data recovery, and message reconstruction. The team was able to identify all data strands in every origami from a single DNA-PAINT recording of 4 µl of a 5 nM mixture of DNA-origami (approximately 4,500 individual DNA-origami). By doing so, all fifteen origami were decoded to successfully retrieve the message 'Data is in our DNA!\n'.

Create a high throughput, integrated analytical engine to design and select data strands using quantitative metrics based on an in-house algorithm. Comparing the

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decode algorithm output with each of the 15 input origami designs (each having a total of 223–338 structures within the 5 nM mixture mixture) indicate varying numbers of each origami were successfully recovered. For example, while on average only ~6 copies of origami design 2 were correctly decoded per experiment, ~147 copies of origami design 6 were successfully decoded. These differences in recovery can partially be explained by the variability in the numbers of errors seen in each structure. Specifically, the decode algorithm was only able to error-correct origami with 7 or fewer total errors, and only up to two false positive errors. The mean errors of the best recovered origami designs (1, 5, 6, 12 and 14) are all lower than these thresholds. A plot of the origami decoded against the mean error rate indicates that there is a strong relationship between both the total number of errors and the number of false negative errors and the ability of the algorithm to decode an individual origami's data. False positives errors, however, are randomly distributed around a mean of 2, but with a wide spread of decoded origami (~1–49%) — suggesting that the location of a false positive error within a structure plays an important role in determining whether the origami designs can be successfully decoded.

Create synthetic biological factories for manufacturing DNA scaffolds using rapid design-build-test cycles of genomes. A researcher has currently established the experimental and instructional infrastructure in support of over 10 undergraduate students who have developed training modules on synthetic biology concepts needed to understand, design, and produce customizable single-stranded DNA from phagemides in E. coli. Based on this project, some of these students were hired last summer, designed, and built DNA plasmids needed to produce custom scaffolds for DNA origami.

Design and fabricate NAM storage platforms using the DNA scaffolds and validate the functionality of genome scaffolds using atomic force icroscopy. Research is being conducted that leads insight into how one might site-specifically deposit dNAM onto semiconductor-grade substrates in preparation for super-resolution microscopy and how the surface density of dNAM may vary based on its local environment. All these insights are helping inform the design, build, and test cycle of Nucleic Acid Memory.

Read arbitrary data files into NAM storage nodes using super-resolution microscopy. The team has created, through a systems-engineering approach, a new technology where digital data is encoded into multiple DNA origami structures and can be retrieved optically below the diffraction limit of light via super-resolution microscopy. By encoding the data using Fountain codes, combined with bi-level error detection/correction, the amount of redundancy required for successful data recovery is minimized (with 100% data retrieval ensured with sufficient node creation). While the team has encoded the short message 'Data is in our DNA!/n' as a proof-of-principal, dNAM platform is scalable and thus has potential for competing with current data storage technologies. For comparisons, the dNAM prototype currently allows for a data storage density 480 Gbit/cm2, a more than ten-fold improvement relative to state-of-the-art magnetic tape capacity of 31 Gbit/cm^2.

Idaho State University - A Disaster Response Complex for Emergency Responders in Idaho ($525,100)

The focus of the project is the development of a Disaster Response Complex (DRC) for research, certification, and training of first responders in collaboration with the Directorate of National & Homeland Security at the Idaho National Laboratory (INL), and the Center for Advanced Energy Studies (CAES). The DRC has three pillars: 1) research, 2) curriculum and certification, and 3) training. The research pillar includes the development of new training lanes/simulations/Chemical, Biological, Radiological, Nuclear, and high yield Explosives (CBRNE) surrogates and markers, the use of robots/small Unmanned Aerial Vehicle (sUAV), virtual reality, augmented reality, and Geographic Information System (GIS) in the training of first responders. The curriculum pillar includes offering courses in topics such as emergency response and gamma/chem spectroscopy. In the final pillar of training, the facility can be used to host events for clients such as the Department of Defense (DoD) CBRNE Response Enterprise (CRE) customers, military personnel, Idaho National Guard and law enforcement agencies/fire departments from Idaho and the region. It is expected that the DRC will be a comprehensive facility that will incorporate natural (earthquakes, hurricanes, flooding) and man-made hazards in training of first responders. The three pillars are summarized and progress on each is reported.

