THIS PAGE INTENTIONALLY LEFT BLANK

SUBJECT

Higher Education Research Council Annual Update

REFERENCE

February 2015	The Board approved changes to the Higher Education Research Strategic Plan.
October 2015	The Board was provided the Performance Measure Report for the Higher Education Research Strategic Plan.
December 2016	The Board approved changes to the Higher Education Research Strategic Plan.
February 2017	The Board was provided the annual update of the Higher Education Research Council.

APPLICABLE STATUTE, RULE, OR POLICY

Idaho State Board of Education Governing Policies and Procedures, Section III.W., Higher Education Research

ALIGNMENT WITH STRATEGIC PLAN

Idaho K-20 Public Education Strategic Plan Goal 2, Innovation and Economic Development, Objective B, Innovation and Creativity

BACKGROUND/DISCUSSION

Board Policy III.W, Higher Education Research, recognizes the significant role research plays in innovation, economic development and enhanced quality of educational programs. By developing and leveraging the State's unique research expertise and strengths, Idaho's universities and college serve as catalyst to spur the creation of new knowledge, technologies, products and industries. This in turn leads to new advances and opportunities for economic growth.

The Board's Higher Education Research Council (HERC) provides recommendations to the Board regarding statewide collaborative efforts and initiatives to accomplish these goals and objectives. In addition, HERC provides direction for and oversees the use of the limited resources provided by the Legislature for research by promoting research activities that will have the greatest beneficial effect on the quality of education and the economy of the State.

The Statewide Strategic Plan for research assists in the identification of research areas that will enhance the economy of Idaho through the collaboration of academia, industry, and government and are in alignment with identified areas of strength at our public universities. Changes to the strategic plan were approved by the Board in December 2016.

The plan represents the role Idaho's research universities play in driving innovation, economic development, and enhancing the quality of educational programs in strategic areas. The plan identifies areas of strength among Idaho's research universities; research challenges and barriers facing the universities;

research opportunities Idaho should capitalize upon to further build its research base, goals to build the research pipeline through engaging undergraduate students, and steps for achieving the research vision for Idaho's universities. Additional responsibilities of HERC include the management of the Incubation Fund and HERC IGEM Fund programs, disbursement of Infrastructure Funds and the matching funds for our Idaho EPSCoR Track 1 project (Managing Idaho's Landscapes for Ecosystem Services). Additional responsibilities include receiving annual reporting on the institutions activities in relation to the Center for Advanced Energy Studies (CAES).

Incubation Fund projects are single-year projects that are at the proof-of-concept stage. Through a competitive process, HERC awards funds to those projects where the principal investigator can rapidly move their project into the development stage. IGEM Fund projects are those that are designed to develop spin-off companies. While these awards may be for up to three years, the funding is contingent upon successful progress as determined by HERC at an annual review of the project.

CAES is a research and education consortium between the Idaho National Laboratory, the University of Wyoming, and the three Idaho public research institutions: Boise State University, Idaho State University, and the University of Idaho.

Dr. Mark Rudin, the current chair of HERC, will provide the Board with the Council's annual update.

IMPACT

Taking a strategic approach to invest in the state's unique research expertise and strengths will lead to new advances and opportunities for economic growth and enhance Idaho's reputation as a national and international leader in excellence and innovation. This update will provide the Board with the opportunity to provide HERC, through the Council's Chair, input on areas of focus or strategic direction.

ATTACHMENTS

STAFF COMMENTS AND RECOMMENDATIONS

In addition to the responsibility for the creation of the state's Higher Education Research Strategic plan HERC is responsible for approximately $4.1M in funds used for the mission of HERC and to incentivize industry and institution research

partnerships. Attachment 2 is the October 2017 performance measure report, Attachment 3, is the research institutions' annual research activity reports, Attachment 4 summarizes the infrastructure funding in FY17, Attachment 5 outlines HERC's FY18 budget allocation, and Attachments 6 and 7 are summaries of the projects funded by HERC in FY18. Attachment 8 is the annual report for the Center for Advanced Energy Studies (CAES).

The strategic plan is monitored annually and updated as needed based on the work of HERC and direction from the Board. HERC uses a competitive process for distributing funds from the Incubation Fund category and the HERC IGEM Fund category. All proposals that are considered must be in alignment with the Board's Higher Education Research Strategic Plan.

BOARD ACTION

This item is for informational purposes only. Any action will be at the Board's discretion.

THIS PAGE INTENTIONALLY LEFT BLANK

HIGHER EDUCATION RESEARCH STRATEGIC PLAN

(2017-2022)

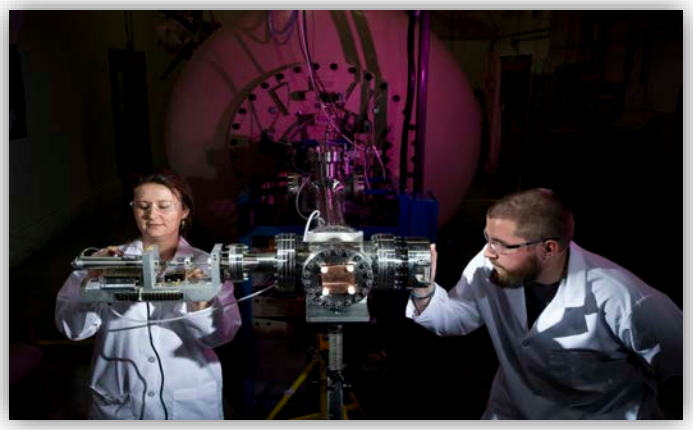
Submitted by: Higher Education Research Council

State Board of Education Approved December 2016

EXECUTIVE SUMMARY

Research is being increasingly acknowledged by industry, government and education as a key factor in the future economic vitality of Idaho. The universities and colleges of Idaho's system of higher education understand the need for greater collaboration in order to be competitive in today's global environment. Recognizing the need to focus on and emphasize existing strengths and opportunities in Idaho's research community, the vice presidents for research and economic development developed the following statewide strategic plan for research to ensure the greatest potential for achieving a vital and sustainable research base for Idaho. The strategic plan identifies the key research areas (basic, translational and clinical) that will become the focal points for research and economic development through partnering among academia, industry and government in science, technology, and creative activity.

Research is fundamental to the mission of a university due to its role in knowledge discovery and in providing new ideas for technology commercialization via patents, copyright, licenses and startup companies. University faculty who engage in research and creative activity are at the leading edge of their respective fields. Research also enhances the national reputation of the faculty and the universities. These faculty and their vibrant research programs attract the best graduate and undergraduate students by providing unique cutting-edge learning experiences in their research laboratories, studios, field sites and classrooms. On the most basic level, and also bolstered through collaborative, interdisciplinary and interprofessional research, such activities strengthen a university's primary product — innovative, well-educated students ready to enter a competitive workforce.



Research is the foundation of a university's economic development role. The influx of research dollars from external grants and contracts creates new jobs at the university, along with the attendant purchases of supplies, services, materials and equipment. The results of the research are new knowledge,

new ideas, and new processes, which lead to patents, startup companies, more efficient businesses as well as a highly trained workforce prepared to tackle 21st century challenges.

Idaho's research universities have strengths and opportunities for economic development in 1) Energy Systems, 2) Natural Resource Utilization and Conservation, 3) Biomedical and Healthcare Sciences, 4) Novel Materials and 5) Systems Engineering and Cybersecurity.

By focusing collaborative efforts in these areas, the research universities will expand research success by:

- Helping Idaho institutions focus on their research strengths;
- Strengthening collaboration among Idaho institutions;
- Creating research and development opportunities that build relationships between universities and the private sector;
- Contributing to the economic development of the State of Idaho;
- Enhancing learning and professional development through research and scholarly activity – also by promoting interdisciplinary and inter-professional research; and
- Building and improving the research infrastructure of Idaho universities to meet current and future research needs.

This statewide Strategic Research Plan for Idaho Higher Education is a tool for identifying and attaining quantifiable goals for research and economic growth and success in Idaho. The plan will be reviewed and updated annually as needed amid the fast-changing pace of research discovery.

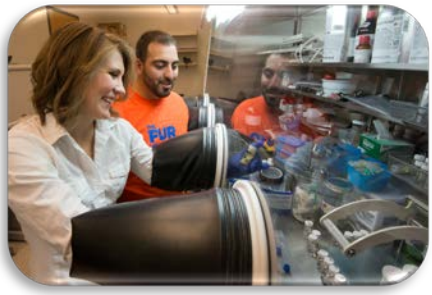
VISION

Idaho's public universities will be a catalyst and engine to spur creation of new knowledge, technologies, products and industries that lead to advances and opportunities for economic growth and enhance the quality of life in Idaho and the nation.

MISSION

The research mission for Idaho's universities is to develop a sustainable resource base by:

- Identifying, recruiting and retaining top faculty with expertise in key research areas;
- Building research infrastructure including facilities, instrumentation, connectivity and database systems to support an expanding statewide and national research platform;
- Attracting top-tier students to Idaho universities at the undergraduate and graduate levels and providing outstanding education and research opportunities that will prepare them to excel in future careers;
- Raising awareness among state, national and international constituencies about the research excellence and capabilities of Idaho's universities by developing and implementing targeted outreach, programs and policies; and
- Collaborating with external public, private, state and national entities to further the shared research agenda for the state, thereby promoting economic and workforce development and addressing the needs and challenges of the state, region and nation.



GOALS AND OBJECTIVES

Goal 1: Increase research at, and collaboration among, Idaho universities and colleges to advance research strengths and opportunities pertaining to critical issues in Idaho, while also providing a vision for national and global impact.

Objective 1.A: Ensure growth and sustainability of public university research efforts.

Performance Measure 1.A.1: Statewide amount of total annual research and development expenditures as reported in the National Science Foundation (NSF) Higher Education Research and Development Survey.
Benchmark: 10% increase per year.

Objective 1.B: Ensure the growth and sustainability of the existing collaborative research at the Center for Advanced Energy Studies (CAES).

Performance Measure 1.B.1: Statewide amount of U.S. Department of Energy (DOE) research and development expenditures as reported in the National Science Foundation (NSF) Higher Education Research and Development Survey.
Benchmark: 10% increase per year.

Objective 1.C: Expand joint research ventures among the state universities.

Performance Measure 1.C.1: Number of new fully sponsored project proposals submitted by an Idaho University that involve a subaward with another Idaho institution of higher education (in either direction).
Benchmark: 50% increase per year.

Performance Measure 1.C.2: Number of new fully sponsored project awards to an Idaho University that involve a subaward with another Idaho institution of higher education (in either direction). Benchmark: 30% increase per year.

Performance Measure 1.C.3: Establish/fund at least one HERC-directed research project per year which collaborates with one other Idaho university that directly addresses issues of particular importance to the State of Idaho.
Benchmark: 1 per year

Goal 2: Create research and development opportunities that strengthen the relationship between state universities and the private sector.

Objective 2.A: Increase the number of sponsored projects involving the private sector.

Performance Measure 2.A.1: Number of new sponsored projects involving the private sector.
Benchmark: 50% increase per year.

Goal 3: Contribute to the economic development of the State of Idaho.

Objective 3.A: Increase the amount of university-generated intellectual property introduced into the marketplace.

Performance Measure 3.A.1: Number of technology transfer agreements (as defined by AUTM [Association of University Technology Managers]).
Benchmark: 15% increase per year.

Performance Measure 3.A.2: Number of invention disclosures (including biomic varieties).
Benchmark: 1 for every $2M of research expenditures.

Performance Measure: 3.A.3: Amount of licensing revenues.
Benchmark: 10% increase per year.

Performance Measure: 3.A.4: Number of startup companies.
Benchmark: 10% increase per year.

Goal 4: Enhance learning and professional development through research and scholarly activity.

Objective 4.A: Increase the number of university and college students and staff involved in sponsored project activities.

Performance Measure 4.A.1: Number of undergraduate and graduate students paid from sponsored projects.
Benchmark: 20% increase per year.

Performance Measure 4.A.2: Percentage of baccalaureate students who had a research experience.
Benchmark: 20% increase per year.

Performance Measure 4.A.3: Number of faculty and staff paid from sponsored projects.
Benchmark: 20% increase per year.

RESEARCH OPPORTUNITIES

Idaho's research universities have developed statewide strengths in strategic research areas that have great potential to drive future economic growth and success. The criteria used to select these areas include: number of faculty and qualifications; peer-reviewed publications and impact; infrastructure (facilities, equipment, information technology, staff); external grant and contract funding; academic programs; student involvement; potential benefit to the State of Idaho; and technology transfer activity, including patents, licenses, and startup companies. By focusing collective research efforts and resources in these areas, the universities will be on the most efficient and effective route to research success and state-wide economic development. These high impact areas include 1) Energy Systems, 2) Natural Resource Utilization and Conservation, 3) Biomedical and Healthcare Sciences, 4) Novel Materials, and 5) Systems Engineering and Cybersecurity.

Energy Systems: Energy is a critical driver of any economy. The projected increases in the population of the world and increases in the standard of living will produce severe strains on the ability to meet the demands of the next few decades. In addition, finite reserves of fossil fuels and pollution from their combustion requires that alternative sources of energy production be developed. The combination of natural resources in Idaho and presence of the Idaho National Laboratory makes energy a natural area of emphasis. Indeed, the three universities with research capabilities already have extensive research projects in this area. The Center for Advanced Energy Studies (CAES) is an example of the significant investment the three Idaho universities, the University of Wyoming, and the Idaho National Laboratory have made to develop expertise in nuclear science and engineering, materials science and engineering, energy systems design and analysis, fossil carbon conversion, geological systems and applications, energy policy and cybersecurity, and environmental and resource sustainability. Further growth in these areas not only takes advantage of the strong base but strongly supports a positive economic impact through new markets for new product development

Natural Resource Utilization and Conservation: In the broad field of natural resource utilization and conservation, Idaho's universities have expertise in water resources, wildfire management and restoration, agriculture, forestry, recreation, and geophysics and geochemical detection, geographical information systems, and monitoring of groundwater pollutants. For example, university geologists, ecologists, and policy experts are collaborating on broad-ranging research projects that examine and predict the impact of climate change on Idaho's water resources. As water is essential to agriculture, recreation, the ecosystem, and human health, the universities have research strength in an area of tremendous societal and economic impact. Agriculture remains an important part of the economy of Idaho. Development of new biomic varieties with improved resistance to disease and climate change remain an area of importance as does the development of new feeds for domestic fish production. The often competing demands for preservation and exploitation put on the environment require understanding of the various ecosystems in the state and region as well as societal, human health, and

economic impacts of policy decisions. Recent national research imperatives, as particularly captured in National Science Foundation's Innovation at the Nexus of Food, Energy, and Water Systems (INFEWS) foundation-wide program and the Department of Energy's report Water-Energy Nexus: Challenges and Opportunities increasingly require multi-sectoral, multi-disciplinary approaches to problems in natural resource utilization and conservation. The depth and breadth of relevant research expertise in the biophysical, rural health and social science fields within Idaho's universities underscores an opportunity that a national emphasis on food, energy, and water security provides. Provided that enhanced coordination and collaboration between Idaho's universities can be successfully executed, we are particularly well-placed to exhibit national and international leadership at the nexus of food, energy, water system research. The future economic success of the state will rely on a deep understanding of these processes.

Biomedical and Healthcare Sciences: Idaho's universities have well-established research programs in selected areas of biological and biomedical sciences. University microbiologists and informatics experts, for example, study real-time change in pathogenic microorganisms that enable them to become resistant to drugs and chemical toxins thus resulting in worsening human disease and mortality rates. These effects are not restricted to humans, domestic and wild animals as well as food plants and trees are experiencing the same phenomena. Also, weeds are becoming resistant to herbicides. These phenomena are having a significant negative impact on Idaho's agriculture and forests. Further stress is being put on these important commercial sectors through climate variability. Research in these areas is critical for preserving important economic sectors of Idaho's economy while addressing future global needs.

The public health infrastructure in rural Idaho is not well understood but is potentially the most fragile aspect of the state's health care system. The rural environment, especially typical in Idaho where agriculture, manufacturing, and fishing are important or dominant parts of the economy, presents extraordinary threats to health. Agriculture brings the use of pesticides and herbicides as well as heavy and potentially dangerous machinery. Manufacturing – depending on the type – is a consistently hazardous industry, and employees involved in fishing and forestry are at much higher risks of trauma. Healthcare and in particular a focus on rural health, provides significant opportunities for economic development in Idaho. Partnerships with private entities in the healthcare industry, funding though the National Institutes of Health and other federal agencies utilize the natural laboratory of Idaho's rural population. Idaho's universities' contributions towards this emerging area of scholarship will add to the global competitiveness of the United States and the State.

Novel Materials: The global materials industry is worth an estimated $550 billion, conservatively. Materials revolutionize our lives by offering advanced performance and new possibilities for design and usage. For example, the market for biocompatible materials has grown from a few to $60B in the past decade. Market size is growing for materials in emerging areas such photonic materials, electronic and dielectric materials, functional coatings, and green materials. Materials research in Idaho is conducted by a wide range of scientists in diverse fields. Across the state, faculty members in Biology, Chemistry, Geosciences, Physics, Electrical Engineering, Mechanical Engineering ,

Nuclear Engineering and Materials Science and Engineering conduct research on improving and developing new materials. Current materials researchers in Idaho cover a broad spectrum of specializations, including semiconductor device reliability, microelectronic packaging, shape memory alloys, DNA machinery, environmental degradation, materials for extreme environments, biomaterials and bio-machinery, materials characterization, and materials modeling. Nanoscale materials and devices, functional materials and their uses and materials for energy applications are a focus of research throughout the state. These areas of research are highly synergistic with local industries and the Idaho National Laboratory (INL). Access to materials characterization equipment and processing laboratories has resulted in collaborations with small businesses and start-up companies.

Systems Engineering and Cybersecurity: Device control , information management, and cybersecurity are an essential part of 21st century life and, therefore, are an important part of educational requirements. For instance, large amounts of sensitive data are collected, processed, and stored electronically but must be accessed and moved in order to have any impact. In fact, many systems are computer controlled through networks. These include such things as the electric transmission grid and transportation in major cities. The universities are beginning to develop research expertise in software development and data management lifecycle design and operations and secure and dependable system design and operations. This area provides a significant area of opportunity for positive economic impact in Idaho, partnerships with the Idaho National Laboratory, and in improving the global competitiveness of the United States. There are already a significant number of firms in Idaho whose interests are in software development for device control, information management and processing. In addition, many of the major research projects being undertaken in the region by various state and federal agencies as well as the universities require the handling of significant amounts of data in a secure and dependable fashion. Currently, research funding in the universities from private and governmental sources is limited by the number of qualified personnel. In addition, within Idaho there is a high demand for graduates at all levels in computer science, hence workforce development in these areas should be a matter of urgency.

EXTERNAL FACTORS: IDAHO RESEARCH ADVANTAGESAND CHALLENGES

There are unique advantages and challenges to research in Idaho. This document seeks to provide guidance on building upon the advantages present in Idaho and address the challenges through the goals in this strategic plan.

Research Advantages

The Idaho National Laboratory (INL) and the Center for Advanced Energy Studies: Idaho is fortunate to be home to the Idaho National Laboratory, one of only 17 U.S. Department of Energy national laboratories in the U.S. The INL's unique history and expertise in nuclear energy, environmental sciences and engineering, alternative forms

of energy, and biological and geological sciences and related fields provides an excellent opportunity for research collaboration with Idaho's university faculty in the sciences, engineering, business and other fields.

The Center for Advanced Energy Studies (CAES), established at the request of the U.S. Department of Energy, is a public-private partnership that includes Idaho's research universities (Boise State University, Idaho State University, and the University of Idaho), the University of Wyoming, and the Battelle Energy Alliance (BEA), which manages the INL. The CAES partners work together to create unique educational and research opportunities that blend the talents and capabilities of Idaho's universities and the INL. A 55,000 square-foot research facility in Idaho Falls supports the CAES energy mission with laboratory space and equipment for students, faculty, and INL staff in collaborative research projects. The State of Idaho invests $3M per year in direct support of the three Idaho research universities.

Natural Resources: Idaho's beautiful natural resources are well known to fishermen, hunters, skiers, and other outdoor enthusiasts. Through its rivers, forests, wildlife, geological formations, and rangelands, Idaho itself is a unique natural laboratory for geological, ecological, and forestry studies. Idaho is home to some of the largest tracts of remote wilderness in the lower 48 states. In addition, the proximity of Yellowstone National Park and the Great Salt Lake provide additional one of a kind opportunities for ecology and geology research.

Small Population: Idaho's relatively small population of 1.6 million people enables every group in the state to be included in research surveys, providing more accurate information than a sampling of only some groups.

Intrastate Networks: The existing networks within the state, including agricultural extension services and rural health networks, provide a foundation for collecting research data from across the state, and rapidly implementing new policies and practices as a result of research discoveries.

Research Challenges

The goals set forth in this strategic plan are specifically designed to address challenges in Idaho. These challenges are identified below and include a description of the challenge and the goal from this strategic plan that addresses that specific challenge.

Lack of Coordination Among Universities In Advancing Research and Economic Development (technology transfer): By and large the research universities have not coordinated and shared their technology transfer and economic development activities among themselves. This not only decreases each university's competitiveness at the national and state level but also increases the costs for achieving a particular goal. There is some redundancy in programs, services and infrastructure between the universities. This duplication both limits the success that any one university can achieve and increases the cost.

Historical Competition Between Universities: One of the greatest problems with growing the research and economic development enterprise within the Idaho university arena has been the competitiveness between research universities. This problem existed at all levels within the universities themselves, extended through university administration to the state level, and was even prevalent in the press. While competition between the universities is to be expected when all are competing for a finite pot of money within the state and is even healthy at some level, the level of competition was counterproductive. The real competition that Idaho universities face is other universities in the United States when it comes to research dollars and attracting faculty and students. Economic development is also not a competition between the state universities but rather a competition with other states.

Goal 1 is designed to remedy these two challenges by "increas(ing) research at, and collaboration among Idaho universities and colleges to advance research strengths and opportunities pertaining to critical issues in Idaho, while also providing a vision for national and global impact."

Competition from Other Universities: In research, university faculty competes nationally for grant funds from federal agencies such as the National Science Foundation, Department of Energy, and the Department of Health and Human Services. Many other states' universities are well ahead of Idaho's universities in terms of state funding per student, patent royalty income, endowments, etc., and are able to move ahead at a faster pace, leaving Idaho universities further behind as time goes on.

Goals 1 and 2 are designed to make Idaho's research universities more competitive nationally and globally through collaboration with each other and by "(strengthening) the relationship between state universities and the private sector."

University Culture: Each of Idaho's research universities aspires to greater levels of achievement in research and creative activity, yet many faculty at each of the universities are not fully engaged on a national level in their respective fields. This is changing for the better under new leadership and with new research-active faculty hires at each institution, but these cultural differences remain, resulting in discomfort with change aimed at making the universities more nationally competitive.

While Goal 1 urges the researchers at Idaho's universities to keep a national and global vision for their research, Goal 4 aims to enhance the research capabilities of faculty by "(enhancing) learning and professional development."

Private Sector Support: Idaho has very little high-technology industry within its borders. This reduces the potential for developing an applied research initiative within the universities that, in many states, provides one important arm of economic development and technology transfer. This also means that it is much harder to develop those private/public partnerships that provide the universities with additional capital to construct research are technology transfer facilities.

The private sector plays a critical role in research. Goal 2 states that we will "create research and development opportunities that strengthen the relationship between state universities and the private sector."

Fragmented Economic Development Initiatives: There are seemingly too many economic development initiatives in Idaho and they are not well coordinated. It is imperative that state, university, and community initiatives work together toward common and agreed to goals. As it is, little progress is being made towards developing an economic strategy for the state that includes the research universities and little money has been secured to drive the economic development process. In fact, it is not uncommon to find that different entities in Idaho are competing against each other.

Positive economic impact is the result of well-organized and collaborative research. It requires strategic planning and execution. Goal 3 indicates that Idaho's research universities focus on "(contributing) to the positive economic impact of the State of Idaho."

Conclusion

This statewide Strategic Research Plan for Idaho Higher Education provides a framework to mitigate these external challenges and help Idaho institutions continue to focus on their research strengths. Overcoming the challenges discussed in this document will require enhanced cooperation between the functional groups at each Idaho university, fueled by a desire to work together towards the common goal of improving Idaho's economy for future generations.

INSTRUCTION, RESEARCH, AND STUDENT AFFAIRS
FEBRUARY 15, 2018

Performance Measure	FY 2014	FY 2015	FY 2016	FY 2017	Benchmark
Statewide amount of total annual research and development expenditures as reported in the National Science Foundation (NSF) Higher Education Research and Development Survey	$142,771,851.00	$146,699,825.00	$154,989,123.00	Not yet available	10% annual increase
Statewide amount of U.S. Department of Energy (DOE) research and development expenditures as reported in the National Science Foundation (NSF) Higher Education Research and Development Survey.	$13,545,198.00	$10,116,040.00	$8,561,218.00	Not yet available	10% annual increase
Number of new fully sponsored project proposals submitted by an Idaho University that involve a subaward with another Idaho institution of higher education (in either direction).	77	69	92	119	50% annual increase
Number of new fully sponsored project awards to an Idaho University that involve a subaward with another Idaho institution of higher education (in either direction).	53	42	58	70	30% annual increase
Number of new sponsored projects involving the private sector.	183	133	165	163	50% annual increase
Number of technology transfer agreements (as defined by AUTM [Association of University Technology Managers]).	34	50	44	33	15% annual increase
Number of invention disclosures (including plant varieties)	47	29	40	38	1 for every $2M of research expenditures
Amount of licensing revenues.	$1,192,007	$441,071	$724,316	$1,271,819	10% annual increase
Number of startup companies.	0	0	8	1	10% annual increase
Number of undergraduate students paid from sponsored projects.	1,383	1,699	1,683	1,811	20% annual increase
Number of graduate students paid from sponsored projects.	860	648	636	716	20% annual increase
Percentage of baccalaureate students who graduated in STEM disciplines and had a research experience.	N/A	N/A	N/A	1	20% annual increase
Number of faculty and staff paid from sponsored projects.	2,050	2,375	2,272	2,383	20% annual increase
K-20 Statewide Stratgic Plan Performance Measures					
Percentage of students participating in undergraduate research.	N/A	N/A	48%	51%	30%
Total amount of research expenditures	73,726,315	101,830,918	102,430,041	98,655,844	
Institution expenditures from competitive Federally funded grants	$81,951,549	$106,047,448	$104,850,624	$104,822,280	$112M annually
Institution expenditures from competitive industry funded grants	$7,748,543	$7,389,079	$8,732,410	$9,681,210	$7.2M annually
Measure of production of intellectual property:					
Number of startups	0	0	8	1	10% annual increase
Number of patents	13	10	18	4	10% annual increase
Number of student internships	2,109	2,090	2,294	2,186	

University of Idaho

Performance Measure	FY2014	FY 2015	FY2016	FY2017
Statewide amount of total annual research and development expenditures as reported in the National Science Foundation (NSF) Higher Education Research and Development Survey (See Note B below)	$95,593,851	$97,492,825	$102,457,123	$109,537,485
Statewide amount of U.S. Department of Energy (DOE) research and development expenditures as reported in the National Science Foundation (NSF) Higher Education Research and Development Survey.	$4,613,198	$3,940,040	$3,694,218	$4,128,612
Number of new fully sponsored project proposals submitted by an Idaho University that involve a subaward with another Idaho institution of higher education (in either direction).	24	25	18	30
Number of new fully sponsored project awards to an Idaho University that involve a subaward with another Idaho institution of higher education (in either direction).	10	14	12	12
Number of new sponsored projects involving the private sector (see Note A below).	68	57	65	65
Number of technology transfer agreements (as defined by AUTM [Association of University Technology Managers]).	7	11	13	5
Number of invention disclosures (including plant varieties)	18	14	18	21
Amount of licensing revenues.	$1,156,407	$419,596	$570,469	$1,232,588
Number of startup companies.	0	0	0	0
Number of undergraduate students paid from sponsored projects.	489	575	697	696
Number of graduate students supported by sponsored projects	488	574	463	544
Percentage of baccalaureate students who graduated in STEM disciplines and had a research experience. (***Note B***)	58.80%	57.85%	60.40%	65.95%
Number of faculty and staff paid from sponsored projects.	1,153	1,175	1,231	1,269
K-20 Statewide Strategic Plan Performance Measures				
Percentage of students participating in undergraduate research. (***Note B***)	59.60%	61.13%	58.80%	64.58%
Total amount of research expenditures	$56,385,826	$54,955,421	$55,893,584	$57,114,745
Institution expenditures from competitive Federally funded grants	$64,567,276	$63,565,943	$63,328,954	$64,092,411
Institution expenditures from competitive industry funded grants (see Note A below).	$5,674,316	$5,422,896	$5,300,451	$4,801,296
private sector	$1,452,711	$1,527,156		
private sector federal flow through	$4,221,605	$3,895,740		
Measure of production of intellectual property:				
Number of startups	0	0	0	0
Number of patents	7	7	3	1
Number of student internships	1,326	764	909	879

Performance Measure Explanatory Notes:

through.

Note B - Due to process improvement, previous years have been corrected to reflect correct figures.

	2014	2015	2016	2017
Institution expenditures from competitive industry funded grants (Note A)	$1,452,711 (a); $4,221,605 (b)	$1,527,156 (a); $3,895,740 (b)	$1,825,722 (a); $3,474,729 (b)	$1,804,800 (a); $2,996,496 (b)

	2014	2015	2016	2017
Number of new sponsored projects involving the private sector (See Note A above)	53 (a); 15 (b)	45 (a); 12 (b)	47 (a); 18 (b)	47 (a); 19 (b)

Boise State University

Performance Measure	FY2014	FY 2015	FY 2016	FY 2017
Statewide amount of total annual research and development expenditures as reported in the National Science Foundation (NSF) Higher Education Research and Development Survey	$26,568,000	$31,341,000	$32,085,000	Not yet available
Statewide amount of U.S. Department of Energy (DOE) research and development expenditures as reported in the National Science Foundation (NSF) Higher Education Research and Development Survey.	4,307,000	$2,090,000	$1,745,000	Not yet available
Number of new fully sponsored project proposals submitted by an Idaho University that involve a subaward with another Idaho institution of higher education (in either direction). [1]	33	26	44	60
Number of new fully sponsored project awards to an Idaho University that involve a subaward with another Idaho institution of higher education (in either direction).[2]	21	15	19	26
Number of new sponsored projects involving the private sector. [3]	22	22	35	33
Number of technology transfer agreements (as defined by AUTM [Association of University Technology Managers]).	27	38	29	28
Number of invention disclosures (including plant varieties)	16	15	16	14
Amount of licensing revenues.*	$35,600	$21,475	$53,847	$39,231
Number of startup companies.	0	0	5	0
Number of undergraduate students paid from sponsored projects.	607	807	836	946
Number of graduate students supported by sponsored projects. **				
Percentage of baccalaureate students who graduated in STEM disciplines and had a research experience.**				
Number of faculty and staff paid from sponsored projects.	651	676	784	867
K-20 Statewide Stratgic Plan Performance Measures				
Percentage of students participating in undergraduate research.	29%	29.40%	35.20%	37.40%
Total amount of research expenditures	$17,340,489	$20,613,353	$18,865,799	$21,094,099
Institution expenditures from competitive Federally funded grants	$17,384,273	$21,042,684	$19,306,479	$21,172,738
Institution expenditures from competitive industry funded grants	$2,074,227	$1,966,183	$2,020,959	$2,939,578
private sector	$134,010	$266,467		
private sector federal flow through	$1,940,217	$1,699,716		
Measure of production of intellectual property:				
Number of startups	0	0	5	0
Number of patents	6	3	4	3
Number of Student internships [4]	411	438	489	394

[1] Represents the number of full proposal submissions that involved a financial relationship
[2] Represents the number of new awards that involved a financial relationship with anothe
[3] Represents the number of new awards that involved a financial relationship with the priv
[4] Internship information is based on estimates by academic year (e.g., FY09=Academic yea

* 2013, 2014 - Licensing revenue includes $30k/year for Micron Licensing Restriction Agreement and is not considered net for OTT.
**Undergraduate and Graduate student totals have been combined into one line as BSU does not have the ability to break this information out.

	2014	2015	2016	2017
Institution expenditures from competitive industry funded grants	a. $134,009.76 b. $1,940,216.83	a. $266,467.06 b. $1,699,715.80	a. $562,457.27 b. $1,458,502.01	a. $681,146.82 b. $2,258,431.54

	2014	2015	2016	2016
Number of new sponsored projects involving the private sector. [3]	a) 10; b) 12	a) 10; b) 12	a) 22; b) 13	a) 17; b) 16

Idaho State University

Performance Measure	FY 2014	FY 2015	FY 2016	FY 2017
Statewide amount of total annual research and development expenditures as reported in the National Science Foundation (NSF) Higher Education Research and Development Survey	$20,610,000	$17,866,000	$20,447,000	$18,564,000
Statewide amount of U.S. Department of Energy (DOE) research and development expenditures as reported in the National Science Foundation (NSF) Higher Education Research and Development Survey.	$4,625,000	$4,086,000	$3,122,000	$3,290,000
Number of new fully sponsored project proposals submitted by an Idaho University that involve a subaward with another Idaho institution of higher education (in either direction).	20	18	30	29
Number of new fully sponsored project awards to an Idaho University that involve a subaward with another Idaho institution of higher education (in either direction).	22	13	27	32
Number of new sponsored projects involving the private sector.	93	54	65	65
Number of technology transfer agreements (as defined by AUTM [Association of University Technology Managers]).		1	2	0
Number of invention disclosures (including plant varieties)	13	0	6	3
Amount of licensing revenues.	0	0	$100,000	$0
Number of startup companies.	0	0	3	1
Number of undergraduate students paid from sponsored projects.	287	317	150	169
Number of graduate students supported by sponsored projects	372	74	173	172
Percentage of baccalaureate students who graduated in STEM disciplines and had a research experience.		71%	13%	12%
Number of faculty and staff paid from sponsored projects.	246	524	257	247
K-20 Statewide Stratgic Plan Performance Measures				
Percentage of students participating in undergraduate research.		41%	45%	45%
Total amount of research expenditures		$26,262,144	$27,670,658	$20,447,000
Institution expenditures from competitive Federally funded grants		$21,438,821	$22,215,191	$19,557,131
Institution expenditures from competitive industry funded grants			$1,411,000	$1,940,336
Measure of production of intellectual property:				
Number of startups	0	0	3	1
Number of patents	0	0	11	0
Number of Student internships	372	888	896	913

Sponsored Project Activity Report
FY2017

Awards for the Period July 1, 2016 through June 30, 2017

Activity Type	Federal	State	Industry	Other	Total	% of Grand Total
Instruction:						
Sponsored Programs	$ 4,981,422	$ 561,397	$ -	$ 136,550	$ 5,679,369	
State Instruction Appropriations	$ -	$ 73,000	$ -	$ -	$ 73,000	
Subtotal Instruction	$ 4,981,422	$ 634,397	$ -	$ 136,550	$ 5,752,369	11.47%
Research:						
Sponsored Programs	$ 26,039,886	$ 1,692,189	$ 1,033,072	$ 1,265,066	$ 30,030,213	
State Research Appropriations	$ -	$ 34,198	$ -	$ -	$ 34,198	
Subtotal Research	$ 26,039,886	$ 1,726,387	$ 1,033,072	$ 1,265,066	$ 30,064,411	59.96%
Other Sponsored Activities:						
Sponsored Programs	$ 9,205,382	$ 2,331,703	$ 69,369	$ 2,714,647	$ 14,321,101	
State Other Sponsored Activities Appropriations	$ -	$ -	$ -	$ -	$ -	
Subtotal Other Sponsored Activities	$ 9,205,382	$ 2,331,703	$ 69,369	$ 2,714,647	$ 14,321,101	28.56%
Grand Totals	**$ 40,226,690**	**$ 4,692,487**	**$ 1,102,441**	**$ 4,116,263**	**$ 50,137,881**	
Percent of Grand Total	***80.23%***	***9.36%***	***2.20%***	***8.21%***	***100%***	***100%***

Expenditures for the Period July 1, 2016 through June 30, 2017

Activity Type	Federal	State	Industry	Other	Totals	% of Grand Total
Instruction:						
Sponsored Programs	$ 4,258,320.86	$ 1,062,914.01	$ -	$ 51,008.43	$ 5,372,243.30	
State Instruction Appropriations	$ -	$ 755,597.12	$ -	$ -	$ 755,597.12	
Subtotal Instruction	$ 4,258,320.86	$ 1,818,511.13	$ -	$ 51,008.43	$ 6,127,840.42	15.63%
Research:						
Sponsored Programs	$ 18,266,576.77	$ 1,056,920.41	$ 665,082.90	$ 1,105,519.09	$ 21,094,099.17	
State Research Appropriations	$ -	$ 637,523.69	$ -	$ -	$ 637,523.69	
Subtotal Research	$ 18,266,576.77	$ 1,694,444.10	$ 665,082.90	$ 1,105,519.09	$ 21,731,622.86	55.44%
Other Sponsored Activities:						
Sponsored Programs	$ 8,084,243.69	$ 1,472,134.40	$ 41,548.04	$ 1,729,806.50	$ 11,327,732.63	
State Other Sponsored Activities Appropriations	$ -	$ 10,473.18	$ -	$ -	$ 10,473.18	
Subtotal Other Sponsored Activities	$ 8,084,243.69	$ 1,482,607.58	$ 41,548.04	$ 1,729,806.50	$ 11,338,205.81	28.93%
Grand Totals	**$ 30,609,141.32**	**$ 4,995,562.81**	**$ 706,630.94**	**$ 2,886,334.02**	**$ 39,197,669.09**	
Percent of Grand Total	***78.09%***	***12.74%***	***1.80%***	***7.36%***	***100%***	***100%***

THIS PAGE INTENTIONALLY LEFT BLANK

Idaho State University
Office for Research
Award Breakdown by Funding Agency Type and Project Type
July 1, 2016 through June 30, 2017

	Federal	State	Industry	Other/Foundation	Totals	Percent of Total
Research	4,048,931	1,352,895	4,439,908	729,344	10,571,078	49%
Training and Instruction	3,096,069	3,883,184	1,101,287	204,136	8,284,676	39%
Other/Public Service	613,569	937,937	743,020	211,391	2,505,917	12%
Totals	7,758,569	6,174,016	6,284,215	1,144,871	21,361,671	100%
Percent of Total	36%	29%	29%	5%	100%	

File Name: ISU OR Annual Awards FY17

IDAHO STATE UNIVERSITY 8/25/2017

SPONSORED PROJECT EXPENDITURE REPORT
FY2017

Expenditures for the Period July 1, 2016 through June 30, 2017

	Federal	State	Industry	Other	Totals	
Training and Instruction	$6,467,778	$1,134,101	$293,642	$140,654	$8,036,175	34%
Research	$11,183,772	$268,229	$1,088,579	$245,016	$12,785,596	54%
Other/Public Service	$1,905,581	$368,150	$558,115	$62,916	$2,894,762	12%
Totals	$19,557,131	$1,770,480	$1,940,336	$448,586	$23,716,533	
Percent of Total	82%	7%	8%	2%	100%	100%

IDAHO STATE UNIVERSITY

8/25/2017

SPONSORED PROJECTS ANNUAL REPORT
Expenditure Comparison by College
Fiscal Years 2017 and 2016

AMOUNT PER FUNDING TYPE

COLLEGE or UNIT	FY 2017				FY 2016			
	FEDERAL	STATE	OTHER	TOTAL	FEDERAL	STATE	OTHER	TOTAL
COLLEGE OF ARTS AND LETTERS	1,395,057	4,702	83,295	1,483,054	1,152,970		93,586	1,246,556
COLLEGE OF BUSINESS	237,790	214,546	234,429	686,765	237,538	238,847	202,176	678,561
COLLEGE OF EDUCATION	1,132,072	880,983	34,526	2,047,581	1,119,923	875,393	53,159	2,048,475
COLLEGE OF SCIENCE AND ENGINEERING	4,841,321	91,073	270,829	5,203,223	4,955,380	80,958	342,330	5,378,668
DIVISION OF HEALTH SCIENCES	3,738,032	16,036	683,274	4,437,342	5,757,465	159,297	410,967	6,327,729
COLLEGE OF TECHNOLOGY	1,208,757	255,990	57,472	1,522,219	1,543,475	193,681	174,992	1,912,148
RISE	638,492		293,578	932,070	1,741,286		1,002,437	2,743,723
ACADEMIC AFFAIRS			23,757	23,757				0
ISU ADMINISTRATION		26,305		26,305	433,103	61,428		494,531
ISU MERIDIAN PROGRAMS	234,616	1,250		235,866	136,250	414,926	36,633	587,809
ISU LIBRARY	500			500	21,063		3,362	24,425
IDAHO MUSEUM OF NATURAL HISTORY	105,965	53,708		159,673	182,986		65,498	248,484
STUDENT SERVICES	1,760,609	3,180	92,632	1,856,421	1,531,417	68,318	98,474	1,698,209
OFFICE OF RESEARCH	4,263,919	222,707	615,131	5,101,757	3,402,333	205,850	673,157	4,281,340
	19,557,131	1,770,480	2,388,922	$23,716,533	22,215,191	2,298,697	3,156,770	$27,670,658

**Federal includes direct and pass through federal dollars
**State is non federal funds from the State of Idaho
**Other is everything not in the above categories