Research Pillar. Efforts in the research pillar have focused on the use of robotics and Chemical, Biological, Radiological, Nuclear, and high yield Explosives (CBRNE) markers/surrogates in a collapsed structure for the training of first responders. On the robotics side, ISU researchers have discussed ideas with collaborators from Idaho National Laboratory (INL). INL has good capabilities, facilities, and experts in robotics. Through discussions, an ISU graduate student was identified and assigned to work with the INL group. The student is focusing on the research aspect of the DRC and will be jointly supervised by senior researchers from ISU and INL. The graduate student (PhD level), collaborators from INL, an academic advisor and supervisor from ISU have been identified. The student's paperwork is currently being processed for access to labs and facilities at INL. The student will be working on adding capabilities to an existing INL's robot (e.g. enhancement for end of arm tooling, attachment of sensors, detectors, and ground penetrating radar) to enhance its performance for disaster response. On the CBRNE side, several meetings were held at the CAES between ISU and INL researchers. The meetings were focused on the development of chemical and biological markers. Collaborators from INL are well-established in the radiological and nuclear detection areas. Available opportunities

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for research in development of markers/surrogates from agencies such as the Defense Threat Reduction Agency (DTRA) were discussed. This effort is continuing. Other technologies such as the use of sUAV and GIS have also been considered for applications in disaster response. INL has good capabilities in sUAV. In addition, the project personnel have discussed collaboration with the College of Technology at ISU which has several sUAVs, some with Light Detection and Ranging (LIDAR) capabilities.

Curriculum and Certification Pillar. On the curriculum side, the project personnel had several meetings with instructors/researchers from INL. This included tours of facilities and capabilities at ISU. The instructors have shown interest in organizing short courses (e.g. 4-days) with hands-on components with topics such as gamma spectroscopy and chemical spectroscopy. Courses will be developed at different levels (e.g. basic to advance) and targeting clients such as Civil Support Teams (CST), members of the Homeland Response Force (HRF), and local responders. The plan is that ISU will provide all the necessary facilities for these classes, including a website for registration and payment. ISU will also help INL in developing tabletop exercises for the advertisement of the class. The project personnel have reached out to ISU's Continuing Education/Workforce Training in the College of Technology who already have a mechanism for advertising, registration, and fee payment. Instructors from ISU and INL held discussions on identifying topics and developing modules for short classes. Technical Resources Group, Inc., a consulting firm specializing in radiological training, reached out to ISU regarding the Transportation Emergency Preparedness Program (TEPP) Training -Modular Emergency Response Radiological Transportation Training (MERRTT) and other topics. The Idaho Office of Emergency Management has shared the Technical Rescue Team Skill Sheets with the project personnel. The researchers at ISU are currently examining these sheets to identify the type of resources needed for certification of first responders in Idaho.

Training and Exercise Pillar. This pillar includes the design and construction of an outdoor collapsed structure. The original footprint of the collapsed structure was 200 ft x 200 ft, the total area of the outdoor training and exercise facility was about one acre. The collapsed structure would house several training lanes such as subterranean, car-rescue, and shoring with possibilities for future expansion. ISU held several meetings with potential users from Idaho National Guard, Idaho National Laboratory, Idaho Office of Emergency Response, Snake River Search, and Idaho Falls Fire Department to gather their input/feedback for the outdoor facility and the training lanes. The Pocatello Fire Department is also interested in using the facility for training exercises. Based on the feedback of the potential users, the Idaho National Guard indicated to enlarge the size of the overall facility to about 3-acres to accommodate the HRF training sessions which typically can have between 500-800 responders training at once. The CST units are smaller (e.g. 22 responders) compared to HRF, but they hold more frequent training sessions (e.g. 12 times per year). The Idaho National Guard also indicated a desire for adding another training lane for high-angle rope rescue. It should be noted that the outdoor facility will be utilized toward all three pillars of the DRC. The stakeholders shared their needs for a training complex such as the DRC. They also provided ISU with information on the upcoming major training and exercise such as the Cascadia Rising 2022 in Idaho and the Wasatch Quake 2021 exercise in Utah. The contact at the Idaho National Guard, who is the Director of Joint Plans and Training, has shared the information about the ISU's DRC with the National Guard units in the states surrounding Idaho. He stated that the DRC at ISU "is a unique opportunity that, with some thought and input, the National Guard can leverage and fill a gap in available high-quality training sites in the western US without expending DoD funding." The project personnel worked with ISU's facilities to find a suitable location on the campus for the development of the outdoor facility. The unoccupied land behind the Idaho Accelerator Center in Pocatello was deemed suitable for the outdoor facility and development of the site has begun.

University of Idaho - Cellulosic 3D Printing of Modular Building Assemblies ($174,900)

The project objective is to identify the methodology, process, and materials necessary to three-dimensional cold print (3D print) building assemblies utilizing, to some maximum extent, wood products. Moving a significant portion of construction into a factory setting where labor and work is organized and executed more efficiently will have the following benefits: 1) increase the quality and energy efficiency of buildings; 2) lower overall construction costs; 3) provide appropriate compensation for a more skilled labor force and, 4) assist in mitigating the current construction skilled labor shortage challenge in Idaho.