THIS PAGE INTENTIONALLY LEFT BLANK

INSTRUCTION, RESEARCH, AND STUDENT AFFAIRS
FEBRUARY 15, 2018

University of Idaho - FY2017 Research Activity Report

Awards for the Period July 1, 2016 through June 30, 2017

	Federal	State of Idaho	Industry	Other	Total	% of Grand Total	% of Sponsor Total
Instruction:							
Sponsored Programs	$ 2,436,518.00	$ -	$ 55,300.00	$ 40,500.00	$ 2,532,318.00		**3%**
	$ 2,436,518.00	$ -	$ 55,300.00	$ 40,500.00	$ 2,532,318.00	**2%**	
Research:							
Sponsored Programs	$ 46,287,492.58	$ 2,929,260.52	$ 1,883,825.61	$ 4,841,089.89	$ 55,941,668.60		**72%**
Federal Land Grant Appropriations (FFY17)	2,722,886.00				2,722,886.00		
State Research/Endowment Appropriations		28,761,886.92			28,761,886.92		
Subtotal Research:	$ 49,010,378.58	$ 31,691,147.44	$ 1,883,825.61	$ 4,841,089.89	$ 87,426,441.52	**71%**	
Public Service:							
Sponsored Programs	$ 16,517,588.42	$ 1,506,596.00	$ 5,000.00	$ 1,479,776.73	$ 19,508,961.15		**25%**
Federal Land Grant Appropriations (FFY17)	2,932,863.00				2,932,863.00		
State Extension Appropriations		11,171,943.50			11,171,943.50		
Subtotal Public Service:	$ 19,450,451.42	$ 12,678,539.50	$ 5,000.00	$ 1,479,776.73	$ 33,613,767.65	**27%**	
Construction:							
Sponsored Programs	-	-	-	-	-	**0%**	**0%**
Total Sponsored Programs Funding	**$ 65,241,599.00**	**$ 4,435,856.52**	**$ 1,944,125.61**	**$ 6,361,366.62**	**$ 77,982,947.75**		
Percent of Total Sponsored Programs	***84%***	***6%***	***2%***	***8%***	***100%***		***100%***
Grand Total of All Funding Per Category	**$ 70,897,348.00**	**$ 44,369,686.94**	**$ 1,944,125.61**	**$ 6,361,366.62**	**$ 123,572,527.17**		
Percent of All Funding	***57%***	***36%***	***2%***	***5%***	***100%***	***100%***	

Expenditures for the Period July 1, 2016 through June 30, 2017 (includes accruals)

	Federal	State of Idaho	Industry	Other	Institutional	Total	% of Grand Total	% of Sponsor Total
Instruction:								
Sponsored Programs	$ 2,344,799.36	$ 196,525.52	$ 71,284.69	$ 235,141.91	$ 540,449.78	$ 3,388,201.26		**4%**
	$ 2,344,799.36	$ 196,525.52	$ 71,284.69	$ 235,141.91	$ 540,449.78	$ 3,388,201.26	**2%**	
Research:								
Sponsored Programs	$ 48,163,612.53	$ 2,813,120.91	$ 1,802,653.85	$ 4,230,199.00	$ 8,606,224.48	$ 65,615,810.77		**73%**
Federal Land Grant Appropriations (D11315,D11316	2,630,129.48					2,630,129.48		
State Research Appropriations (D11311,D51346,D51360)		21,410,433.93				21,410,433.93		
State Endowment/Other Appropriations		6,913,604.93				6,913,604.93		
Other Sources	141,283.97		226,980.94	3,960,992.15	8,638,248.48	12,967,505.54		
Subtotal Research:	$ 50,935,025.98	$ 31,137,159.77	$ 2,029,634.79	$ 8,191,191.15	$ 17,244,472.96	$ 109,537,484.65	**75%**	
Public Service:								
Sponsored Programs	$ 15,330,974.59	$ 1,276,348.26	$ 5,000.00	$ 1,293,248.49	$ 2,676,983.09	$ 20,582,554.43		**23%**
Federal Land Grant Appropriations (D21325)	2,324,593.08					2,324,593.08		
State Extension Appropriations (D1321)		10,884,385.54				10,884,385.54		
Other Sources				-	68,766.21	68,766.21		
Subtotal Public Service:	$ 17,655,567.67	$ 12,160,733.80	$ 5,000.00	$ 1,293,248.49	$ 2,745,749.30	$ 33,860,299.26	**23%**	
Construction:								
Sponsored Programs	$ -	$ -	$ -	$ -	$ -	$ -	**0%**	**0%**
Total Sponsored Programs Funding	$ 65,839,386.48	$ 4,285,994.69	$ 1,878,938.54	$ 5,758,589.40	$ 11,823,657.35	$ 89,586,566.46		
Percent of Total Sponsored Programs	***74%***	***5%***	***2%***	***6%***	***13%***	***100%***		**100%**
Grand Total of All Funding Per Category	$ 70,935,393.01	$ 43,494,419.09	$ 2,105,919.48	$ 9,719,581.55	$ 20,530,672.04	$ 146,785,985.17		
Percent of All Funding	***48%***	***30%***	***1%***	***7%***	***14%***	***100%***	**100%**	

THIS PAGE INTENTIONALLY LEFT BLANK

FY 2016 INFRASTRUCTURE REPORT SUMMARY - BSU

	Total $	Detailed Allocations
Library Support		
Graduate Research Assistantships / Research Associates	$100,000	Graduate College / Chemistry Graduate Assistants
Post-Doctoral Fellows		
Technician Support		
Maintenance Contracts		
Research Equipment / Project Support		
Competitvely Awarded Summer Research Support		
Start-Up Funds for New Hires	$23,194	COEN funds for researcher Liz Godwin
Incentives to Reward Faculty for Research Achievements		
Other	$126,806	Salary /Fringe for Tech Transfer Director / Patent officer
Total Allocation	$250,000	

FY 2016 INFRASTRUCTURE REPORT SUMMARY - BSU

	Detailed Allocations
Publications in Refereed Journals	
Presenations at Professional Meetings and Conferences	
Grants Received as a Result	
Grants Pending	
Student Participation	
Faculty Participation	
Other Participation	
Patents Awarded	
Patents Pending	

FY 2016 INFRASTRUCTURE REPORT SUMMARY - ISU

	Total $	Detailed Allocations
Library Support	$0	
Graduate Research Assistantships / Research Associates	$0	
Post-Doctoral Fellows	$0	
Technician Support	$0	
Maintenance Contracts	$0	
Equipment: Research Data Center	$221,191	Research computer and network equipment was purchased, configured, and installed. This included: 10/40 Gbps Intra-RDC network connectivity, 40 Gbps switch, Multiple 10 Gbps connections between servers, switches, and storage (i.e., 10 Gbps to each server, with 40 Gbps network connectivity in the data center to minimize bottlenecks) Redundant (2x10 Gbps) connection between RDC and IRON Data Transfer Node built on Globus architecture to facilitate faster file transfers, Three (3) racks One (1) Dell FC830 server 256 GB RAM, 4- 2.1 GHz Intel Xeon E5 4660 processors (56 cores total) Two (2) Dell FC360 servers 256 GB RAM, 2- 2.4 GHz Intel Xeon E5 2630 processors (16 cores total) Research disk storage 83 TB total (18 TB SSD, 65 TB SATA)
CERE Van Kity Lohse	$7,979	Van for transporting equipment, faculty, staff, and students to research project sites.

Equipment: EAMES Microscopy Lab	$20,832	P0024115 Superior Technical Services, Inc Viper Quad Board surplus FEI ON 4035 268 00410--Work Order 7171-1 Mark Norviel IT----FEI Co: Microscope Cntrl SFWR PK UPGRD Dual Beam Micrscp tag#089465--Kurt J Lesker Co: 6flnae, 6 cntr rings, 6 clamps, 2 adampters, 2 pumps, 2 centering rings.Upgrade, ---PO0024153:Configure and Test DB835 PC to xP 3.8--- Vacuum gauge
Competitvely Awarded Summer Research Support		
Start-Up Funds for New Hires		
Incentives to Reward Faculty for Research Achievements		
Other		
Total Allocation	$250,003	

FY 2016 INFRASTRUCTURE REPORT SUMMARY - ISU

	Detailed Allocations
Publications in Refereed Journals	No publications have been printed/accepted at this point describing the use of the Research Data Center at this point. Publications are anticipated in the future.
Presenations at Professional Meetings and Conferences	The Research Data Center was introduced and described at two Idaho State University faculty/researcher meetings and at one National Science Foundation XSEDE regional meeting.
Grants Received as a Result	One grant (contract) has been received that was enabled by the development of the Research Data Center. This was a computationally intensive project funded by Idaho Transportation Department to process both LiDAR and aerial imagery for their District 5.
Grants Pending	Two grants are pending that will rely upon and make extensive use of the RDC should they be funded. One has been submitted to NASA and the other to the National Science Foundation.
Student Participation	4 students utilizing van for research site travel. No students have been directly involved in using the Research Data Center to date.
Faculty Participation	Three ISU faculty are currently using the RDC with more expected in the fall semester. 4 faculty using the CERE Van
Other Participation	Contract with Advanced Fibers in Idaho Falls for analysis.
Patents Awarded	n/a
Patents Pending	n/a

THIS PAGE INTENTIONALLY LEFT BLANK

FY 2016 INFRASTRUCTURE REPORT SUMMARY - LCSC

	Total $	Detailed Allocations
Library Support	$26,500	
Graduate Research Assistantships / Research Associates	$7,500	11th Annual Lewis-Clark State College Research Symposium
Post-Doctoral Fellows	$0	
Technician Support	$0	
Maintenance Contracts	$0	
Research Equipment	$0	
Competitvely Awarded Summer Research Support	$6,000	Forest Grove Police Log film; Hells Canyon Institute
Start-Up Funds for New Hires	$0	
Incentives to Reward Faculty for Research Achievements	$17,608	Grant-writing incentive stipends: 14
Other	$17,392	Qualitrix subscription; KRUMP research materials; AmeriCorps match
Total Allocation	$75,000	

FY 2016 INFRASTRUCTURE REPORT SUMMARY - LCSC

	Detailed Allocations
Publications in Refereed Journals	**KRUMP:** Davis, C.A. (2015). Abstract #20524, KRUMP: Case-study on Inner-city Origins, Applications and Diverse Demographics Transference: Special Preconvention Supplement to Research Quarterly for Exercise and Sport (March). Davis, C.A. (2015). Abstract #20524, KRUMP: Case-study on Inner-city Origins, Applications and Diverse Demographics Transference: Special Preconvention Supplement to Research Quarterly for Exercise and Sport (March). Davis, C.A. (2015). Abstract #20524, KRUMP: Case-study on Inner-city Origins, Applications and Diverse Demographics Transference: Special Preconvention Supplement to Research Quarterly for Exercise and Sport (March). **| Upper Division Math NSF:** SIAM ED16 in Philadelphia, AMS section meeting. In Pullman, MAA section meeting at Gonzaga, Joint math meeting 3 presentations: Poster presentation for NSF IUSE projects, NSF DUE invited session, CODEE session on Differemtial Equations education.

	Detailed Allocations
Presenations at Professional Meetings and Conferences	**KRUMP:** International Presentations: Davis, C.A. (2017). Research Session: What is BLISS? Origins, Applications, and Outcomes, International Council for Physical Education, Recreation, Sport, and Dance, (ICPER*SD), Boston, MA Davis, C.A. (2017). Active Session: The BLISS Instructional Model Traditional Dance Teaching Methods Made Stronger, International Council for Physical Education, Recreation, Sport, and Dance, (ICPER*SD), Boston, MA National Presentations: Davis, C.A. (2017). Active Session: Cultural Dance + Props = Stress Release in Students, National Dance Society (NDS): Norfolk, VA Davis, C.A., Hodges, W., Cooper, D., Davis, G.M., Coffelt, E. (2017). Research and Active Session: DC KRUMP: Fun, Exercise & Healing with LA/Idaho Demolition Crew! Society for Health and Physical Education in America National Conference (SHAPE America): Boston, MA Davis, C.A. (2016). Research and Active Session: The BLISS Instructional Model Traditional Dance Teaching Methods Made Stronger, National Dance Society (NDC): College Station, TX Davis, C.A. (2016). Research and Active Session: Express the True You! KRUMP Street Dance, Helping At-Risk Youth, National Dance Society (NDS): College Station, TX Davis, C.A., Brown, J. (2016). Research and Active Session #0604-000726: West Coast KRUMP: BLISS Teaching Tools and Tight New Moves!, Society for Health and Physical Education in America National Conference (SHAPE America): Minneapolis, MA Davis, C.A., Brown, J., Rios, N., (2015). Active Session, ID #60127: KRUMP Creators: West Coast Crews Bring Fresh Moves to Class, National SHAPE America Convention, Seattle, WA Regional Presentations: Davis, C.A. (2014-17). Street Dance/KRUMP? Invited guest artist, Lionel Hampton Jazz Festival, University of Idaho, Moscow, ID State Presentations: Davis, C.A. (2016). Research Session: KRUMP, Cross-fit, & Traditional PE, with at-risk teens in a residential treatment facility, Idaho Conference on Undergraduate Research (ICUR), Boise, ID Local Presentations: Davis, C.A., Brown, J. (2015). Invited presenter: KRUMP, Teen Power, Lewiston, ID **|** **INBRE Pilot Project Latta:** The effects of spontaneous mutation on neural function. INBRE Annual Conference The effects of mutation on agerelated changes in protein aggregation. ICUR Annual Conference The effects of spontaneous mutation on neural function. SSE/SSB/ASN Annual Meeting **|** **INBRE Pilot Project Stoffregen:** Poster presented at 2017 INBRE statewide research conference Invited talk at 2017 INBRE statewide research conference Invited talk at 2017 RAIN (Regional Association of INBRE Networks)
Grants Received as a Result	

	Detailed Allocations
Grants Pending	
Student Participation	Krump: 3; INBRE Pilot Project Latta: 5; INBRE Pilot Project Stoffregen: 6; Research Symposium: 258
Faculty Participation	Forest Grove Police Log: 1; KRUMP: 2; INBRE Pilot Project Latta: 2; INBRE Pilot Project Stoffregen: 3; Research Symposium: 39
Other Participation	Forest Grove Police Log: 5; KRUMP: 4; Upper Division Math: Marie Snipes at Kenyon college (PI), Thomas Asaki at WSU (PI), Chris Camfield (PI), Jodi Frost (educational consultant), Carol Schumacher (Beta tester), Jason Siefken (Beta tester), Amanda Harsy-Ramsay (Beta tester), and Catherine Socha (Tested modules in a high school); Research Symposium: 1 - Dr. John Ruche
Patents Awarded	
Patents Pending	

FY 2017 INFRASTRUCTURE REPORT SUMMARY-UI

	Total $	Detailed Allocations
Library Support	$0	
Graduate Research Assistantships / Research Associates	$36,321	$34,180 - 1 graduate assistant; $2,141 - 1 research associate
Post-Doctoral Fellows	$12,071	
Technician Support	$82,458	$30,813 -Glass Blower provides repair and construction services to UI labs; $18,348 Mass Spec Unit - Mass Spectrometry Director provides research support to UI labs; $33,297 - Optical Imaging Director provides research support to UI labs
Maintenance Contracts	$0	
Equipment	$78,736	$45,805 - Noran System 7 Spectral Acquisition and Imaging Microscope; $17,736- Equipment to build a pilot scale facility for gluocosinate extraction; $15,195 - Fish tanks
Start-Up Funds for New Hires	$0	
Incentives to Reward Faculty for Research Achievements	$0	
Other	$77,903	$72,276 - Postdoctoral fellow promoted to faculty working on EPSCoR director's research projects; $52 - conference room operating expenses; $1,751 - circuit installation for Noran Microscope; $3,824 - IGERT PhD candidate recruitment
Total Allocation	$287,489	

FY 2017 INFRASTRUCTURE REPORT SUMMARY-UI

	Detailed Allocations
Publications in Refereed Journals	8
Presenations at Professional Meetings and Conferences	6
Grants Received as a Result	3
Grants Pending	3
Student Participation	34
Faculty Participation	21
Other Participation	1 commerical partner interested in licensing the glugosinate extraction technology and building a commercial plant; 1 commericial partner is interested in purchasing the product from the first commercial partner; 4 PhD Candidates; community outreach.
Patents Awarded	n/a
Patents Pending	1

NOTE: The glassblower, Mass Spectrometry Core and the Optical Imaging Core provide services to research laboratories, which affects research activities of students, faculty and staff, including publications, presentations, and grants.30 students and 20 faculty hosted 6 PhD candidates (two were current UI students) for the Integrative Graduate Education & Research Traineeship (IGERT) program. One faculty member was active in community outreach for Boise River flood control. FY17 begining balance was $305,880; $287,489 were expensed. Remaining $18,391 were obligated to finish pilot scale facility for gluocosinate extraction and partial purchase of a Droplet Digital Polymerase Chain Reaction equipment.

FY 2018 Allocation of HERC Funds

		Total $4,163,200	Proposed Allocation
	HERC IGEM		1,900,000
	Infrastructure Funds		825,000
	Matching Grants (EPSCoR Match)		800,000
	Incubation Fund		435,500
	Undergraduate Research		200,000
	Administrative Costs		2,700
Total		**$4,163,200**	
Balance		$0	
IGEM Funds			$0
BSU		IGEM16-01, IGEM 16-02	$1,200,000
ISU			$0
UI		IGEM17-01	$700,000
LCSC			$0
Transfer to Targeted Research			$0
Total IGEM			**$1,900,000**
Research Infrastructure Funds			$0
BSU			$250,000
ISU			$250,000
UI			$250,000
LCSC			$75,000
Total Infrastructure			**$825,000**
Matching Award Grants			
NSF-EPSCoR (Managing Idaho's Landscapes for Ecosystem Services - $20M) (2013 - 2018)			$800,000
Total Matching Grants			**$800,000**
Targeted Research			$0
Idaho Incubation Fund (7th round)			
BSU			$243,100
ISU			$49,800
UI			$142,600
Transfer in			
Total Targeted Research			**$435,500**
Undergraduate Research			
Total Undergraduate Research			**$200,000**

Administrative Costs	
FY18 Administrative Costs	$2,700
Total Administrative Costs	**$2,700**
Total Budget / Allocation	**$4,163,200**

NOTES

Idaho Incubation Fund Program

Progress Report Form

Proposal No.	**IF18-001**
Name:	**Kevin Feris and Erik Coats**
Name of Institution:	**Boise State University**
Project Title:	**Operation, Optimization, and Evaluation of a Pilot Scale Algae Resource Recovery Unit**
Reporting Period:	**July 1, 2017 to June 30, 2018**

Information to be reported in your progress report is as follows (attach additional information as needed):

1. Summary of project accomplishments for the period just completed and plans for the coming reporting period:

Task 1 – Continue operations and data acquisition from of the ARRU for a full growing season (i.e. through September/October 2018): The ARRU was operated continuously into September 2017. Operations ended 9-4-17 as night time temperatures were becoming cool, the lagoon water required for one of our treatments was no longer available (the UI dairy had conducted their annual lagoon draining to irrigate local fields), and smoke from wildfires in the region made it unsafe to work outdoors. We focused our efforts on sample analysis and data interpretation. As of 12-18-17 we have completed our algal biomass productivity measures (Figure 1) and our nutrient uptake measurements (Figure 2). Here we present just results of phosphorus uptake, however nitrogen uptake rates illustrate similar patterns. On-going work is measuring the biomass quality of the cultivated algal biomass

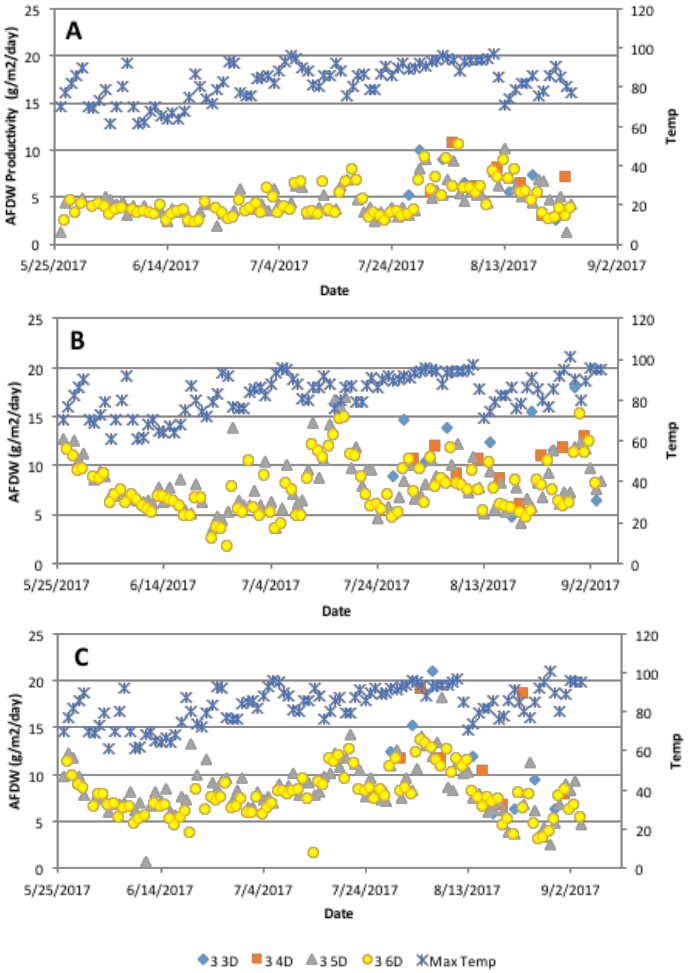


Figure 1. Algal biomass produced in the ARRU across all three treatments (A: Lagoon water; B: AD/PHA effluent mixture (10:90); C: 100% PHA effluent) measured as ash free dry weight (AFDW) and maximum daylie temperature.

(i.e. protein content, carbohydrate content, lipid content, and ash content). Information integrated across the full growing season run will be used to estimate capital and operating costs for a full scale ARRU and inform presentation of value propositions for potential commercialization.

Project plans for reporting period 1-1-18 to 6-30-18:
During the final six months of this project we will complete our analysis of the ARRU samples collected during the spring/summer/fall 2017 operational period. This will include finalizing our measures of biomass quality, nutrient capture, and biomass productivity. We will compare these measures to environmental and operational factors monitored during the operational period as a means by which to better understand the limits on algal productivity and nutrient capture. These analyses will then also be used to make projections of the economic potential of the technology when operated as a stand alone system as in concert with a PHA/AD treatment system. These projections will then be used to estimate the economic potential of our integrated system and subsequently be used to present the value of the technology to potential commercial partners.

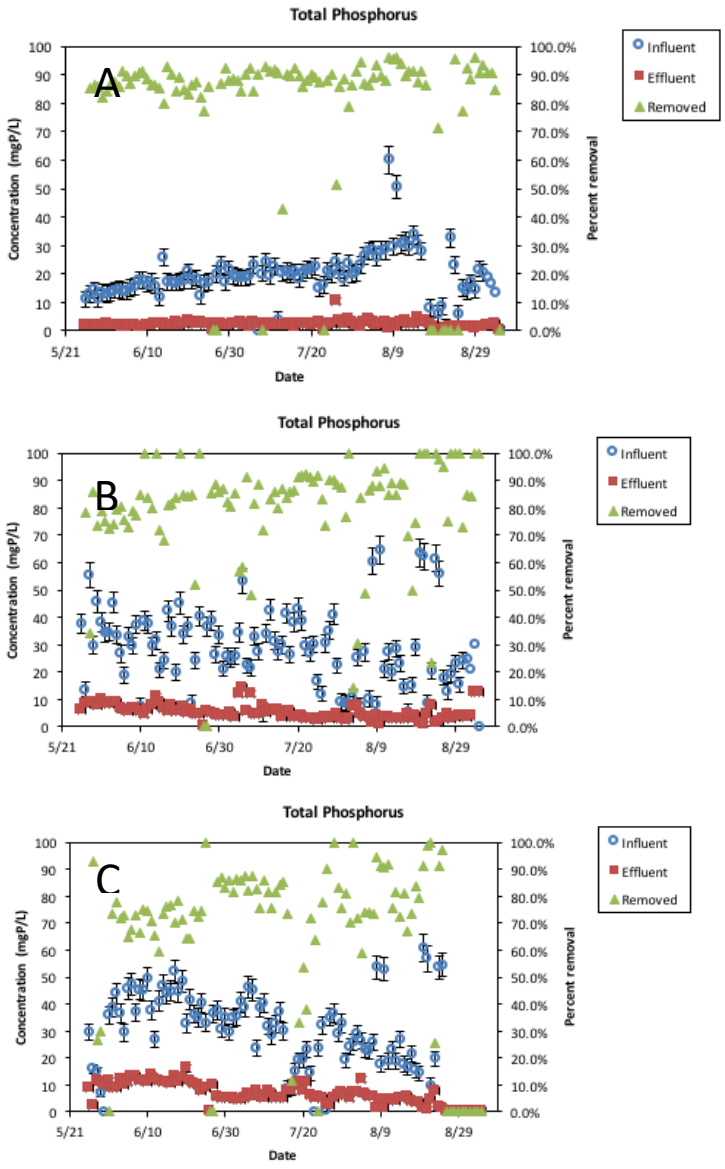


Figure 2. Nutrient update (i.e. Total Phosphorus removal) by the ARRU across all three treatments (A: Lagoon water; B: AD/PHA effluent mixture (10:90); C: 100% PHA effluent) fur the full duration of operation.

2. Summary of budget expenditures for the period just completed (include project burn rate):

$26,134 of the awarded $34,198 has been expended as of 11-14-17. This represents 76% of the project budget. Given that the majority of the experimental work associated with this proposal was slated to occur between 7-1-17 and 9-30-17 associated with

system operations, it is appropriate for the majority of the funding to be expended during this period. The remaining budget will be expended during the 2nd half of the project to support the remaining data collection and data analysis.

3. Numbers of faculty and student participation resulting from the funding, including internships:

2 tenured faculty:
Dr. Kevin Feris (Boise State University) and Dr. Erik Coats (University of Idaho)
1 PhD student
Nicholas Guho (University of Idaho)
5 Undergraduate research assistants
Gary Dunn (Boise State University)
Katie Maries (University of Idaho)
Alex Crozes (University of Idaho)
Cody Barrick (University of Idaho)
Andrew Blanchard (University of Idaho)
Kyle Allen (University of Idaho)
1 Research Scientist
Cindi Brinkman (University of Idaho)

4. List patents, copyrights, plant variety protection certificates received or pending:

No invention disclosures, patents, copyrights, etc. have been filed as of yet for this project. However, our on-going analyses may yield opportunities for such filings, we are not currently ready to pursue such activities.

5. List technology licenses signed and start-up businesses created:

No technology licenses or start up businesses have been filed or created as of yet for this project. However, we are actively discussing how to pursue commercialization of the technology optimized in this project. However, we will need to finalize our data analysis to as part of that discussion to finalize our strategies.

Status of private/industry partnerships (include enough information to judge level of engagement):
As part of this project we are pursuing development of a Industrial advisory group (IAG) as a means by which to present our findings, gather feedback on the viability of the ideas in real world applications, and seek input on our plans for future commercialization. Our overall goal is to leverage the expertise of these industry professionals to help realize technology commercialization. Currently we are assembling an IAG associated with a new USDA award that consists of members of the Idaho Dairymen's Association and the Washington Dairy Products Commission. We will leverage this group for discussions of the work performed associated with this project as well.

6. Any other pertinent information that will indicate to the council that the project is meeting satisfactory progress.

History and on-going success of the collaboration between Drs. Feris and Coats: Dr. Feris and Dr. Coats have been collaborating for approximately 10 years on wastewater to biopower-bioplastics-algae systems. We have received funding through the US Department of Agriculture (USDA), Idaho National Laboratory (INL) and the Center for Advanced Energy Studies (CAES), and the Environmental Protection Agency (EPA) in support of this work.

The ARRU pilot-scale system we constructed as part of our prior SBOE award and continued operation and optimization of as part of this project was recently used as the basis for successfully pursuing additional extramural research funding. We recently received word that a pending proposal at the USDA has been selected for funding. That proposal was in part supported by the preliminary data generated from our ARRU and will allow us to continue the work and system optimization well beyond the scope of the project supported by the SBOE. We are optimistic that the SBOE funding coupled with additional USDA support will yield novel insights and further allow us to bring the combined PHA-AD-Algae technology to commercialization.

IGEMs/HERC Project Status Report
Idaho Infrastructure Proposal
Semi-Annual Progress Report
December, 18th 2017

Proposal No.	**AHRC42**
P.I. Name:	**Jon Stoner**
Name of Institution:	**Idaho State University/ Idaho Accelerator Center**
Project Title:	**Infrastructure to support Active Pharmaceutical Ingredient designation for ^{67}Cu.**

Executive Summary:

During the first half of the FY17 work was executed on key quality indices as required by FDA guidelines for Active Pharmaceutical Ingredient cGMP processing " *Q7 Good Manufacturing Practice Guidance for Active Pharmaceutical Ingredients, Guidance for Industry*." The items worked on were:

1). Measurement and qualification methods for verifying activity of the sample and cleanliness of the clean room

2). Required documents listing for API certification

3). Process run tracking and documentation

4). RFQ for submission to FDA certification consultants.

A small portion of the budget, $1017, was spend on a used cleanroom particle monitor so routine measurements during processing can be taken.

PROJECT STATUS REPORT ACTIVITIES PLANNED

This is the semi-annual status report for FY 2018 for the IGEMs funded project Infrastructure to support Active Pharmaceutical Ingredient designation for 67Cu. The project proposal listed the following major project activities:

1). Complete an RFP to established FDA API consulting companies (Q1, FY18)
2). Select a student (Q1, FY 18)

3). Complete the high level QA and SOP documents (Q2, FY18)
4). Complete the run tracking system and begin equipment qualification runs. Order capital equipment if required. (Q3, FY18)
5). If possible, draft Validation Master Plan (Q4, FY18)

PROJECT STATUS REPORT – Activity Review

The first half of FY18 was marked by an increase in required shipments by our partner, Clarity Pharmaceutical. Clarity is rapidly pursuing human trial experiments in calendar year 2018 and several key shipments supported their pre-trial animal and quality certification experiments. This required us to delay bringing on an FDA API consultant and instead do work directly on the process to improve quality control systems. In that regard, one piece of capital was acquired, a particle counter, so that clean room cleanliness could be recorded for each process run. In addition, an extensive calibration project was performed to verify activity of each run shipped. This involved work with NIST traceable sources, our HPGe detector and an inexpensive ion-chamber that we acquired for dose level analysis and calibration with the customer. Over the last 5 months we have implemented a log-book process recording system in partial fulfillment of our project run tracking system (item 4 above). Only the PI and radiochemist have been involved in the 1H FY18.

During 1H FY18, we worked closely with Clarity to define the required Q7 quality systems we will require of the future FDA consultant. An RFQ (as opposed to an RFP) has been generated with significant feedback from ISU's purchasing department in Q2, FY18 (instead of the planned Q1 FY18) which is out for bid. We expect to have the consultant on board early in calendar year 2018.

The second half of this project will involve the selection of the FDA consultant, hiring of a student, writing documents, create a VMP and performing validation experiments. Our customers will do their initial API audits in 2018.

FINANCIAL Summary FY 2018 to date

As of 12/5/17	**HERC IGEM**
Budget	49,800
Spent	4,288
Remaining	45,512

We have deliberately underspent our grant funds during the first half of the year as we anticipated much higher activity during the second half of the project.

Spend categories to date are $3271 salary support for the radiochemist and $1017 for capital. The spend will increase dramatically as the consultant is brought on for work ($35,000) and a student is hired in 2H FY18 and the burn rate will increase to meet the budget projection.

Prepared by Jon Stoner, P.I.
Director of Technical Operations
Deputy Director, Office of Research
ISU

Mid-Year Report

ISBOE Tritium Exit Sign Recycling

Dr. Richard N Christensen

Wailam Chan, Graduate student

Professor and Director of the Nuclear Engineering Program
Acting Associate Director, Center for Advanced Energy Studies (CAES)
Idaho Falls Center
The University of Idaho

31 December 2017

1. Background

This project is designing, building and testing a system to recycle Tritium EXIT signs. The system will include two devices which will be patentable: the tritium getter geometry and arrangement, and the argon/helium-3 separator. These two devices are unique. The system will first crush the glass ampules, extract the tritium/ helium-3 mixture, combine that mixture with an argon carrier gas, adsorb the tritium on the unique tritium getter, and then condense out the argon in the unique argon condenser leaving the harvestable helium-3. A scaled system is being designed, built, constructed and operated using hydrogen and standard helium at UI. Once it is operational, a larger system will be built and tested by our industrial partner, Alpha Tech, of Salt Lake City Utah using actual tritium EXIT signs. Alpha Tech is receiving no funds from this project so their demonstration will be after this project ends. This technology will be applicable to commercial EXIT sign operations, but also applicable to molten salt reactors.

2. Design of the Tritium EXIT Signs Recycling System

As explained above, the purpose of this system is to recycle the helium and the tritium. Below is shown a system to accomplish the recycling. Although we present the operational procedure for the following system, there are two components that are critical to the operation of this system: the Tritium Getter and the cold trap. Initial efforts have been to design the Tritium Getter and the Cold Trap. Thus **Section 3.1** presents the design of the tritium getter, while **Section 3.2** presents the design and testing of the Cold trap.

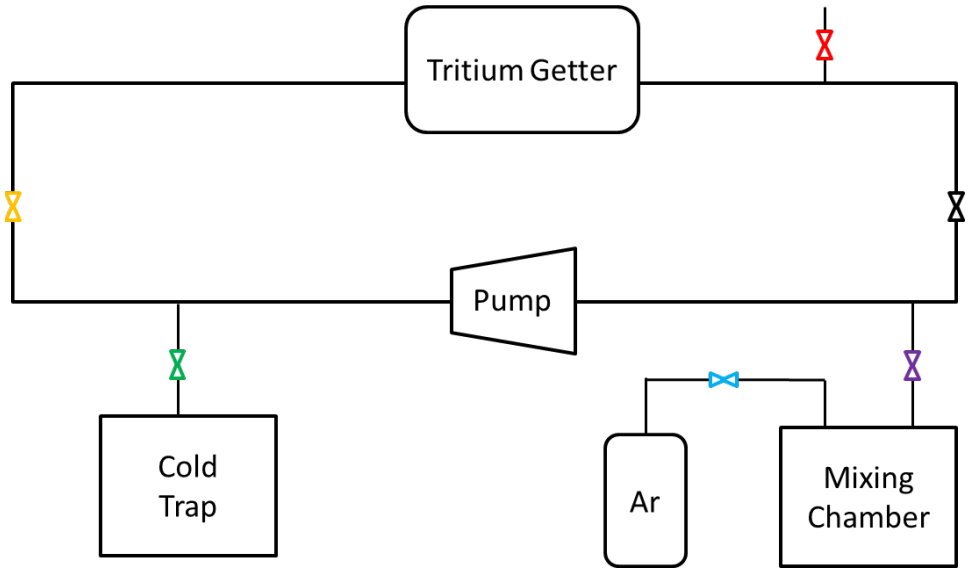


Figure 1: Layout of the recycling system

2.1. Procedures of the Recycling System

1. The whole system is vacuumed through the red valve, while the yellow, green, black valves are open and the blue and purple valves are closed.
2. Next, the green and red valves are closed and the blue and purple valves are opened.
3. The mixture of helium, hydrogen, and argon is transferred from the mixing chamber into the circulation loop through the purple valve.
4. The purple valve is closed after the pressure of the circulation loop reaches 1.5 atmospheres pressure
5. The circulation pump is then started.
6. The concentration of hydrogen in the circulation loop decreases as the hydrogen gas is absorbed by the zirconium cobalt inside the tritium getter.
7. The green valve is opened and all of the helium-argon mixture is transferred into the cold trap for the separation of helium and argon as the argon is condensed and the helium is left in the gaseous state as .

3. Accomplishments

3.1. Construction of the Tritium Getter

A proof-of-concept prototype to test hydrogen absorption by the zirconium cobalt powder has been constructed (See the assembled system in Figure 1. Figure 1 also gives the assembly of the various parts). This apparatus will be used to demonstrate the feasibility of extracting hydrogen from the mixture of helium, hydrogen, and argon. From the literature search, it is evident that zirconium cobalt powder has a strong capability of absorbing hydrogen molecules in a batch system [1][2]. The prototype will test the hydrogenation capability of zirconium cobalt (ZrCo) in a continuous flow system, in the presence of argon and helium as explained above.

A proof-of-concept prototype to test hydrogen absorption by the zirconium cobalt powder will be conducted as soon as the ZrCo powder is obtained. A quote for ZrCo powder has been recently received from SAES Getters USA and the powder has been ordered from the company. The actual test on the tritium getter will be conducted as soon as the ZrCo powder arrives in February 2018.

The test will consist of two vessels and a pressure gauge. The first vessel would hold hydrogen and the second would house the zirconium cobalt powder and is shown in **Figure 1**. The two vessels would be connected by tubing with a valve and a pressure gage attached to a tee. The vessel shown in **Figure 1** would be evacuated. Initially, the pressure in the two would be isolated by the valve which would be closed. After the valve was opened the pressure would be recorded on a continuous basis during the test. The hydrogen would be given time to interact with the zirconium cobalt (a minimum of fifteen minutes). A decrease in pressure over time will indicate the hydrogen is being absorbed. A second test will use a mixture of hydrogen and helium, wherein the first compartment will contain the mixture of the hydrogen and helium. Proof of

concept will be achieved when the pressure in the total system reaches the initial partial pressure of the helium if it were contained within the entire system.

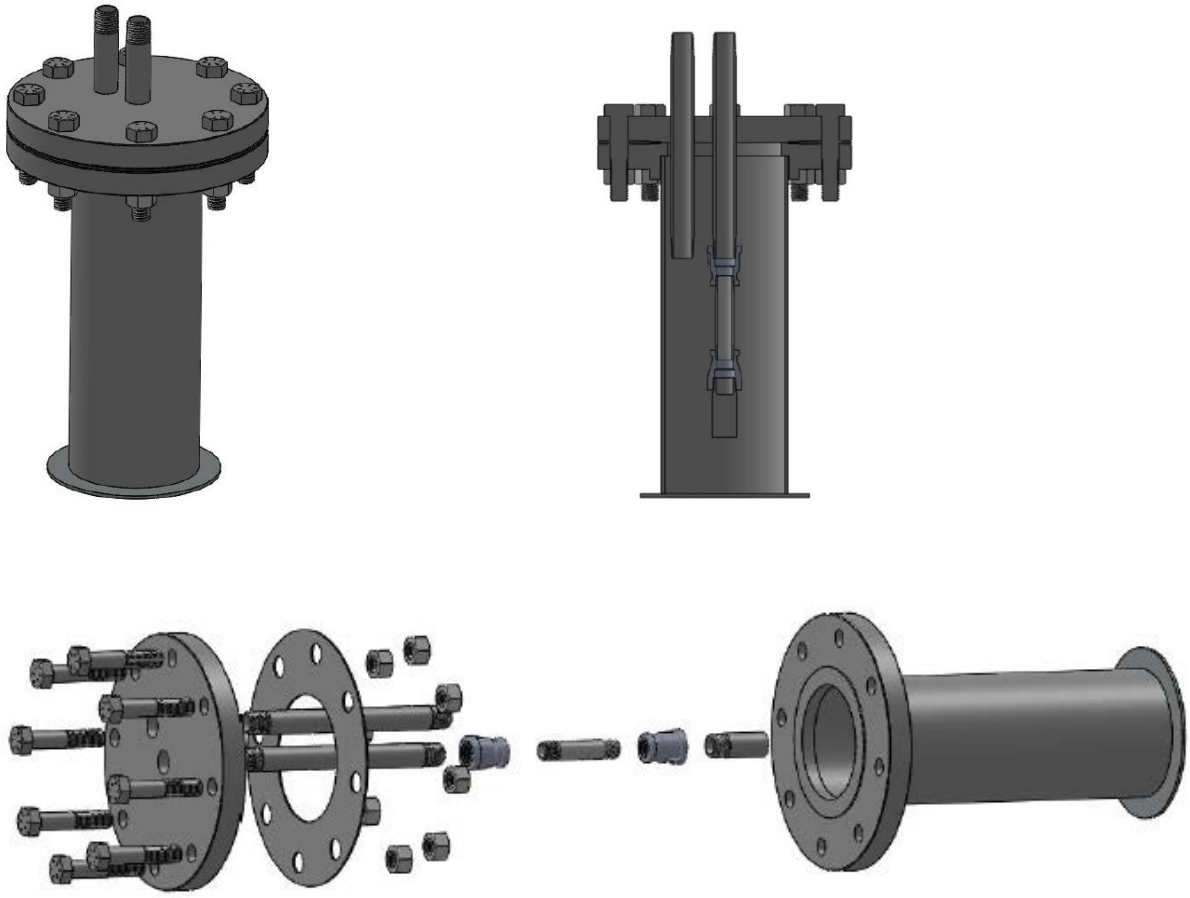


Figure 2: The SolidWorks assembly of the tritium getter

3.1.1 Designs and Analytical Models

A benchmark system was used to come up with a design for the project. The constraint of the system was the volume that the zirconium cobalt powder would occupy. Calculations were made by estimating the density of the zirconium cobalt powder and then dividing the required mass of the powder by the density. The density of the zirconium cobalt solid was found and then the powder density was estimated using the iron solid to powder density ratio. With this volume we were able to come to the final design shown in Figure 2.

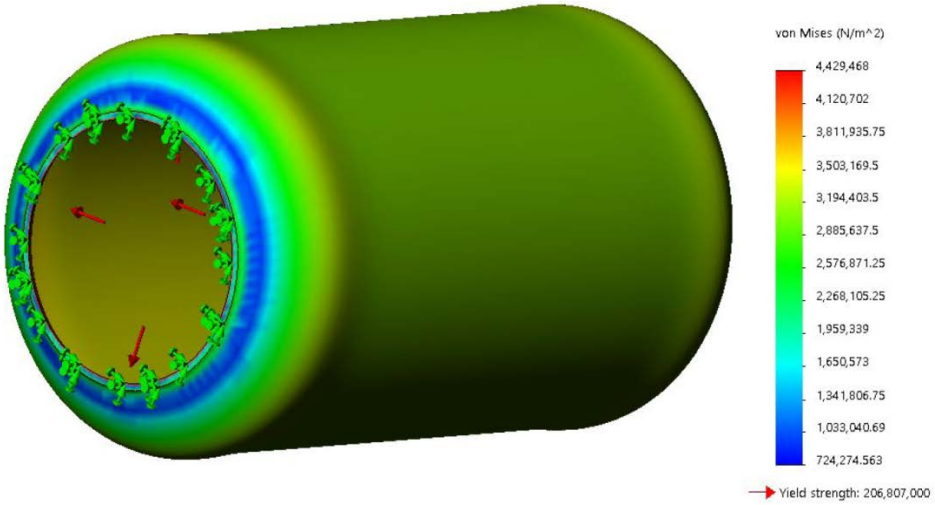


Figure 3: FEA SolidWorks analysis on the cylinder at 2 atm to calculate if it would yield.

During the experiment, the tritium getter is connected to the circulation loop. The pressure inside the tritium getter will increase to 2 atm with the gas mixture of helium, hydrogen, argon passing through. Due to the fact that high temperature (100 to 400C) would be involved in both the hy/dehydrogenation process, a finite element analysis was conducted to study the yield stress distribution in the getter when it is pressurized to 2 atm from the inside. Figure 3 shows the FEA result by using SolidWorks. From the result, it can be seen that the Von Mises stress inserted on the getter does not exceed 5 MPa, which is significantly below the yield strength of stainless at around 200 MPa. As a result, yielding and deflection would not cause safety concerns to the getter prototype when it is pressurized in the experiment.

3.1.2 List of Components for the Tritium Getter Prototype.

The components used to fabricate the Tritium Getter Prototype are shown in the table below:

Item ID	Description	Size	# of Items
8360T14	Muffler Stainless Steel 316	NPT 1/2	1
4452K254	316 SS reducer 1/2" to 3/8"	1/2" to 3/8"	2
9446T33	Porous Disk (4 items/package)	3/4" dia , 1/16" thick	1
68095K362	Low-Pressure Steel Unthreaded Pipe Flange	9"	1
4548K155	Standard-Wall 316/316L Stainless Steel Pipe Nipple	3/8" dia, 3" length	1
7750K119	Standard-Wall Steel Pipe	4" ID, 0.237" thick	1
68095K383	Low-Pressure Steel Unthreaded Pipe Flange (Lid)	9"	1
44615K524	Standard-Wall Steel Pipe Nipple	1/2" ID, 8" long	2
94095K91	High-Temperature Extreme-Pressure Graphite Gasket	9" OD	1
93827A253	HIgh Strength Steel Hex Nut Grade 8 ZInc-aluminum Coated (10/ pack)	5/8"-11 Thread	1
8983k118	304 Stainless steel sheet	6" x 6" , .120" thick	1
7551A23	High-Temperature Surface Fillers in Syringes	putty adhesive 4 oz	1
91257A806	Zinc Yellow-Chromate Plated hex head Screw (5 per pack)	5/8"-11, 3" length	2
SST051-040	Ultra-High Temperature Heating Tapes		1
URBEST -100-1250C	K Type Thermocouple Temperature Sensor for Industry, Agriculture, Chemical	13 mm thread, 5mm probe	1
ITC-106VH	PID Temperature Thermostat Controllers, Fahrenheit & Centigrade, K Sensor, Solid State Relay for Sous Vide, Home Brewing	100ACV - 240ACV,	1
	Ocharzy Waterproof Rectangle Project Enclosure	230mmX150mmX85 mm	1

32353	wire 12 thhn str black 500'	500'	4
32354	wire 12 thhn str white 500'	500'	4
3214509	scotch electrical tape	3/4X450"	1
34554	Term sp 16-14		2
4127585	Nipple black	1/2"X3"	1
47820	Coupling Black	1/2"	1
47816	Black Elbow	1/2"	1
	Tax		1
31470	Cord Power 16/3 SJT	6'	1
45278	thread seal tape	1/2"X200"	1
34927	Conn Wire Ground Green		1
34784	Wire 12 THHN Str Green	500'	1
40556	Valve ball gas lever	1/2	2
4338661	Hex Bushing	1/2X1/4	1
4504163	Hose barb	1/4X1/4	1

3.2. Construction of the Argon Condenser Prototype

A lab-scale argon condenser was constructed to demonstrate the feasibility of the separation between argon and helium. Upon extraction of tritium from helium, a helium-argon gas bi-product remains. It is necessary to separate gaseous helium and argon from one another for Helium to be commercially marketable. Helium freezes at near 0 K the, while argon condenses around 87.3 K and will freeze around 83.8 K. Due to the requisite temperatures, liquid nitrogen, with a boiling point at 77K, has been proposed as the primary coolant. However, the narrow range of temperatures that argon is liquid dictates that small scale tests and fluid analysis are performed prior to large scale testing.

3.2.1 Design and Analysis.

The prototype of the argon condenser was determined to be a helical coil, constructed from copper tubing (see **Figure 4**). Argon has a narrow window between the condensing and the freezing temperatures, making it critical to determine just how long it needed to be exposed to the cryogenic temperatures. The amount of time spent in the bath translated to how quickly the gas was moving through the tube and how long the tube needed to be for the argon to reach condensing temperatures.

It was determined that the two main inputs for the cold trap device are the gaseous Helium-Argon mixture and Liquid Nitrogen. These two inputs were held in separate containers. First, a container was used to hold the liquid nitrogen without leaking. The liquid nitrogen container also accepted a secondary coil that contained the Helium-Argon gaseous mixture.

The condensing coil was made of copper. A coil copper tubing with the necessary length of tubing will fully condense all the argon while keeping a compact design that can easily be submersed in a liquid nitrogen bath. A gaseous mixture was fed into the copper coil. If the coil were immersed in liquid nitrogen, the Argon will condense out of the mixture. After condensing, all that will remain on the upper part of the condenser is helium in a gaseous state while liquid argon will accumulate on the lower bottom of the condenser.

For the separation of Helium and Argon to be feasible, the device must be able to withstand cryogenic temperatures. Among the materials that can withstand these temperatures, two of the obtainable materials were 303 Stainless Steel and copper. Copper was found to be cheaper, easier to obtain, and easier to work with than the stainless steel. A batch method using a cold trap was determined to be the simplest approach to test. However, copper tubing was easily be shaped and formed into a coil. This coil condenser would also be compact enough to fit in the testing environment, therefore the coil condenser was the concept chosen to be pursued.

The parts to be tested are shown in Figure 4, below.

Figure 4: Parts and assembly drawings of the argon condenser prototype

3.2.2 Analytical Models.

Analytical modeling was the most important step during the project build process. To create a \ device that condenses argon into a liquid, the gas mixture has to be exposed to a cryogenic environment for a specific amount of time. In this case, argon has a narrow window between the condensing and the freezing temperatures, making it critical to determine just how long it needs to be exposed to the cryogenic temperatures. The amount of time spent in the bath translated to how quickly the gas was moving through the tube and how long the tube needed to be for the argon to reach condensing temperatures. By use of convection heat transfer and thermal energy balances, the length of tube necessary to condense argon can be modeled.

While creating an analytical heat transfer model, several assumptions had to be made. First, the mode of heat transfer was purely convection from the gas mixture to the surrounding environment. The thermal resistance of the copper tubing could be ignored because the coil could be treated as thin-walled tubing. The temperature of the surrounding environment (liquid nitrogen) would remain constant despite warming and evaporation over time. As the Liquid Nitrogen evaporates, more will be added to the system yielding a constant average temperature. Also, as the liquid nitrogen evaporates, bubbling and churning could occur within the bath, which results in forced convection over copper tubing. Since forced convection is taking place, the convection coefficient should fall between 200 to 1000 $\frac{W}{m^2K}$. Finally, since a phase change is taking place, the total length of tubing required to separate and condense Argon is the sum of the

length of tubing required to lower the temperature of the gas mixture to Argon's saturation temperature and the length of tubing required to remove enough heat to fully condense Argon into a liquid.

In the end, a spreadsheet was created to vary the diameter of the tubing and flow rate at which the gas mixture moves through the coil condenser. Thermal energy balances were used to determine the surface area over which convection heat loss is occurring. Equation (1) was derived to determine the surface area (A_1 portrayed in Figure 4) which is required to convect enough heat to reduce the temperature of the gas to Argon's saturation temperature. Equation 1 states that the sum of the energy lost by Helium and Argon is equivalent to the heat energy lost by the system through convection.

$$hA_1(T_{ave} - T_N) = \dot{m_{Ar}} c_p (T_{inlet} - T_{sat_{Ar}}) + \dot{m_{He}} c_p (T_{inlet} - T_{sat_{Ar}}) \quad (1)$$

where h is the convection coefficient, T_{ave} is an average of the gas inlet temperature (T_{inlet}) and the temperature of the liquid nitrogen (T_N), $T_{sat,Ar}$ is the saturation temperature of argon, $\dot{m}$ is the mass flow rate of either helium or argon, and c_p is the specific heat either helium or argon

The heat loss by surface area two (A_2) was analyzed in a similar way

$$hA_2(T_{sat_{Ar}} - T_N) = \dot{m_{Ar}} h_{fg} \quad (2)$$

where the remaining heat loss to condense Argon comes from mainly from the Argon gas as it condenses. This energy is transferred to and boils the liquid nitrogen in the tank outside the coil containing the Argon. Argon's latent heat of vaporization (h_{fg}) is taken into consideration while undergoing a phase change. Once the two surface areas were determined using Equations 1 and 2, they were summed together and the total condensing surface area was found.

$$A_{tot} = A_1 + A_2 \quad (3)$$

From there, a total length of pipe required to separate and condense Argon from the gaseous mixture was determined using the surface area equation for a cylinder.

$$A_{tot} = \pi D_{pipe} L \quad (4)$$

It was determined that for a volume flow rate of 0.1 cfm (1 L/min) and a tube diameter of 0.375 inches, the required tube length to condense Argon was approximately 20 ft. This coil is shown in Figure 5.

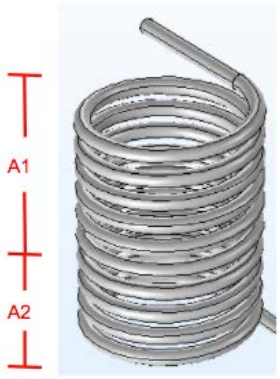


Figure 5: A coil condenser with the two areas required to fully condense Argon outlined. Area 1 (A1) reduces the temperature of the gaseous mixture to the saturation temperature of Argon and Area 2 (A2) fully condenses Argon.

Analytical modeling was also used to determine the time required to condense argon if there was no flow through the system. These calculations correlated to a batch system in freezing the Argon, as well as could be used to determine how accurate the model assumptions where in determining the length of tubing required, in that they could be verified through experimental findings. The same physical properties used in the tube length equations, where applied to these calculation, and it was assumed transient conduction would be an accurate model for this application from providing a model of temperature change with respect to time of an infinite cylinder submerged in a different temperature fluid . First, the Biot number was calculated in order to verify transient conduction by 1-term solutions was an accurate model. Eq .5 shows the Biot number equation, h is the heat transfer coefficient, Lc is the characteristic length for the cross section of copper tubing, and k is the thermal conductivity of Argon

Upon calculation, it was discovered the Biot number was greater than .1, verifying the 1-term solution method to be an accurate model for conduction. The base equation used for the 1-term

$$\mathrm{Bi} = \frac{\mathrm{hL_c}}{\mathrm{k}} \tag{5}$$

solution method is the non-dimensional centerline temperature for all geometries can be seen in Eq. 6 and is comprised of the of the Fourier number (*Fo*), centerline temperature difference (θ_{0}^{*}),

as well as the coefficients for 1-term solutions (C_1, ζ_1), which are based off the calculated Biot number for the system geometry being evaluated.

$$\theta_0^* = C_1 \exp(-\zeta_1^2 F_0) \tag{6}$$

The non-dimensional centerline temperature and can be found by using a ratio of the difference between the final temperature of the Argon (T_0) and the temperature of the surrounding environment of Liquid Nitrogen (T_∞) to the difference between the initial Argon temperature (T_i) and the surrounding environment temperature. The centerline temperature equation can be seen in Eq.7.

$$\theta_0^* = \frac{T_0 - T_\infty}{T_i - T_\infty} \tag{7}$$

The Fourier number is comprised of the thermal diffusivity of Argon (α), the characteristic length for a cylinder (L_c) and time (t). The characteristic length used for this calculation was the outer radius of the tubing, and thermal diffusivity was selected from Argon at 200 Kelvin.

$$F_0 = \frac{\alpha t}{L_c^2} \tag{8}$$

Time to condense Argon can be solved for by manipulating equations 6, 7, and 8, resulting in Eq. 9.

$$t = \frac{\mathrm{Ln}\left[\frac{\theta_0^*}{C_1}\right] L_c^2}{-\zeta_1^2 \alpha} \tag{9}$$

From the above equation, solving for time, with properties taken at the average of the initial and final temperatures of Argon, a time of roughly 30 seconds was determined for Argon to fully condense from its initial temperature.

3.2.3 Experiment and Results.

Testing was conducted by first connecting the cold trap to an Argon tank and allowing the Argon gas to fill the device. During the fill process, the other end of the coil was allowed bleed off, reducing the contamination due to atmosphere in the system. The cold trap device was then verified for leaks by applying a soaping solution to the fittings. Minor leaks were detected and sealed through further tightening of the couplings. After leaks were remedied and pressure remained constant throughout the device, testing began. The system was filled with Argon and pressurized to 20 PSI. The copper coil was placed into a holding tank and Liquid Nitrogen was added to the tank, submerging the coil. Initially, the pressure slowly and steadily decreased. Once the majority of the coils were submerged, the pressure rapidly decreased from 10 PSI to -20 PSI, where it then held constant. This indicated a phase change from Argon gas to a liquid or solid state in approximately 1 second. It was determined that the entire condensing process, from 20 PSI to -20 PSI occurred within a matter of approximately 45 seconds. The experimental results support the fact that liquid nitrogen is able to condense argon effectively from helium-argon gas mixture in a short time.

3.2.4 List of Components.

The list of components needed and used to run the experiments is show below.

ITEM NO.	PART	DESCRIPTION	QTY.	VENDOR	PART NUMBER
1	Helix	Copper Helix made from copper tubing	1	Ace Hardware	49857 | 0829014985 75
3	45 Degree Flared Fitting	Brass Flared fitting for 3/8 Tubing	2	McMaster-Carr	50635K564
4	Threaded Reducer	3/8 to 1/4 in Threaded Reducer	1	McMaster-Carr	4757T178
5	Threaded Pipt T-Fitting	3/8 in. Brass T-Fitting	2	McMaster-Carr	4429K252
6	Bushing	Brass Bushing for 3/8 in	3	McMaster-Carr	50785K631
7	Barbed Tube Fitting	1/4 Brass Barbed Tube Fitting	1	McMaster-Carr	44555K125
8	45 Degree Flared Fitting	3/8 Pipe to 45 Degree Flared Fitting	2	McMaster-Carr	50635K382
9	Pressure Gague	Vacuum and Pressure Gage	2	McMaster-Carr	3941K53
10	Gas Flow Regulator	Inert gas flow regulator	1	Tool Planet	ST-55083
11	Vacuum Tubing	Automotive Vacuum Tubing	1	McMaster-Carr	50375K82

4. Ongoing Processes for the experiment.
Prototypes of the tritium getter and argon condenser have been constructed over the past several months. The results of these tests indicate that the tritium getter will work as planned. In addition these tests have also indicated that the argon condenser will work better than imagined. With these two critical components proven, literature and these experimental results indicate that the proposed tritium EXIT signs system can be constructed within the time period of the contract. The next step of the project is to integrate all components and parts together into a whole system. The setup of the circulation circuit is now at the final stage of the designing process. All minor components such as pumps, valves, connections will be finalized in less than a month. In expectation, the first test of the tritium recycling system would happen in the beginning of March.

5. Preparation for Experiments with Hydrogen.
In order to do the tests safely within the CAES facility several items have been completed or are in progress. The experiment must be conducted in a glove box, with any gas release going to a fume hood.

5.1 Glove Box.
The University of Idaho had a glove box in one of the labs that the project was given permission to use. However, in order to use that glove box, which had been sitting idle for the past ten years, it had to be completely renovated. In this renovation, the seals on the window were removed and replaced. In addition, new gloves were purchased and installed. Fittings were purchased to facilitate flow into and out of the glove box. In order to vent any hydrogen gas safely, vents were established and flow rates measured to assure that no combustible mixture could ever be established within the glove box or within the fume hood that was set up to exhaust any mixture to the outside environment. The fume hood mass flow rate draw and been measured and recorded. A vacuum pump has been purchased and some gases have also been purchased so that we have the correct gases on hand when we are ready to run the experiment.

5.2 Word and Control Document.
A work and control document has been started that describes in great detail all procedures to be used when working with hydrogen. We insist that the students understand in great detail the procedures to be used during normal operation and during any unexpected happening. This work and control document has to be approved before any experimentation can occur.

6. Patents and Commercialization.
Alpha Tech is currently in discussion with the University of Idaho to reach an agreement regarding licensing of the technology. We are in the processing of filling out the patent disclosure. Alpha Tech has worked with a radiation safety officer to design a facility to handle tritium. They are working with Jeremy Tamsen, University of Idaho's tech transfer officer to finalize these arrangements.

7. Cost.
A complete breakdown of the costs is shown in the attachment to this report.

8. References.
[1] Nagasaki, T., Konishi, S., Katsuta, H., Naruse, Y., (1986). A zirconium-cobalt compound as the material for a reversible tritium getter. *Fusion Technology, Volume 9,* 506-509.

[2] Kou, H., Huang, Z., Luo, W., Sang, G., Meng, D., Luo, D., Zhang, G., …Hu, C., (2015). Experimental study on full-scale ZrCo and depleted uranium beds applied for fast recovery and delivery of hydrogen isotopes. *Applied Energy, 145,* 27-35.
http://dx.doi.org/10.1016/j.apenergy.2015.02.010

INSTRUCTION, RESEARCH, AND STUDENT AFFAIRS
FEBRUARY 15, 2018

FWRITEM University of Idaho
Itemized Expenditures by Orgn Code
From 01-JUL-2017 To 31-DEC-2017

Orgn: CAK622 - ISBOE Tritium EXIT Sign Recylcling 30-Jan-2018 10:41 AM

Salaries				
E4105 Salaries				6609.60
				$ 6609.60
Irregular Help				
E4135 TH-Student				1555.20
				$ 1555.20
Fringe Benefits				
E4282 Student CFR Fringe Expense				195.93
				$ 195.93
Operating Expenses				
E5307 Analytical Services				
09-NOV-17	J1179335	GlassBlower Services - Utgikar		45.00
E5724 Research Supplies				
27-SEP-17	Z0825645	0914 COMSOL INC 781-273-3322 M		945.50
10-OCT-17	Z0826342	0919 TFS*FISHER SCI CHI 800-76		2369.43
07-NOV-17	Z0827625	1016 AMAZON.COM AMZN.COM/BILL		7.61
07-NOV-17	Z0827625	1018 SHIMADZU SCIENTIFIC INSTR		63.00
07-NOV-17	Z0827626	1024 IDAHO VALVE FITTING 208-		123.44
24-NOV-17	Z0826963	0929 IDAHO VALVE FITTING 208-		669.82
24-NOV-17	Z0826963	1003 IDAHO VALVE FITTING 208-		381.60
24-NOV-17	Z0826963	1004 TFS*FISHERSCI ECOM HUS 80		897.03
24-NOV-17	Z0826963	1006 HAMILTON COMPANY 775-8583		365.76
24-NOV-17	Z0826963	1009 MEASUREMNT COMPUTNG 508-9		586.50
E5749 Other Specific Use Supplies				
01-NOV-17	I1964002	Airgas Inc		328.57
01-NOV-17	I1964063	Airgas Inc		715.85
01-NOV-17	I1964003	Airgas Inc		382.18
02-NOV-17	B1758987	Airgas Inc		0.00
02-NOV-17	B1758987	Airgas Inc		0.00
06-NOV-17	I1964852	Fisher Scientific Co.		1269.30
07-NOV-17	!0303703	Fisher Scientific Co.		0.00
14-NOV-17	B1759555	Airgas Inc		0.00
				$ 9150.59
		Total Expenses		$ 17511.32

FWRITEM University of Idaho
Itemized Expenditures by Orgn Code
From 01-JUL-2017 To 31-DEC-2017

Orgn: CAK622 - ISBOE Tritium EXIT Sign Recylcling 30-Jan-2018 10:41 AM

Salaries				
E4105 Salaries				6609.60
				$ 6609.60

INSTRUCTION, RESEARCH, AND STUDENT AFFAIRS
FEBRUARY 15, 2018

Irregular Help	
E4135 TH-Student	1555.20
	$ 1555.20
Fringe Benefits	
E4282 Student CFR Fringe Expense	195.93
	$ 195.93
Operating Expenses	
E5307 Analytical Services	45.00
E5724 Research Supplies	6409.69
E5749 Other Specific Use Supplies	2695.90
	$ 9150.59
Total Expenses	$ 17511.32

AN EVOLUTIONARY APPROACH FOR PROCEDURAL OPPONENT GENERATION IN VIDEO GAMES.

PROGRESS REPORT: Grant Number IF18-004
PRINCIPAL INVESTIGATOR: Barrie Robison
REPORTING PERIOD: July 1, 2017 – January 1, 2018

SUMMARY OF PROJECT ACCOMPLISHMENTS:

Hired lead artist and game developer (Landon Wright).

Hired lead programmer (Samantha Heck).

Developed "Project Hastur" into a playable beta stage. The game is a "tower defense" style game with real time strategy elements. The player must compete a population of evolving aliens that adapt to their individual strategy. We can provide copies of the game for PC, Mac, or Linux platforms.

Presented the project at the "Artificial Intelligence in Digital Entertainment" conference in Snowbird, UT, October 2017. This presentation led to a seminar invitation to the University of Alberta, where we are scheduled (March 9th, 2018) to meet with faculty interested in collaborations, as well as industry representatives from Bioware (a triple A game studio).

Completed the first round of play testing (using UI undergraduate students), which helped us refine the evolutionary model and fix bugs and errors.

Dr. Robison has been invited to speak about the project at the Eastern Washington University Darwin Day seminar on February 16th.

We are registered as an exhibitor at the upcoming EVO-WIBO meeting (Evolutionary Biologists from Washington, Idaho, British Columbia, and Oregon) in Port Townsed, WA, April 13-15, 2018.

PLANS FOR THE NEXT REPORTING PERIOD:

We have been approached by the UI to participate in their crowdfunding platform (U&I Give). Our plans for this campaign are described under "Additional Funding", below.

Continue to beta test and refine the game mechanics.

Build out 10 more playable game regions, and link them with a migration model.

Develop story elements to support campaign mode.

Release the game on the Steam platform.

File for the formation of an LLC.

Begin and sustain an advertising and promotion campaign, which will coincide with our crowdfunding campaign.

SUMMARY OF BUDGET EXPENDITURES:

As of Jan 1, 61% of our funds remain. We are on track with regard to our spending projections, as the burn rate for the programmer position will increase from 10 hours per week to 40 hours per week beginning in May 2018.

Detailed reports of our expenditures are attached.

FACULTY AND STUDENT PARTICIPATION:

One staff (artist/game developer) and one student (programmer) position were directly supported by grant funds during the reporting period. However, additional participants in the PROJECT included 16 more undergraduates from Computer Science, Biology, Virtual Technology and Design, Music, English, and Business. Drs. Barrie Robison and Terry Soule are the primary faculty, but we collaborate with colleagues from Education (3), English (1), VTD (3), Music (1), and Business (1).

Total Student Participants: 17
Total Faculty Participants: 11
Total Staff Participants: 1

PATENTS, COPYRIGHTS, AND CERTIFICATES:

None

LISCENSES AND START-UP BUSINESSES:

Our primary aim remains the creation of an LLC that works closely with the UI to license and distribute our games. In the coming six months, we seek to recruit help from our business colleagues, the Office of Technology Transfer, and the Idaho Technology Council in forming a start-up company.

INDUSTRY AND PRIVATE PARTNERSHIPS:

None (yet).

ADDITIONAL FUNDING AND BURN RATE:

Our burn rate is described in the attached financial statements.

We have applied for a $2.6 million grant from the National Science Foundation with our colleagues from the College of Education. We are also working on additional proposals for future games that would be licensed to the LLC.

We have also been approached to participate in the UI's crowdfunding platform, U&I give. Our campaign will launch on Feb 12th (Darwin Day), and we seek to raise $10,000 - $20,000 in additional funding to support more features for the game. This has the dual benefit of increasing awareness of the game and increasing retail sales. We are currently working with our development officers to identify potential sources of matching funds in the private sector. We view this activity as an opportunity to leverage IGEM funding and produce an even better product than would be possible with IGEM funding alone.

ADDITIONAL INFORMATION:

None.

THIS PAGE INTENTIONALLY LEFT BLANK

Idaho Incubation Fund Program

Progress Report Form

Proposal No.	**IF18-005**
Name:	**Daniel Fologea (PI), Denise Wingett (co-PI)**
Name of Institution:	**Boise State University**
Project Title:	**Engineered Advancements in Measuring Molecular Interactions in Support of Local Bio-industry**
Reporting Period:	**July 1, 2017 to January 1, 2018**

Information reported in this progress report:

1. Summary of project accomplishments for the period just completed and plans for the coming reporting period. Page 2

2. Summary of budget expenditures for the period just completed (include project burn rate). Page 4

3. Faculty and student participation resulting from the funding, including internships. Page 4

4. Patents, copyrights, plant variety protection certificates received or pending. Page 5

5. Technology licenses signed and start-up businesses created. Page 5

6. Status of private/industry. Page 5

7. Any other pertinent information that will indicate to the council that the project is meeting satisfactory progress. Page 6

1. Summary of project accomplishments for the period just completed and plans for the coming reporting period

The major objective of this project is the development and testing of novel technologies pertaining to the reconstitution of both artificial and natural lipid membranes supported by solid supports for integration with the KinExA instrument produce by Sapidyne, a Boise company which is the sole developer and producer of the instrument. The achievement of this objective will ensure a significant advantage and marketability over competing instruments by providing novel capabilities of investigating the functionality of biological systems in health and disease, diagnostics, and drug development.

The major milestones / timeline for the period just completed, as described in the approved proposal, are: i) Screen and select student applicants / at award notification; ii) Coat glass beads with artificial membranes and test their interactions with the KinExA instrument / 2 months; iii) Coat glass beads with cell membranes, and iv) Prepare patent / 3-12 months.

The major accomplishments in relation to the milestones of the project are:

Milestone i): **Screen and select student applicants.** Four undergraduate students and one graduate student have been selected to participate on this project. Detailed information of the students is provided in the "Faculty and student participation in the project" section.

Milestone ii): **Coat glass beads with artificial membranes and test their interactions with the KinExA instrument.** For this task, we produced artificial membrane systems around large glass beads (~50 μm diameter) to be used in the KinExA instrument. The procedure consisted of mixing the glass beads with lipid mixtures in organic solvents, followed by forced evaporation of the organic phase under vacuum for 48 hours. The lipid mixture consisted of 10 mg Asolectine, 4 mg Cholesterol, and 0.6 mg Ganglioside GM1 (which is the target lipid for Cholera Toxin subunit B – CTB, for further studies of binding with KinExA), dissolved in 200 μL chloroform. After hydration of the lipids in a physiological buffer, the formed multilayers have been thinned to bilayers by sonication and tested for CTB binding with the KinExA instrument. To assess the binding, we used a FITC-labelled CTB that presents green excitation under blue illumination. Major results: After bead preparation, their ability to bind the FITC-CTB was assessed by fluorescence microscopy. The bare glass beads showed the absence of any non-specific binding of the FITC-CTB, while the GM1 containing beads provided a strong fluorescent signal, indicative of binding. In the same illumination conditions, the beads prepared with lipids and no GM1 showed no interaction, as indicated by the absence of green fluorescence. Next, we proceeded with introducing the beads in the flow cell of the KinExA instrument and tested the binding/unbinding of FITC-CTB. Our results clearly indicate that the functionalized beads are capable of binding the fluorescent ligand, therefore proving the feasibility of our approach for quantifying protein-membrane interactions by using artificial systems.

Milestone iii): **Coat glass beads with cell membranes**. For this task, we used Jurkat cells (lymphocyte) and sheep red blood cell (RBC) as precursors for the supported membranes. The cells have been mixed with the glass beads and subjected to sonication in a water-bath sonicator for four minutes. The membrane breaking-reforming process enabled reconstitution of the membranes around the glass beads, which have been imaged by fluorescence microscopy in the

presence of lipophilic dyes. Both products showed that the cell membranes have been reconstituted around the glass beads, as observed from the fluorescence yielded upon exposure to appropriate excitation wavelengths. To test the binding with the KinExA instrument, we proceeded by using the RBC-coated glass beads and FITC-antibody capable of binding specifically components of the RBCs. Although the testing of the binding with the KinExA instrument showed specific binding, we encounter problems with repeatability when using the same batch of functionalized glass beads. The analysis of the pressure curves indicated an unusual change in the pressure of the system during the flow of the buffer over the beads. After consultation with Sapidyne, we concluded that the reconstituted membranes were not stable enough and portions of the membranes were shedding while exposed to the fluid flow. This was also observed from microscopy imaging experiments, which indicated an incomplete coating of the membrane, detrimental to the supported membrane stability. To eliminate this major roadblock, we proceeded with an alternative approach for functionalization of intact cell membranes. In this approach, we aimed the binding of the cell membranes directly onto the surface of the beads by using a strong linker such as a biotin-streptavidin system (the strongest non-covalent bond in nature). Our first attempt to functionalize the beads with streptavidin failed since the proteins were not absorbed on the surface of either PMMA or glass beads. Therefore, we decided to functionalize both the beads and cell membranes with biotin, followed by cross-linking with streptavidin. In this respect, we used biotinylated BSA protein, which is very strongly absorbed on the surface of PMMA beads, that are largely used as a solid phase for KinExA experiments. The biotinylated beads have been tested by fluorescence microscopy with FITC-streptavidin, showing an excellent binding between the beads and target proteins. The next major step was the functionalization of the cell membranes with biotin. To achieve this objective, we used a biotinylated lipophilic linker, FSL-biotin. This linker is capable of self-inserting into any lipid membranes in an orientation-specific manner, hence exposing the biotin to the extracellular environment. After cell membrane biotinylation, we cross-linked the beads and the cell membranes in the presence of streptavidin. Both microscopy imaging and binding experiments performed with the KinExA instrument indicate an excellent stability of the functionalized beads, therefore demonstrating the superiority of this approach for studying ligand-cell membrane interactions. With these findings, we are progressing with the analysis of stability, which was proposed to be finalized within the last six months of the project.

1.1 Plans for the coming reporting period

In accordance to the milestones and timeline presented in the proposal, our plans for the upcoming reporting period are:

-finalize the investigations on the stability of artificial and natural membranes reconstituted on beads and establish standard operational procedures to produce and characterize supported membranes for using them with the KinExA instrument.

-quantify antibody affinity for cell surface antigens with KinExA, and quantify the affinity of CTB to artificial membranes containing variable amounts of GM1.

-disseminate the scientific results through publications and presentations.

-submit patent application to the Office of Technology Transfer at Boise State.

-update the documentation of the available KinExA procedures by including full descriptions of the novel technologies.

2. Summary of budget expenditures for the period just completed

The initial budget was amended **with prior approval** as follows:

-the graduate student fee remission cost ($11,898) was distributed between undergraduate student salaries ($5,949), and OE (materials and supplies) $5,711. $238 has been added to the total fringe benefits. This re-distribution was required because the two graduate students working on this project received the student fee remission from other sources.

-prior ISBOE approval has been obtained to purchase a biosafety cabinet ($6,960.66) needed for cell culturing in the PI lab, which is used in conjunction with the CO_2 incubator. The total equipment budget did not change because of this acquisition.

Below it is the summary of the budget expenditures for the reported period:

Salaries

PI summer. Budgeted: $7,867; Spent: $7,867; Burn rate: 100%

Undergraduate students. Budgeted: $11,349; Spent: $3,229; Burn rate: 28.5%

OE

Materials and supplies, Computers, Red Laser upgrade, Recharge center. Budgeted: $37,511; Spent: $14,608.85; Burn rate: 38.9%

Capital equipment. Budgeted: $14,800; Spent: $10,747.64; Burn rate:72.6%

Note: Capital equipment purchased for this reporting period: Biosafety cabinet ($6,960.66), CO_2 incubator ($3,786.69)

3. Faculty and student participation in the project

The PI (Dr. Daniel Fologea, Physics) and the co-PI (Dr. Denise Wingett, Biology) fully participated in the developments related to this project for the reported period. Dr. Rebecca Hermann provided continuous assistance and technical expertise with cell culture initiation, maintenance, and assessment, including proper student training. All the participants underwent CITI training for biosafety and work with mammalian cell cultures. Together, the PI and the co-PI selected four undergraduate students to work on this project: Colleen Poulton and Jessika Dagostino (Biology), Lizzie Leung (Health Sciences), and Andy Bogard (Physics). The students have been hired as research assistants for this project, and worked an average of 10 hours/week (the stipend has been paid from the budgeted funds). Also, a BMOL graduate student, Mark Smith, was involved full time in the research work of this project. Mark benefited from a research assistantship from the BMOL graduate program but this research is a major component of his dissertation research. In addition, another graduate student (Marcelo Ayllon, a Hispanic graduate student) became fully involved in this project and decided to use the novel technology

for his dissertation research focused on quantifying the interactions between cholera toxin and artificial lipid membranes, with the goal of screening drug inhibitors and producing decoy targets for in vivo application. Three out of four undergraduate students are women, one is a native American, and one graduate student is Hispanic, therefore the workforce dedicated to this project has a great diversity index.

4. Progress with patents and copyrights

Preliminary discussions about patenting the technology of producing supported membranes for integration with the KinExA technology have been initiated with the Technology Officer at Boise State University when the award was announced. Our first disclosure draft included formation of supported membranes by using glass beads and sonication for both artificial and natural cell membranes. However, our new findings with regards to the excellent stability of either artificial or natural cell membranes supported by PMMA beads and crosslinked via biotin-avidin requires a major update of the disclosure for patenting. This work is currently underway, and it is within the timeline proposed for this task (3-12 months).

5. Technology licenses signed and start-up businesses created

The proposed technology is intended to be included into and offered with the line of KinExA instruments produced and commercialized by the partner company, Sapidyne instruments. Sapidyne is a well-established company, which operates worldwide from its headquarters in Boise and is the sole developer, manufacturer and supplier of the patented KinExA family of scientific instruments. The company has well established commercialization and marketing paths in place. Boise State University is seeking IP for the newly developed technology, which will be licensed by Sapidyne. The company will use their marketing and commercialization strategies for adoption of the newly developed technologies for their current and new customers.

6. Status of private part/industry partnerships

This project provided opportunities for developing an outstanding partnership with the industry partner, Sapidyne Instruments from Boise, which is the producer of the KinExA Instrument. Sapidyne loaned free of charge a KinExA3200 instrument and the Autosampler as kind-in contribution for the duration of this project, which have been set by the company in the PI's lab at Boise State University. They also provided multiple supplies for this project, and on-site training for the students and faculty involved in this project. Numerous meetings have been set up for discussing the progress with this project, the roadblocks, and for troubleshooting. Also, Sapidyne provided assistance with beads sorting, binding procedures, and donated multiple items required for cell cultures to the participant faculty. The company is extremely pleased with the progress of our investigations, especially with the proposed strategy of creating supported cell membranes by direct attachment of the cells to the PMMA beads. Once our scientific results are validated, the research team will disseminate the scientific results through presentations and publications, while Sapidyne will expose and promote the novel technologies together with the instrument at market fairs and scientific meetings at local, regional, national, and international venues. This technology will create a great advantage for the company over competitive instruments, which is expected to result in a significantly increased share market.

7. Other information and conclusions

All the milestones stated in the proposal for the reported period have been met or exceeded. A significant progress is reported ahead of time with regards to the stability of the supported membranes, which is a crucial achievement for the proposed development. Two abstracts with student first authors and related to the scientific findings have been accepted for presentation at the prestigious Biophysical Society meeting in February 2018 (San Francisco, CA), which will provide an excellent opportunity to present the new technology to more than 7,000 participants. All the undergraduate and graduate students participating at this project are included as co-authors of the presentations. The newly developed methods raised a sustained interest from several scientists at Boise State University, which are planning to use it for quantitative measurements to be included in several federal grant proposals. A manuscript that includes our findings is currently under preparation, and an updated disclosure discussed with the Technology Officer at Boise State University.

Idaho Incubation Fund Program

Progress Report Form

Proposal No.	**IF18-006**
Name:	**Sin Ming Loo, PhD**
Name of Institution:	**Boise State University**
Project Title:	**Infrasound Detector for Localizing Gun Shot**
Reporting Period:	**Sept – Dec 2017**

Information to be reported in your progress report is as follows (attach additional information as needed):

1. Summary of project accomplishments for the period just completed and plans for the coming reporting period:

- Deployed detection array in Little Cottonwood Canyon near Salt Lake City, Utah, along highway that accesses Snowbird and Alta ski resorts as part of an avalanche detection study. This deployment is part of Utah DOT study looking for ways to upgrade and expand the present avalanche detection systems being used.
  - Redesigned microphone sensor enclosure to improve environmental stability and reduce wind noise level.
  - Developed a control board enclosure for ease of system deployment and data collection.
  - Designed a battery + photovoltaic power system to ensure continuous operation for the winter months.
- Built a second system for deployment and testing here at Boise State University.
  - The array will be mounted on the roof of the Micron Engineering Center building to collect data on infrasound sensitivity and internal sensor noise levels.
- Planned worked
  - Based on environmental data, develop filters and algorithms to ensure infrasound detection between 0.5Hz and 20Hz.
  - Calculate and program threshold limits for avalanche and gunshot detection into present firmware based on ongoing environmental testing.
  - Upgrade present control board with WiFi and Bluetooth connectivity for real-time remote data collection and expand file system memory capability.
  - Investigate the use noise cancelling to eliminate noise outside of the desired infrasound range.

2. Summary of budget expenditures for the period just completed (include project burn rate):

    - Original Budget: $74,600
    - Expenses from September 2017 to December 2017: $7,392
    - Note: The burn rate is slower than planned as we started in September 2017. One more student has been hired to work on this project. He will start January 2018.

3. Numbers of faculty and student participation resulting from the funding, including internships:

    - Primary Investigator Prof. S. M. Loo
    - Graduate/Undergraduate Study Employees: Mark Laverty, Austin Davis, Grady Anderson

4. List patents, copyrights, plant variety protection certificates received or pending:

    - None at this writing

5. List technology licenses signed and start-up businesses created:

    - None at this writing

6. Status of private/industry partnerships (include enough information to judge level of engagement):

    - The project will continue to work with WMDTech; a local business that provides training and implementation of explosive device detection and neutralization.
    - WMDTech along with their Utah Law Enforcement contact have suggested the gunshot detection array could be used by fish and game to detect and mitigate poaching.

7. Any other pertinent information that will indicate to the council that the project is meeting satisfactory progress.

    - A second prototype is being setup on the Micron Engineering Center's roof for system debugging and long-term reliability testing
    - WMDTech have been contacted and agreed to do gunshots testing.

Idaho Incubation Fund Program

Progress Report Form

OSP Proposal No.	**7855**
Name:	**Gaby Dagher**
Name of Institution:	**Boise State University**
Project Title:	**Malicious Community Extractor (MACE): A Robust Toolkit for Unmasking Criminal Networks**
Reporting Period:	**July 1st, 2017 to December 31st, 2017**

Information to be reported in your progress report is as follows (attach additional information as needed):

1. Summary of project accomplishments for the period just completed and plans for the coming reporting period:

1.a Summary of accomplishments

- We completed developing an investigator-centric interface for MACE that is optimized for how investigators intend to use the MACE toolkit.
- We designed the test cases for testing the MACE toolkit, and we are at the final stage of executing the quality assurance plan to thoroughly test the MACE toolkit, including the new user interface.

1.b Plans for next reporting period [Jan. 1st, 2018 - June 30th, 2018]

- To complete the execution of the quality assurance plan.
- To benchmark the MACE toolkit's performance against existing state-of-the art cyber forensic tools.
- To Beta-Test the MACE toolkit to evaluate usability, ensure functionality and to validate accuracy.
- To start marketing the MACE toolkit to cybersecurity companies and to law enforcement agencies at the local, state, and federal levels.

2. Summary of budget expenditures for the period just completed (include project burn rate):

See attached file: MACE_Mid-year_Financials.xlsx

3. Numbers of students participated in the project so far:

2 – Graduate
3 – Undergraduate

4. List technology licenses signed and start-up businesses created.

None yet.

5. Any other pertinent information that will indicate to the council that the project is meeting satisfactory progress.

We will soon submit for publication a manuscript on the current stage of the MACE toolkit.