The outcome of this research is the development of a reliable and cost-effective process for printing panels (i.e., wall, floor, and roof assemblies) on a horizontal plane using a 3D printing process to produce a structural insulated panel. The proposal end goal is to build panels that are up to 10 feet wide by 16 to 20 feet in length that can be loaded onto a flatbed truck required to transfer it to the construction site for assembly. Significant discovery was made on each of the three tasks identified as Year 1 deliverables.

Research and identify the printing mix of wood/natural fibers, binders, and adhesives. The team has successfully extruded a room temperature mixture of resins and wood that flows and cures well.

Develop the technical description design for a 3D fibrous wood wall printing process, including prototype printer design specifications. The team has experimented with spray and extrusion methods of printing and has developed the design for a printer that will produce a two foot by two foot by 6 to 10-inch thick assembly for thermal and eventual structural testing. The Boise State University team has created a first draft analysis on constructability for the upcoming panels that provides a good overview of the site issues with modular construction such as moisture control.

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Develop the business case for private industry investment. A business case has been developed and is ready for solicitation of private industry investment and information.

IGEM – CAES

The Center for Advanced Energy Studies is a research and education consortium between Boise State University, Idaho National Laboratory, Idaho State University, University of Idaho, and University of Wyoming.

NEW INFRASTRUCTURE BUILDS COLLABORATIVE POTENTIAL

A 2019 CAES Summer Visiting Faculty Program project led by Boise State University faculty member Mike Hurley in conjunction with Donna Guillen at the Idaho National Laboratory (INL), received a $489k Nuclear Energy University Program (NEUP) award. This award will provide for the installation of a 3D metal printer at the CAES facility, thereby establishing the capability to additively manufacture metallic nuclear grade materials at CAES and within the Nuclear Sciences User Facilities (NSUF) network.

An INL-funded project to install a new $5M Transmission Electron Microscope began in July and, upon completion, will further enhance INL's Advanced Design and Manufacturing initiative and maintain CAES' Microscopy and Characterization Suite status as a world-class characterization facility. The virtual groundbreaking ceremony took place in July, and the installation should occur in early 2021.

A research wind turbine was installed just outside CAES headquarters in January. The 70-foot tall turbine is virtually connected to a microgrid at INL's Energy Systems Laboratory (ESL) via grid inverters that allow emulation of the wind turbine's generation data. This adds wind to the solar and storage assets of ESL's microgrid and contributes to INL's participation in DOE's Microgrids, Infrastructure Resilience, and Advanced Controls Launchpad (MIRACL) program, which is designed to advance the design and operation of microgrids, or distributed energy systems powered primarily by wind, with the goal of boosting resilience, security, and flexibility of the systems.

CAES CONNECTIONS IN PROJECTS RECOGNIZED WITH NEUP, NEET AWARDS

A number of faculty from CAES member universities and researchers from the Department of Energy's Idaho National Laboratory are leading or collaborating on teams that recently received $5.1M in awards through DOE's Nuclear Energy University Program (NEUP) and Nuclear Energy Enabling Technologies (NEET). Several of the projects with CAES connections originated at the annual NUC-CAES CINR Workshop held in August 2019, and a NEUP-funded project stemmed from the 2019 CAES Summer Visiting Faculty Program.

CAES UNVEILS NEW FELLOWSHIP

After more than a year of planning and coordinating, CAES announced the inaugural ISTP CAES Fellow in July. Closely aligned to the mission needs of CAES and the U.S. Department of Energy's INL, this fellowship is one of two offered through the newly launched Idaho Science and Technology Policy Fellowship (ISTPF) program, a collaborative effort among three CAES entities: University of Idaho, Boise State University, and Idaho State University. ISTP Fellows spend a year embedded in an Idaho state government agency, developing, and implementing solutions that address challenges in areas such as energy, cybersecurity, water, public health, and economic development. The ISTP CAES Fellow will concentrate his/her efforts on one or more of the focus areas outlined in the CAES Strategy: Nuclear Energy; Energy-Water Nexus; Cybersecurity; Advanced Manufacturing; Innovative Energy Systems; Energy Policy; and Computing, Data, and Visualization. The goal is to develop a network of leaders who understand government and policymaking and are prepared to use their knowledge and skills to create a better future, complementing CAES' vision of accelerating energy solutions and creating the next generation of energy leaders. CAES played an integral part in the program's launch, which is nonpartisan and does not advocate for policy.