IGEM# 16-01

Computer Science at Boise State University:

An Investment in Idaho's Future

1st July 2017 –1st January 2018 Progress Report

BOISE STATE UNIVERSITY

IGEM #16-01

Computer Science at Boise State University: An Investment in Idaho's Future

1st July 2017 – 1st January 2018, Annual Report

Table of Contents

IGEM 16-01: Computer Science at Boise State University: An Investment in Idaho's Future

1st July 2017– 1st January 2018 Progress Report

Project Summary

The Idaho Global Entrepreneurial Mission (IGEM) and the State Board of Education Higher Education Research Council (HERC) have provided three years of funding to continue the strategic forward momentum of the Boise State University Computer Science Department to help meet compelling state economic development, research, and workforce needs.

This progress report summarizes the activities of the first six months during the third year of the project.

Project Accomplishments

The project plan identified four primary strategies to achieve this goal:

1. *Sustain current faculty lines and continue forward trajectory.*
2. *Increase partnerships with local companies to facilitate knowledge development and transfer*
3. *Increase CS related research and economic development activity.*
4. *Produce more computer science graduates that qualify for software and related technical positions in Idaho*

Progress to date toward implementing these strategies is detailed in the following subsections.

Strategy One: Sustain Current Faculty Lines and Continue Forward Trajectory

The current IGEM grant supports five faculty (one full professor, one associate professor, and three assistant professors) – Dianxiang Xu, Steve Cutchin, Elena Sherman, Edoardo Serra, and Sole Pera (partial support). Two of the faculty are in the area of software engineering while two are in the area of data science (and databases) and another in visualization. Dr. Xu led the effort to create the PhD program and the governance of it has now transitioned to two Co-Directors and a steering committee. Dr. Cutchin became the Director of Research Computing (split 50% with his faculty appointment), which is allowing him to increase the reach of his efforts to more researchers across the campus and beyond. Dr. Sherman, Dr. Serra and Dr. Pera have also taken appropriate leadership roles in the department.

Another strong impact of the IGEM grant has been in the additional hiring that the department did in the previous year. Using the eight lines provided by JFAC and other funding, the department

successfully hired eleven faculty in less than one year! Overall, the department now stands at **27 faculty members**, an increase in size of over 300% from four years ago. In each case, the faculty hired were among the top choices in the respective areas. Given the extremely competitive nature of hiring in computer science, the hiring success has been very successful. This fall is the start of the second year for these new faculty. We have retained all the faculty that were hired last year, which is better than many CS departments at other Universities.

Strategy Two: Industry Partnerships

The CS Department continues to increase its formal and informal connections with industry and the IGEM hires are integral to the following initiatives and connections. The new downtown location has been particularly conducive to growing partnerships with industry.

Boise State University supports and encourages CS faculty to establish partnerships with industry via joint research projects, service on industrial boards, consulting and faculty and student involvement. We have several ongoing examples of faculty working with our industry partners:

- The department recently received a $2 million award from NSF to revolutionize the middle two years of the undergrad computer science program. It was one of seven awards out of 80+ proposals received from across the country. A major goal of this five-year project (titled: *CS Professionals Hatchery*) is to create unique learning experiences (named *Hatchery Units*) for our students in conjunction with industry so students graduate with better professional skills and are able to hit the road running in a way that is an exemplar for other programs everywhere. Seventeen companies are involved in the design of the hatchery units and integration with the curriculum. In Fall 2017, several of these professional Hatchery Unit courses were taught for the first time with help from industry. These include CS-HU 130 (Foundational values), CS-HU 271 (Agile Development), and CS-HU 390 (Technical Interviews, Jobs and Careers). A total of 14 proposals for Hatchery Unit courses were received from teams of faculty and industry partners. These will be implemented over the next two years.

- The new downtown location has led to many informal and formal meetings and visits from industry. For example, several companies and agencies have hosted their strategy retreats/meeting in our space. These include: Micron, HP, Metageek, AppDetex, Idaho Technology Council, Idaho Dept of Commerce, and State Board of Education. Such meetings have led to multiple informal networking opportunities for the faculty and students.

- Dr. Tim Andersen has continued as a consultant at Micron, and is also currently working as a consultant at AppDetex, a local startup company.

- Dr. Sole Pera is working on the advisory board at ReleVent City, a recent Boise startup.

- Dr. Steve Cutchin is working as a consultant for Digital Mechanics, a 3D capture and reconstruction startup.

- Drs. Andersen, Cutchin, Serra, and Spezzano have finished a research project on *Precision Agriculture* with J.R. Simplot Co., that was also funded by IGEM, helping them to fuse information from multiple sources (such as historical yield data, satellite imagery, sensor data, and etc.) to assist farmers in intelligent decision making. This project also involved multiple graduate students and a post-doc. Their research results have been widely circulated inside Simplot and they are looking into ways to put it into production.

- 7 Industry partners committed to donate an additional $70,000 to the Expand.CS Scholarships program, which has allowed us to offer at least 14 new scholarships to students for the 2017-2018 academic year. These scholarships are designed to encourage and help students to finish their degree faster. The industry partners who donated are AppDetex, Clearwater, HP, Impact Sales, MetaGeek, Paylocity and Whitecloud.

Community Events. The CS Department continues to host *Boise Code Camp* and participate in *develop.idaho* and *Hackfort* to strengthen connections with industry and entrepreneurs. The Boise Code Camp has grown to over 1000 participants in 2017 and continues to be one of the largest code camps in the Northwest.

Senior Design Projects. **In Fall 2017, 10 new senior capstone projects were sponsored by 6 local industry partners, organizations and startups**. We are working with companies from multiple sectors including high-tech, health care, government, transportation, non-profits, and agriculture.

Industrial Advisory Board. Alden Sutherland, VP and Chief Information Security Officer at AmerisourceBergen (a Fortune-16 company that recently bought multi-billion dollar local company MWI), currently heads the board. The board meets at least twice yearly with the department and provides feedback and strong support for curriculum, facilities, and hiring.

Strategy three: Increase research

The rate of research grant submissions continues to increase, with **28 grant proposals submitted** in the first six months of 2017-2018. As a comparison, last year we had 33 grant proposals submitted for the entire year. **Six new** grants were **funded** during Fall 2017 for a total funding of $604,397. Most of the others are pending review.

Last year we had nineteen awards for a record $4.47 million (not including $700K from this IGEM award). Despite that, the faculty continue to be active in pulling in new funding in the first five months of this year. **Compared to three years before the first IGEM award (2010-2012), the total research funding since then (2013-2017 – 4.5 years) has gone up by 50x!** (From $209K to $10.57 million. This does not include the two IGEM awards.)

The inter-disciplinary PhD in Computing program was started in Fall 2016. The program has emphasis in Computer Science, Cyber-Security, and Computational Science and Engineering, with a planned

emphasis in Data Science in the near future. The PhD program now has 15 students, up from 3 last year. It involves faculty from multiple departments across the campus. The PhD program has the potential to significantly increase the research profile of the department and college and to draw top-notch talent to come to Boise State University and potentially end up in local industry.

Last year, with additional JFAC funding, the department had started the work to create the CLICS (Cyber Lab for Industrial Control Systems) lab. The CLICS lab is now operational in the new space in the adjoining US Bank building. It was designed in collaboration with Idaho National Lab and several companies such as GE, Honeywell, Idaho Power, Suez Water and others. . Dr. Hoda Mehrpouyan and Dr. John Stubban are the co-directors of the lab. Several other faculty are also involved in this lab. The lab has state-of-the-art equipment for process control testbed and smart grid testbed.

Strategy Four: Enhancing the Student Pipeline

In Fall 2017, we started the second year in the new City Center Plaza building in downtown Boise. Located at 777 West Main Street in Downtown Boise, adjacent to the Grove Plaza, City Center Plaza (CCP) is in the heart of Boise's technology ecosystem. The Department of Computer Science occupies a first floor lobby that connects by elevator/stairway to the second and third floors where classrooms, offices and labs are located. Recently, the department has also expanded into the 2nd floor of the adjoining US Bank building.

This new location provides computer science students with an unparalleled opportunity for internships and other interactions with industry in a modern and inviting learning environment. The new location is already lead to an increased interest from potential students, both in-state and out-of-state, in the Computer Science department.

The undergraduate program continues to grow each year with **711 students in Fall 2017**, a 3.5% increase from 687 in Fall 2016. The total number of students (majors, minors, graduate students) is now **937**. Last year 69 Bachelors and 16 Masters students graduated. There have already been 35 Bachelors and 15 Masters graduates in Summer/Fall 2017. With around 110 students in senior-level Operating Systems (CS 453 course, F'17-S'18, one of the last classes they take), we expect the total number of graduates this year to go up again significantly. We also expect to have a record number of Masters students completing this year.

The Computer Science major continues to be one of the largest major for incoming freshmen in Fall 2017. Last year 90% of graduates accepted jobs in Idaho versus around 80% historically. So not only is the output increasing, the in-state retention after graduation has also improved. We will have data for this year in time for the annual report but we expect similar results.

The IDoCode project (funded by the National Science Foundation) to introduce high quality computer science in high schools is in its fourth year. We now have 62 teachers in four cohorts. As a result of the

work of the CS faculty and their external partners, we have around **1400+ high school students taking computer science courses in Fall 2017** in Boise and West Ada school districts alone, which is a **32x increase** from three years ago.

All of the above point towards a booming student pipeline that is promising to increase the computer science workforce in Idaho significantly. As an example of its impact, we continue to see software companies locating near the new CS downtown location. Kount, which received an $80 million investment last year, is planning to move to a remodeled building 2 blocks from the CS department and expect to hire 80-90 new employees[1]. Tangocard, a software company from Seattle, opened an engineering office in Boise in the Hoff building, again 2 blocks from the CS department so that they can actively recruit from us. Paylocity is opening a new software development center within a block or two of the CS building in 2018 and holding a special session for CS seniors. The list keeps getting longer each year!

Future Plans

The department is well on its way to further sustained growth in all areas. We expect the number of graduates to be around 80-90 this coming year. The research activity continues to be at a high-level and the interaction with industry continues to increase and deepen with the new downtown location. After some time to settle down after the hectic growth, the department needs to start planning for the next round of growth!

Faculty and Student Participation

Five faculty and twelve graduate research assistants were supported directly on this grant. The supported faculty have in turn worked with more students and staff because of grants they received. As a result there were a total of **five faculty, 49 students/staff** that were supported directly or indirectly (excluding the three PIs). Additionally, several additional students have started internships at local companies because of the renewal of the Expand.CS program this fall.

Name	Undergraduate	Graduate	Post-docs	Visiting Researchers
Steve Cutchin	9	6	0	0
Edoardo Serra	0	3	1	0
Elena Sherman	2	3	0	0
Dianxiang Xu	12	4	1	1
Sole Pera	3	4	0	0
Total	26	20	2	1

Patents and Copyrights

There are no patents or copyrights to report at this time.

[1] https://idahobusinessreview.com/2017/09/11/kount-will-move-across-the-river-and-into-downtown/

Startups and Technology Licenses

Students were involved in the following new startups, supported by Co-PI Jim Conrad and Bogdan Dit via the Senior Design course. Some of these startups are in conjunction with Boise State Venture College.

- Nelson Irrigation — water saving system and app for farmers
- LittleAuthors — continued work on startup from last year. Story-telling/creation app for children
- Predictable Ryde — continued work on startup from last year. Real-time bust information to parents and schools

Expenditure Report

Five faculty and twelve graduate assistants were directly supported via the IGEM grant during this period.

Budget from July 2016 to June 2017				
Category	**Salary**	**Fringe**	**Tuition**	**Total**
Faculty	$177,130.63	$51,058.49		$228,129.12
Graduate Assistants	$83,601.76	$11,751.90	$8,754.00	$104,107.66
Total	**$260,732.39**	**$62,810.39**	**$8,754.00**	**$332,296.78**

Idaho Incubation Fund Program

Progress Report Form

Proposal No.	**IGEM16-002**
Name:	**Kurtis Cantley**
Name of Institution:	**Boise State University**
Project Title:	Enhancing Capabilities in Microfabrication at Boise State
Reporting Period:	**July 1, 2017 through December 31, 2017**

Information to be reported in your progress report is as follows (attach additional information as needed):

1. Summary of project accomplishments for the period just completed and plans for the coming reporting period:

   A comprehensive report on the status of this IGEM project was submitted in May 2017, followed by a year two report in July 2017. The earlier document contained detailed information about faculty grant activity and use of the Idaho Microfabrication Laboratory (IML) for education and research as well as external partnerships. It provided strong quantitative evidence for the positive impact the IML is having at Boise State and across Idaho in terms of education and research productivity. The total number of faculty and student users as well as proposals submitted that rely on the IML has been growing consistently for the last four years. The IML is the most accessible provider of advanced semiconductor processing and fabrication and additive manufacturing equipment in Idaho.

   In the past six months, we have continued to build on the previous improvements and successes made possible primarily through IGEM investment and support. One of the main long-term growth strategies was of course to add new fabrication and characterization capabilities, but also to make investments that would allow the IML to handle a higher number of concurrent users. Adjustment of hourly rates to more accurately reflect actual costs of tool operation has also made the IML more attractive to a broader user base. The result of these proactive policies is continued substantial growth in usage hours by both internal and external users. Specifically, **the first two quarters of FY18 have seen double the number of internal student use hours and nearly triple the number of external (industrial) use hours relative to the first half of FY17.**

   Several recent accomplishments have helped further the technological capabilities and process throughput of the IML. A highlight from fall 2017 was the purchase and installation of an additional AJA Orion physical vapor deposition (sputtering) tool for a heavily discounted price from a local company (QTI Sensing Solutions). One AJA Orion system has already been in operation in the IML for the past several years. It is has been extremely heavily used, such that it often becomes difficult to reserve time on the equipment to perform depositions. At the same time, it has also

historically generated the most revenue of any tool. At a cost of $30,000 plus $25,000 budgeted for upgrades, we have effectively doubled the capacity of the IML for depositions of thin-film insulators, semiconductors, and metals (including mult-layered alloys). A similar system purchased new would cost in the range of $250,000-$300,000. A list of other highlights from the previous six months is provided below:

- Upgrades to the Oxford PlasmaLab 180 inductively coupled plasma (ICP) etcher have been successfully installed by a technician from the company. These included an Ocean Optics USB3000 optical endpoint detection system and the addition of an argon gas delivery line with mass flow controller. This upgrade has greatly improved process control on the tool and expanded its etching capabilities to numerous other materials.
- Ownership of a recently acquired aerosol jet printer and ultraviolet sintering tool was transferred to the IML after departure of a faculty member from Boise State. Funds were used to install support infrastructure for these pieces of equipment, which furthers the stated mission of this grant in expanding expertise and augmenting existing capabilities in the emerging research areas of flexible/printed electronics and thin-film and 2D materials.
- Ownership of an nScript 3DN Microdispense System was also transferred to the IML and that tool is fully operational in the additive manufacturing portion of the lab (ENGR 106).
- The formerly purchased OAI contact printing system has been fully and upgraded with the capability to handle 8” wafers. This capability has already been utilized by American Semiconductor, Inc. for their fabrication process.
- The additional 200 A electrical panel has been installed to provide additional capacity to instruments in the clean room. To save money, this project was added on to the larger project involving a new power transformer servicing the ENGR and MEC buildings.

2. Summary of budget expenditures for the period just completed (include project burn rate):

   As of January 1st 2018, approximately $132,000 of the $203,000 budget for equipment and other expenses has been spent. With salaries and benefits included to date for graduate students, the technical support engineer (Travis Gabel), and Prof. Harish Subbaraman totaling $116,000, the grand total spent in the first six months is $249,000. **This value corresponds to a burn rate (excluding remaining salaries) of approximately $41,500/month** averaged over the first six months of the fiscal year. Major purchases and expenditures include:

   - $30,000 for the AJA sputter system purchased from QTI Sensing Solutions.
   - Additional funds up to $25,000 budgeted upgrades to the new AJA sputter system ($9,600 already spent).
   - $10,000 matching funds provided to Profs. David Estrada and Harish Subbaraman for a successfully funded DOE proposal for electronic ink development and metrology equipment (complementary to IML areas of focus).

- Approximately $115,000 in salary and benefits for ECE faculty Dr. Harish Subbaraman (for the year).
- $12,000 on the new 200 A electrical panel.
- Approximately $105,000 in salary and benefits for technician Mr. Travis Gabel for the full year.
- Graduate student stipends and benefits totaling approximately $77,000 for the year.
- $102,000 in total for supplies, and facility and equipment upgrades and installation.

3. Numbers of faculty and student participation resulting from the funding, including internships:

   For the spring 2018 semester, there are three full-time PhD students supported by the project. Prof. Harish Subbaraman and the technical support engineer (Travis Gabel) also continue to be supported with salary and fringe benefits. Information on the students being directly supported this year as well as their advisors, projects, and pertinent information is provided below:

   - Sumedha Gandharava (Prof. Kurtis Cantley) – Researching resistive memory device simulation, fabrication, and electrical characterization. Sumedha was employed in a 6-month internship at Micron Technology during the fall 2017 semester where she worked on electrical testing of phase change memory technology.
   - Pradeep Kumaradrivel (Prof. Kris Campbell) – Working on memristor and electronic device fabrication, process integration, and testing.
   - Twinkle Pandhi (Prof. David Estrada) – Researching printed electronics and sensors. Received a student travel award as well as a 2nd place poster award at the 2017 FLEX conference in June, the nation's leading forum for flexible, printed and hybrid electronics technology.

   Several other students have also received awards and internships that were either directly enabled by or related to work in the IML that was made possible by IGEM funding. This list includes:

   - Kiyo Fujimoto (Prof. Dave Estrada) – Upon entering graduate school, Kiyo was initially awarded a 3-year DOE Nuclear Fellowship. This year, she also received a prestigious INL Graduate Fellowship. In large part, Kiyo's work that led to the fellowship was enabled by IGEM through the additional additive manufacturing capabilities in the IML (the Dimatix materials inkjet printer and the Optomec aerosol jet printer and associated UV sintering equipment). Recipients of INL's Graduate Fellowship will have their university tuition and fees covered during the last two years of their doctoral research, plus a $60,000 annual salary paid by INL for their work at the lab. A link to the press release of this announcement is at the end of the report.
   - Binay Joshi (Prof. David Estrada) – Binay was funded on IGEM for part of last year, and was an intern at FiberGuide, Inc. in summer 2017. He continues to collaborate with FiberGuide in their product development efforts.

- Tony Varghese (Profs. David Estrada and Yanliang Zhang) – Tony received a best poster award and cash prize at the 36th annual ınternational Conference on Thermoelectrics (ICT 2017) in Pasadena, CA in August.

4. List patents, copyrights, plant variety protection certificates received or pending:

   "Optically Gated Transistor". Inventor: Campbell. Provisional Patent filed May 2017.

   "STARShiP: Strain sensing using AeRosol jet Printing of flexible capacitive strain gauges". Inventors: Watinks, Elquist, Warren, Riggs, Estrada, Fujimoto. Provisional Patent filed May 2017.

5. List technology licenses signed and start-up businesses created:

   At this time there are no start-up businesses created as a direct result of IGEM funding. However, memristor (resistive memory) technology and processing techniques developed by Prof. Kris Campbell in the ECE department continues to be licensed by Knowm, Inc. and M. Alexander Nugent Consulting (MANC) of Santa Fe, NM. Their projects have been ongoing, resulting in significant use of and revenue for the IML, and accounting for approximately 25% of all licensing revenue at Boise State in calendar years CY16 and CY17.

6. Status of private/industry partnerships (include enough information to judge level of engagement):

   External interest in use of the facility continues to grow rapidly. Not only is the number of external use hours increasing at a much faster rate than the 30% per year outlined in the original proposal, but the overall number of external partners continues to grow. Several new agreements with Idaho businesses and organizations have been put in place since the start of the project to use the IML and new equipment and processes contained in it. A list of currently active external partners and associated project includes:
   - Idaho National Laboratory (INL, Idaho Falls, ID) – The Idaho National Laboratory is continuing to expand its collaborative work with Boise State. One of the emphasis areas is advanced manufacturing, and the IML plays a key role in this initiative. A large program on in-pile instrumentation was funded in August 2017 with the effort at Boise State centered on the investigation of materials for sensors. This work is heavily utilizing the IML. In addition, the Center for Advanced Energy Studies (CAES) is expanding its efforts in advanced manufacturing and is working more closely with Boise State on additive manufacturing. Additional funding is expected in FY 18 that will include funds in the budget for work in the IML.
   - American Semiconductor, Inc. (Boise, ID) – American Semiconductor has continued to heavily use the facility for a number of activities including photolithography, wet chemical etching and processing, and metrology. Their results have been presented at multiple conferences and workshops with

credit to the IML at Boise State. In 2017, they received a grant from NextFlex, America's Flexible Hybrid Electronics (FHE) Manufacturing Institute, to develop and deliver mechanically flexible RFID tags that can automatically log and wirelessly transmit environmental data. Profs. David Estrada and Harish Subbaraman are collaborators on this project.

- Fiberguide Industries (Caldwell, ID) – Fiberguide continues to increase their use of resources recently acquired by the IML including the new AJA sputter system as well as the new additive manufacturing inkjet and aerosol jet printers in their work involving gold coated fiber optics.
- Emerson Cargo Solutions (formerly PakSense, Inc., Boise, ID) – Emerson has been performing collaborative research, particularly with Profs. Harish Subbaraman and David Estrada through their recent IGEM grant to develop sensors that help detect potato rot.
- Micron Technology (Boise, ID) – Micron has sponsored a senior design team to identify the relationship between the structure of a semiconducting superlattice and its electrical properties using IML high temp annealing resources. This is a continuation of a project first started in the IML in the Fall of 2017.
- L3 Technologies (San Diego, CA) – Collaborative research with Prof. Maria Mitkova to develop amorphous to crystalline transition materials for optical recording. L3 paid a student (Karishmae Kadrager) to perform work in the IML, as well as Prof. Mitkova as a consultant.
- QTI Sensing Solutions (Boise, ID) – QTI is currently using the new Bruker Stylus Profiler as part of their incoming inspection routine for received brass housings as part of their quality inspection program.

7. Any other pertinent information that will indicate to the council that the project is meeting satisfactory progress.

   Another emphasis area for the IML is providing additional opportunities for education through new courses and labs. This fall, ECE 440/540 (Introduction to Integrated Circuit Processing) had 12 total students enrolled. In spring 2018, a new ECE 497/597 (Memristor Fabrication) class being taught by Prof. Kris Campbell has 18 students currently enrolled (see photo). Another course taught by Prof. Dave Estrada on Nanoscale Transport processes makes use of a $25,000 NASA CLUSTER grant to develop new devices such as strain gauges using additive manufacturing (link to press release is below). Finally, the MSE 280 (Intro to Materials Lab Practice) course will have approximately 15-20 students this semester (spring 2018) involved in projects that use the IML in some capacity for materials development. Many employers consider these types of hands-on learning activities to be very positive experiences.

A photograph of one of the memristor fabrication course lab sections learning photolithography techniques in the clean room.

Press release for Kiyo Fujimoto's INL fellowship:
https://news.boisestate.edu/update/2017/10/02/students-awarded-prestigious-idaho-national-lab-fellowships/

Press release for Nanoscale Transport class:
https://news.boisestate.edu/update/2017/05/16/nanotechnology-reaching-new-heights-boise-state-university/

Security Management of Cyber Physical Control Systems July 2016-June 2019

Year 2 Mid-Year Report

State Board of Education
Higher Education Research Council
Idaho Global Entrepreneurial Mission (IGEM) Initiative Grant

Grant Number IGEM17-001

University of Idaho, College of Engineering

Project Director and PI: Larry Stauffer, Dean

Co-PI's: Fredrick Sheldon, Chair and Professor, Computer Science
Brian Johnson, SEL Endowed Chair, Electrical & Computer Engineering
Michael Haney, Assistant Professor, Computer Science
Daniel Conte de Leon, Assistant Professor, Computer Science

Executive Summary

Cyber-attacks and intrusions are nearly impossible to reliably prevent given the openness of today's networks and the growing sophistication of advanced threats. Knowing the vulnerabilities is not adequate, as the evolving threat is advancing faster than traditional cyber solutions can counteract. Accordingly, the practice of cyber security should focus on ensuring that intrusion and compromise do not result in business damage or loss through more resilient solutions. We are creating a platform to facilitate and build complementary and multidisciplinary R&D capabilities to address these pressing problems. Our platform will incubate innovative products and services for safeguarding cyber physical control systems (CPCSs) that are ubiquitous and underpin key sectors of our economy. Early participation of industry will aid in vetting promising technologies. Better methods for assessment combined with more resilient systems design will safeguard against potentially immense economic impact currently being faced by Idahoan stakeholders.

Idaho SBOE Contact:
Caron Howell
(208) 332-1563
Carson.howell@osbe.idaho.gov

Security Management of Cyber Physical Control Systems
July 1-December 31, 2017

Table of Contents

I. Summary of Project Accomplishments and Plans

This report provides the status of the project titled "Security Management of Cyber Physical Control Systems" which is an Idaho Global Entrepreneurial Mission (IGEM) Initiative Grant # IGEM17-001 sponsored by the Higher Education Research Council (HERC) of the Idaho State Board of Education (ISBOE). We are concluding the first eighteen-months of this three-year project and this report provides an update of progress during the time period of (July 1-December 31, 2017).

During the next six-month period, January 1-June 30, 2017, we plan to continue with our work plan as described in the proposal. Specifically we plan to complete the hiring of faculty and graduate students and place six student interns with industry partners. With regard to infrastructure enhancements we plan to complete the equipment installations in the power systems laboratory and start installation of the node in Coeur d' Alene. We will also make preparations for the third and final year of this project.

II. Budget Expenditures

Expenditures July 1 - December 30, 2017				
Category	Approved	Expenditur	Remaining	Notes
Salaries	$ 460,715	$224,278	$236,437	faculty and students
Fringe Benefits	$ 128,732	$ 54,145	$ 74,587	faculty and students
Travel	$ 10,000	$ 5,836	$ 4,164	
Operating	$ 78,153	$ 9,093	$ 69,060	saving for upcoming search expenses
Capital Outlay	$ -	$ -	$ -	
Tuition	$ 22,400	$ 11,974	$ 10,426	
Total	$ 700,000	$305,326	$394,674	

III. Demonstration of Economic Development/Impact

In this section we detail our accomplishments, organized by the four Objectives of the project.

(1) Strengthen our capacity by adding key faculty and enhancing laboratories.

In the second six months of 2017 we made substantial progress on laboratory enhancements, building collaborations, and producing research results. We added a new faculty member from last year's search process and reassigned the time of an existing faculty member to make progress on the goals of the project. We also continued the search process for the final two faculty positions called for in the proposal with on-site interviews scheduled for January. We also hired two PhD graduate students. A summary is as follows:

III.1.A Faculty Searches

Our work plan calls for the hiring of four new faculty members. We now have two of these faculty working. The latest hire is professor Dakota Roberson. Dr. Roberson earned a PhD in Electrical Engineering from the University of Wyoming in 2017. During his studies, he was also a half-time intern for Sandia National Laboratories. Being located in our program in Idaho Falls is an excellent fit for his national laboratory background and is already helping us in our work with the Idaho National Laboratory. His area of expertise is in wide-area damping control to control the effects of asymmetric time delay in geographically disparate locations, impact on coupling due to sensor/output collocation issues, and forced oscillations in the wide-area damping control environment. These situations matter because grid operators consider all of these limitations as they develop control systems to be implemented in their jurisdiction. However, sensor/output collocation disparities may limit their ability to ever implement the control.

We are currently conducting searches for the following two remaining positions. Knowing the difficulty in finding faculty in these particular areas we started the searches last year and are on our second round of reviews. We have three individuals scheduled to interview for the Idaho Falls position in Idaho Falls January 8, 10, and 11. We have been conducting telephone interviews with candidates for the position in Moscow and expect to have on-campus interviews towards the end of January. These positions are:

- Assistant Professor in Computer Science in Idaho Falls; expertise in security in internet of things.
- Assistant/Associate Professor in Computer Science in Moscow; expertise in cyber security of cyber-physical controls systems.

II.1.B Graduate Students

Currently two graduate students, both in PhD programs, are working as research assistants under the project--Mohammad Ashrafuzzaman and Ananth A. Jillepalli. Both were hired at the beginning of fall 2017 semester. Mohammad was assisting Krishna Koganti (who graduated in summer 2017) with his work on the VMWare based Industrial Control Systems (ICS) Testbed project. Mohammad authored a paper based on this work that was accepted for the MALCON2017 conference. For his own research under this project, Mohammad is working on detecting and preventing stealthy cyber-attacks on cyber-physical power systems using deep learning techniques and cybernomics. He has started applying deep learning algorithms to detect false data injection attacks in power systems. The data-sets he is using are being generated by a MATLAB simulation by Dr. Yacine Chakhchoukh. Mohammad has presented the idea as a poster in the Pacific Northwest Industry Workshop and is now writing a paper for submission in a journal.

Ananth Jillepalli is developing a High-level and Extensible System for Training and Infrastructure risk Assessment (HESTIA) for cyber physical control systems (CPCS) infrastructure. Identifying vulnerabilities in a CPCS infrastructure can be challenging without a high-level security policy specification. Yet knowing the security policy specification is not sufficient to eliminate vulnerabilities. Knowledge of possible attacks and respective defense

measures are also needed to secure CPCS infrastructure. Ananth has also assisted Krishna Koganti in testing Krishna's Matlab-based ICS testbed. During his tenure as a research assistant in fall 2017 semester, Ananth has worked on several publications, a poster, and a lightning talk.

III.1.C Laboratory Enhancements

The most significant accomplishment with respect to laboratory enhancements is the expansion of the Power Applications Laboratory in Moscow. It underwent a major expansion from about 1,500 sq.ft. to 2,200 sq.ft. (Figure 1). In the original proposal we planned to use the existing space and just enhance the equipment in it. But we took advantage of an opportunity presented by the Murdock Foundation to invest an additional $285,000 of their funding invested in the laboratory with an additional $200,000 of other funding invested in Coeur d' Alene to create a distributed testbed with locations in Moscow, Idaho Falls, and Coeur d' Alene. We have worked with the Schweitzer Engineering Laboratory (SEL) Engineering Services Division to design this testbed for performing research on cybersecurity of power and industrial control systems. This testbed will enable research and development of novel and secure techniques and algorithms for securing today and tomorrow's Power Grid (PG) along with other types of Industrial Control Systems (ICS). The major advantage of this testbed is that it will enable researchers and engineers to perform and collaborate on ICS-specific cybersecurity research, development, and testing on a system that closely resembles current distributed critical infrastructure cyber-physical control systems. The testbed will expose hardware-in-the-loop simulation, enable the capture and use of real operational data, integrate current and future components of the power grid and other industrial control systems, and enable realistic attack-defend scenarios for research, evaluation, and testing. It will integrate with the current Real Time Digital Simulator (RTDS) and be accessible from the other UI locations as well as BSU. This capability will significantly enhance our ability to demonstrate (in-situ) advanced PG/ICS technology to Idaho industry partners.

The increased scope and capability of this change has come with a cost, in that the enhancements will take about 9 months longer than we originally anticipated. However, this is a small price to pay for the benefit we are gaining. The space for the test bed was remodeled and completed the end of November, two months behind schedule because of asbestos abatement in the new space. A contract was given to Schweitzer Engineering Laboratories for the industrial control equipment and RTDS upgrade. The equipment started to arrive in December, as shown in Figure 2. The RTDS and associated amplifiers were moved to the lab and test equipment was connected to the RTDS as shown in Figures 3-6. We will provide a more comprehensive description of the laboratory in the next, upcoming annual report.

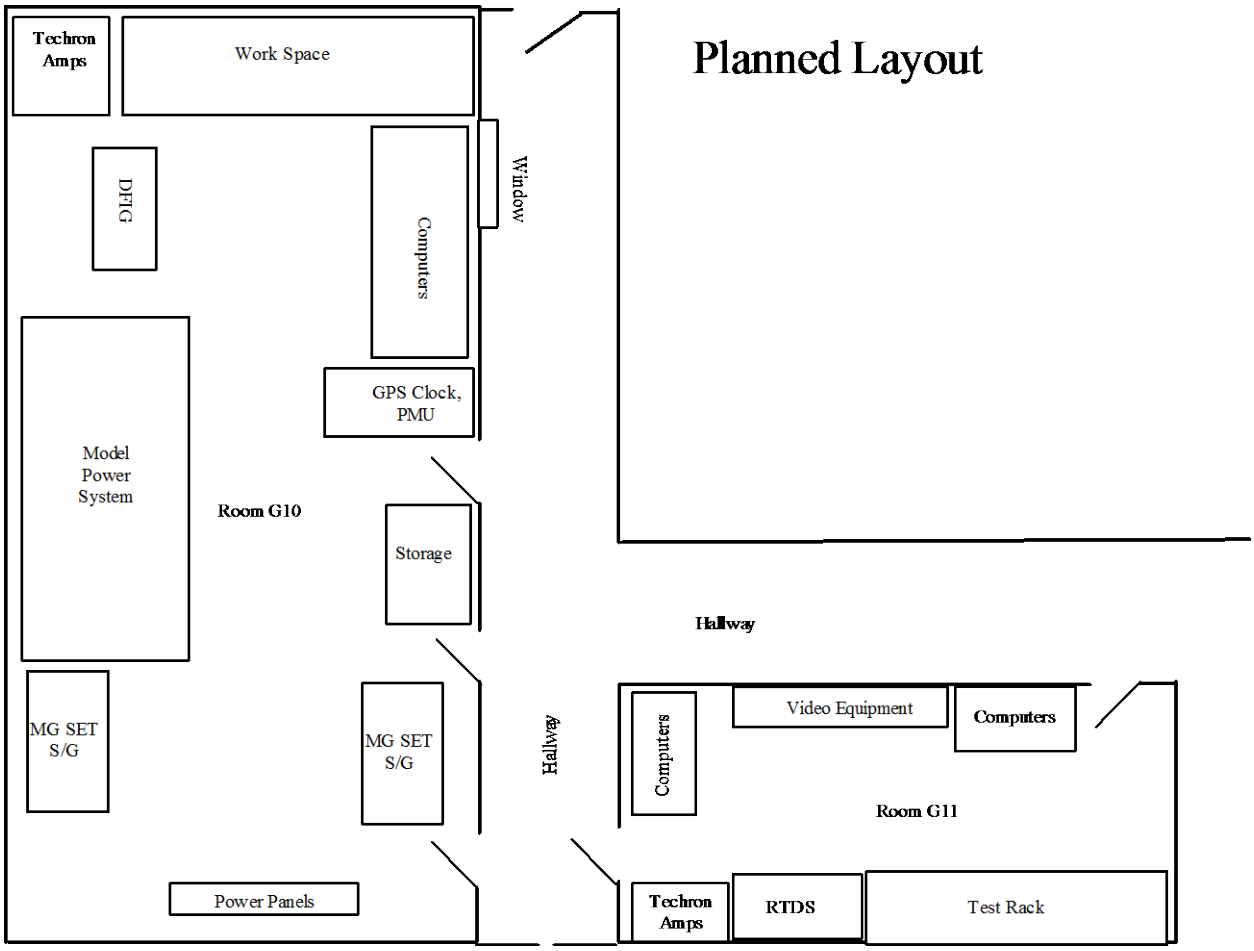


Figure 1: Illustration of Power Systems Laboratory Expansion

Figure 2: Some of the test equipment for the expanded power lab along with new equipment racks

Figure 3: Amplifiers moved and installed in the new space.

Figure 4: Some of the test equipment for the expanded power lab along with new equipment racks

Figure 5: RTDS, some of the test equipment racks and power amplifiers in remodeled lab space

Figure 6: Some of the test equipment for the expanded power lab along with new equipment racks

(2) Strengthen collaboration with Idaho industry and other Idaho universities

III.2. Industry and University Collaborations
Our team had numerous on-going and one-time collaborations with industry and other universities. Some of these collaborations are listed below:

Brian Johnson has had weekly meetings with Craig Rieger and Tim McJunkin from the INL related resilient control of critical infrastructure. Efforts included:
(1) Ongoing research project as part of DOE Grid Modernization Lab project related to resilience metrics for power distribution systems.
(2) Collaboration on an ongoing LDRD proposal related to cybersecurity for industrial control systems, with collaboration from Virginia Commonwealth University.
(3) Collaboration course ECE 469/569: Resilient Control of Critical Infrastructure with collaboration between UI, BSU, and INL along with some interaction with Naval Post Graduate School, Weber State University, and Idaho State University.

Brian Johnson had monthly meetings with engineers from ABB Corporations, University of Illinois, Argonne National Lab and Bonneville Power Administration as part of a project addressing cybersecurity for HVDC transmission systems.

Brian Johnson and Yacine Chakhchouhk have been part of a project with Avista Corporation looking at non-wire solutions that use sensors and controls to alleviate the need for new transmission lines to improve reliability of power systems at a lower cost.

Brian Johnson was advisor for three industry sponsored senior design teams, one sponsored by Avista and one by Schweitzer Engineering Laboratories.

Yacine Chakhchoukh is having regular meetings with professors at Virginia Tech (Lamine Mili, Michael von Spakovsky, and Konstantinos Triantis). The team is writing a joint proposal with other professors at other universities to submit in March 2018 to the NSF. The title is: "Enhancing the resilience of interdependent power systems and emergency services via micro-grids" targeted starting date August 2018. For this project the cyber-security test-bed will be used in the research conducted at the University of Idaho. Collaboration will be started with AVISTA Corporation on this project.

Date: September 18, 2017: Visit and presentation: **Visitor/Speaker:** Dr. Svitlana Volkova, Senior Research Scientist, Data Sciences and Analytics Group, National Security Directorate, Pacific Northwest National Laboratory (PNNL). **Title:** Topic: Predicting the Future with Deep Learning and Signals from Social Media. Also, Dr. Volkova and a research and recruiting team from PNNL visited the University of Idaho and met with students and faculty.

Date: October 09, 2017: Visit and presentation: **Visitor/Speaker:** Ginger Wright, Program Manager for Domestic Nuclear Cybersecurity at Idaho National Laboratory (INL). CS Colloquium presentation, **Title:** Cyber Informed Engineering. Ms. Wright also met with College of Engineering faculty and students.

Date: November 27, 2017: Visit and presentation: **Visitor/Speaker:** Dr. Glenn A. Fink, Senior Cyber Security Researcher, Pacific Northwest National Laboratory (PNNL). CS Colloquium presentation, **Title:** Security and Privacy Grand Challenges for the Internet of Things. Dr. Fink also met with College of Engineering faculty and students.

Date: November 27, 2017: Presentation: **Visitor/Speaker:** Jason Dearien, Senior Application Engineer, Schweitzer Engineering Laboratories (SEL), **Title:** Requirements and Challenges of Building Software for Critical Infrastructure. Mr. Dearien also met with College of Engineering faculty and students after the presentation.

Date: Fall, 2017: Live Table Top Exercise: **Visitor/Speaker:** Dr. Jessica Smith, Cybersecurity Researcher, Pacific Northwest National Laboratory (PNNL), helped organize and participated in a critical infrastructure cybersecurity event tabletop exercise for University of Idaho students.

Date: Fall, 2017: Engineering Capstone Design Projects. **Customer:** Dr. Jessica Smith, Cybersecurity Researcher, Pacific Northwest National Laboratory (PNNL), is sponsoring two College of Engineering Capstone Design projects focused on cybersecurity of the Power Grid and Industrial Control Systems.

(3) Foster technology transfer and commercialization through technology incubation
During the past six months we have had several proposals accepted and submitted for research in this area.

III.3.A Proposals

ACCEPTED

H.L. Hess, B. Johnson, Y. Chakhchoukh, "Framework for Siting and Sizing Energy Storage for Enhanced Performance of the Avista System," Avista Corporation, August 15, 2017 - August 31, 2018, $83,712.89.

A. Ibrahim, B. Rezaie, B.K. Johnson, "Aerogel Insulation System: An Innovative Energy Efficient Thermal Wall," Avista Corporation, Sept. 1, 2017- August 30, 2018, $88,777.

B.K. Johnson, Y. Chakhchoukh and D. Conte de Leon, "Testbed for Power and Industrial Control Systems," Murdock Charitable Trust, May 18, 2017-August, 31, 2019, $284,500 (total project $872,407)

SUBMITTED

B.K. Johnson, H.L. Hess, Y. Chakhchoukh (all University of Idaho), Craig Rieger (INL, and Milos Manic (Virginia Commonwealth University, Real-time Sensing of Transient Occurrences through Resilient Design (ReSTORD), Bonneville Power Administration, $459,588

B.K. Johnson, H. Lei, Student Support for the 2018 International Conference on Probabilistic Methods Applied to Power Systems, National Science Foundation, $12,750

Title: SaTC: EDU: Development of Reverse Engineering Laboratory and Curriculum
Amount Requested: ~$ 300,000
Proposed Period: October 1, 2018 to September 30, 2020 (2 years).
Proposed Source: NSF, Secure and Trustworthy Cyberspace, Education: SaTC:EDU.
Location: University of Idaho, Idaho Falls, Idaho, U.S.A.
PI: Haney, Michael; Computer Science, Idaho Falls, University of Idaho.
CoPI: Roberson, Dakota; Electrical and Comp. Engineering, Idaho Falls, University of Idaho

Title:
SaTC: CORE: Small: Cybersecurity Analysis of PMU-based State Estimation for the Smart Grid
Amount Requested: $ 499,982
Proposed Period: August 20, 2018 to August 19, 2021 (3 years).
Proposed Source: NSF, Secure and Trustworthy Cyberspace, SaTC, CORE Program.
Location: University of Idaho, Moscow, Idaho, U.S.A.
PI: Chakhchoukh, Yacine; Electrical and Computer Eng. Moscow, University of Idaho.
CoPI: Conte de Leon, Daniel; Computer Science, Moscow, University of Idaho.
CoPI: Johnson, Brian K.; Electrical and Computer Eng. Moscow, University of Idaho.

III.3.B Publications

PUBLISHED or ACCEPTED

Conte de Leon, Daniel; Stalick, Antonius Q.; Jillepalli, Ananth A.; Haney, Michael A.; Sheldon, Frederick T. (2017) "*Blockchain: Properties and Misconceptions*", Asia Pacific Journal of Innovation and Entrepreneurship, Volume: 11 Issue: 3, pp. 286-300, December 2017. https://doi.org/10.1108/APJIE-12-2017-034.

Conte de Leon, Daniel; Brown, Matthew G.; Jillepalli, Ananth A.; Stalick, Antonius Q.; Alves-Foss, Jim. *"High Level and Formal Router Policy Verification."* The Journal of Computing Sciences in Colleges, Volume 33, Number 1, pp. 118, October 2017. https://dl.acm.org/citation.cfm?id=3144631

Jillepalli, Ananth A.; Sheldon, Frederick T.; Conte de Leon, Daniel; Haney, Michael A.; Abercrombie, Robert K. "*Security Management of Cyber Physical Control Systems Using NIST SP 800-82r2*". In Proceedings of the 13th International Wireless Communications and Mobile Computing Conference (IWCMC), 26-30 June 2017, Valencia, Spain, IEEE. DOI: 10.1109/IWCMC.2017.7986568http://ieeexplore.ieee.org/document/7986568/

Conte de Leon, Daniel; Goes, Christopher; Jillepalli, Ananth A.; Haney, Michael A.; Krings, Axel. "*ADLES: Specifying, Deploying, and Sharing Hands-On Cyber-Exercises*", Journal of Computers and Security, To Appear, Elsevier 2018. https://www.journals.elsevier.com/computers-and-security

Jillepalli, Ananth A.; Conte de Leon, Daniel; Sheldon, Frederick T.; Haney, Michael A. "*Hardening the Client-side: A Guide to Enterprise-level Hardening of Web Browsers.*" In Proceedings of the 15th IEEE International Conference on Dependable, Autonomic and Secure Computing (IEEE DASC 2017). November 2017. IEEE.

Koganti, Venkata SreeKrishna; Ashrafuzzaman, Mohammad; Jillepalli, Ananth A.; Conte de Leon, Daniel; Sheldon, Frederick T.; *"A Virtual Testbed for Security Management of Industrial Control Systems."* In Proceedings of the 12th International Conference on Malicious and Unwanted Software (MALCON 2017). November 2017. IEEE.

S. Basumallik, S. Eftekharnejad, N. Davis, N. Nuthalapati, B.K. Johnson, "Cyber Security Considerations on PMU-base State Estimation," *Proceedings of the 2017 Cybersecurity Symposium.* Coeur d'Alene, Idaho, April 17-18, 2017

P. Penkey, H. Samkari, B.K. Johnson, H.L. Hess, "Voltage Control by Using Capacitor Banks and Tap Changing Transformers in a Renewable Microgrid," 2017 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT), April 23-26, 2017, Arlington Virginia

N. Fischer, B.K. Johnson, J.D. Law, A.G. Miles, "Induction Motor Modeling for Development of a Secure In-Phase Motor Bus Transfer Scheme," 2017 IEEE International Electric Machines and

Drives Conference (IEMDC), Miami, FL May 22-25, 2017. Reviewed based on extended abstract)

N. Fischer, J.D. Law, A.G. Miles, B.K. Johnson, "Dynamic Modeling of an Improved In-Phase Motor Bus Transfer Scheme," *Proceedings of the International Conference on Power Systems Transients (IPST2017)*, Seoul, South Korea, June 26-29-18, 2017.

Anujan, B.K. Johnson, E.J. William, "Protection Studies of Geographically Dispersed Type 3 Wind Energy Systems," *Proceedings of the 2017 IEEE Power and Energy Society General Meeting*, Chicago, IL, July 2017

S. Chilukrui, M. Alla, B.K. Johnson, "Enhancing backup protection for thermal power generating stations using sampled values," *Proceedings of the 2017 North American Power Symposium,* Morganton, WV, September 17-19, 2017.

S. Basumallik, S. Eftekharnejad, N. Davis, B.K. Johnson, "Impact of false data injection attacks on PMU-based state estimation," *Proceedings of the 2017 North American Power Symposium,* Morganton, WV, September 17-19, 2017.

H. Beleed and B.K. Johnson, "Comparative study on IEEE12 bus system with D-FACTS devices in different simulation tools," *Proceedings of the 2017 North American Power Symposium,* Morganton, WV, September 17-19, 2017.

W. Parker, B.K. Johnson, C. Rieger, T. McJunkin, "Identifying critical resiliency of modern distribution systems with open source modeling," *Proceedings of Resilience Week 2017*. Wilmington DE, September 19-21, 2017

V. Koganti, M. Ashrafuzzaman, A. Jillepalli, F.T. Sheldon, B.K. Johnson, "A Virtual Testbed for Security Management of Industrial Control Systems," MALCON 2017, Malware Conference, January 2018, San Juan, Puerto Rico (delayed due to hurricane damage)

SUBMITTED

Jillepalli, Ananth A.; Conte de Leon, Daniel; Sheldon, Frederick T.; Haney, Michael A. *"Enterprise-level Hardening of Web Browsers."* Submitted to Springer Security Informatics Journal. https://security-informatics.springeropen.com/

Steiner, Stuart; Jillepalli, Ananth A.; Conte de Leon, Daniel; *"Applying the Principle of Least Privilege to Harden Web Application Security."* Submitted to Springer Security Informatics Journal. https://security-informatics.springeropen.com/

Jillepalli, Ananth A.; Conte de Leon, Daniel; Sheldon, Frederick T.; Chakhchoukh, Yacine; Johnson, Brian K.; Haney, Michael A. *"An Architecture for HESTIA."* Submitted to 24th National Conference on Communications (NCC 2018). February 2018. Hyderabad, India.

Steiner, Stuart; Jillepalli, Ananth A.; Conte de Leon, Daniel; *"Hardening Web Applications Using a Least Privilege DBMS Access Model."* Submitted to 24th National Conference on Communications (NCC 2018). February 2018. Hyderabad, India.

IN PREPARATION

Jillepalli, Ananth A.; Conte de Leon, Daniel; Bhandari, Venkata A.; Steiner, Stuart; Alves-Foss, Jim *"Analysis of Web Browser Security Configuration Options."* To be submitted to IEEE Access Journal. http://ieeeaccess.ieee.org/

Ashrafuzzaman, Mohammad; Jillepalli, Ananth A.; Chakhchoukh, Yacine; Conte de Leon, Daniel; Sheldon, Frederick T.; "*Detecting Stealthy False Data Injection Attacks in Smart Grid Using Deep Learning"*. To be submitted to Future Generation Systems Journal.

III.3.C Presentations

Title: Application of Protection Challenges for Connecting to a Microgrid
Place**:** Idaho Commons.
Co-sponsored by the IEEE Palouse Section and the University of Idaho.
Date&Time: September 14, 5:00pm
Speaker: John Kumm, P.E., POWER Engineers.

Title: Traveling Wave Technology for Accurate Fault Location and Ultra-High Speed Line Protection
Place: Schweitzer Engineering Laboratories Event Center.
Co-sponsored by the IEEE Palouse Section and the University of Idaho.
Date&Time: September 25, 6:00pm
Speaker: Venkat Mynam, Principal Research Engineer, Schweitzer Engineering Laboratories, Inc.

Title: Remedial Action Scheme Preventing Country-Wide Blackout
Place: Idaho Commons, University of Idaho.
Co-sponsored by the IEEE Palouse Section and the University of Idaho.
Date&Time: October 10, 6:00pm
Speaker: Brian Clarke, P.E., Automation Engineer, Schweitzer Engineering Laboratories, Inc.

Title: Smart Cities for Promoting Global Sustainability
Place: Washington State University.
Co-sponsored by the IEEE Palouse Section and the University of Idaho.
Date&Time: November 7, 11:00am
Speaker: Mohammad Shahidehpour, University Distinguished Professor, Bodine Chair Professor of Electrical and Computer Engineering, and Director of the Robert W. Galvin Center for Electricity Innovation at Illinois Institute of Technology (IIT)

(4) Strengthen and expand the workforce

In our proposal we stated that accomplishments in this Objective would not occur until year 3. However, our team has already made some progress, namely:

III.4.A Student Internships

1. INL: Four Cybersecurity students participated in internships at Idaho National Laboratories during the summer of 2017. These students worked on projects related to the cybersecurity with a focus on industrial control systems and critical infrastructure protection.

2. PNNL: Three Cybersecurity students participated in internships at Pacific Northwest National Laboratory during the summer of 2017. These students worked on projects related to the cybersecurity of industrial control systems.

III.4.B Cybersecurity Competitions and Student Professional Development

1. November, 10-11, 2017: NICCDC: NIATEC Collegiate Cyber Defense Competition, Pocatello, Idaho: Eight University of Idaho students (7 from Moscow and 1 from Idaho Falls) traveled and participated in this live cyber defense competition organized yearly by NIATEC at Idaho State University.

IV. Description of Future Project Plans

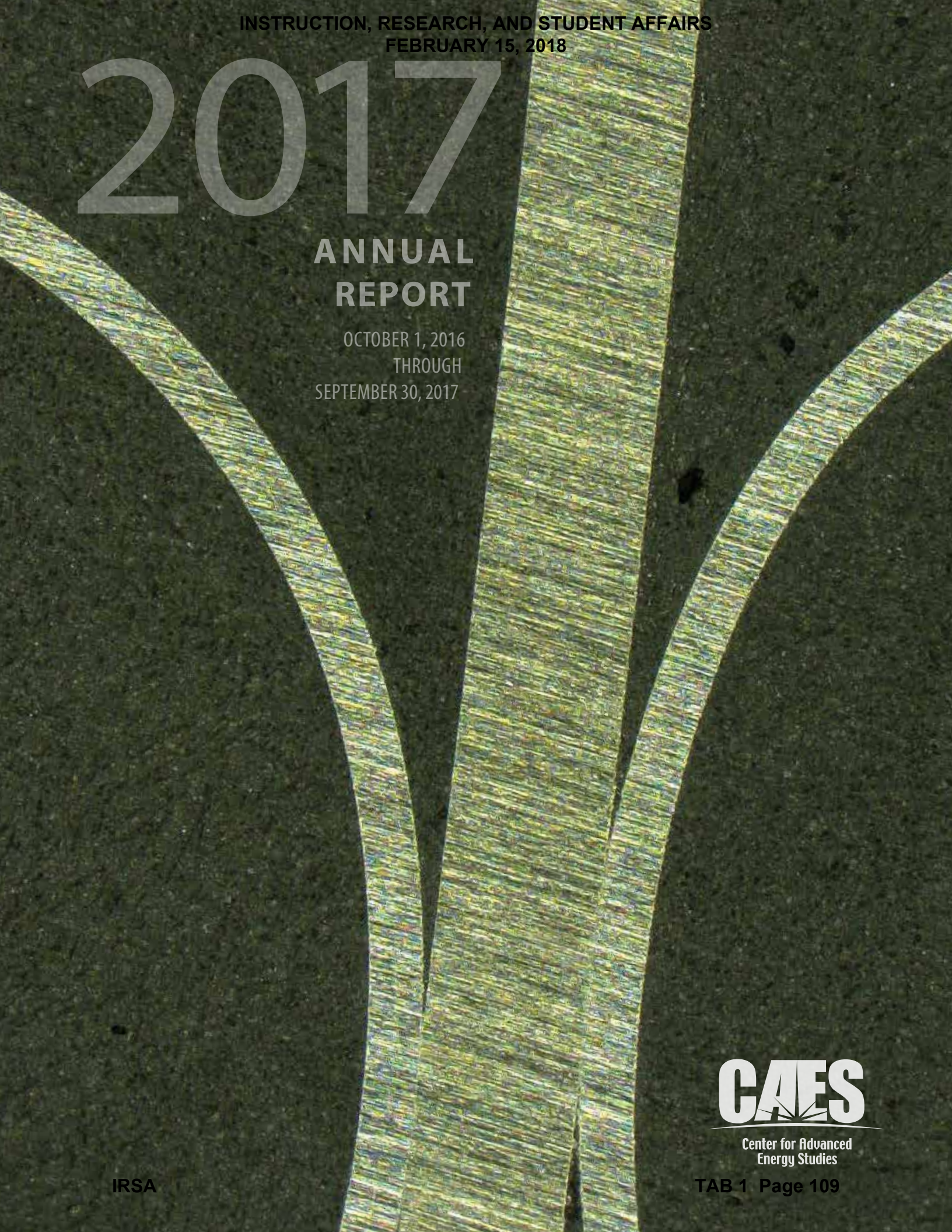
Plans for the future are to accomplish the deliverables of the four objectives. Specifically for the second half of year one we plan to:

- Complete the hires of listed in III.1.A above.
- Complete the enhancements to the Power Applications Laboratory. This task has been expanded by the additional funding from the Murdock Foundation.
- Host the Cybersecurity Symposium 2018, April 9-11 in Coeur d' Alene, organized by the University of Idaho and sponsored by the Center for Secure and Dependable Systems in the College of Engineering.
- Co-sponsor the June 2018 Probabilistic Methods in Power Systems Conference in Boise, Idaho.
- Place six student interns in industry this coming summer to develop demonstrations for the distributed test bed.

THIS PAGE INTENTIONALLY LEFT BLANK

2017 ANNUAL REPORT

OCTOBER 1, 2016
THROUGH
SEPTEMBER 30, 2017



CAES
Center for Advanced Energy Studies

ON THE COVER: VISIBLE SCRATCHES ARE SEEN ON A STEEL AND ZIRCONIUM METAL SAMPLE PRIOR TO POLISHING INSIDE THE CAES ADVANCED MATERIALS LABORATORY.

Message from the Director:

When I came to the Center for Advanced Energy Studies (CAES) in May 2017, I was immediately impressed by the collaborative nature that exists here. From its founding, CAES was established to strengthen relationships between academia, industry, and national laboratories so the world's increasingly complex energy challenges can be identified and solved, in partnership.

The CAES model is effective because our affiliated institutions are committed to a collaborative approach that recognizes and utilizes the distinctive capabilities of each organization. CAES is a classic example of an organization that is stronger together than each of its individual parts. Backed by our five affiliated institutions — Idaho National Laboratory, Boise State University, Idaho State University, the University of Idaho, and the University of Wyoming — CAES has become a place where world-renowned researchers interact daily with university faculty, and where high-achieving students receive hands-on experience, increasing our collective impact, igniting innovation, strengthening the regional workforce, and creating a new generation of energy professionals.

After more than a decade of performing collaborative energy research, CAES will spend 2018 reviewing and refreshing our strategic direction to make sure it continues to align with university, laboratory, and regional needs. This fall, I made visits to all four CAES universities, meeting with their leadership, professors, and students. It was rewarding to hear that such diverse institutions are united by a common desire to be part of CAES' success. The collaboration, cohesion, and shared vision that are essential to our mission remain strong.

A significant development this last year was a reorganization within Idaho National Laboratory (INL) that made CAES a full INL directorate, on the same level as the laboratory's Nuclear Science & Technology (NS&T), National & Homeland Security (N&HS), Energy and Environment Science & Technology (EES&T), Materials & Fuels Complex (MFC), and the Advanced Test Reactor (ATR) research organizations. This realignment gives further prominence and accountability to our work, while also broadening our network of CAES collaborators, specialized equipment, and unique facilities.

Each day, we make progress fulfilling CAES' foundational vision, but our full potential is still ahead of us. The CAES team continues to put in place the capabilities to enable "win-wins" and set a foundation for a new period of innovation and growth. This is a place to think big, but it all comes down to our people, and the pride they take in what they're doing. I am delighted to be associated with so many remarkable researchers, both seasoned and newly minted, but all game-changing. What we do every day makes a difference, and I'm convinced it will all add up to something extraordinary.

Sincerely,

Noël Bakhtian, Director of CAES

FY 2017 | By the Numbers

INVESTMENTS

$3M STATE OF IDAHO INVESTMENT IN CAES

$7.7M IDAHO NATIONAL LABORATORY'S INVESTMENTS IN CAES OPERATIONS AND INFRASTRUCTURE

$788,308 LABORATORY DIRECTED RESEARCH AND DEVELOPMENT

$493,009 CAVE EQUIPMENT UPGRADES

OUTREACH

130 CAES PUBLICATIONS AND PROCEEDINGS

9 COLLABORATIVE PLANNING MEETINGS HOSTED BY CAES

1,119 VISITORS TO THE CAES CAVE 3-D IMMERSION RESEARCH ENVIRONMENT

STUDENT IMPACT

76 STUDENTS FROM CAES UNIVERSITIES INTERNED AT INL IN AREAS INCLUDING NUCLEAR ENGINEERING, BIOLOGICAL SCIENCES, COMPUTER SCIENCE AND MECHANICAL ENGINEERING, PLUS:

12 JOINT APPOINTMENTS FROM CAES UNIVERSITIES

5 INL GRADUATE FELLOWS FROM CAES UNIVERSITIES

3 POSTDOCTORAL RESEARCHERS FROM CAES UNIVERSITIES

Regional Leadership

Wastewater Treatment, Recycling and Energy Research

CAES and the Northwest Food Processors Association (NWFPA) co-hosted a meeting in February 2017 to address challenges with wastewater treatment and energy consumption in food processing, one of the Northwest's biggest industries. The Boise meeting convened more than 30 researchers from government, national laboratories, industry and academic institutions to discuss challenges in wastewater management and energy efficiency. Attendees and speakers included representatives from the Idaho Department of Commerce, 12 companies and researchers from all CAES member institutions.

DID YOU KNOW?

NWFPA IS A TRADE ASSOCIATION OF MORE THAN 140 PROCESSOR COMPANIES AND 350 SUPPLIERS INCLUDING CHOBANI, CLIF BAR, AND THE J.R. SIMPLOT COMPANY.

Intermountain Energy Summit

CAES was a presenting sponsor for the 2017 Intermountain Energy Summit Aug. 8-9 in Idaho Falls. CAES Director Noël Bakhtian was given the honor of introducing featured speaker Laura Holgate of the Belfer Center for Science and International Affairs. Her talk was entitled "Virtuous circles: Linking business and nuclear security." Mike Hagood, INL Regional Initiatives director and former acting CAES director, moderated the panel discussion "Nuclear Energy Re-imagined: Innovation in Applications," which featured panelists Simon Irish, CEO of Terrestrial Energy; Mark Peres, Fluor's executive project director; Dr. Ashley Finan, Nuclear Innovation Alliance; and Dr. Richard Boardman, Idaho National Laboratory.

INTERMOUNTAIN ENERGY SUMMIT

INL DIRECTOR MARK PETERS INTRODUCES A SPEAKER AT THE INTERMOUNTAIN ENERGY SUMMIT.

The breakout discussion, "Re-imagining Regional Coal Development," was moderated by Mark A. Northam, founding director University of Wyoming's School of Energy Resources. Richard A. Horner, who has headed UW's Special Projects and Technology Directorate since 2015, was a panelist. The University of Wyoming has been a member of CAES since 2014.

Produced Water and Rare- Earth Elements

Representatives from all CAES institutions participated in a working group on June 26 at University of Wyoming. The event focused on identifying methods for optimizing the secondary value in produced water and rare-earth elements associated with oil and gas production, including hydraulic fracturing. Forthcoming white papers could be further developed into research proposals. Coordinators included Kipp Coddington (UW director, Carbon Management Institute), Jon Brandt (UW professor, director, Center of Excellence for Produced Water Management), Bill Bellamy (VP CH2MHill & UW professor of Practice), Travis McLing and Rob Podgorney (both INL). Forthcoming white papers will outline key objectives to optimize produced water utilization and rare earth production as a base for regional economic development.

25

THE NUMBER OF FACULTY, STAFF, AND GRADUATE STUDENTS WHO ATTENDED THE PRODUCED WATER/RARE-EARTH ELEMENT MANAGEMENT WORKING GROUP

Collaborative Meetings and Seminars

In FY 2017, CAES hosted, sponsored or participated in dozens of meetings that attracted researchers from the region and beyond. Here is a partial list of events that took place at CAES.

- Acid Transport Modeling Using the Finite Element Method (FEM)
- Advancing Energy Innovation Through Proper Data Management
- Advancing Marine and Hydrokinetic Energy Technology Through Materials
- Brown-bag Session: Gates, Guards and Geeks: The Changing Face of Nuclear Security
- Social-Ecological and Technological Systems Science and the New Energy Landscape
- CAES Energy Policy Institute 2017 Research Conference
- Carbon Engineering
- CyberSecurity Energy Connected
- DOE Nuclear Energy University Program call for proposals collaborative meeting
- Geothermal Energy: Here and Now: Sustainable, Clean, Flexible
- Heat, fluid flow and mechanics in MOOSE: The Porous Flow module
- International Conference on Probabilistic Methods Applied to Power Systems (PMAPS)
- Connecting research with DOE Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) opportunities
- Microstructure and in-pile sensors
- Northwest Energy Coalition NW Clean & Affordable Energy Conference
- Produced Water and Rare Earth Elements Planning Meeting
- Public Water Supply: How Much Energy Does It Take?
- INL LDRD Annual Poster Session
- My Amazing Future
- Engineering Your Future
- Lab-Bridge seminar on technology commercialization
- Lab-Bridge Pitch Competition
- Report on the Western Idaho Nuclear Complex
- Scintillator Neutron Detectors for Nuclear Science and Security
- The I-Ching: Ancient Chinese Philosophy Interconnected to Modern Science and Technology
- Thoughts on Developing Fuels & Materials for Advanced Nuclear Reactors
- Transient Kinetic Approach to Catalytic Materials for Energy-Efficient Routes to Ammonia, Ethylene and Related Chemicals
- Development of a Novel Rectenna-Based Waste Heat Harvesting Device: A DOE-ARPAe Approach
- University of Idaho Engineering Design EXPO
- Waste Water Treatment/Recycling and Energy Research for the Food Processing Industry
- Web Applications for Identifying Inefficiencies in City Water Systems

New Leadership

2017 saw some new faces added to the CAES leadership team.

Noël Bakhtian

Anita Gianotto

Ethan Huffman

Noël Bakhtian was hired as CAES director in May, replacing interim director Mike Hagood. Bakhtian most recently served as a senior policy adviser for environment and energy in the White House Office of Science and Technology Policy. She has also held technical positions with the U.S. Department of Energy. She earned her engineering doctorate at Stanford University's Department of Aeronautics and Astronautics; holds masters' degrees from Stanford University and the University of Cambridge, where she was a Churchill Scholar; and completed her bachelor's degree in mechanical engineering and physics at Duke University.

Anita Gianotto was hired as CAES chief operating officer in October, replacing interim COO Gary Gresham. Previously, she served as INL's Energy and Environment Science & Technology (EES&T) manager for Research Operations. Anita actively managed the EES&T Laboratory Directed Research and Development (LDRD) portfolio and coordination of two EES&T strategic documents (INL Lab Agenda and Lab Plan). Prior to her role in EES&T, she served as the INL LDRD program manager and INL Research Management System lead gaining extensive experience in management of research operations. She has over 25 years of hands-on research experience in analytical chemistry focusing on mass spectrometric analyses and other analytical instrumentation. Anita earned her Bachelor and Master of Science in microbiology from Idaho State University.

Ethan Huffman was hired as CAES lead for Communications and Legislative Affairs in October. Huffman previously worked for U.S. Congressman Mike Simpson working closely with state and federal agencies, county commissioners, non-profit organizations, and business leaders across eastern Idaho. He also worked for the Idaho National Laboratory from 2004 to 2012. Huffman holds a bachelor's degree in mass communication from Idaho State University and a master's degree in communication and leadership studies from Gonzaga University.

Amy Moll came on as Boise State University's associate CAES director, replacing David Solan. Moll has been with Boise State since 2000, most recently serving as dean of the College of Engineering. She holds a bachelor's degree in ceramic engineering from the University of Illinois, and earned her master's and doctorate in materials science and engineering from the University of California at Berkeley. In 2015, she was honored with a "100 Inspiring Women in STEM" Award from Insight Into Diversity magazine.

Amy Moll

Richard Christensen was appointed interim associate director for the University of Idaho when former Associate Director Tom Wood retired. A faculty member and director of UI's Nuclear Engineering program in Idaho Falls, Christensen joined the UI and CAES family in 2015, bringing in 17 new full-time graduate students. He was awarded two Department of Energy Nuclear Energy University Program grants, collaborating with the University of Michigan and the University of Wisconsin, and is working with two nuclear startup companies on novel nuclear facilities. Christensen will serve as associate director until a national search for a permanent replacement is complete.

Richard Christensen

Ed Synakowski, the new vice president of Research at the University of Wyoming, was appointed to the CAES Steering Committee following the retirement of former Wyoming VPR Bill Gern. Synakowski is the former DOE associate director of Science for Fusion Energy Sciences. A Fellow of the American Physical Society and the Institute of Physics, he has authored over 150 refereed publications. Synakowski received his Ph.D. in physics at the University of Texas at Austin and a Bachelor of Arts degree from the Johns Hopkins University.

Ed Synakowski

At the CAES Energy Policy Institute, **Harold Blackman**, the associate vice president of Research at Boise State University, took the helm as interim director. Former EPI Director David Solan accepted a senior advisory role at the U.S. Department of Energy. When CAES headquarters opened in early 2009, Blackman was the institution's second director, building meaningful relationships among leadership, faculty, staff, and students across all the affiliated institutions.

Harold Blackman

New Research Staff

University Idaho

Amin Mirkouei and **Alex Vakanski** joined CAES in industrial technology tenure track positions. David Arcilesi joined CAES in a mechanical engineering tenure track position, and **Dakota Roberson** is involved in an electrical and computer engineering effort with the Idaho Global Entrepreneurial Mission (IGEM).

Idaho State University

Leslie Kerby and **Haiming Wen** joined CAES as ISU/INL joint appointments for nuclear science and engineering. They each bring new capabilities to our Nuclear Science and Engineering research program. Kerby is engaged in modeling and simulation activities for nuclear and other energy systems, including neutronics, while Wen studies the behavior of irradiated nuclear fuel materials and related areas. Wen left ISU in August. **Mason Jaussi** (right) also joined CAES supporting safety efforts.

ISU'S MASON JAUSSI JOINED CAES TO SUPPORT SAFETY EFFORTS.

Boise State University

Cassandra Koerner joined EPI in January 2017 as project coordinator, providing key research support and coordinating work among affiliated collaborators. In the public and private sectors, Koerner has worked on several regional environmental impact projects as a researcher, technical writer and budget manager.

Idaho National Laboratory

James Pittman (above) joined the CAES Catalysis and Transient Kinetics Laboratory. This lab houses two Temporal Analysis of Products systems to design advanced catalytic materials that consume far less energy while minimizing byproduct and waste streams. Pittman is a leading expert in the design and fabrication of TAP systems. He will use his skills to ensure both the CAES reactor systems operate at peak performance. Pittman has been a professional welder since high school and has done specialty work on TAP systems since their invention in the late 1980s. Pittman's experience building hardware around scientific concepts will be essential to developing better techniques for catalyst design.

Research Highlights

CAES collaborative developing new sensors

A collaborative between Idaho National Laboratory, Boise State University, and the University of Notre Dame was awarded funding through the Department of Energy's Nuclear Energy Enabling Technology (NEET) and Nuclear Science User Facilities (NSUF) programs to develop and demonstrate an additive manufacturing approach to fabricating spatially resolved sensors for in-pile thermal conductivity measurement. The team will print three omega thermal conductivity sensors onto fuel components using an aerosol jet printing approach, and study in-pile performance of the printed sensors through irradiation and post-irradiation testing. This research has the potential to establish a new sensor-manufacturing paradigm for the nuclear industry.

DR. HAIMING WEN LED SEVERAL ISU RESEARCH COLLABORATIONS AT CAES.

ISU leads teams for NEET, NSUF

Dr. Haiming Wen, a CAES joint appointment from ISU, led a team of doctoral students, master's students and visiting doctoral students in two projects. "Enhancing irradiation tolerance of steels via nanostructuring by innovative manufacturing" includes three INL collaborators – Dr. James I. Cole, Dr. Isabella van Rooyen, and Dr. Yongfeng Zhang. The second project was a Laboratory Directed Research and Development (LDRD) project: "Advanced manufacturing of metallic fuels and cladding by equal-channel angular pressing."

Partnering with French nuclear scientists

Dr. George Imel of ISU participated in an OECD Nuclear Energy Agency (NEA) meeting of the Expert Group on Improvement of Integral Experiments Data for Minor Actinide Management in Paris, France, May 31-June 1, 2017. The French agreed to financially support a Ph.D. student to further study oscillator techniques for use in French experiments. This agreement offers a unique opportunity for a CAES student to perform their dissertation at one of the most active nuclear research centers in the world.

Performing innovative nuclear energy research

DOE'S Office of Nuclear Energy strives to promote integrated and collaborative research conducted by partners at national laboratories, universities, industry and international entities. CAES partners pursued three Consolidated Innovative Nuclear Research (CINR) projects in 2016-17.

1 ELUCIDATION OF ELECTROCHEMICAL BEHAVIOR OF TECHNETIUM, TELLURIUM, AND IODINE IN MOLTEN SALT SOLUTIONS; DR. KRISHNAN RAJA, UNIVERSITY OF IDAHO

2 INTEGRATED SILICON/ CHALCOGENIDE GLASS HYBRID PLASMONIC SENSOR FOR MONITORING OF TEMPERATURE IN NUCLEAR FACILITIES; DR. MARIA MITKOVA, BOISE STATE UNIVERSITY

3 ADDITIVE MANUFACTURING OF THERMAL SENSORS FOR IN-PILE THERMAL CONDUCTIVITY MEASUREMENT; DR. YANLIANG ZHANG, BOISE STATE UNIVERSITY

Informing global clean energy investment decisions

CAES will be the integrator for a new effort to provide timely, quantified and unbiased data. The Energy Systems Strategies, Assessment and Integration (ESSAI) model aims to help inform global clean energy investment and policy decisions through comprehensive interdisciplinary research, with a focus on the role of nuclear energy. Already ESSAI has spawned new collaborations, discussions and ultimately innovative ideas in interdisciplinary energy systems studies within CAES.

CAES is currently executing a study, coordinated with the LINE Commission with the intent to inform state leadership, to evaluate the potential value chain of advanced reactors, particularly as it pertains to opportunities for Idaho and the Northwest region. Specifically, tasks include evaluating potential markets, both traditional and emerging; enumerating barriers and incentives to attract industry; and, evaluating the existing public-private partnership framework to drive advanced nuclear reactor economic development.

KIYO FUJIMOTO IS A DOE INTEGRATED UNIVERSITY PROGRAM FELLOW WORKING ON A PROJECT FUNDED BY A NUCLEAR ENERGY UNIVERSITY PROGRAM GRANT. SHE IS ALSO ONE OF FIVE RECIPIENTS OF A 2017 INL GRADUATE FELLOWSHIP.

Modeling enhanced geothermal site

A CAES team led by INL's Rob Podgorney is aiding the University of Utah FORGE team, building the "earth model" and subsequent "reservoir models" for the enhanced geothermal pilot site near Milford, Utah. FORGE (Frontier Observatory for Research in Geothermal Energy) is a DOE project aimed at developing sites where hot subsurface rock can be fractured and water introduced to create steam to drive turbines and generate electricity. CAES interns Andy Lau (Boise State University) and Michael Janis (University of Oklahoma) are assembling the earth model and writing the code to transfer it into INL's FALCON modeling and simulation program.

Earning annual nuclear energy research funding

CAES consortium members won more than $5 million in nuclear energy research and infrastructure funding from the U.S. Department of Energy. DOE awarded more than $66 million in nuclear energy research, facility access, crosscutting technology development and infrastructure awards in 27 states. In total, 86 projects were selected to receive funding; 25 projects include collaborators from CAES member institutions. These awards provide funding for nuclear energy-related research through the Nuclear Energy University Program (NEUP), Nuclear Science User Facilities (NSUF), Nuclear Energy Enabling Technology (NEET) and Infrastructure Award programs.

25

DOE NUCLEAR ENERGY-FUNDED PROJECTS INCLUDE CAES MEMBER INSTITUTIONS

25

RAPID TURNAROUND PROJECTS AWARDED TO CAES THROUGH DOE'S NUCLEAR SCIENCE USER FACILITIES PROGRAM

$5.3

MILLION

AMOUNT OF DOE MONEY CAES MEMBERS WON FOR NUCLEAR ENERGY R&D AND INFRASTRUCTURE

Awards and Recognition

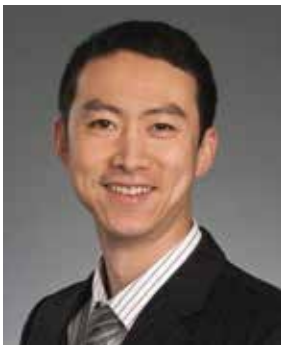
Dr. Donald McEligot

UI's McEligot honored

At the 2017 TURBO EXPO, Dr. Donald M. McEligot, visiting professor of nuclear engineering at CAES/University of Idaho and a nuclear science directorate fellow at INL, was awarded the American Society of Mechanical Engineers (ASME) Gas Turbine Heat Transfer Committee Outstanding Service Award. The award is an acknowledgment by the ASME International Gas Turbine Institute committees to their members who have made significant contributions in terms of personal service to the committee and its operations.

DID YOU KNOW?

THE TURBO EXPO WAS FORMERLY THE INTERNATIONAL GAS TURBINE CONFERENCE.



Yanliang Zhang

BSU's Zhang earns NSF CAREER Award

CAES/Boise State University engineering professor Yanliang Zhang earned a prestigious National Science Foundation Faculty Early Career Development (CAREER) Award.

The CAREER award is the NSF's most prestigious award supporting junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations. It is intended to give promising researchers an early career boost by providing stable research funding over an extended period. His project was selected to receive about $500,000 over five years.

169

TEAMS ENTERING THE GEORGE BARLEY CLEAN WATER SCIENCE PRIZE OPENING PHASE WORKING GROUP

3

ENTRIES ADVANCING TO THE CONTEST'S STAGE 1, INCLUDING UI'S TEAM BLUEXGREEN

DOE Nuclear Energy research funding

CAES Affiliates Were Prime Awardees

2017 NEUP R&D AWARD	$796,741	K. RAJA (UI), G. FREDRICKSON (INL), AND S. FRANK (INL)	ELUCIDATION OF ELECTROCHEMICAL BEHAVIOR OF TECHNETIUM, TELLURIUM, AND IODINE IN MOLTEN SALT SOLUTIONS
2017 NEET AWARD	$890,000	M. MITKOVA (BSU), I. VAN ROOYEN (INL)	INTEGRATED SILICON/ CHALCOGENIDE GLASS HYBRID PLASMONIC SENSOR FOR MONITORING OF TEMPERATURE IN NUCLEAR FACILITIES
2017 NSUF R&D AWARD	$500,000	Y. ZHANG (BSU), C. JENSEN (INL)	ADDITIVE MANUFACTURING OF THERMAL SENSORS FOR IN-PILE THERMAL CONDUCTIVITY MEASUREMENT
2017 INFRASTRUCTURE AWARD	$295,392	D. ESTRADA (BSU)	SYNTHESIS AND CHARACTERIZATION EQUIPMENT TO SUPPORT ADVANCED MANUFACTURING FOR NUCLEAR SENSORS
2017 INFRASTRUCTURE AWARD	$247,471	V. UTGIKAR (UI)	DYNAMIC MATERIALS TESTING LOOP AND THERMAL ANALYSIS SYSTEM

DOE Nuclear Energy research funding

CAES Affiliates Were Partner Awardees

2017 NEET AWARD	$300,000	V. AGARWAL (INL) , Y. ZHANG (BSU)	3-D CHEMO-MECHANICAL DEGRADATION STATE MONITORING, DIAGNOSTICS AND PROGNOSTICS OF CORROSION PROCESSES IN NUCLEAR POWER PLANT SECONDARY PIPING STRUCTURES
2017 NEUP AWARD	$325,000	R. CHRISTENSEN (UI), P. SABHARWALL (INL)	EXPERIMENTAL DETERMINATION OF HELIUM/AIR MIXING IN HELIUM COOLED REACTOR
2017 INFRASTRUCTURE AWARD	$150,000	G. PASTORE (INL), 20 ADDITIONAL PARTNERS	DEVELOPMENT OF A MECHANISTIC HYDRIDE BEHAVIOR MODEL FOR SPENT FUEL CLADDING STORAGE AND TRANSPORTATION
2017 INFRASTRUCTURE AWARD	$299,337	R. CHRISTENSEN (UI) 10 ADDITIONAL PARTNERS	ADVANCEMENTS TOWARDS ASME NUCLEAR CODE CASE FOR COMPACT HEAT EXCHANGERS

Education and Outreach

Family Nuclear Science Night

To inspire a new generation of scientists, engineers and technicians, INL sponsored its first Family Nuclear Science Night at CAES on Nov. 3, 2016. Families had the opportunity to meet nuclear scientists and engineers and engage in hands-on activities focused on nuclear science. The event, presented in conjunction with Nuclear Science Week, was co-sponsored by CAES and the University of Idaho American Nuclear Society Student Chapter (UI-ANS).

UNIVERSITY OF IDAHO AND CAES GRADUATE RESEARCHER AMEY SHIGREKAR SPEAKS TO A YOUNG STUDENT AT INL'S FAMILY NUCLEAR SCIENCE NIGHT.

Big Ideas Grant

An interdisciplinary team of graduate students and faculty from the University of Idaho won a grant from UI's Vandal Ideas Project to fund, "Increasing the Go-on Rate in Southeast Idaho through the Nexus of Food, Energy, and Water." The project aims to increase the percentage of southeast Idaho high school seniors going to college by providing mentorship for senior projects. Seniors will be connected with mentors from INL and local industries to assist in senior projects relating to the Water–Energy–Food Nexus.

TRIO student day

UI-ANS students partnered with the CAES, INL, Eastern Idaho Technical College and ISU on Dec. 2, 2016, to present STEM day for ISU-TRIO students. Federal TRIO Programs prepare disadvantaged individuals for succestsful entry into, retention in, and completion of post-secondary education.

>100

STUDENTS HOSTED DURING TRIO STUDENT DAY

Engineering Your Future

High school students from eastern Idaho schools converged on CAES Feb. 22, 2017, to participate in "Engineering Your Future," an event featuring workshops on mechanical engineering basics, wind energy, data visualization and drone flight simulation. Activities included GridGame, a computer program devised by INL engineer Tim McJunkin to simulate electrical power grid management, as well as hands-on STEM from INL's Energy and Environment Science & Technology directorate.

Cyber Physical Security Laboratory

With support from INL and the National Science Foundation, the Energy Systems Technology and Education Center (ESTEC) at ISU began building the Cyber Physical Security Laboratory using input from the program's Technical Advisory Committee and instructors. The lab provides hardware and software that cyber students need to complete their coursework. An associated 4-tank process control station is designed with physical system security. This station will be connected in a network that has various levels of cybersecurity, allowing cybersecurity training on real industrial control systems.

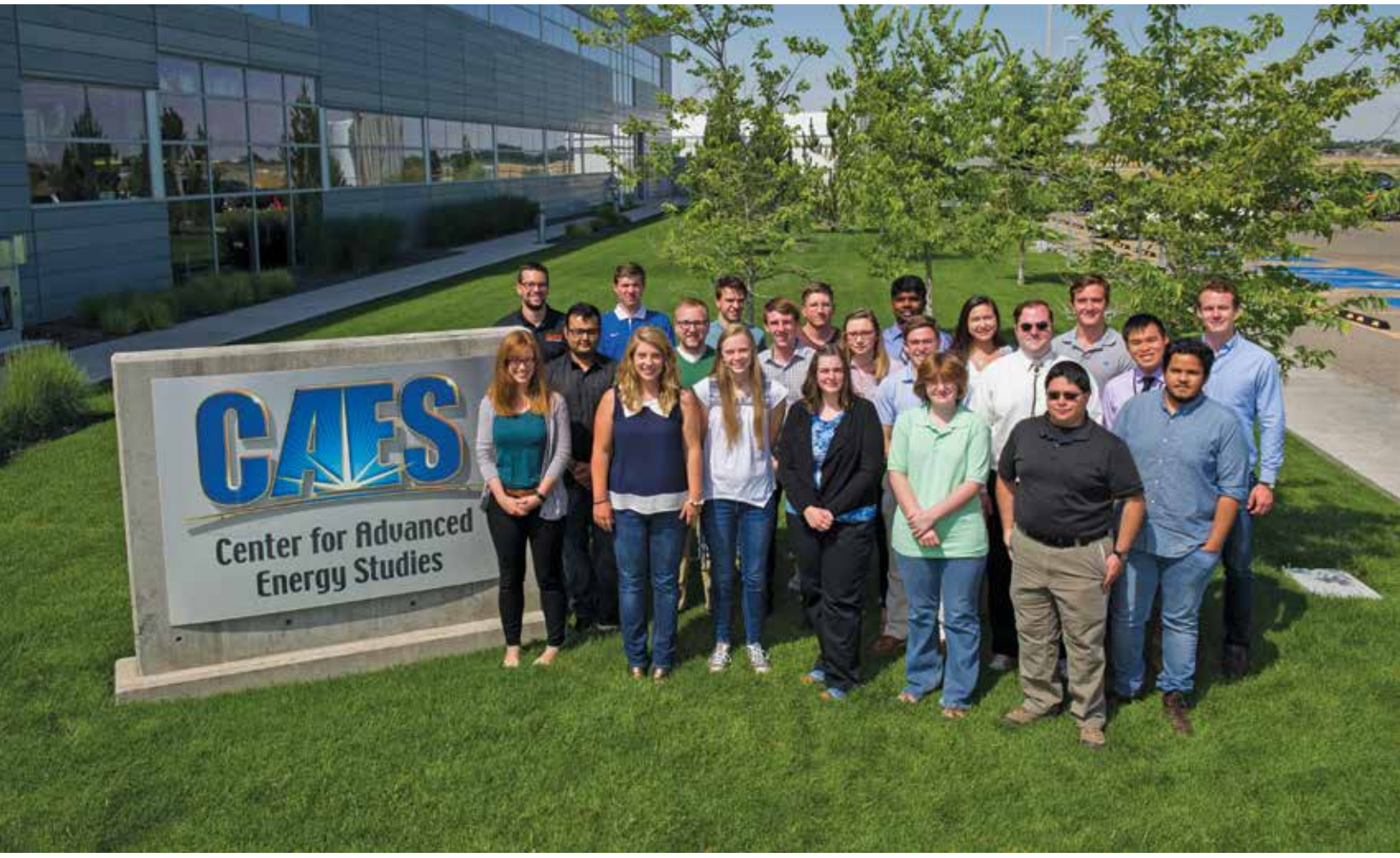
STUDENTS PLAY THE GRIDGAME DURING THE ENGINEERING YOUR FUTURE EVENT.