CTAP STEPS UP TO CREATE FACE SHIELDS

The CAES Technical Assistance Program (CTAP) at Boise State University led a collaborative effort to create hundreds of face shields for medical personnel in the Boise area and beyond. The project involved several BSU faculty and staff members and resulted in the design, manufacture, and distribution of the shields. CTAP played a variety of roles in the effort, including procurement of critical materials to begin manufacture, acting as a liaison to St. Luke's Hospital to deliver prototypes and collect feedback, participating in design reviews, and working directly to develop contractual agreements for all aspects of the work. By early May, CTAP's team had manufactured a total of 480 shields for St. Luke's. An additional 200 masks were created for personnel in Gorongosa National Park in Mozambique through CTAP's work with the Carr Foundation, a nonprofit organization founded by Idaho Falls native Greg Carr that has collaborated with the Mozambique government to protect and restore the park's ecosystem and develop an ecotourism industry to benefit local communities. CTAP is a business portal that provides innovative solutions to technical problems faced by businesses throughout the region. Students work closely with faculty and staff at CTAP, allowing them to gain hands-on experience to enhance their academic work.

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CAES SUMMER VISITING FACULTY PROGRAM WRAPS UP 3RD YEAR

The CAES Summer Visiting Faculty Program (CSVFP) completed its third year in August with 11 faculty members from CAES universities partnering with researchers from the Department of Energy's Idaho National Laboratory (INL) to develop proposals in one of the seven CAES focus areas. CSVFP is designed to create robust connections between the faculty members and INL researchers, creating long-term impact to the universities and INL; to bring in external funding to complete innovative and inspiring research, providing value to the institutions, INL, and the funding agency; and to facilitate student integration into joint research. Participants work together throughout the summer to produce a ready-to-submit CAES-branded proposal or, if a funding opportunity is not yet open, an extensive white paper.

INAUGURAL CAES FELLOWS COHORT NAMED

CAES announced the first cohort of CAES Fellows in early June. Six Fellows were selected: an INL researcher and faculty members from Boise State University, Idaho State University, and University of Wyoming. Those selected have demonstrated extensive engagement in the CAES community and collaborated with partners at INL and the CAES universities in at least one of the focus areas outlined in the CAES Strategy. Each has exhibited impressive leadership: mentoring students, leading research projects and workshops, representing their organization at CAES events, and taking the initiative to create stronger bonds among the members of the CAES consortium. Fellows serve two-year appointments during which they are provided with resources and opportunities to drive further collaboration among the CAES entities. From its headquarters in Idaho Falls to spoke locations across Idaho and Wyoming, CAES leverages its collective expertise to inspire innovation and impact, empowering students, faculty, researchers, and industry to accelerate solutions to complex energy issues. The CAES Fellows initiative was launched this spring to advance this effort.

WORK ON DISASTER RESPONSE COMPLEX, IGEM RECIPIENT, PROGRESSES

Construction began in summer 2020 on the Disaster Response Complex (DRC), a collaborative project involving Idaho State University (ISU) and the Department of Energy's Idaho National Laboratory (INL) that will lead to a regional/national training center complex in Pocatello that mimics the features of a structure collapsed by an earthquake, hurricane, or other natural disasters, for the research, certification, and training of first responders. ISU was awarded $1.1 million from the Idaho State Board of Education's Idaho Global Entrepreneurial Mission Higher Education Research Council (IGEM-HERC) in summer 2019 to build the DRC, while seed funding for the project came via a 2018 CAES program development award and a 2018 CAES Collaboration Fund award. The collaboration between INL and ISU provides expertise in chemical, biological, radiological, and nuclear research.

CAES BY THE NUMBERS

Investments:

- **$3 million** – State of Idaho investment in CAES
- **$5 million** – Idaho National Laboratory investments in CAES*
- **$5.1 million** – Federal nuclear energy funding to CAES faculty (NEUP, NSUF, and NEET awards)
- **$5 million** – INL investment in new transmission electron microscope at CAES

Outreach:

- **2116** visitors experienced the CAES Computer-Assisted Virtual Environment (CAVE) 3D data immersion research environment*
- **68** workshops, seminars, and speeches sponsored by CAES*

Student Impact:

- **109** students from CAES-affiliated universities interned at Idaho National Laboratory
- **15** students from CAES affiliated universities were offered graduate fellowships at Idaho National Laboratory
- **11** faculty members from CAES member universities participated in the third annual CAES Summer Visiting Faculty Program

*From the most recent completed FY, federal fiscal year FY19 (October 1, 2018 to September 30, 2019)

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