Internships and Assistantships

Each year, internships and assistantships provide opportunities for the best and brightest students to further their educations by working with CAES scientists and engineers. Internships and assistantships are an opportunity for universities and INL to showcase capabilities and get new perspectives on research. Students learn how to solve real-world problems under the guidance of distinguished scientific and technical experts.

IN FISCAL YEAR 2017, 76 STUDENTS FROM CAES AFFILIATED SCHOOLS INTERNED AT INL.

This year, 76 students had a CAES internship or assistantship or came from CAES partner universities and worked on INL projects. An additional 15 worked at CAES as Center for Space Nuclear Research (CSNR) fellows or Nuclear Science User Facilities interns.




Thomas Blackham


Kiyo Fujimoto


Stephen Hancock


Rahul Reddy Kancharla


Emma Redfoot

New INL graduate program

INL has collaborated with several universities to develop the new INL Graduate Fellowship Program. The first call for the program closed earlier this year and 11 fellows were selected in August. During this pilot call, INL targeted candidates from Center for Advanced Energy Studies (CAES) and National University Consortium (NUC) schools.

Congratulations to:
Thomas Blackham (ISU)
INL adviser: Tammie Borders
University thesis adviser: Leslie Kerby

Kiyo Fujimoto (BSU)
INL adviser: Troy Unruh
University thesis adviser: David Estrada

Stephen Hancock (UI)
INL adviser: Richard Boardman
University thesis adviser: Richard Christensen

Rahul Reddy Kancharla (BSU)
INL adviser: Josh Kane and William Smith
University thesis adviser: Elisa Barney Smith

Emma Redfoot (UI)
INL adviser: Shannon Bragg-Sitton
University thesis adviser: Bob Borrelli

The recipients of these nationally competitive fellowships have their tuition and fees covered by their university during their first years of graduate school (years one to three) and their tuition and fees plus a $60,000 annual salary paid by INL during the last two years of their doctoral research performed at the lab.

FOR MORE INFORMATION ABOUT THE PROGRAM, CONTACT ALI JOSEPHSON (208-526-0940) OR MICHELLE THIEL BINGHAM (208-526-7830).

Industry Engagement

Characterizing irradiated stainless steel welds

Customers from Japan's Nippon Nuclear Fuel Development Co., Ltd. visited CAES in June to view researchers' work with atom probe tomography. Their goal was to characterize how irradiation-induced material changes such as precipitation (solids coming out of solution) and spinodal decomposition (rapid unmixing of liquids or solids). The specimens were irradiated in Norway's Halden reactor and prepared in Japan before being shipped to CAES. The team successfully demonstrated that atom probe tomography can be used to quantify the amount of spinodal decomposition experienced by delta ferrite, a component of certain stainless steel welds.

12
MAXIMUM NUMBER OF MODULES IN NUSCALE POWER'S SMR POWER PLANT

50
MWE
POWER LEVEL OF EACH MODULE

Analyzing small modular reactor economics

The CAES Energy Policy Institute at BSU completed a techno-economic analysis of NuScale Power's small modular reactor plant design. The "Economies of Small" report compares costs of the systems and functions of NuScale's advanced design with those of existing large nuclear power plants. A proprietary final report was delivered in November 2016 to NuScale executives, who then contracted a second report from EPI. A regional Levelized Cost of Electricity study will compare NuScale's electricity to other generation options in specific regions of the U.S. and one region abroad.

Finding savings in food processing plants

CAES researchers at UI and INL are working together to help Idaho food processing companies reduce their energy and water use, with support from Avista Corp. A $93,600 grant from Avista funds a one-year project to evaluate north Idaho food processing plants. With mentoring from INL researchers, the UI team will create in-depth models of a plant's energy and water use. Beyond tapping into expertise across UI's colleges and locations, the project connects to CAES' Energy-Water Initiative and helps Avista meet the Idaho Public Utilities Commission's directive for utility companies to support reduced energy consumption by funding research and technology development.

Publications and Proceedings

Boise State University

1. Barnes, P., Lewis, J., Smith, K., Dufek, E., Dumias, J. & Xiong, H. (2017). *Sodium Electrolyte Degradation: Evaluating Pure Electrolyte Degradation through a Safe and Convenient NMR Technique.* Paper presented at the PacRim 12 ACS.

2. Black, G., Aydogan, F., Labor, L. & Solan, D. *Economies of Small.* Proprietary Final Report to NuScale.

3. Deng, C., Lau, M.L., Barkholtz, H.M., Xu, H., Parrish, R., Xu, M.O., . . . Xiong, H. (2017). Amorphous boron nanorod as an anode material for lithium-ion batteries at room temperature. *Nanoscale,* 9(30), 10757-10763. doi:10.1039/c7nr03017g

4. Jaques, B.J. (2016a). *CARAT (Collaboration for Advanced Research on Accident-Tolerant Fuel: Fuels subgroup).* Paper presented at the Research Activities in the Synthesis and Corrosion behavior of Uranium Mononitride, Stockholm, Sweden.

5. Jaques, B.J. (2016b). *Characterization of Kerogen Morphology in Oil Shales.* Student poster presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

6. Jaques, B.J. (2016c). *Cluster Evolution in F/M Alloys upon Neutron, Proton, and Self-ion Irradiation.* Student paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

7. Jaques, B.J. (2016d). *High Temperature Behavior of Zirconium Alloys.* Student poster presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

8. Jaques, B.J. (2016e). *High Temperature Investigation of Zirconium Alloys in Air.* Student paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

9. Jaques, B.J. (2016f). *In-situ Monitoring of Mechanochemically-stimulated Self-propagating Reactions in the Lanthanide.* Student paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

10. Jaques, B.J. (2016g). *New Techniques for Old Materials: Mechanochemical Synthesis and Advanced Processing of Lanthanide and Chalcogenide Compounds.* Student paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

11. Jaques, B.J. (2016h). *Proton Irradiation Effect on Nanostructured Thermoelectric Half-Heusler* $Hf_{0.25}Zr_{0.75}NiSn_{0.99}Sb_{0.01}$. Student poster presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

12. Jaques, B.J. (2016i). *Synthesis, Sintering, and Hydrothermal Corrosion Studies of Advanced Multiphase Actinide Fuels.* Student paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

13. Jaques, B.J. (2016j). *TEM In-situ Cantilever Testing to Assess Grain Boundary Cohesion in Irradiated ODS.* Student paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

14. Jaques, B.J., Watkins, J., Braine, T., Typurska-Puschel, B., Xu, P., Lahoda, E. J., & Butt, D. P. (2016). *Hydrothermal corrosion studies on nitride fuels.* Paper presented at the Top Fuel 2016 Conference, Boise, ID.

15. Jaques, B.J. (2017a). *Half-Heusler materials synthesis and characterization.* Paper presented at the BSU Undergraduate Research Conference.

16. Jaques, B.J. (2017b). *High temperature behavior of dysprosium rods.* Paper presented at the BSU Undergraduate Research Conference.

17. Jaques, B.J. (2017). *High temperature behavior of Zirconium alloys.* Paper presented at the BSU Undergraduate Research Conference.

18. Jaques, B.J. (2017). *Re-creation of purple: A study of color-shifted dyes available for Fayum funerary portraits.* Paper presented at the BSU Undergraduate Research Conference.

19. Kaur, M., Sundararajan, J.A., Burns, J., Wu, Y., Schimel, T. & Qiang, Y. (2016) Cr-Doping and Heat-Treatment Effect on Core-Shell Ni Nanocluster Film, *Journal of Materials Science*, 51, 10873-10886. doi:10.1007/s10853-016-0299-4

20. Li, L. (2016a). *Carbo Dioxide Sorption in Manganese Dioxide Octahedral Molecular Sieves.* Paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

21. Li, L. (2016b). *How to Use Computer Modeling to Facilitate New Materials Design*, Idaho State University.

22. Li, L. (2016c). *Materials-by-Design for Electronic and Energy Applications*, Boise State's Chemistry Department.

23. Li, L. (2017). *Computational Studies of* UO_2*, UN and Zr Materials for Pellet-Cladding Interactions.* Paper presented at the Irradiation Growth and PACE Meetings, Manchester, UK.

24. Liu, X., Miao, Y.B., Wu, Y.Q., Maloy, S.A. & Stubbins, J.F. (2017). Stability of nanoclusters in an oxide dispersion strengthened alloy under neutron irradiation. *Scripta Materialia,* 138, 57-61. doi:10.1016/j.scriptamat.2017.05.023

25. Luthman, H. & Gardner, J. (2016). *Parameter Estimation for HVAC System Models from Standard Test Data.* Paper presented at the ASME 2016 International Congress & Exposition, Phoenix, AZ.

26. Pandey, S.C., Xu, X., Williamson, I., Nelson, E.B. & Li, L. (2017). Electronic and vibrational properties of transition metal-oxides: Comparison of GGA, GGA plus U, and hybrid approaches. *Chemical Physics Letters,* 669, 1-8. doi:10.1016/j.cplett.2016.12.005

27. Pasebani, S., Charit, I., Guria, A., Wu, Y., Burns, J., Butt, D.P., . . . Shao, L. (2017). A preliminary investigation of high dose ion irradiation response of a lanthana-bearing nanostructured ferritic steel processed via spark plasma sintering. *Journal of Nuclear Materials,* 495, 78-84. doi:10.1016/j.jnucmat.2017.08.010

28. Prabhakaran, R., Wu, Y., Burns, J., Cole, J., Charit, I., Mishra, R., . . . Byun, T.S. (2016). *Effect of Neutron Irradiation on Friction Stir Processed MA956 and MA754.* Paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

29. Smith, K., Parrish, R., Wei, W., Hu, Y., Liu, Y., Li, T. & Xiong, C. (2014). *Three-Dimensional Graphene from CO_2 as a Promising Anode for Sodium-Ion Batteries.* Paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

30. Tolman, K., Ubic, R., Liu, B., Williamson, I., Bedke, K., Nelson, E.B., . . . Chen, X.M. (2017). Empirical evidence for A-site order in perovskites. *Journal of the American Ceramic Society,* 100(1), 429-442. doi:10.1111/jace.14547

31. van Rooyen, I.J., Lillo, T.M., Wen, H.M., Hill, C.M., Holesinger, T.G., Wu, Y.Q. & Aguiar, J.A. (2016a). *Micro/nano-structural examination and fission product identification in neutron irradiated AGR-1 TRISO fuel.* Paper presented at the ANS Winter Meeting, Las Vegas, NV. HTR2016 conference proceedings (652-669).

32. Varghese, T., Hollar, C., Richardson, J., Kempf, N., Han, C., Gamarachchi, P., . . . Zhang, Y. (2016). High-performance and flexible thermoelectric films by screen printing solution-processed nanoplate crystals. *Sci Rep,* 6, 33135. doi:10.1038/srep33135

33. Wen, H., Aitkaliyeva, A., Miller, B., Wu, Y., Keiser, D. & Gan, J. (2017). *Atom Probe Tomography Study of Fission Gas Bubbles in Neutron Irradiated U-Mo Nuclear Fuel.* Paper presented at the CAMECA APT User's Group Meeting, Madison, WI.

34. Wharry, J.P., Yano, K.H., Patki, P.V. & Wu, Y.Q. (2018). Mechanics of irradiated alloys studied through in situ TEM testing.

35. Williamson, I., Hernandez, A.C., Wong-Ng, W. & Li, L. (2016). High-Throughput Computational Screening of Electrical and Phonon Properties of Two-Dimensional Transition Metal Dichalcogenides. *JOM,* 68(10), 2666-2672. doi:10.1007/s11837-016-2068-x

36. Williamson, I., Li, S.S., Hernandez, A.C., Lawson, M., Chen, Y. & Li, L. (2017). Structural, electrical, phonon, and optical properties of Ti- and V-doped two-dimensional MoS_2. *Chemical Physics Letters,* 674, 157-163. doi:10.1016/j.cplett.2017.02.053

37. Williamson, I., Wilson, N., Lawson, M., Li, S., Chen, Y. & Li, L. (2017). Computational Screening of Metal-Site Dopants in Two-Dimensional MX_2 (M = Mo, W; X = S, Se, Te). *Journal of Applied Physics*.

38. Wong-Ng, W., Liu, G., Levin, I., Williamson, I., Ackerman, P., Talley, K.R., . . . Li, L. (2016). X-ray diffraction and density functional theory studies of $R(Fe0.5Co0.5)O_3$ (R = Pr, Nd, Sm, Eu, Gd). *Powder Diffraction,* 31(04), 259-266. doi:10.1017/s088571561600049x

39. Wu, Y. (2016). *Instrumentations, Capabilities and Applications at MaCS, CAES.* Paper presented at the ANS Winter Meeting, Las Vegas, NV.

40. Wu, Y., Burns, J., Butt, D.P. & Gates, G.A. (2016). *Study Ancient Pigment Structure by Using Advanced Characterization Techniques.* Paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

41. Wu, Y.Q., van Rooyen, I.J., Burns, J., Madden, J.W. & Wen, H.M. (2016). *Identification of Ag-rich Phase in TRISO Fuels by Using Atom Probe Tomography.* Paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

42. Wu, Y. & Taylor, J.L. (2017). *Instrumentations, Capabilities and Applications at MaCS, CAES.* Paper presented at the NSUF Partner Facilities Working Group Meeting.

43. Xiong, H., Smith, K., Savva, A., Wharry, J. & Butt, D. (2017). *Understanding Irradiation Effect on the Structure and Electrochemical Charge Storage Properties of TiO_2 Anode for Lithium-ion Batteries.* Paper presented at the American Chemical Society Spring Meeting

44. Yano, K.H., Swenson, M.J., Wu, Y. & Wharry, J.P. (2017). TEM in situ micropillar compression tests of ion irradiated oxide dispersion strengthened alloy. *Journal of Nuclear Materials,* 483(107-120), 107-120. doi:10.1016/j.jnucmat.2016.10.049

BOISE STATE UNIVERSITY

Idaho State University

45. Bosted, P.E., et. al. (CLAS Collaboration, 2016). Target and beam-target spin asymmetries in exclusive pi(+) and pi(-) electroproduction with 1.6-to 5.7-GeV electrons. *Physical Review C,* 94(5). doi:ARTN 05520110.1103/PhysRevC.94.055201

46. Fisher, M.A., Nawotniak, S.E. K. & Karuntillake, S. (2017). *Modeling a volcanic eruption column on Mars: a 4D solution.* Paper presented at the 48th Lunar and Planetary Science Conference, The Woodlands, TX.

47. Jacobsen, R.T., Penoncello, S.G. & Lemmon, E.W. (2017). *Thermodynamic Properties of Cryogenic Fluids, 2nd Edition*: Springer International Publishing. doi:doi.org/10.1007/978-1-4899-1798-0

48. Kerby, K. (2017). An Energy-dependent Numerical Model for the Condensation Probability Gamma_j, *Computer Physics Communications,* 213, *29*.

49. Kerby, L., Tumulak, A., Lepp anen, J., Valtavirta, V. & DeHart, M. (2017). *Preliminary Serpent-MOOSE Coupling and Implementation of Functional Expansion Tallies in Serpent.* Paper presented at the International Conference of Mathematics and Computational Methods Applied to Nuclear Science and Engineering.

50. Lum, E., Pope, C.L., Stewart, R., Byambadorj, B. & Beaullieu, Q. (2017). *Evaluation of Run 138B at Experimental Breeder Reactor II, A Prototype Liquid Metal Fast Breeder Reactor* (DE-NE0008301), June 30, 2017.

51. Mashnik, S. & Kerby, L. (2016) MCNP6 Updated Fission Cross Section Calculations at Intermediate Energies. *European Physical Journal Web of Conferences*, 117, 3008.

52. Mashnik, S.G., Kerby, L.M., Gudima, K.K., Sierk, A.J., Bull, J.S. & James, M.R. (2017). Production of energetic light fragments in extensions of the CEM and LAQGSM event generators of the Monte Carlo transport code MCNP6. *Physical Review C,* 95(3). doi:ARTN_03461310.1103/PhysRevC.95.034613

53. Pope, C. L. (2016). *Experimental Breeder Reactor II Benchmark Evaluation* (DE-NE-0008301), Dec. 30, 2016.

54. Pope, C. L., Savage, B., Johnson, B., Muchmore, C., Nichols, L., Roberts, G., . . . Smith, C. (2017). *Nuclear Power Plant Mechanical Component Flooding Fragility Experiments Status* (INL/EXT-17-42728).

55. Pope, C.L., Solbrig, C.W. & Andrus, J.P. (2018). Fuel Conditioning Facility Inert Gas Filled Reprocessing Hot Cell Leak Rate Measurement. *An. Nucl. Energy*, 111, 676-682. https://doi.org/10.1016/j.anucene.2017.08.058

56. Rehak, J., Kerby, L., DeHart, M., Slaybaugh, R. & Lepp anen, J. (2016). Implementation of Weighted Delta-Tracking with Scattering in the Serpent 2 Monte Carlo Code. *Transactions of the American Nuclear Society*, 116.

57. Ryan, E. & Pope C.L. (2017). Smoothed Particle Hydrodynamics Model Optimization and Comparison for Flow Over an Ogee Spillway. *Journal of Fluid Mechanics*.

58. Stewart, R., Pope, C. & Ryan, E. (2017). Fast spectrum reactor fuel assembly sensitivity analysis. *Annals of Nuclear Energy*, 110, 1091-1097. doi:10.1016/j.anucene.2017.06.058

59. Wendt, B., Kerby, L., Tumulak, A., Lepp anen, J. & DeHart, D. (2017). Advancement of Functional Expansion Tallies Capabilities in Serpent 2. *Transactions of the American Nuclear Society*, 116.

Idaho State UNIVERSITY

University of Idaho

60. Adefisan, O.O., McDonald, A.G. & Fabiyi, J.S. (2016). Effect of rattan fiber treatments on the strength and sorption properties of cement bonded composites. *Journal of Bamboo and Rattan,* 15(1&2), 1-16.

61. Akram, J., Kalvala, P.R., Misra, M. & Charit, I. (2017). Creep Behavior of Dissimilar Metal Weld Joints between P91 and AISI 304. *Materials Science & Engineering A*, 688, 396-406.

62. Alsagabi, S., Pasebani, S. & Charit, I. (2017). *High Temperature Tensile Properties and Related Microstructural Evolution of Grade 92 Steel.* Paper presented at the Mechanical and Creep Behavior of Advanced Materials (pp. 263-272), TMS-Springer, San Diego, CA.

63. Aunan, M.M., Fairley, J.P. & Larson, P.B. (2016). *Protocols for gas and vapor sampling in hydrothermal discharge area.* Paper presented at the GSA Rocky Mountain Section meeting, Moscow ID.

64. Balogun, A.O. & McDonald, A.G. (2016). Decomposition kinetic study, spectroscopic and pyrolytic analyses of Isoberlinia doka and Pinus ponderosa. *Biomass Conversion and Biorefinery*, 6(3), 315-324. doi:DOI: 10.1007/s13399-015-0185-3

65. Balogun, A.O., Lasode, O.A. & McDonald, A.G. (2017). Thermo-physical, chemical and structural modifications in torrefied biomass residues. *Waste and Biomass Valorization*. doi: 10.1007/s12649-016-9787-7

66. Blair, R., Pesic, B., Raja, L., Ehrsam, I. & Kline, J. (2016). *Role of admixtures in concrete during corrosion of rebar: Effect of glycerol and silica, formulations.* Paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

67. Blair, R., Pesic, B., Kline, J., Ehrsam, I. & Raja, K. (2017). Threshold Chloride Concentrations and Passivity Breakdown of Rebar Steel in Real Concrete solution at Different pH Conditions with the Addition of Glycerol. *Acta Metall. Sin.* doi:DOI 10.1007/s40195-017-0532-4

68. Borrelli, R.A., Ahn, J. & Hwang, Y. (2017). Approaches to a Practical Systems Assessment for Safeguardability of Advanced Nuclear Fuel Cycles. *Nuclear Technology,* 197(3), 248-264. doi:10.1080/00295450.2016.1273713

69. Borrelli, R.A., Tolman, M. & Lee, J. (2017). *Preliminary analysis of facility design for pyroprocessing safeguardability.* Paper presented at the 2017 American Nuclear Society Annual Meeting, San Francisco, CA.

70. Breton Toral, A., Trejo Estrada, S.R. & McDonald, A.G. (2016). Lactic Acid Production from Potato Peel Waste, Spent Coffee Grounds and Almond Shells with Undefined Mixed Cultures Isolated from Coffee Mucilage from Coatepec Mexico. *Fermentation Technology,* 06(01), 139-145. doi:10.4172/2167-7972.1000139

71. Butt, H.N. (2016). Assessment of passive safety system of a Small Modular Reactor (SMR). *Annals of Nuclear Energy,* 98, 191-199.

72. Chen, M., Shi, S., Sun, X., Christensen, R.N., Skavdahl, I., Utgikar, V. & Sabharwall, P. (2016). *Experimental and Numerical Study of Heat Transfer and Pressure Drop in a High-Temperature Printed Circuit Heat Exchanger.* Paper presented at the 8th International Topical Meeting on High Temperature Reactor Technology 2016 (HTR2016), Las Vegas, NV.

73. Chen, M., Sun, X., Christensen, R.N., Shi, S., Skavdahl, I., Utgikar, V. & Sabharwall, P. (2016). *Development of a Thermal-Hydraulic Analysis Code for an FHR.* Paper presented at the 11th International Topical Meeting on Nuclear Reactor Thermal Hydraulics, Operation and Safety (NUTHOS-11), Gyeongju, South Korea.

74. Coldsnow, K., Nandanwar, S.U., Porter, A., Utgikar, C., Sabharwall, P. & Aston, D.E. (2016). *Multicomponent Adsorption of Radioactive Iodine and Krypton using ETS-10 Supported Carbon Nano-Polyhedrons.* Paper presented at the 2016 ANS Winter Meeting, Las Vegas, NV.

75. Davidson, J.R.J., Fairley, J., Nicol, A., Gravley, D. & Ring, U. (2016). The origin of radon anomalies along normal faults in an active rift and geothermal area. *Geosphere,* 12(5), 1656-1669. doi:10.1130/Ges01321.1

76. Dutt, A., Pasebani, S., Charit, I. & Mishra, R.S. (2017a). On the Creep Behavior of Dual-Scale Particle Strengthened Nickel Based Alloy. *Materials Science & Engineering A,* 676, 406-410.

77. Dutt, A., Pasebani, S., Charit, I. & Mishra, R. S. (2017b). *On the Creep Behavior of Dual-Scale Particle Strengthened Nickel Based Alloy.* Paper presented at the Mechanical and Creep Behavior of Advanced Materials, San Diego, CA.

78. Fairley, J.P. (2016). *Models and Modeling: An Introduction for Earth and Environmental*. Oxford, UK: John Wiley & Sons.

79. Guria, A. & Charit, I. (2017a). *Mechanical Properties and Serrated Flow in Al-Bearing, High-Cr Accident Tolerant Ferritic Steel.* Paper presented at the Mechanical and Creep Behavior of Advanced Materials, San Diego, CA.

80. Guria, A. & Charit, I. (2017b). Tensile properties of accident-tolerant aluminum-bearing ferritic steels. *Annals of Nuclear Energy,* 100, 82-88. doi:10.1016/j.anucene.2016.09.018

81. Howe, D., Garcia-Perez, M., Taasevigen, D., Rainbolt, J., Albrecht, K., Li, H., . . . Wolcott, M. (2016). Thermal pretreatment of a high lignin SSF digester residue to increase its softening point. *Journal of Analytical and Applied Pyrolysis*. doi:10.1016/j.jaap.2016.03.012

82. Howe, D.T., Taasevigen, D., Garcia-Perez, M., McDonald, A.G., Li, G.S. & Wolcott, M. (2017). Steam gasification of a thermally pretreated high lignin corn stover simultaneous saccharification and fermentation digester residue. *Energy,* 119, 400-407. doi:10.1016/j.energy.2016.12.094

83. Kline, J. (2016). *Doubling the Life of Concrete Structures.* Paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

84. Kundu, A. (2017). *A Preliminary Study on the High Energy Ball Milling and Spark Plasma Sintering of Fe-9Cr Alloy.* Paper presented at the TMS 2017 Structural Materials Division (SMD) Graduate Students Poster Competition, San Diego, CA.

85. Lindsey, C.R., Fairley, J.P. & Larson, P.B. (2016). *Geostatistical characterization of fluid pathway connection in hot spring clusters in the Lower Geyser Basin, Yellowstone National Park, Wyoming.* Paper presented at the GSA Rocky Mountain Section meeting, Moscow, ID.

86. Lindsey, C.R., Price, A.N., Aunan, M.M., Villegas, G.A. & Fairley, J.P. (2016). *Using a simple analytical model to test for equipment tampering at Porcupine Hill Geyser, Yellowstone National Park, Wyoming.* Paper presented at the Geological Society of America annual meeting, Denver, CO.

87. Lubenow, B.L., Fairley, J.P., Lindsey, C.R. & Larson, P.B. (2016). Influences on shallow ground temperatures in high flux thermal systems. *Journal of Volcanology and Geothermal Research,* 323, 53-61. doi:10.1016/j.jvolgeores.2016.04.039

88. Luo, S., Cao, J. & McDonald, A.G. (2017). Esterification of industrial lignin and its effect on the resulting poly(3-hydroxybutyrate-co-3-hydroxyvalerate) or polypropylene based composites. *Industrial Crops and Products*, 97, 281-291.

89. Lyon, K.L., Utgikar, V.P. & Greenhalgh, M.R. (2017). Dynamic Modeling for the Separation of Rare Earth Elements Using Solvent Extraction: Predicting Separation Performance Using Laboratory Equilibrium Data. *Industrial & Engineering Chemistry Research,* 56(4), 1048-1056. doi:10.1021/acs.iecr.6b04009

90. Maskal, A.B. & Aydogan, F. (2017a). Mathematical spacer grid models for single phase flow. *Annals of Nuclear Energy,* 103, 130-146. doi:10.1016/j.anucene.2017.01.019

91. Maskal, A.B. & Aydogan, F. (2017b). Mathematical spacer grid models for two phase flow. *Annals of Nuclear Energy,* 103, 173-193. doi:10.1016/j.anucene.2017.01.024

92. McEligot, D.M. & Johnson, R.W. (2017). Bypass Flow Resistance in Prismatic Gas-Cooled Nuclear Reactors. *Journal of Nuclear Engineering and Radiation Science,* 3(1), 011003. doi: 10.1115/1.4035047

93. Moody, A., Fairley, J.P., Plummer, M., Dowling, C., Neumann, K. & Florea, L. (2016). Designing an engineered geothermal reservoir in the welded tuffs of the Snake River Plain. *GSA special publication Geothermal Energy: an Emerging Resource, Eds.*

94. Nandanwar, S.U., Coldsnow, K., Porter, A., Sabharwall, P., Aston, D.E., McIlroy, D.N. & Utgikar, V. (2017). Adsorption of radioactive iodine and krypton from off-gas stream using continuous flow adsorption column. *Chemical Engineering Journal,* 320, 222-231. doi:10.1016/j.cej.2017.03.020

95. Oyarzún, R., Oyarzún, J., Fairley, J.P., Núñez, J., Gómez, N., Arumí, J. & Maturana, H. (2017). A simple approach for the analysis of the structural-geologic control of groundwater in an arid rural, mid-mountain, granitic and volcanic-sedimentary terrain: The case of the Coquimbo Region, North-Central Chile. *Journal of Arid Environments*, 142, 31-35. doi:10.1016/j.jaridenv.2017.03.003

96. Pasebani, S. & Charit, I. (2017). *Advanced Manufacturing of Nanostructured Ferritic Steels with Enhanced Irradiation Performance for Nuclear Applications.* Paper presented at the Nanostructured Materials for Nuclear Applications II, TMS 2017 Conference, San Diego, CA.

97. Pasebani, S., Charit, I., Wu, Y., Burns, J., Cole, J. & Butt, D. (2017). *Nanostructured Ferritic Steels: Synthesis, Microstructure and Mechanical Properties.* Paper presented at the Mechanical Behavior of Nanostructured Materials, TMS 2017 Conference, San Diego, CA.

98. Peterson, J., Haney, M. & Borrelli, R. A. (2017). *Cybersecurity vulnerability assessment methodologies for nuclear power plants, Proc.* Paper presented at the 2017 American Nuclear Society Annual Meeting, San Francisco, CA.

99. Prabhakaran, R., Wu, Y., Burns, J., Cole, J., Charit, I., Mishra, R., … Byun, T.S. (2016). *Effect of Neutron Irradiation on Friction Stir Processed MA956 and MA754.* Paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

100. Prabhakaran, S., Wu, Y., Burns, J., Cole, J., Charit, I., Mishra, R.S., . . . Byun, T.S. (2017). *Effect of Neutron Irradiation on Friction Stir Processed ODS Alloys (MA956 and MA754).* Paper presented at the 2017 Technical Division Young Professional Poster Competition, Structural Materials Division (SMD), San Diego, CA. (Dr. Charit's PhD student, Ramprashad Prabhakaran, won the competition).

101. Price, A.N., Lindsey, C.R. & Fairley, J.P. (2016). *Analytical modeling of heat flux and subsurface flowpaths using shallow seismic refraction and ground temperatures at Burgdorf hot springs, Idaho.* Paper presented at the GSA Rocky Mountain Section meeting, Moscow ID.

102. Raja, K., Pesic, B., Kline, J., Blair, R. & Ehrsam, I. (2016). *Controlling the Permeability of Corrosion Inducing Ions in the Concrete by Nano-viscosity Modifiers.* Paper presented at the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

103. Redfoot, E. & Borrelli, R.A. (2017). *Nuclear fuel cycle simulator as a means to model a nuclear hybrid energy system, Proc.* Paper presented at the 2017 American Nuclear Society Annual Meeting, San Francisco, CA.

104. Ricco, P., Walsh, E.J., Brighenti, F. & McEligot, D.M. (2016). Growth of boundary-layer streaks due to free-stream turbulence. *International Journal of Heat and Fluid Flow,* 61, 272-283. doi:10.1016/j.ijheatfluidflow.2016.05.003

105. Roth, G.A. & Aydogan, F. (2017). Mass closure models for a system code based on six fields. *Progress in Nuclear Energy,* 94, 147-161. doi:10.1016/j.pnucene.2016.09.020

106. Sitler, S., Raja, K., & Charit, I. (2016). *High Temperature Oxidation Study of Hafnium and Zirconium Diborides: MHD Electrode Coatings.* Paper presented at Processing and Manufacturing Poster Session of the Materials Science and Technology 2016 Conference, Salt Lake City, UT.

107. Sitler, S.J., Raja, K.S. & Charit, I. (2017). ZrB_2-HfB_2 solid solutions as electrode materials for hydrogen reaction in acidic and basic solutions. *Materials Letters*, 188, 239-243. doi:10.1016/j.matlet.2016.10.122

108. Sittiho, A., Tungala, V., Charit, I. & Mishra, R.S. (2016). *Microstructure and Mechanical Properties of Friction Stir Processed APMTTM Alloy.* Paper presented at the Solid State Processing, Materials Science & Technology Conference, Salt Lake City, UT.

109. Sittiho, A., Tungala, V., Charit, I. & Mishra, R.S. (2017). *Understanding of Microstructure and Mechanical Properties of Friction Stir Processed Al-Bearing, High-Cr Ferritic Stainless Steel.* Paper presented at the Mechanical and Creep Behavior of Advanced Materials (pp. 263-272), TMS-Springer, San Diego, CA.

110. Skavdahl, I., Utgikar, V., Christensen, R., Sabharwall, P., Chen, M. & Sun, X. (2016). *Helium Brayton Cycle Design for Advanced High Temperature Reactor System.* Paper presented at the 2016 American Nuclear Society Winter Meeting, Las Vegas, NV.

111. Stan, T., Sprouster, D.J., Ofan, A., Odette, G.R., Ecker, L.E. & Charit, I. (2017). X-ray absorption spectroscopy characterization of embedded and extracted nano-oxides. *Journal of Alloys and Compounds,* 699, 1030-1035. doi:10.1016/j.jallcom.2016.12.350

112. Stankovikj, F., McDonald, A.G., Helms, G. L. & Garcia-Perez, M. (2016). Quantification of Bio-Oil Functional Groups and Evidences of the Presence of Pyrolytic Humins. *Energy & Fuels,* 30(8), 6505-6524. doi:10.1021/acs.energyfuels.6b01242

113. Stankovikj, F., McDonald, A.G., Helms, G.L., Olarte, M.V. & Garcia-Perez, M. (2017). Characterization of the Water-Soluble Fraction of Woody Biomass Pyrolysis Oils. *Energy & Fuels,* 31(2), 1650-1664. doi:10.1021/acs.energyfuels.6b02950

114. Valentin, F.I., Artoun, N., Anderson, R., Kawaji, M. & McEligot, D.M. (2016). Study of Convection Heat Transfer in a Very High Temperature Reactor Flow Channel: Numerical and Experimental Results. *Nuclear Technology,* 196(3), 661-673. doi:10.13182/Nt16-46

115. Villegas, G.A., Aunan, M.M., Sorensen, A.P., Lindsey, C.R., Fairley, J.P. & Larson, P.B. (2016). *Preliminary reconnaissance of West Astringent Creek thermal area, Yellowstone National Park.* Paper presented at the American Geophysical Union annual meeting, San Francisco, CA.

116. Villegas, G.A. & Fairley, J.P. (2016). *Evaluating the difference in heat flux measurements from unconsolidated soils in a vertical sequence through thermocouple sensors.* Paper presented at the Geological Society of America annual meeting, Denver, CO.

117. Villegas, G.A., Lindsey, C.R., Aunan, M.M., Price, A.N., Fairley, J.P. & Larson, P.B. (2016). *Quantifying errors in heat flux measurements using a vertical sequence of thermocouple sensors.* Paper presented at the GSA Rocky Mountain Section meeting, Moscow, ID.

University of Idaho

University of Wyoming

118. Bagdonas, D.A., McLaughlin, J.F., Nye, C. & Quillinan, S.A. (2016). *Alternative rare earth element resource evaluation of coal by-products; a type example form the Powder River Basin, Wyoming.* Paper presented at the Geological Society of America annual meeting, Denver, CO.

119. Enriquez, A.J., Finnoff, D.C., McLaughlin, J.F. & Bagdonas, D.A. (2016). *Economic Feasibility of Rare Earth Element Extraction from Wyoming Coal Ash/Char.* Paper presented at the Geological Society of America annual meeting, Denver, CO.

120. Grana, D. (2016a). Bayesian linearized rock physics inversion. *Geophysics,* 81, D625-D664.

121. Grana, D. (2016b). Pressure-velocity relations in reservoir rocks: Modified MacBeth's equation. *Journal of Applied Geophysics,* 132, 234-241. doi:10.1016/j.jappgeo.2016.07.020

122. Grana, D. (2016c). Rock physics modeling in conventional reservoirs. *New Frontiers in Oil and Gas Exploration*: Springer.

123. Grana, D., Lang, X. & Wu, W. (2016). Statistical facies classification from multiple seismic attributes: comparison between Bayesian classification and Expectation-Maximization method and application in petrophysical inversion. *Geophysical Prospecting*, 65(2), 544-562. doi: 10.1111/1365-2478.12428

124. Grana, D., Verma, S. & Podgorney, R. (2016). *Rock Physics Modeling for the Potential FORGE Site on the Eastern Snake River Plain, Idaho.* Paper presented at the Stanford Geothermal Workshop.

125. Grana, D. *Estimation and re-parameterization of pressure and saturation changes from time-lapse seismic data.* Paper presented at the AAPG/SEG International Conference.

126. Lang, X. & Grana, D. (2016). Geostatistical inversion of prestack seismic data for the joint estimation of facies and seismic velocities using stochastic sampling from Gaussian mixture posterior distributions. *SEG Expanded Abstracts*, 36, 2916-2920.

127. Miller, Q.R.S., Wang, X.Y., Kaszuba, J.P., Mouzakis, K.M., Navarre-Sitchler, A.K., Alvarado, V., . . . Heath, J.E. (2016). Experimental Study of Porosity Changes in Shale Caprocks Exposed to Carbon Dioxide-Saturated Brine II: Insights from Aqueous Geochemistry. *Environmental Engineering Science,* 33(10), 736-744. doi:10.1089/ees.2015.0592

128. Mueller, S., Jafari, F. & Roth, D. (2016). A covert authentication and security solution for GMOs. *BMC Bioinformatics,* 17(1), 389. doi:10.1186/s12859-016-1256-6

129. Nye, C., Quillinan, S.A., Neupane, G., McLing, T., Bagdonas, D. & McLaughlin, J.F. (2016). *Aqueous Rare Earth element Patterns and Concentration in Co-Produced Brines and Industrial Ponds, Wyoming.* Paper presented at the Geological Socieity of America annual meeting, Denver, CO.

130. Schlanser, K., Grana, D. & Campbell-Stone, E. (2016). Lithofacies classification in the Marcellus Shale by applying a statistical clustering algorithm to petrophysical and elastic well logs. *Interpretation,* 4(2), SE31-SE49.

UNIVERSITY OF WYOMING

THE CENTER FOR ADVANCED ENERGY STUDIES IS A RESEARCH AND EDUCATION CONSORTIUM AMONG IDAHO NATIONAL LABORATORY, BOISE STATE UNIVERSITY, IDAHO STATE UNIVERSITY, THE UNIVERSITY OF IDAHO AND THE UNIVERSITY OF WYOMING.




CENTER FOR ADVANCED ENERGY STUDIES
995 UNIVERSITY BOULEVARD
IDAHO FALLS, ID 83401
WWW.CAESENERGY.ORG

CAES Center for Advanced Energy Studies

WORK-BASED LEARNING INITIATIVE

SUBJECT

National Governors Association Work-Based Learning Policy Academy

REFERENCE

September 2017	Board adopts the Governor's Higher Education Task Force recommendations, which includes incorporation of the recommendations submitted by the Governor's Workforce Development Task Force.
December 2017	Report from Workforce Development Council included discussion of the National Governors Association grant.

BACKGROUND/DISCUSSION

Idaho is one of six states competitively selected to participate in the National Governors Association (NGA) Center for Best Practices Policy Academy on Work-Based Learning. Each selected state receives a grant of $80,000.00 for its participation in the policy academy. The grant is provided to support the commitment shared by education, workforce, and legislative stakeholders to strengthen and scale work-based learning as part of the state's strategy to build a skilled workforce aligned with industry needs. A team of interagency and industry representatives serving on a workgroup led by the Idaho Workforce Development Council will collaborate to move forward this effort. Participating agencies include the State Department of Education (SDE), Office of the State Board of Education, Idaho Career-Technical Education, Division of Vocational Rehabilitation, STEM Action Center, Department of Labor, and Department of Commerce among others.

The following goals for this initiative include: 1.) Adopting a framework for high-quality work-based learning; 2.) Designing and implementing a statewide internship/externship program; 3.) Identifying and implementing opportunities to integrate the co-op model for middle-skill STEM occupations; 4.) Identifying best practices in scaling registered apprenticeships; 5.) Examining and adopting policies and incentives and incentives to encourage work-based learning; and 6.) building a toolkit for local school districts to expand work-based learning.

STAFF COMMENTS AND RECOMMENDATIONS

The goals pursued through this initiative aligns with the Board's and Governor's goals to increase work-based learning opportunities, and in doing so assist with efforts to help the state meet its goal of having 60 percent of Idahoans between 25 and 34 attain a postsecondary certificate or degree by 2025. Board staff will be working with institutions, the Department of Education, and across agencies to achieve the desired goals of this initiative.

BOARD ACTION

This item is for informational purposes only. Any action taken will be at the Board's discretion.

THIS PAGE LEFT INTENTIONALLY BLANK

SUBJECT

Common Course Indexing

REFERENCE

June 1996	The Board adopted a common course listing for general education core.
September 2017	The Board adopted the Governor's Higher Education Task Force recommendations to include employing a Common Course numbering system.

APPLICABLE STATUTE, RULE, OR POLICY

Idaho State Board of Education Governing Policies & Procedures, Section III.N. General Edcuation

ALIGNMENT WITH STRATEGIC PLAN

Idaho K-20 Public Education Strategic Plan goal 4, Effective and Efficient Educational System, Objective B, Alignment and Coordination

BACKGROUND/DISCUSSION

On January 6, 2017, Governor C.L. "Butch" Otter created a Higher Education Task Force and charged them with studying the state of higher education in Idaho and making recommendations that focus on postsecondary access and completion.

Among the recommendations, under access and affordability, included the need to develop a common course numbering system within the General Education Matriculation (GEM) framework that would assist students in transferring to and between postsecondary institutions. This included assisting with the transferability of courses taken in high school for postsecondary credit. Since the adoption of the task force recommendations, Board staff has worked with GEM discipline groups and the Council on Academic Affairs and Programs to develop a common indexing convention for a core set of curricula within the GEM framework. Common course indexing includes three elements: common course number, common course title, and common GEM area designation.

IMPACT

Development of a common course numbering system will provide greater transparency of course articulation and seamless transfer for Idaho's students. It will also provide greater consistency for equivalent courses to be recognized with similar GEM designation across all institutions.

ATTACHMENTS

Attachment 1 – Common Course Index

STAFF COMMENTS AND RECOMMENDATIONS

A list of courses has been compiled by Board staff with feedback from the GEM discipline groups, state General Education committee, and the Council on Academic Affairs and Programs. The list identifies courses that are available to students across most Idaho public institutions and reflects the most commonly utilized course numbers and titles across institutions. Courses are designated at the 100 or 200 level; GEM stamped at most institutions; and, maintain equivalencies across institutions consistent with the Course Transfer website. It is important to note that in June 1996 the Board approved a similar list for general education core to ease the transfer of students between public institutions. While the new list is consistent across institutions, it is not as extensive as those identified in 1996.

Efforts are underway by institutions to implement common course indexing for the attached list of courses no later than the 2019-20 academic year. Board staff will provide regular updates to the Board throughout the 2018 calendar year. It is anticipated that Board Policy III.N will be amended to provide Board guidance on adoption and maintenance of common course listings.

BOARD ACTION

This item is for informational purposes only. Any action will be at the Board's discretion.

Idaho State Board of Education Common Course Index (Numbering/Titling/GEM Designation)

Written Communications
ENGL 101: English Composition I
ENGL 102: English Composition II

Oral Communications
COMM 101: Fundamentals of Oral Communications

Mathematical Ways of Knowing
MATH 123: Math in Modern Society
MATH 130: Finite Mathematics*
MATH 143: College Algebra (or Precalculus A)
MATH 144: Trigonometry (or Precalculus B)
MATH 147: College Algebra and Trigonometry (or Precalculus A and B)
MATH 160: Survey of Calculus
MATH 170: Calculus I
MATH 153: Statistical Methods
MATH 257: Math for Elementary Teachers 2

Scientific Ways of Knowing
BIOL 100: Concepts of Biology
BIOL 227: Human Anatomy and Physiology I
CHEM 100: Concepts of Chemistry
CHEM 101: Introduction to Chemistry
CHEM 102: Essentials of Organic and Biochemistry
CHEM 111: General Chemistry I
PHYS 111: General Physics I
PHYS 112: General Physics II
GEOL 101: Physical Geology
GEOL 102: Historical Geology

Social and Behavioral Ways of Knowing
ANTH 101: Physical Anthropology
ANTH102: Cultural Anthropology
ECON 201: Principles of Macroeconomics
ECON 202: Principles of Microeconomics
HIST 101: Western Civilization I
HIST 102: Western Civilization II
HIST 111: United States (U.S.) History I
HIST 112: United States (U.S.) History II
POLS 101: American National Government
PSYC 101: Introduction to General Psychology
SOC 101: Introduction to Sociology
SOC 102: Social Problems

Humanistic and Artistic Ways of Knowing
MUSI 100: Introduction to Music
PHIL 101: Introduction to Philosophy
PHIL 103: Ethics
ENGL 175: Introduction to Literature

All Foreign Language at the first and second level to be titled “Elementary [Language] I” and “Elementary [Language] II”, numbered as 101 and 102 (respectively), and GEM-stamped in Humanistic and Artistic Ways of Knowing. The first four letters of the language should be used in the course prefix (e.g., SPAN, FREN, GERM, etc.).

ART 100 (Survey of Art/Intro to Art/World Art and Culture) is offered at all institutions with the exception of College of Southern Idaho and College of Western Idaho. ART 101 (Art History I/History of Western Art I) is offered as Art History I/History of Western Art I at all institutions with the exception of Lewis-Clark State College and the University of Idaho, which offer it as Visual Art. In light of these circumstances, institutions are to consider an art course across the system sharing a common title and number.

*Course offered as MATH 130 at all institutions except Boise State University, which counts the course as an elective upon receipt of transfer credit.

SUBJECT

Postsecondary Guided Pathways Planning Report

REFERENCE

August 2010	Board established an attainment goal that 60% of Idaho's 25-34 year olds will have a postsecondary degree or certificate by 2020.
August 2011	Board reviewed data regarding Idaho's status in meeting the 60% goal by 2020, and heard strategies to meet the goal.
December 2011	Board approved the framework for Complete College Idaho: A Plan for Growing Talent to Fuel Innovation and Economic Growth in the Gem State, and directed staff to obtain stakeholder feedback and buy-in, and bring back the plan for approval at the June 2012 Board meeting.
June 2012	Board approved the postsecondary degree and certificate projections and the Complete College Idaho: A Plan for Growing Talent to Fuel Innovation and Economic Growth in the Gem State.
June 2015	Board approved changes to Board Policy III.S., establishing co-requisite, accelerated, and emporium support models as the approved delivery of remedial instruction, a strategy included in the Complete College Idaho plan.
September 2017	Board adopts the Governor's Higher Education Task Force recommendations, which includes Complete College America 'Game Changer' strategies.
December 2017	Board received an update on implementation of Complete College America 'Game Changer' strategies from institutions.

BACKGROUND / DISCUSSION

In 2010, the Board established an attainment goal that 60% of Idaho's 25 to 34 age demographic would have a postsecondary credential by 2020. (The Governor's Higher Education Task Force recommendation has since called for this goal to be revised or extended.) Subsequent to the Board adopting the 60% attainment goal, in August 2011 Board Staff presented revised degree completion projections and proposed possible strategies to aid the state in meeting the 60% attainment goal. In October 2011, the Complete College Idaho

(CCI) Team attended the Complete College America (CCA) Annual Convening and Completion Academy in Austin, Texas to develop a draft completion Plan. In December 2011, the Board approved the framework for Complete College Idaho: A Plan for Growing Talent to Fuel Innovation and Economic Growth in the Gem State (CCI Plan). In addition to integrating CCA strategies into the proposed plan, staff collected feedback from public and private stakeholders. The Board at its June 2012 meeting approved the final version of the CCI Plan.

On January 31, 2018, chief academic officers, Complete College America, and two Board members convened at Boise State University to develop a statewide action plan for moving forward with strategies outlined in the Guided Pathways recommendation approved by the Governor's Higher Education Task Force and adopted by the Board. Some of the outcomes sought from CCI and CCA strategies are to be achieved through this plan.

IMPACT

The plans developed by the chief academic officers address five key goals, which include the development of: system-wide meta-major fields and milestone courses; flexible plans for dual credit that lead to degree progress and postsecondary exploration; consistent system-wide intervention strategies for academically distressed students; consistent system-wide strategies for achieving completion of thirty semester hours a year by full-time students; and instruction that can lead to the equivalent of an Associate's Degree through a delivery model that is external to the traditional classroom environment. Once implemented, the outcomes will strengthen the P-20 pipeline, increase accessibility for postsecondary learning and credential completion, and contribute to the Board's attainment goals and the workforce needs in Idaho.

STAFF COMMENTS AND RECOMMENDATIONS

Staff and institutions will provide regular updates on progress toward the implementation of Guided Pathway strategies. This will provide an opportunity for the Board to track progress and provide feedback.

BOARD ACTION

This item is for informational purposes only. Any action will be at the Board's discretion.

BOISE STATE UNIVERSITY

SUBJECT

Online, Bachelor of Arts in Public Health

APPLICABLE STATUTE, RULE, OR POLICY

Idaho State Board of Education Governing Policies & Procedures, Section III.G. and Section V.R.

ALIGNMENT WITH STRATEGIC PLAN

The proposed online, Bachelor of Arts in Public Health aligns with the State Board of Education's Idaho K-20 Public Education Strategic Plan Goal 1, Objectives A, B, and C. The wholly online format of the proposed Bachelor of Arts in Public Health is accessible to Idaho students (Objective A), regardless of socioeconomic status, age, and geographic location. The proposed degree effectively allows the re-integration of adult learners into the educational system (Objective B) because adult learners can balance work/personal life responsibilities while pursuing a degree due to the online format. The online format of the program and the flexibility it affords a student who may have family responsibilities, or live in a rural county, contribute to a higher level of educational attainment (Objective C) for Idaho residents as they can take advantage of a degree program despite these factors.

BACKGROUND/DISCUSSION

Boise State University's (BSU) proposed online Bachelor of Arts in Public Health will operate under the guidelines of Board Policy V.R. as it pertains to wholly online programs. Boise State University currently offers a Bachelor of Science in Public Health in a traditional format. The proposed program will complement the existing program by providing an additional option for students who want to enhance their professional careers or begin a new career. Because it is entirely online, the proposed program will enable BSU to reach potential students who need flexibility in their education that result from professional and personal responsibilities. These students may also live in a rural area of Idaho that does not have face-to-face educational opportunities.

Many of the students who enter the program will be working adults with some prior college experience who want to enhance their careers in the health sector. The program will focus on skills in collaborative leadership, quantitative literacy, and public health analysis. Graduates will develop the knowledge base, analytic abilities, catalyst thinking, and interpersonal skills needed to become a promoter of positive social change.

The following quote from http://www.careersinpublichealth.net/careers/ provides an overview of the careers that can be pursued with a BA in Public Health: *"Graduates of public health can find careers suited to a wide variety of interests and skills, in both traditional public health and service-focused organizations as well as new practice settings and non-profit organizations. Public health graduates*

can look forward to a wealth of opportunities in each state and city around the country and even the world. Common areas of employment include federal, state and local health agencies (e.g. Centers for Disease Control and Prevention, EPA), consulting firms, consumer advocacy organizations, hospitals and integrated health care systems, and private business and industry."

A similar program offered by Idaho institutions includes Idaho State University's (ISU) Bachelor of Arts and Bachelor of Science in Health Education. While ISU's program is not fully online, some Health Education courses are available online to students.

IMPACT

The program's size will be scaled to demand for the program, and BSU projects the program will reach a size of 292 students by the sixth year, graduating approximately 78 students per year once the program is up and running.

The student fee will be in accordance with the Online Program Fee as defined in the Board Policy V.R., 3.a.x. BSU will initially charge $344 per credit hour, which aligns with a reasonable estimate of Boise State's undergraduate 2018-2019 per-credit estimate of $314 per credit, plus the $30 per credit online fee, for a total of $344 per credit.

BSU anticipates that students entering the program will typically have at a minimum an AA or AS degree, or 60 credits of coursework. For the 60 credits required for completion of the proposed program, students will pay $344 per credit; the total cost of those 60 credits totals $20,640.

ATTACHMENTS

STAFF COMMENTS AND RECOMMENDATIONS

Boise State University's proposed BA in Public Health is consistent with their Service Region Program Responsibilities and their Five-Year Plan for Delivery of Academic Programs in Region III. As provided in Board Policy III.Z, no institution has the statewide program responsibility for Public Health at the undergraduate level. Idaho State University currently has the statewide program responsibility for the Master's in Public Health.

The proposed fee for the fully-online BA in Public Health is comparable to the fees that would be paid for students seeking the final 60 credit hours for this degree in a traditional delivery mode ($344 per credit hour).

The proposal completed the program review process and was presented to the Council on Academic Affairs and Programs (CAAP) on January 17, 2018; to the Committee on Instruction, Research, and Student Affairs (IRSA) on February 2, 2018; and to the Business Affairs and Human Resources (BAHR) Committee on February 2, 2018.

Staff recommends approval.

BOARD ACTION

I move to approve the request by Boise State University to create a new online program that will award Bachelor of Arts in Public Health in substantial conformance to the program proposal submitted as Attachment 2.

Moved by _____ Seconded by _____ Carried Yes _____ No _____

I move to approve the request by Boise State University to designate an online program fee for the Bachelor of Arts in Public Health in the amount of $344 per credit in conformance with the program budget submitted to the Board in Attachment 2.

Moved by _____ Seconded by _____ Carried Yes _____ No _____

THIS PAGE LEFT INENTIONALLY BLANK

Institutional Tracking No. _____

Idaho State Board of Education

Proposal for **Undergraduate/Graduate Degree** Program

Date of Proposal Submission:	December 18, 2017
Institution Submitting Proposal:	Boise State University
Name of College, School, or Division:	College of Health Sciences; School of Allied Health Sciences
Name of Department(s) or Area(s):	Department of Community and Environmental Health

Program Identification for Proposed New or Modified Program:

Program Title:	Bachelor of Arts in Public Health						
Degree:		Degree Designation	X	Undergraduate	X	Graduate	
Indicate if Online Program:	X	Yes		No			
CIP code (consult IR /Registrar):	51.2201, PUBLIC HEALTH GENERAL						
Proposed Starting Date:	Fall 2018						
Geographical Delivery:	Location(s)	Online Only		Region(s)	Online Only		
Indicate (X) if the program is/has:	X	Self-Support (Online Program Fee)		Professional Fee			
Indicate (X) if the program is:	X	Regional Responsibility		Statewide Responsibility			

Indicate whether this request is either of the following:

- [ ] New Degree Program
- [ ] Undergraduate/Graduate Certificates (30 credits or more)
- [X] Expansion of Existing Program
- [ ] Consolidation of Existing Program
- [ ] New Off-Campus Instructional Program
- [X] Other (i.e., Contract Program/Collaborative Expand existing program to wholly online

College Dean (Institution)	12/7/17 Date	Vice President for Research (Institution; as applicable)	Date
Graduate Dean or other official (Institution; as applicable)	Date	Academic Affairs Program Manager, OSBE	Date
FVP/Chief Fiscal Officer (Institution)	12/18/17 Date	Chief Academic Officer, OSBE	Date
Provost/VP for Instruction (Institution)	12/14/17 Date	SBOE/Executive Director Approval	Date
President	12/18/17 Date		

Rationale for Creation or Modification of the Program

1. **Describe the request and give an overview of the changes that will result.** Will this program be related or tied to other programs on campus? Identify any existing program that this program will replace.

Boise State University proposes the creation of a completely online degree-completion program that will award a Bachelor of Arts in Public Health (BAPH). The program will operate under the guidelines of SBOE Policy V.R as they pertain to wholly online programs, and it will make use of a specific set of courses totaling 60 credits that will be offered online (see Appendix A).

The online BAPH program will complement the Bachelor of Science in Public Health program, which is offered in-person. The in-person BS in Public Health was launched in Fall 2016 in response to recommendations of external reviewers, and was created to provide a more focused, recognizable, and professionally valuable degree option than the program it partially replaced, the BS in Health Sciences Studies.

The existing face-to-face program will continue to be offered as it is now. However, so as to better serve those students who cannot pursue a public health degree in a traditional delivery method, we are creating an option for students to complete the degree program wholly online. Whether they are enhancing their professional careers or beginning a new career, graduates will be prepared for a diversity of career paths within federal, state, and local agencies; for-profit and non-profit organizations; and business and industry.

The proposed program will prepare students to be engaged and educated citizens who can address community health-related challenges. The curriculum includes courses in public health analysis that build quantitative literacy as well as cross-course foci in collaboration, catalyst thinking, and resilience, all 21st century skills needed in today's workplace. The curriculum will explore issues that affect populations of people, and develop analysis, critical thinking, and communication skills to provide a flexible skill set that enables students to effectively adapt with the quickly changing public health landscape. The program will focus on building collaborative leadership skills and knowledge of public health to promote positive social change.

2. **Need for the Program**. Describe the student, regional, and statewide needs that will be addressed by this proposal and address the ways in which the proposed program will meet those needs.

   a. **Workforce need:** Provide verification of state workforce needs that will be met by this program. Include State and National Department of Labor research on employment potential. Using the chart below, indicate the total projected annual job openings (including growth and replacement demands in your regional area, the state, and nation. Job openings should represent positions which require graduation from a program such as the one proposed. Data should be derived from a source that can be validated and must be no more than two years old.

The following quote from http://www.careersinpublichealth.net/careers/ gives a nice overview of the careers that can be pursued with a BA in Public Health: *"Graduates of public health can find careers suited to a wide variety of interests and skills, in both traditional public health and service-focused organizations as well as new practice settings and non-profit organizations. Public health graduates can look forward to a wealth of opportunities in each state and city around the country and even the world. Common areas of*

employment include federal, state and local health agencies (e.g. Centers for Disease Control and Prevention, EPA), consulting firms, consumer advocacy organizations, hospitals and integrated health care systems, and private business and industry."

Further indication of the breadth of careers available to a Public Health graduate are indicated by a study by Economic Modeling Specialists International (EMSI) of job postings between February 2016 and February 2017 in ID, WA, and OR from employers looking for candidates with Public Health skills: The job titles in those listings included the following:

- Public Health Analysts
- Health Educators
- Health Services Directors
- Behavioral Health Care Managers
- Practice Managers
- Policy Analysts
- Community Health Workers

Because of the broad range of career paths available to a Public Health graduate, federal and state Department of Labor data is of limited value. The most relevant job titles are:

- Medical and health services managers, SOC 11-9111
- Health educators, SOC 21-1091
- Community health workers, SOC 21-10

The category "Medical and health services managers" is, unfortunately, very broad. It includes 23 different job titles, five of which are applicable to a BA in Public Health graduate and others that require additional training. Because there is no information available on the numbers of jobs represented under each job title, we will arbitrarily use 20% of the job openings associated with "Medical and health services managers" in the tables below.

A better indication of jobs available for public health graduates is provided by a report commissioned from the Educational Advisory Board. That report analyzed data from online job postings from March 1, 2016 to February 28, 2017, and identified employer demand at the national, regional, state, and local level. They assessed positions that listed 'public health and safety,' 'community health,' 'epidemiology,' 'behavioral health,' 'public health education,' 'biostatistics,' 'community health improvement,' 'environmental health and safety,' 'disease control,' 'health promotion programs,' or other public health-related skills. They excluded titles such as 'health director,' 'police officer,' or 'health engineer,' that require additional or technical courses of study. Listed in the table below are averages between the first and second halves of 2016.

Total projected annual job openings			
	State DOL data	**Federal DOL data**	**Other data source: (describe):** Study by Educational Advisory Board (see text above)
Local (Service Area)	26	N/A	102
State	52	N/A	210
Nation	N/A	24,480	50,634

2016 National Employment Matrix Title and Code		Employment		Occupational Openings projected 2016-26 Annual Average
Job Title	**SOC CODE**	**2016**	**2026**	
Medical and health services managers (20% of total numbers)	11-9111	70,440 (20% of 352,200)	84,400 (20% of 422,000)	7,280 (20% of 34,400)
Health educators	21-1091	61,000	69,900	8,700
Community health workers	21-1094	57,500	67,800	8,500
Total				24,480

2014-2024 Idaho Long Term Employment Projections		Base Employment and Projected Employment		Total Annual Openings
Job Title	**SOC CODE**	**2014**	**2024**	
Medical and health services managers (20% of total numbers)	11-9111	363 (20% of 1,815)	435 (20% of 2,175)	16 (20% of 82)
Health educators	21-1091	381	449	15
Community health workers	21-1094	435	567	21
Total				52

b. Student need. What is the most likely source of students who will be expected to enroll (full-time, part-time, outreach, etc.). Document student demand by providing information you have about student interest in the proposed program from inside and outside the institution. If a survey of was used, please attach a copy of the survey instrument with a summary of results as **Appendix B.**

We anticipate that the online modality will appeal to adult learners and that 40% of the students will be full-time, with 60% part-time. Students select online programs rather than face-to-face to overcome time and/or geographical constraints. The Boise State University brand will attract residents of rural Idaho, Oregon, and Montana. The curriculum will increase their understanding of and ability to act on factors impacting the quality of life in their area, allowing them to give better advice/input for improving community health and have more employment options if they choose to stay in their rural area.

c. Economic Need: Describe how the proposed program will act to stimulate the state economy by advancing the field, providing research results, etc.

N/A

d. Societal Need: Describe additional societal benefits and cultural benefits of the program.

Regardless of their career paths, graduates with public health training benefit society in many ways. Students gain understanding of the complex nature of social problems and ways to address them. Two issues that illustrate the diversity of challenges that must be addressed are obesity and issues related to aging populations.

- As Idaho communities struggle to deal with the obesity epidemic, public health graduates understand that a "one size fits all" approach will not address obesity across the state. Public health graduates will be prepared to see communities as systems and that addressing these issues requires cross-sector collaboration.
- As Idahoans retire and want to live healthy, functional lives in their homes, graduates trained in public health can contribute to assessing the resources and assets of the area to identify gaps in services and help navigate the intricacies of healthcare. Community health workers, health educators, and others providing community level assistance will be instrumental to cost-effective solutions to keep our seniors in their communities and homes as long as possible.

e. If Associate's degree, transferability:

N/A

3. **Similar Programs**. Identify similar programs offered within Idaho and in the region by other in-state or bordering state colleges/universities.

Similar Programs offered by Idaho public institutions (list the proposed program as well)		
Institution Name	**Degree name and Level**	**Program Name and brief description if warranted**
Boise State University	**BS in Public Health**	IN-PERSON – prepares students for employment in entry-level positions in agencies, organizations, and businesses and admission into post-baccalaureate professional programs (e.g. medicine, dentistry, veterinary medicine, clinical laboratory science, physical therapy, health care administration).
	BS in Public Health, Environmental & Occupational Health emphasis	IN-PERSON -prepares students for employment in the dynamic fields of environmental protection and occupational hygiene.
	BS in Public Health, Health Education and Promotion emphasis	IN-PERSON –focuses on enhancing the health and well-being of individuals and communities. Graduates can sit for the Certified Health Education Specialist exam and work in private, public, and voluntary health agencies; hospitals/clinics and corporations.
	BA in Public Health (proposed)	ONLINE - prepares candidates for a career in addressing community health-related challenges and are able to enhance their professional careers or get an entry-level position within federal, state, and local agencies; for-profit and non-profit organizations; and business and industry.

University of Idaho	**n/a**	n/a
Idaho State University	**Bachelor of Arts or Bachelor of Science in Health Education**	IN-PERSON - prepares students to plan, implement, and evaluate health promotion programs, interventions and strategies, and serve as an advocate to support healthy behaviors and healthy environments.
Lewis Clark State College	**n/a**	n/a

Similar Programs offered by other Idaho institutions and by institutions in nearby states		
Institution Name	**Degree name and Level**	**Program Name and brief description if warranted**
Brigham Young University-Idaho	Bachelor of Science in Public Health	ONLINE - prepares students to work in Public Health careers promoting, educating, and protecting the health of a population.
Arizona State University	Bachelor of Science in Community Health	ONLINE - learn to create healthy, sustainable communities with an emphasis on working with specific populations.
University of Arizona	Bachelor of Science in Public Health	ONLINE - promote an understanding of health and disease based on public health principles.
University of Colorado-Denver	Bachelor of Arts or Science in Public Health	IN-PERSON - prepares students for diverse fields including law and medicine, as well as a spectrum of entry-level positions in business, public service and more.

4. **Justification for Duplication with another institution listed above.** (if applicable). If the proposed program is similar to another program offered by an Idaho public institution, provide a rationale as to why any resulting duplication is a net benefit to the state and its citizens. Describe why it is not feasible for existing programs at other institutions to fulfill the need for the proposed program.

Idaho State University's BA/BS in Health Education program is not offered online and is grounded in health education.

5. **Describe how this request supports the institution's vision and/or strategic plan.**

Goals of Institution Strategic Plan	**Proposed Program Plans to Achieve the Goal**
Goal 1: Create a signature, high-quality educational experience for all students	Boise State's online program development process allowed us to create a cohesive, consistent, rigorous, and outcome-driven educational experience.

Goal 2: Facilitate the timely attainment of educational goals of our diverse student population	The online delivery of this program will enable students with work, life, or other adult responsibilities to complete their degree requirements with minimal interruption of life situation and obtain a marketable health-related degree.
Goal 3: Gain distinction as a doctoral research university	n/a
Goal 4: Align university program and activities with community needs	The proposed program is designed to meet the needs of both of post-traditional students who want to advance their careers and local employers who want a more professionally qualified employment base. Additionally, public health graduates are uniquely prepared to tackle issues that affect wellness in their communities.
Goal 5: Transform our operations to serve the contemporary mission of the university	n/a

Assurance of Quality. Describe how the institution will ensure the quality of the program. Describe the institutional process of program review. Where appropriate, describe applicable specialized accreditation and explain why you do or do not plan to seek accreditation.

The following measures will ensure the high quality of the new program:

Regional Institutional Accreditation: Boise State University is regionally accredited by the Northwest Commission on Colleges and Universities (NWCCU). Regional accreditation of the university has been continuous since initial accreditation was conferred in 1941. Boise State University is currently accredited at all degree levels (A, B, M, D).

Program Review: Boise State has instituted a new program review procedure. At the inception of new programs, the programs will submit to the Office of the Provost a three-year assessment plan to be scheduled into the Periodic Review/Assessment Reporting Cycle. The plan includes program learning outcomes; and an implementation plan with a timeline identifying when and what will be assessed, how the programs will gather assessment data, and how the program will use that information to make improvements. Then, every three years, the programs will provide Program Assessment Reports (PAR), which will be reviewed by a small team of faculty and staff using a PAR Rubric, which includes feedback, next steps, and a follow-up report with a summary of actions.

Specialized Accreditation: The program will seek accreditation by the Council on Education for Public Health (CEPH). CEPH has standards for accreditation of Standalone Baccalaureate Programs. The proposed program is being designed to follow these standards and BSU will begin the accreditation process for both online and in-person public health programs in Spring of 2018.

Program Development Support: The online Bachelor of Arts in Public Health is one of several that are being created via the eCampus Initiative at Boise State University. Boise State's online program development process uses a facilitated 10-step program design process to assist program faculty members in the creation of an intentional, cohesive course progression with tightly aligned course and program outcomes. A multi-expert development team, which includes an instructional designer, multimedia specialist, graphic designer, and web designer, works collaboratively with the faculty member. One master version of each course is developed for consistent look and feel of courses across the program; the master course utilizes professional created common template aligned with nationally used Quality Matters course design standards.

Academic Integrity: Academic integrity is vital to the mission of Boise State University and encompasses the totality of academic rigor, ethical behavior, intellectual curiosity, appropriate teamwork, and persistence. All assignments submitted by a student must represent his/her own ideas, concepts, and current understanding or must cite the original source. Boise State proactively supports academic integrity by providing training, maintaining a website dedicated to academic integrity, providing tools such as pedagogical strategies, workshops, and tips for designing tests, as well as establishing policies and procedures for students who violate the academic integrity policy within the Student Code of Conduct. For this new online program, we will use the following strategies to encourage academic integrity:

- During the design and development of the curriculum and assessment of each course, instructors will be informed by staff of Boise State's eCampus Center about best practices for online course design based on Quality Matters ™ and best practice strategies to promote academic integrity in online education based on WCET's recommendations (Version 2.0, June 2009).
- Through the program development process, course production, course launch support provided by the eCampus Center, and other means, instructors will be reminded about the importance of academic integrity and encouraged to report and act upon suspected violations.
- Academic integrity will be addressed within online student orientation. Programs may require online students to complete the university's Academic Integrity Online Workshop.
- At the beginning of each course, the instructor will communicate expectations regarding academic integrity to students in the syllabus and verbally and may require completion of the university's Academic Integrity Online Workshop.

Student Authentication: Because the proposed program will be offered entirely online, it is important to include mechanisms by which we authenticate the identity of students enrolled in the program. We will use the following mechanisms:

- During the admissions process, the university will confirm required official transcripts and other documentation required for admission into the program.
- Associated with access to and use of our Learning Management System, a secure log-in environment will be provided and students will be required to use strong passwords and change them every 90 days.
- When high-stakes exams are required, faculty will be encouraged to utilize remote or online proctoring services when appropriate. In those instances, students will need to provide valid photo identification before gaining access to the graded assessments or other required activities.
- Instructors will utilize Blackboard's Safe Assignment plagiarism detection program when appropriate.
- Instructors are expected to be informed of and aware of the importance of student identity authentication and to report and act upon suspected violations.

6. In accordance with Board Policy III.G., an external peer review is required for any new doctoral program.

Not applicable

7. Teacher Education/Certification Programs All Educator Preparation programs that lead to certification require review and recommendation from the Professional Standards Commission (PSC) and approval from the Board.

Will this program lead to certification?
Yes_____ No__X___

If yes, on what date was the Program Approval for Certification Request submitted to the Professional Standards Commission?

8. Five-Year Plan: Is the proposed program on your institution's approved 5-year plan? Indicate below.

Yes X No __

Curriculum, Intended Learning Outcomes, and Assessment Plan

10. Curriculum for the proposed program and its delivery.

a. Summary of requirements. Provide a summary of program requirements using the following table.

Credit hours in required courses offered by the department(s) offering the program.	60
Credit hours in required courses offered by other departments:	0
Credit hours in institutional general education curriculum	34-36
Credit hours in free electives	24-26
Total credit hours required for degree program:	120

Please refer to Appendix A for a degree box listing of program curriculum

b. Additional requirements. Describe additional requirements such as comprehensive examination, senior thesis or other capstone experience, practicum, or internship, some of which may carry credit hours included in the list above.

Students participate in several culminating experiences, including the following:

- PUBH 455 Public Health Project: students work on a project that synthesizes the key concepts as well as demonstrating key communication and information literacy skills.
- HLTH 400 Interprofessional Capstone: part of the BSU Finishing Foundations, students review the degree program and learn how to articulate their academic experience onto their resume. Students work in teams to tackle interdisciplinary public health issues.

11. Program Intended Learning Outcomes and Connection to Curriculum.

a. Intended Learning Outcomes. List the Intended Learning Outcomes for the proposed program, using learner-centered statements that indicate what will students know, be able to do, and value or appreciate as a result of completing the program.

Graduates will:

1. Connect the history, philosophy, and core concepts of public health to current issues.
2. Explain the organization, management, financing, and delivery of health services and public health systems.
3. Analyze how biological, behavioral, environmental, socio-economic, and cultural factors impact human health and contribute to health disparities.
4. Employ the essential components of an effective public health program including assessment, planning, implementation, and evaluation.
5. Apply research, epidemiologic, and statistical methods for evidence-based decision-making.
6. Propose solutions for health promotion and disease prevention through public health systems.

7. Use effective communication and teamwork strategies to inform and engage colleagues, policy makers, and community members to address pertinent public health issues.
8. Advocate adherence to ethical and legal principles in contemporary public health.
9. Apply leadership, management, finance, and organizational awareness skills to implement public health programs in a variety of settings.

12. Assessment plans

a. Assessment Process. Describe the assessment process that will be used to evaluate how well students are achieving the intended learning outcomes of the program.

The Department of Community and Environmental Health will review both qualitative evaluation-based information and quantitative academic-based data provided by students who are either actively enrolled in the program or have graduated. The department faculty will use this information to adjust key courses and overall program objectives or requirements.

b. Closing the loop. How will you ensure that the assessment findings will be used to improve the program?

Information gleaned from both qualitative and quantitative assessments will be presented to department faculty during planned meetings as needed during the semester as well as immediately following each semester. Changes will be made to course and program curriculum as warranted.

c. **Measures used.** What direct and indirect measures will be used to assess student learning?

Below are listed some general examples of assessment measures anticipated throughout the program:

- Course specific assessment measures will be used to assess the course-specific objectives. Assessment measures may include quizzes, tests, assignments, or course-specific projects.
- Assessment measures will vary to ensure students demonstrate various communication methods with course-specific content.
- Graduate exit survey to be conducted at the end of students' final semester.
- Stakeholder and graduate/alumni survey to be conducted annually in accordance with CEPH accreditation standards.
- Students will be prepared and encouraged to take the test to be a Certified Health Education Specialist (CHES). The department will track the number of graduates who sit for the CHES exam.

d. Timing and frequency. When will assessment activities occur and at what frequency?

- Course specific assessments will occur throughout each course, as well as at the end of each course when offered.
- The department will informally review course related data every semester and formally review data annually.
- The department will conduct exit surveys for every graduate.
- The department will perform the Program Assessment Review (PAR) every three years as required by Boise State University.

Enrollments and Graduates

13. **Existing similar programs at Idaho Public Institutions.** Using the chart below, provide enrollments and numbers of graduates for similar existing programs at your institution and other Idaho public institutions.

Existing Similar Programs: Historical enrollments and graduate numbers								
Institution and Program Name	**Fall Headcount Enrollment in Program**				**Number of Graduates From Program (Summer, Fall, Spring)**			
	FY15	FY16	FY17	FY18 (most recent)	FY15	FY16	FY17	FY18 (most recent)
BSU BS in Public Health	n/a	n/a	5	6	n/a	n/a	n/a	(not available)
BS in Public Health, Environmental & Occupational Health emphasis	n/a	n/a	5	11	n/a	n/a	n/a	(not available)
BS in Public Health, Health Education and Promotion emphasis	n/a	n/a	20	30	n/a	n/a	n/a	(not available)
ISU Bachelor of Arts or Bachelor of Science in Health Education	74	57	53	(not available)	5	8	5	(not available)

14. **Projections for proposed program:** Using the chart below, provide projected enrollments and number of graduates for the proposed program:

Proposed Program: Projected Enrollments and Graduates First Five Years											
Program Name: Bachelor of Arts in Public Health (ONLINE)											
Projected Fall Term Headcount Enrollment in Program						**Projected Annual Number of Graduates From Program**					
FY19 (first year)	FY20	FY21	FY22	FY23	FY23	FY19 (first year)	FY20	FY21	FY22	FY23	FY23
20	93	167	258	292	292	0	6	25	52	78	78

15. **Describe the methodology for determining enrollment and graduation projections.** Refer to information provided in Question #2 "Need" above. What is the capacity for the program? Describe your recruitment efforts? How did you determine the projected numbers above?

The program's size will be scaled to demand for the program. The numbers in the table above reflect a reasonable and attainable scaling up of the program.

Marketing and recruitment efforts will include a digital marketing campaign, a web landing page, request for information form, and a full program website with details regarding the key program assets, curriculum plan, and costs. In addition, a comprehensive communication plan will be implemented to attract and nurture interested students. Strategic, personalized communications will engage and support students throughout the recruitment lifecycle. Our coaching approach to student services will support online students and maintain their connection to Boise State through graduation.

16. **Minimum Enrollments and Graduates.** Have you determined minimums that the program will need to meet in order to be continued? What are those minimums, what is the logical basis for those minimums, what is the time frame, and what is the action that would result?

Because the program will be utilizing the online fee model, it is best to put minimum enrollment in terms of course registrations, which are what translate to revenue. Based on estimated expenses for instruction and for support personnel expenses, estimate the minimum number of course registrations to achieve breakeven is:

- Year 1: Annual credits 529, Annual FTEs 17.64
- Year 2: Annual credits 2,186, Annual FTEs 72.86
- Year 3: Annual credits 3,188, Annual FTEs 106.26
- Year 4: Annual credits 3,705, Annual FTEs 123.51
- Year 5: Annual credits 3,798, Annual FTEs 126.59

If enrollments do not meet expectations, expenses will adjust to reflect actual activity. The program's financial sustainability will be evaluated at least annually.

Resources Required for Implementation – fiscal impact and budget

17. **Physical Resources.**

a. **Existing resources**. Describe equipment, space, laboratory instruments, computer(s), or other physical equipment presently available to support the successful implementation of the program.

The available space and equipment is currently acceptable to operate a successful program.

b. **Impact of new program**. What will be the impact on existing programs of increased use of physical resources by the proposed program? How will the increased use be accommodated?

No impact.

c. **Needed resources.** List equipment, space, laboratory instruments, etc., that must be obtained to support the proposed program. Enter the costs of those physical resources into the budget sheet.

Operating expenses associated with program support staff and new faculty is reflected in the budget.

18. **Library resources**

a. **Existing resources and impact of new program**. Evaluate library resources, including personnel and space. Are they adequate for the operation of the present program? Will there be an impact on existing programs of increased library usage caused by the proposed

program? For off-campus programs, clearly indicate how the library resources are to be provided.

Library resources are sufficient.

b. Needed resources. What new library resources will be required to ensure successful implementation of the program? Enter the costs of those library resources into the budget sheet.

None

19. Personnel resources

a. Needed resources. Give an overview of the personnel resources that will be needed to implement the program. How many additional sections of existing courses will be needed? Referring to the list of new courses to be created, what instructional capacity will be needed to offer the necessary number of sections?

The following support personnel will be hired:

- Program Director: 1.0 FTE hired in year one.
- Coordinator 0.5 FTE hired in year 2.
- Administrative Assistant: 0.4 FTE in year two; 0.6 FTE in year 3 and beyond.
- Academic advisor: 1.0 FTE hired in year 4.

The table below depicts the schedule of course offerings for the first three years of the program.

Schedule of Classes Offered for Online BA in Public Health: First three years. Numbers in cells refer to number of sections to be offered

			FA 2018		SP 2019		SU 2019		FA 2019		SP 2020		SU 2020		FA 2020		SP 2021	
	Session>>		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
	Cr.↓																	
PUBH 303	Foundations of Public Health	3	1		1		1		1		1		1		2		2	
PUBH 240	Foundations of Health Ed & Promotion	3	1		1		1		1		1		1		1		2	
PUBH 318	Public Health Analysis	3		1		1		1		1		1		1		2		2
PUBH 325	Foundations of Leadership	3		1		1		1		1		1		1		1		2
PUBH 315	Public Health Policy and Law	3			1						2						2	
PUBH 310	Evidence-based Public Health	3			1						1						4	
PUBH 326	The Practice of Leadership	3				1						2						2
PUBH 382	Research Methods in Health	3				1						1						4
PUBH 342	Health Ed & Promotion Methods	3					1						1					
MDS 410	Case Studies in Leadership	3					1						3					
PUBH 365	Quality Improvement & Perf Mgmt	3						1						1				
PUBH 419	Public Health Communications	3						1						3				
PUBH 344	Health Behavior Theory and Practice	3							2						1			
PUBH 470	Collaborating for Change	3							1						4			
PUBH 418	Advanced Public Health Analysis	3								2						1		
PUBH 420	Strategic Planning & Project Mgmt	3								1						3		
PUBH 440	Health Ed & Promotion Programming	3									1		1		1		1	
PUBH 480	Epidemiology	3									1		1		1		1	
PUBH 455	Public Health Project	2										1		1		1		1
PUBH 400	Interprofessional Capstone	1										1		1		1		1
PUBH 490	Capstone in Leadership	3										1		1		1		1
	Total	**60**																
	Credits offered per semester		6	6	12	12	12	12	15	15	21	21	24	24	30	27	36	36
	Required FTE (24 credits=1 Faculty FTE)		1.5				4.0						7.4					

The following table depicts the instructional staff that will be hired to support the program:

New Instructional FTEs for Program					
	Year 1	Year 2	Year 3	Year 4	Year 5
Lecturer	0.0	1.0	3.0	3.7	3.8
Adjunct	1.5	3.0	4.5	5.5	5.7

b. Existing resources. Describe the existing instructional, support, and administrative resources that can be brought to bear to support the successful implementation of the program.

During the implementation phase and beyond, the program will be supported as necessary by the College of Health Sciences and the eCampus Center in the Division of Extended Studies. During year one, the Program Director will manage a majority of the administrationand will also receive assistance from existing department staff. In subsequent years, personnel resources for the proposed program will be hired specifically for that program.

c. Impact on existing programs. What will be the impact on existing programs of increased use of existing personnel resources by the proposed program? How will quality and productivity of existing programs be maintained?

Because limited administrative or instructional resources from existing programs will be used for the proposed program, there will be a minimal impact on resources available for existing programs. We do expect some movement of students from the existing face-to-face BS in Public Health to the new online program, and estimate that 10% of the enrollment of the new program will consist of those students. While historic attrition from the face-to-face program is within normal BSU parameters, we are hopeful that the new online program will be an option for those students that need to move from the Boise area and for those for whom a BS is not an appropriate academic fit. However, enrollments in the existing program are robust, and therefore no threat is posed by the new program.

d. Needed resources. List the new personnel that must be hired to support the proposed program. Enter the costs of those personnel resources into the budget sheet.

See "a." above and budget sheet.

20. Revenue Sources

a. **Reallocation of funds:** If funding is to come from the reallocation of existing state appropriated funds, please indicate the sources of the reallocation. What impact will the reallocation of funds in support of the program have on other programs?

N/A

b. **New appropriation**. If an above Maintenance of Current Operations (MCO) appropriation is required to fund the program, indicate when the institution plans to include the program in the legislative budget request.

No new appropriation will be required.

c. **Non-ongoing sources**:

i. If the funding is to come from one-time sources such as a donation, indicate the sources of other funding. What are the institution's plans for sustaining the program when that funding ends?

N/A

ii. Describe the federal grant, other grant(s), special fee arrangements, or contract(s) that will be valid to fund the program. What does the institution propose to do with the program upon termination of those funds?

N/A

d. Student Fees:

i. If the proposed program is intended to levy any institutional local fees, explain how doing so meets the requirements of Board Policy V.R., 3.b.

N/A

ii. Provide estimated cost to students and total revenue for self-support programs and for professional fees and other fees anticipated to be requested under Board Policy V.R., if applicable.

The student fee will be in accordance with the Online Program Fee as defined in the Board Policy V.R., 3.a.x. That policy enables the institution to set a price-point appropriate for the program; students will pay an online program fee in lieu of tuition. The price-point for our online program fee will be as follows: we will charge the same rate as the per-credit rate for tuition and fees that is charged to resident students with the additional charge of $30 per credit online fee. We will automatically increase the fee in any years that the State Board of Education increases Boise State's per-credit rate for tuition and fees. We estimate the FY19 standard undergraduate per-credit rate to be $314 per credit hour; thus, the total paid by a student per credit would be $344 per credit.

For the 60 credits required for completion of the proposed program, the total cost will be $20,640. A review of the four institutions listed in section 3 shows out-of-state student tuition ranges from $29,340 to $59,820.

We project that by the fourth year of the program, it will generate 5,561 SCH, which will yield a total revenue of $1,913,077.

21. Using the budget template provided by the Office of the State Board of Education, provide the following information:

- Indicate all resources needed including the planned FTE enrollment, projected revenues, and estimated expenditures for the first **four** fiscal years of the program.
- Include reallocation of existing personnel and resources and anticipated or requested new resources.
- Second and third year estimates should be in constant dollars.
- Amounts should reconcile subsequent pages where budget explanations are provided.
- If the program is contract related, explain the fiscal sources and the year-to-year commitment from the contracting agency(ies) or party(ies).
- Provide an explanation of the fiscal impact of any proposed discontinuance to include impacts to faculty (i.e., salary savings, re-assignments).

I. PLANNED STUDENT ENROLLMENT

	FY 2019		FY 2020		FY 2021		FY 2022		FY 2023	
	FTE	Headcount	FTE	Headcount	FTE	Headcount	FTE	Headcount	FTE	Headcount
A. New enrollments	16.0	39	71.4	111	123.4	177	166.8	235	190.6	261
B. Shifting enrollments	1.8	4	7.9	12	13.7	20	18.5	26	21.2	29
Total Enrollment	17.8	43	79.4	123	137.1	197	185.4	261	211.7	289
Student Credit Hours Generated	533		2,381		4,113		5,561		6,352	

II. REVENUE

	FY 2019		FY 2020		FY 2021		FY 2022		FY 2023	
	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time
1. New Appropriated Funding Request										
2. Institution Funds										
3. Federal										
4. New Tuition Revenues from Increased Enrollments										
5. Student Fees		$183,250		$819,042		$1,414,743		$1,913,077		$2,185,231
6. Other (i.e., Gifts)										
Total Revenue	$0	$183,250	$0	$819,042	$0	$1,414,743	$0	$1,913,077	$0	$2,185,231

Ongoing is defined as ongoing operating budget for the program which will become part of the base.

One-time is defined as one-time funding in a fiscal year and not part of the base.

Budget Notes:

I.A, B. Calculation of FTE and headcount as follows:

>1 FTE = 30 credits

>Headcount determined as the distinct number of students in the program that year.

>Assume that 90% of the enrollments will be new enrollments and 10% will be shifting enrollments.

>Assume 4.4% attrition from one semester to the next.

II.5. >Student Fee revenue calculated as Student Credit Hours * $344 per credit.

>$344 calculated as estimate of 2018-2019 resident per-credit of $314 rate plus $30 per credit online fee.

>Assume in calculations that per-credit fee is stable over time; however, it will align with the amount charged to traditional resident students. Thus the cost per credit will increase at the same rate as the standard per-credit rate

III. EXPENDITURES

	FY 2019		FY 2020		FY 2021		FY 2022		FY 2023	
	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time
A. Personnel Costs										
1. FTE		2.50		5.48		9.52		12.31		12.60
2. Faculty		$0		$42,600		$125,670		$157,620		$161,880
3. Adjunct Faculty		$37,800		$75,600		$111,510		$139,860		$143,640
4. Graduate/Undergrad Assistants										
5. Research Personnel										
6. Directors/Administrators		$93,333		$70,000		$70,000		$70,000		$70,000
7. Administrative Support Personnel		$0		$11,635		$17,452		$17,452		$17,452
8. Fringe Benefits		$40,207		$70,465		$123,520		$164,733		$167,266
9. Other: Academic Advisors/Coordinators		$0		$18,333		$27,500		$71,500		$71,500
Total Personnel and Costs	$0	$171,341	$0	$288,633	$0	$475,652	$0	$621,165	$0	$631,738

Budget Notes (continued)

III.A.2	Faculty FTE: Calculated using (Credit hour load)/24
III.A.3	Adjunct FTE: Calculated using (Credit hour load)/24
III.A.6	Administrator: Program Coordinator starting January 2018 before program's anticipated launch in Fall 2018. Spring 2018 wages included in FY 2019.
III.A.7	Support Personnel:0.60 FTE Administrative Assistant starting FY 2020.
III.A.8	Benefits calculated at professional $13,100+(annual wage*20.72%), classified $13,100+(annual wage*21.50%).
III.A.9	Other - 0.50 FTE Coordinator starting FY 2020 and 1.0 FTE Academic Advisors start FY 2022.

B. Operating Expenditures											
1. Travel		$2,157		$2,625		$2,625		$2,625		$2,625
2. Professional Services										
3. Other Services										
4. Communications										
5. Materials and Supplies		$925		$1,125		$1,125		$1,125		$1,125
6. Rentals										
7. Materials & Goods for Manufacture & Resale										
8. Miscellaneous - Computer Hardware/Software		$3,947		$6,210		$7,685		$10,280		$10,986
Total Operating Expenditures	$0	$7,029	$0	$9,960	$0	$11,435	$0	$14,030	$0	$14,736

Budget Notes (continued):

III.B.1 Travel to Boise State University main campus and training

III.B.5 Materials & Supplies: Office supplies and materials

III.B.8 Miscellaneous: Include computer hardware/software and an annual license cost for a wellness app for every student

	FY 2019		FY 2020		FY 2021		FY 2022		FY 2023	
	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time
C. Capital Outlay										
1. Library Resources										
2. Equipment										
Total Capital Outlay	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

	FY 2019		FY 2020		FY 2021		FY 2022		FY 2023	
	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time	On-going	One-time
D. Capital Facilities Construction or Major Renovation										
E. Other Costs										
1. Boise State Central		$18,325		$81,904		$141,474		$191,308		$218,523
2. Boise State eCampus Center		$19,177		$85,714		$148,054		$200,206		$228,687
3. Boise State Online Innovation Fund		$8,630		$38,571		$66,625		$90,093		$102,909
4. Boise State Online Marketing, Recruitment, Enrollment & Retention Fund		$63,818		$285,236		$492,692		$666,240		$761,019
5. College of Health Sciences Revenue Share		$0		$0		$0		$45,914		$52,446
Utilities										
Maintenance & Repairs										
Other										
Total Other Costs	$0	$109,950	$0	$491,425	$0	$848,846	$0	$1,193,760	$0	$1,363,584
TOTAL EXPENDITURES:	$0	$288,320	$0	$790,019	$0	$1,335,932	$0	$1,828,955	$0	$2,010,058
Net Income (Deficit)	$0	-$105,070	$0	$29,023	$0	$78,811	$0	$84,122	$0	$175,172

Budget Notes (specify row and add explanation where needed; e.g., "I.A.,B. FTE is calculated using…"):

III.E.1	Boise State Central Services: A fund dedicated to funding support services for online students
III.E.2	Boise State eCampus Center: Provide funding for initiative management, online course/program development and other support services
III.E.3	Boise State Online Innovation Fund: Seed funding for academic programs, initiative infrastructure, and eventually innovation grants
III.E.4	Boise State Online Marketing, Recruitment, Enrollment and Retention Fund: A fund dedicated to marketing the program, recruiting students, enrolling qualified students and retaining students throughout the life of the program
III.E.5	College of Health Sciences Revenue Share (2.4% share)

Appendix A: CURRICULUM

Note that the courses to be offered as part of online program are those with course prefixes of PUBH, HEP, and HLTH.

Public Health Bachelor of Arts Online program	
Course Number and Title	Credits
Foundational Studies Program requirements indicated in bold. See page 50 for details and lists of approved courses.	
ENGL 101 Introduction to College Writing	3
ENGL 102 Intro to College Writing and Research	3
UF 100 Intellectual Foundations	3
UF 200 Civic and Ethical Foundations	3
DLM Mathematics	3
DLN Natural, Physical, & Applied Sciences course with lab	4
DLN Natural, Physical, and Applied Sciences course in a second field	3-4
DLV Visual and Performing Arts	3
DLL Literature and Humanities	3-4
DLS Social Sciences course	3
DLS Social Sciences course in a second field	3
PUBH 210 Health Services Administration	3
PUBH 230 Introduction to Environmental Health	3
PUBH 240 Foundations of Health Education and Promotion	3
HEP 342 Health Promotion Methods	3
HEP 344 Health Behavior Theory and Practice	3
HEP 440 Health Promotion Programming	3
PUBH 303 Foundations of Public Health	3
PUBH 310 Evidence-based Public Health	3
PUBH 315 Public Health Policy and Law	3
PUBH 318 Public Health Analysis	3
PUBH 325 Human Health & Disease	3
PUBH 326 Community Determinates of Health	3

PUBH 365 Quality Improvement and Performance Management	3
PUBH 382 Research Methods in Health (CID)	3
PUBH 418 Advanced Public Health Analysis	3
PUBH 419 Public Health Communications	3
PUBH 420 Strategic Planning and Project Management	3
PUBH 470 Collaborating for Change	3
PUBH 480 Epidemiology	3
PUBH 455 Public Health Project	2
HLTH 400 Interprofessional Capstone (FF)	1
Electives	24-26
Total	120

THIS PAGE INTENTIONALLY LEFT BLANK

SUBJECT

Board Policy III.S. Remedial Education – Second Reading

REFERENCE

August 2007	The Board approved second reading of changes to Board Policy III.S.
June 2012	The Board approved the Complete College Idaho Plan.
April 2015	The Board approved the first reading of changes to Board Policy III.S.
June 2015	The Board approved the second reading of changes to Board Policy III.S.
September 2017	The Board adopts the Governor's Higher Education Task Force recommendations, which includes co-requisite support strategies for remedial instruction.
December 2017	The Board approved the first reading of changes to Board Policy III.S.

APPLICABLE STATUTES, RULE OR POLICY

Idaho State Board of Education Governing Policies & Procedures, Section III.S.

ALIGNMENT WITH STRATEGIC PLAN

Goal 4, Effective and Efficient Educational System, Objective B, Alignment and Coordination

BACKGROUND/DISCUSSION

In April 2015, the Board approved changes to Board Policy III.S., Remedial Education. Specific amendments included updating terminology, removing outdated terminology referencing "developmental education", and transitioning approved remediation from the traditional remedial course model to three separate approved models in alignment with the three models for remediation adopted with the approval of the Board's Complete College Idaho plan and work with Complete College America (CCA). CCA has since redefined the original remediation reform initiative to focus on co-requisite remediation. It has also updated the language used in referring to co-requisite remediation, changing from a single delivery model to a support system that may be implemented through various models or methods.

Proposed policy amendments will clarify that co-requisite support models are to be credit bearing and will fulfill a gateway course requirement; whereas, remedial courses maintain no college-level content and therefore do not count toward degree requirements. For the purposes of this policy, a gateway course is defined as the first English or Math course requirement needed for a student's program of study.

Additional amendments include clarifying student eligibility for enrollment in co-requisite support courses and remedial courses and ensuring that non-co-requisite remedial sequences will be structured by institutions in a way that will provide

students with the opportunity to enroll in the gateway course within the first academic year. The policy also clarifies procedures for student enrollment in remedial courses, piloting non-approved models, and annual Board reporting.

IMPACT

Proposed amendments will update the policy to better align with changes identified by Complete College America to help with implementation and student support. This policy further ensures students are provided an opportunity to complete their academic program in a timely manner.

ATTACHMENTS

Attachment 1 - Board Policy III.S. Remedial Education-Second Reading Page 3

STAFF COMMENTS AND RECOMMENDATIONS

Adoption of this policy will bring this policy into alignment with changes made at the national level and in alignment with what the Board intended for its vision of the delivery of postsecondary remedial education. Proposed amendments will also facilitate full implementation of co-requisite remedial support in alignment with the Governor's Higher Education Task Force recommendation to scale co-requisite remediation. Most importantly, it will help ensure that more students are provided with access to courses that not only have higher success rates, but also count toward degree progress.

There were no changes between first and second reading. Board Staff recommends approval.

BOARD ACTION

I move to approve the second reading of proposed amendments to Board Policy III.S. Remedial Education as submitted in Attachment 1.

Moved by _____ Seconded by _____ Carried Yes _____ No _____

Idaho State Board of Education
GOVERNING POLICIES AND PROCEDURES
SECTION: III. POSTSECONDARY AFFAIRS
SUBSECTION: S. Remedial Education ~~June 2015~~February 2018

1. Coverage

All students at the University of Idaho, Idaho State University, Boise State University, Lewis-Clark State College, College of Southern Idaho, North Idaho College, the College of Western Idaho and Eastern Idaho Technical College are included in this subsection.

2. Definitions

a. ~~Accelerated Model means a combined delivery series model whereby remedial content is embedded into credit bearing courses.~~ Co-requisite Course Model~~:~~ means ~~A~~a delivery model whereby remedial instruction is delivered ~~alongside~~simultaneously with college level content as a separate course or lab as part of a co-requisite support program.

~~a.~~b. ~~Co-Requisite Model means a delivery model whereby remedial instruction is delivered alongside college level content.~~ Co-requisite Support~~:~~ means ~~A~~academic courses or content that supplements the content of gateway mathemat~~h~~ics and English courses during the same academic term to increase the success rates for ~~S~~students in ~~N~~need of ~~A~~additional ~~S~~support.

c. Embedded Model~~:~~ means ~~A~~a combined delivery ~~series~~ model whereby remedial content is a part of the content delivered through gateway courses as part of a co-requisite support program.

~~b.~~d. Emporium Model means a delivery model whereby remedial ~~education~~ support is delivered in a computer lab setting where students receive individualized instruction from faculty and engagement with technology based programs as part of a co-requisite support program.

~~c.~~e. ~~Remedial Courses means a courses numbered below 100.~~ Gateway course means the first postsecondary mathematics or English ~~C~~course that a student takes that fulfills the mathematics or English requirement for the student's program of study.

f. Remedial Courses~~:~~ means ~~Education means a duplication of a secondary program/course and support services in basic academic skills to prepare students for college level coursework.~~ ~~C~~courses that are: ~~(1)~~

i. designed for students in need of additional support to succeed in gateway courses in mathematics or English and ~~(2)~~

ii. required to be completed before a student may enroll in the gateway course for that subject. Remedial Courses may take the following forms:~~:~~

~~C~~courses numbered below 100, which serve as a duplication of secondary ~~program/~~curriculum or courses and support services in basic academic skills to prepare students for college level content and are a pre-requisite to enrolling in the college-level mathematics and English course.

g. ~~f.~~ Students in Need of Additional Support~~:~~ means ~~S~~students who have been identified by the institution's placement process ~~to be~~as underprepared to take gateway mathematics and English courses without additional academic content or interventions.

3. ~~Remedial Models~~ The State Board of Education has approved the ~~following models for delivering remedial education: Accelerated, Co-Requisite, and Emporium,~~ Co-requisite Course Model, Embedded Model, and Emporium Model as the methods for serving students in need of additional support. Students enrolling into Co-requisite Support shall be provided with the option to do so in one of the ~~aforementioned~~defined models. Institutions may also pilot the use of additional delivery models provided the models ~~implemented allow students to enter a credit bearing course in the first year of study and~~ are evidence based; evidence need not be Idaho specific. Institutions choosing to exercise this pilot option shall notify both the Council on Academic Affairs and Programs and the Instruction, Research, and Student Affairs Committee of:

a. Their intent to pilot a new delivery model; and

b. The results of said pilot.

~~The pilot method~~Piloted models must be assessed annually and may be continued and scaled beyond the first year if ~~it~~ the pilot achieves equal or greater success rates in students completing gateway mathematics and English courses as compared to rates achieved in approved Co-requisite Support models.

4. Each institution shall maintain a mechanism for diagnostic testing in English language arts and mathematics, and provide corrective measures for students identified as needing additional supports.

5. Students determined to be in need of instruction at the level equivalent to that offered through Adult Basic Education programs may be required to enroll in a remedial course. The remedial sequence required of these students shall be designed to ensure the student has the opportunity to enroll in the gateway course within the first academic year.

6. Student ~~E~~enrollment in a remedial course must be identified by the institution and approved through established institutional processes~~by the institution~~.

~~3.~~7. Credits earned in remedial courses may not apply toward the requirements for a certificate or degree.

8. ~~Remedial education S~~success rates in co-requisite support ~~courses~~models and remedial courses shall be reported annually to the Board.

THIS PAGE LEFT INTENTIONALLY BLANK

SUBJECT

Board Policy III.Z, Planning and Delivery of Postsecondary Programs and Courses – Second Reading

REFERENCE

April 2011	Board approved the first reading of the proposed amendments to Board Policy III.Z, Planning and Delivery of Postsecondary Programs to include the inclusion of statewide program responsibilities into policy.
June 2011	Board approved the second reading of the proposed amendments to Board Policy III.Z. Planning and Delivery of Academic Programs and Courses as amended.
June 19, 2013	The Board was presented with proposed corrections to institutions' statewide program responsibilities.
August 15, 2013	The Board approved the first reading of the proposed amendments to Board Policy III.Z, Planning and Delivery of Postsecondary Programs and Courses to include updating institutions statewide responsibilities.
December 2013	The Board approved the second reading of Board Policy III.Z.
June 18, 2015	The Board approved the first reading of Board Policy III.Z.
August 13, 2015	The Board approved the second reading of Board Policy III.Z.
October 20, 2016	The Board approved the first reading of the proposed amendments to Board Policy III.Z that updates institutions statewide program responsibilities.
December 15, 2016	The Board approved the second reading of proposed amendments to Board Policy III.Z. that updates institutions statewide program responsibilities.
December 21, 2017	The Board approved the first reading of proposed amendments to Board Policy III.Z that changes the planning timeframe from five years to three years.

APPLICABLE STATUTE, RULE, OR POLICY

Idaho State Board of Education Governing Policies and Procedures, Section III.Z, Planning and Delivery of Postsecondary Programs and Courses.
Section 33-113, Idaho Code, Limits of Instruction.

ALIGNMENT WITH STRATEGIC PLAN

Goal 2, Innovation and Economic Development, Objective D, Education to Workforce Alignment

BACKGROUND/DISCUSSION

The purpose of Board Policy III.Z, "is to ensure Idaho's public postsecondary institutions meet the educational and workforce needs of the state through academic planning, alignment of programs and courses, and collaboration and coordination." The purpose is to also meet the statutory requirement to "as far as practicable prevent wasteful duplication of effort" by the institutions.

The proposed amendments changes the planning timeframe from five years to three years to provide the Board with a better understanding where institutions are aligning their focus with program delivery by offering more relevant information about an institution's program goals and how those align with institution mission and state or regional education workforce needs. The three-year planning process also aims to offer added flexibility to institutions with respect to program planning and proposal processes, without expense to Board oversight of program delivery, institutional accountability for resource allocation, and collaborative efforts across postsecondary institutions.

IMPACT

Proposed changes will simplify the information collected and reported, streamline the planning process, and improve the applicability of information provided to the Board.

ATTACHMENTS

Attachment 1 – Proposed Amendments to Board Policy III.Z Page 3

STAFF COMMENTS AND RECOMMENDATIONS

The Council on Academic Affairs and Programs (CAAP) supports maintaining the planning process and changing the period from five years to three years. While CAAP believes it is a useful tool; a more concise report about the institution's goals and mission with programs would be more valuable to the Board.

There were no changes between the first and second reading. Board staff recommends approval.

BOARD ACTION

I move to approve the second reading of proposed amendments to Board Policy III.Z, Planning and Delivery of Postsecondary Programs and Courses as submitted in Attachment 1.

Moved by _____ Seconded by _____ Carried Yes _____ No _____

Idaho State Board of Education
GOVERNING POLICIES AND PROCEDURES
SECTION: III. POSTSECONDARY AFFAIRS
Subsection: Z. Planning and Delivery of Postsecondary Programs and Courses
~~December 2016~~February 2018

The purpose of this policy is to ensure Idaho's public postsecondary institutions meet the educational and workforce needs of the state through academic planning, alignment of programs and courses (hereinafter referred to collectively as "programs"), and collaboration and coordination. This subsection shall apply to the University of Idaho, Boise State University, Idaho State University, Lewis-Clark State College, Eastern Idaho Technical College, College of Southern Idaho, College of Western Idaho, and North Idaho College (hereinafter "institutions"). The State Board of Education (the Board) aims to optimize the delivery of academic programs while allowing institutions to grow and develop consistent with their vision and mission with an appropriate alignment of strengths and sharing of resources.

This policy requires the preparation and submission of academic plans to advise and inform the Board in its planning and coordination of educational programs in a manner that enhances access to quality programs, while concurrently increasing efficiency, avoiding unnecessary duplication and maximizing the cost-effective use of educational resources. As part of this process, the Board hereby identifies and reinforces the responsibilities of the institutions governed by the Board to deliver Statewide Programs. The provisions set forth herein serve as fundamental principles underlying the planning and delivery of programs pursuant to each institution's assigned Statewide and Service Region Program Responsibilities. These provisions also require collaborative and cooperative agreements, or memorandums of understanding, between and among the institutions.

This policy is applicable to campus-based face-to-face programs, including those that use technology to facilitate and/or supplement a physical classroom experience. It also applies to hybrid and blended programs where a substantial portion of the content is delivered on-line and typically has reduced seat time.

1. Definitions

   a. Designated Institution shall mean an institution whose main campus is located in a service region as identified in subsection 2.b.ii.1) and 2) below.

      i. For purposes of this policy, with respect to academic programs, Designated Institutions and Partnering Institutions shall include only the University of Idaho, Idaho State University, Boise State University, and Lewis- Clark State College and shall have Service Region Program Responsibility for those regions identified in subsection 2.b.ii.1).

      ii. For purposes of this policy, with respect to career technical programs, Designated Institutions and Partnering Institutions shall include only the

College of Southern Idaho, College of Western Idaho, North Idaho College, Eastern Idaho Technical College, Lewis-Clark State College, and Idaho State University and shall have Service Region Program Responsibility for those regions identified in subsection 2.b.ii.2).

b. A memorandum of understanding (MOU) is an agreement between two or more institutions offering programs within the same service region that details how such programs will be delivered in a collaborative manner. An MOU is intended to provide specific, practical details that build upon what has been provided in each Institution's Plan.

c. Partnering Institution shall mean either (i) an institution whose main campus is located outside of a Designated Institution's identified service region but which, pursuant to a Memorandum of Understanding, offers Regional Programs in the Designated Institution's primary service region, or (ii) an institution not assigned a Statewide Program Responsibility which, pursuant to a Memorandum of Understanding with the institution assigned the Statewide Program Responsibility, offers and delivers a statewide educational program.

d. Service Region Program shall mean an educational program identified by the Board to be delivered by a Designated Institution within its respective service region that meets regional educational and workforce needs.

e. Service Region Program Responsibility shall mean an institution's responsibility to offer and deliver a Service Region Program to meet regional educational and workforce needs in its primary service region as defined in subsection 2.b.ii.1) and 2) below. Service Region Program Responsibilities are assigned to the Designated Institution in each service region, but may be offered and delivered by Partnering Institutions in accordance with the procedures outlined in this policy.

f. Statewide Program shall mean an educational program identified by the Board to be delivered by a particular institution which meets statewide educational and workforce needs. Lewis-Clark State College, Eastern Idaho Technical College, North Idaho College, College of Southern Idaho, and College of Western Idaho do not have Statewide Program Responsibilities.

g. Statewide Program Responsibility shall mean an institution's responsibility to offer and deliver a Statewide Program in all regions of the state. Statewide Program Responsibilities are assigned to a specific institution by the Board, taking into account the degree to which such program is uniquely provided by the institution.

2. Planning and Delivery Process and Requirements

   a. Planning

i. ~~Five~~Three-Year Plan

The Board staff shall, using the Institution Plans submitted, create and maintain a rolling ~~five~~ three (~~5~~3) year academic plan (~~Five~~Three-Year Plan) which includes all current and proposed institution programs. The ~~Five~~Three-Year Plan shall be approved by the Board annually at its August Board meeting.

ii. Institution Plan

Each institution shall, in accordance with a template to be developed by the Board's Chief Academic Officer, create and submit to Board staff a rolling ~~five~~ three (~~5~~3) year academic plan, to be updated annually, that describes all current and proposed programs and services to be offered in alignment with each institution's Statewide and Service Region Program Responsibilities (the Institution Plan). Institution Plans shall be developed pursuant to a process of collaboration and communication with the other institutions in the state.

1) Statewide Programs

Institutions assigned a Statewide Program Responsibility shall plan for and determine the best means to deliver such program. Each institution assigned a Statewide Program Responsibility shall include in its Institution Plan all currently offered and proposed programs necessary to respond to the workforce and educational needs of the state relating to such Statewide Program Responsibilities. Each Institution Plan shall include the following information for proposed Statewide programs:

a) A description of the Statewide Programs to be delivered throughout the state and the anticipated resources to be employed.

b) A description of the Statewide Programs to be offered by a Designated or Partnering Institution.

c) A summary of the Memoranda of Understanding (MOU's), if any, to be entered into with Partnering Institutions pursuant to Subsection 2.b.iii. below.

2) Service Region Programs

It is the responsibility of the Designated Institution to plan for and determine the best means to deliver Service Region Programs that respond to the educational and workforce needs of its service region. If, in the course of developing or updating its Institution Plan, the Designated Institution identifies a need for the delivery of a program within its service region, and the Designated Institution is unable to provide the program, then the Designated Institution shall coordinate with a Partnering Institution

(including institutions with Statewide Program Responsibilities if applicable) located outside of the service region to deliver the program in the service region. The Institution Plan developed by a Designated Institution shall include the following:

a) A description of the proposed academic programs to be delivered in the service region, or outside of the service region, by the Designated Institution and the anticipated resources to be employed.

b) A description of proposed programs to be offered in the service region by Partnering Institutions, including any anticipated transition of programs to the Designated Institution.

c) A description of proposed Statewide Programs to be offered in the service region by an institution with Statewide Program Responsibilities, or by the Designated Institution in coordination with the institution holding the Statewide Program Responsibility.

d) A summary of proposed MOU's, if any, to be entered into between the Designated Institution and any Partnering Institutions in accordance with Subsection 2.b.iii. below.

3) Institution Plan Updates

Institution Plans shall be updated and submitted to Board staff annually as follows:

a) Preliminary Institution Plans shall be developed according to a template provided by the Board's Chief Academic Officer and submitted to the Council for Academic Affairs and Programs (CAAP) for review, discussion and coordination annually in April.

b) Following review by CAAP, Institution Plans shall be submitted to Board staff. Upon submission of the Institution Plans to Board staff, the Board's Chief Academic Officer shall review the Institution Plans for the purpose of optimizing collaboration and coordination among institutions, ensuring efficient use of resources, and avoiding unnecessary duplication of programs.

c) In the event the Board's Chief Academic Officer recommends material changes, he/she shall work with the institutions and then submit those recommendations to CAAP for discussion prior to submission to the Board for inclusion in the ~~Five~~Three-Year Plan.

d) The Board's Chief Academic Officer shall then provide their

recommendations to the Board for enhancements, if any, to the Institution Plans at a subsequent Board meeting. The Board shall approve the Institution Plans annually through the ~~Five~~Three-Year Plan submitted by Board staff. Board approval of Institution Plans acts as a roadmap for institutional planning and does not constitute Board approval of a program. Institutions are still required to follow the standard program approval process as identified in Board Policy Section III.G to gain program approval.

b. Delivery of Programs

i. Statewide Program Delivery

The Board has established statewide program responsibilities for the following institutions. This statewide program list shall be updated by the Board every two years.

Boise State University must assess the need for and, when determined necessary by the assessment, ensure the statewide delivery of all educational programs in the following degree program areas:

Program Name	Degrees
Public Policy and Administration	M.S., Ph.D.
Community and Regional Planning	M.C.R.P., Ph.D.
Social Work (Region V-VI —shared with ISU)	M.S.W.
Social Work	Ph.D.

Idaho State University must assess the need for and, when determined necessary by the assessment, ensure the statewide delivery of all educational programs in the following degree program areas:

Program Name	Degrees
Audiology	Au.D., Ph.D.
Physical Therapy	D.P.T., Ph.D.
Occupational Therapy	M.O.T.
Pharmaceutical Science	M.S., Ph.D.
Pharmacy Practice	Pharm.D.
Nursing (Region III shared w/ BSU)	M.S., D.N.P.
Nursing	Ph.D.
Physician Assistant	M.P.A.S.
Speech Pathology	M.S.
Deaf Education	M.S.
Sign Language Interpreting	B.S.
Health Education	M.H.E.
Public Health	M.P.H.
Health Physics	B.S., M.S., Ph.D.
Dental Hygiene	B.S., M.S.
Medical Lab Science	B.S., M.S.
Clinical Psychology	Ph.D.

University of Idaho must assess the need for and, when determined necessary by the assessment, ensure the statewide delivery of all educational programs in the following degree program areas:

Program Name	Degrees
Law	J.D.
Architecture	B.S. Arch., M. Arch.
Integrated Architecture & Design	M.S.
Landscape Architecture	B.S.L.A., M.L.A.
Interior Design	B.I.D., M.S.
Animal & Veterinary Science	B.S.A.V.S.
Animal Science	M.S.
Veterinary Science	D.V.M.
Plant Science	M.S., Ph.D.
Agricultural Economics	B.S.Ag.Econ.
Applied Economics (Agricultural)	M.S.
Food Science	B.S.F.S., M.S., Ph.D.
Forestry	B.S.Forestry
Renewable Materials	B.S.Renew.Mat.
Wildlife Resources	B.S.Wildl.Res.
Fishery Resources	B.S.Fish.Res.
Natural Resource Conservation	B.S.Nat.Resc.Consv.
Rangeland Ecology & Management	B.S.Rangeland.Ecol.Mgmt.
Fire Ecology & Management	B.S.Fire.Ecol.Mgt.
Natural Resource concentrations in: • Forestry • Renewable Materials • Wildlife Resources • Fishery Resources • Natural Resource Conservation • Rangeland Ecology & Management • Fire Ecology & Management	M.S., M.N.R., Ph.D.

ii. Service Region Program Delivery

The Board has established service regions for the institutions based on the six geographic areas identified in Section 33-2101, Idaho Code. A Designated Institution shall have the Service Region Program Responsibility to assess and ensure the delivery of all educational programs and services necessary to meet the educational and workforce needs within its assigned service region.

1) Academic Service Regions

Region I shall include the area within Area No.1 under Section 33-2101, Idaho Code. Lewis-Clark State College and the University of Idaho are the Designated Institutions serving undergraduate needs. The University of Idaho is the Designated Institution serving the graduate education

needs.

Region II shall include the area within Area No.2 under Section 33-2101, Idaho Code. Lewis-Clark State College is the Designated Institution serving undergraduate needs. The University of Idaho is the Designated Institution serving the graduate education needs.

Region III shall include the area within Area No.3 under Section 33-2101, Idaho Code. Boise State University is the Designated Institution serving undergraduate and graduate education needs.
Region IV shall include the area within Area No.4 under Section 33-2101, Idaho Code. Idaho State University is the Designated Institution serving undergraduate and graduate needs; with the exception that Boise State University will meet undergraduate and graduate business program needs.

Region V shall include the area within Area No.5 under Section 33-2101, Idaho Code. Idaho State University is the Designated Institution serving undergraduate and graduate education needs.

Region VI shall include the area within Area No.6 under Section 33-2101, Idaho Code. Idaho State University is the Designated Institution serving undergraduate and graduate education needs.

2) Career Technical Service Regions

Postsecondary career technical education is delivered by six (6) institutions, each having responsibility for serving one of the six geographic areas identified in Section 33-2101.

Region I shall include the area within Area No.1 under Section 33-2101, Idaho Code. North Idaho College is the Designated Institution.

Region II shall include the area within Area No.2 under Section 33-2101, Idaho Code. Lewis-Clark State College is the Designated Institution.

Region III shall include the area within Area No.3 under Section 33-2101, Idaho Code. College of Western Idaho is the Designated Institution

Region IV shall include the area within Area No.4 under Section 33-2101, Idaho Code. College of Southern Idaho is the Designated Institution.

Region V shall include the area within Area No.5 under Section 33-2101, Idaho Code. Idaho State University is the Designated Institution.

Region VI shall include the area within Area No.6 under Section 33-2101,

Idaho Code. Eastern Idaho Technical College is the Designated Institution.

3) Program Offerings by Partnering Institutions

If a Partnering Institution (other than an institution with Statewide Program Responsibilities) identifies a Service Region Program not identified, or anticipated to be identified, in a Designated Institution's Plan, and the Partnering Institution wishes to offer such program in the Designated Institution's service region, then the Partnering Institution may communicate with the Designated Institution for the purpose of allowing the Partnering Institution to deliver such program in the service region and to include the program in the Designated Institution's Plan. In order to include the program in the Designated Institution's Plan, the Partnering Institution must demonstrate the need within the service region for delivery of the program, as determined by the Board (or by the Administrator of the Division of Career Technical Education in the case of career technical level programs). In order to demonstrate the need for the delivery of a program in a service region, the Partnering Institution shall complete and submit to the Chief Academic Officer of the Designated Institution, to CAAP and to Board staff, in accordance with a schedule to be developed by the Board's Chief Academic Officer, the following:

a) A study of business and workforce trends in the service region indicating anticipated, ongoing demand for the educational program to be provided.

b) A survey of potential students evidencing demand by prospective students and attendance sufficient to justify the short-term and long-term costs of delivery of such program.

c) A complete description of the program requested to be delivered, including a plan for the delivery of the program, a timeline for delivery of the program, the anticipated costs of delivery, the resources and support required for delivery (including facilities needs and costs), and program syllabuses.

4) Designated Institution's First Right to Offer a Program

In the event the Partnering Institution has submitted the information set forth above to the Board's Chief Academic Officer) for inclusion in the Designated Institution's Plan, and a need is demonstrated by the Partnering Institution for such program in the service region, as determined by the Board (or by the Administrator for the Division of Career Technical Education in the case of career technical level programs), or prior to the submission of an updated Institution Plan by the Designated Institution, it is determined by the Board that an emergency need has arisen for such

program in the service region the Designated Institution shall have a first right to offer such program.

The Designated Institution must within six (6) months (three (3) months in the case of associate level or career technical level programs) of receiving the request from a Partnering Institution to offer said program determine whether it will deliver such program on substantially the same terms (with respect to content and timing) described by the Partnering Institution. In the event the Designated Institution determines not to offer the program, the Partnering Institution may offer the program according to the terms stated, pursuant to an MOU to be entered into with the Designated Institution. If the Partnering Institution materially changes the terms and manner in which the program is to be delivered, the Partnering Institution shall provide written notice to the Chief Academic Officer of the Designated Institution and to the Board's Chief Academic Officer of such changes and the Designated Institution shall be afforded the opportunity again to review the terms of delivery and determine within three (3) months of the date of notice whether it will deliver such program on substantially the same terms.

iii. Memoranda of Understanding

When a service region is served by more than one institution, an MOU shall be developed between such institutions as provided herein and submitted to the Board's Chief Academic Officer for review and approval by the Board prior to entering into such agreements. Each MOU shall be entered into based on the following guidelines, unless otherwise approved by the Board.

If an institution with Statewide Program Responsibility has submitted the information set forth in Subsection 2.a.ii. above to a Designated Institution and Board staff in a timely manner (as determined by the Board's Chief Academic Officer) for inclusion in the Designated Institution's Plan, then the Designated Institution shall identify the program in its Institution Plan and enter into an MOU with the institution with Statewide Program Responsibility in accordance with this policy. If, prior to the submission of an updated Institution Plan by the Designated Institution, it is determined by the Board that an emergency need has arisen for such program in the service region, then upon Board approval the institution with Statewide Program Responsibility and the Designated Institution shall enter into an MOU for the delivery of such program in accordance with the provisions of this policy.

iv. Facilities

For programs offered by a Partnering Institution (whether an institution with Statewide Program Responsibilities, or otherwise) within a municipal or metropolitan area that encompasses the campus of a Designated Institution, the Partnering Institution's programs offerings shall be conducted in facilities

located on the campus of the Designated Institution to the extent the Designated Institution is able to provide adequate and appropriate property or facilities (taking into account financial resources and programmatic considerations), or in facilities immediately adjacent to the campus of the Designated Institution. Renting or building additional facilities shall be allowed only upon Board approval, based on the following:

1) The educational and workforce needs of the local community demand a separate facility at a location other than the campus of the Designated Institution or adjacent thereto as demonstrated in a manner similar to that set forth in Subsection 2.b.ii.1) above, and

2) The use or development of such facilities are not inconsistent with the Designated Institution's Plan.

Facilities rented or built by a Partnering Institution (whether an institution with Statewide Program Responsibilities, or otherwise) on, or immediately adjacent to, the "main" campus of a Designated Institution may be identified (by name) as a facility of the Partnering Institution, or, if the facility is rented or built jointly by such institutions, as the joint facility of the Partnering Institution and the Designated Institution. Otherwise, facilities utilized and programs offered by one or more Partnering Institutions within a service region shall be designated as "University Place at (name of municipality)."

For programs offered by a Partnering Institution (whether an institution with Statewide Program Responsibilities, or otherwise) within a municipality or metropolitan area encompassing a campus of a Designated Institution, to the extent programmatically possible, auxiliary services (including, but not limited to, bookstore, conference and other auxiliary enterprise services) and student services (including, but not limited to, library, information technology, and other auxiliary student services) shall be provided by the Designated Institution. To the extent programmatically appropriate, registration services shall also be provided by the Designated Institution. It is the goal of the Board that a uniform system of registration ultimately be developed for all institutions governed by the Board. The Designated Institution shall offer these services to students who are enrolled in programs offered by the Partnering Institution in the same manner, or at an increased level of service, where appropriate, as such services are offered to the Designated Institution's students. An MOU between the Designated Institution and the Partnering Institution shall outline how costs for these services will be allocated.

v. Duplication of Courses

If courses necessary to complete a Statewide Program are offered by the Designated Institution, they shall be used and articulated into the Statewide Program.

vi. Program Transitions

Institutions with Statewide Program or Service Region Program Responsibilities may plan and develop the capacity to offer a program within a service region where such program is currently being offered by another institution (the Withdrawing Institution) as follows:

1) The institution shall identify its intent to develop the program in the next update of its Institution Plan. The institution shall demonstrate its ability to offer the program through the requirements set forth in Subsection 2.b.ii.3) above.

2) Except as otherwise agreed between the institutions pursuant to an MOU, the Withdrawing Institution shall be provided a minimum three (3) year transition period to withdraw its program. If the Withdrawing Institution wishes to withdraw its program prior to the end of the three (3) year transition period, it may do so but in no event earlier than two (2) years from the date of notice (unless otherwise agreed). The Withdrawing Institution shall enter into a transition MOU with the institution that will be taking over delivery of the program that includes an admissions plan between the institutions providing for continuity in student enrollment during the transition period.

vii. Discontinuance of Programs

Unless otherwise agreed between the applicable institutions pursuant to an MOU, if, for any reason, (i) a Designated Institution offering programs in its service region that supports a Statewide Program of another institution, (ii) a Partnering Institution offering programs in the service region of a Designated Institution, or (iii) an institution holding a Statewide Program Responsibility offering Statewide Programs in the service region of a Designated Institution, wishes to discontinue offering such program(s), it shall use its best efforts to provide the institution with Statewide or Service Region Program Responsibility, as appropriate, at least one (1) year's written notice of withdrawal, and shall also submit the same written notice to the Board and to oversight and advisory councils. In such case, the institution with Statewide or Service Region Program Responsibilities shall carefully evaluate the workforce need associated with such program and determine whether it is appropriate to provide such program. In no event will the institution responsible for the delivery of a Statewide or Service Region Program be required to offer such program (except as otherwise provided herein above).

3. Existing Programs

Programs being offered by a Partnering Institution (whether an institution with

Statewide Program Responsibilities, or otherwise) in a service region prior to July 1, 2003, may continue to be offered pursuant to an MOU between the Designated Institution and the Partnering Institution, subject to the transition and notice periods and requirements set forth above.

4. Oversight and Advisory Councils

   The Board acknowledges and supports the role of oversight and advisory councils to assist in coordinating, on an ongoing basis, the operational aspects of delivering programs among multiple institutions in a service region, including necessary resources and support and facility services, and the role of such councils in interacting and coordinating with local and regional advisory committees to address and communicate educational needs indicated by such committees. Such interactions and coordination, however, are subject to the terms of the MOU's entered into between the institutions and the policies set forth herein.

5. Resolutions

   All disputes relating to items addressed in this policy shall be forwarded to the Board's Chief Academic Officer for review. The Board's Chief Academic Officer shall prescribe the method for resolution. The Board's Chief Academic Officer may forward disputes to CAAP and if necessary make recommendation regarding resolution to the Board. The Board will serve as the final arbiter of all disputes.

6. Exceptions

   a. This policy is not applicable to programs for which 90% or more of all activity is required or completed online, or dual credit courses for secondary education.

   b. This policy also does not apply to courses and programs specifically contracted to be offered to a private, corporate entity. However, in the event that an institution plans to contract with a private corporate entity (other than private entities in the business of providing educational programs and course) outside of their Service Region, the contracting institution shall notify the Designated Institutions in the Service Region and institutions with Statewide Program Responsibilities, as appropriate. If the corporate entity is located in a municipality that encompasses the campus of a Designated Institution, the Board encourages the contracting institution to include and draw upon the resources of the Designated Institution insomuch as is possible.