COLLEGE OF ENGINEERING

RESEARCH AT A GLANCE

BOISE STATE UNIVERSITY

WELCOME

Boise State University. This metropolitan public university at the base of the Rocky Mountain foothills prepares students for success, and advances Idaho, the nation, and the world. Recognized by U.S. News & World Report as one of the top 50 most innovative universities in the country, Boise State is the largest undergraduate and graduate institution of higher education in Idaho and a "R2" doctoral research institution serving more than 33,000 students annually. Located in Idaho's vibrant capital city, Boise State is also in one of the most beautiful and talked-about cities in the country, and in one of the fastest growing regions. Our 200+ -acre campus (approximately 81 hectares) serves Idaho and the Northwest while also attracting students from every state, and from more than 60 countries. In the past 10 years, we have quadrupled the number of doctoral degrees, and doubled master's degree offerings. In 2023–24, we offer approximately 200 programs of study, including 13 doctoral programs. University research expenditures are $83 million. Together, our commitment to and investment in innovation, educational access, research and creative activity, and trailblazing programs and partnerships make Boise State a vital contributor towards thriving arts, recreation, government, industry, technology, and healthcare.

The College of Engineering. Through an unshakeable focus on learning, the College of Engineering (COEN) provides students with a world-class education, and hands-on research, internship, and student club experience. Launched in 1997, we now serve approximately 2400 undergraduates and 530 graduate students, with over 600 graduates in 2023–24. At the same time, college research expenditures from approximately 75 tenured or tenure-track faculty principal investigators (PIs) and their teams reached $17 million. Twenty-first century educational needs drive our approach as a college. We are committed to life-long learning; working with integrity in inclusive multidisciplinary settings; interdisciplinary thinking; integrated teaching and research; and an appreciation of creativity and innovation in everything we do. Our offerings in engineering, computer science, and social science address the complexity of today's global challenges.

College Research Strengths. As this document shows, we offer substantive research breadth. In addition, the college has particular shared expertise and external funding in five strength areas: (1) materials, (2) computing, (3) built environment (human-made infrastructure for how we live, work, and play), (4) biomedical, and (5) microelectronics. Unprecedented federal investment through the CHIPS and Science Act has further enhanced our microelectronics strength given institutional support from the Boise State Institute for Microelectronics Education and Research, launched in 2023 to further regional growth.

We Invite Your Engagement. College of Engineering personnel conduct research and offer laboratory and service center research support. To advance scientific study and serve the community and society, we invite engagement from university affiliates, industry personnel, and entrepreneurs. Please use this document to identify areas of interest, and email contacts at the provided links. For assistance with this exploration, general questions about the college, or how you might engage with microelectronics or multiple units, please contact Todd Otanicar, Associate Dean for Research Affairs, at coenresearch@boisestate.edu.

TABLE OF CONTENTS

COLLEGE CENTERS

The College of Engineering provides core facilities and service centers to faculty, students, and regional partners that are pivotal to impactful research.

NAME/CONTACT	SERVICE SUMMARY
Center for Advanced Energy Studies (CAES) at Boise State University *David Estrada*	Boise State collaborates as part of a multi-institutional research-education and innovation partnership as a catalyst to address our most ambitious energy challenges at regional, national, and global levels. Together, three Idaho universities, private industry, and the Idaho National Laboratory address energy innovation and policy; the energy-water nexus; advanced manufacturing; cybersecurity; and computing and data visualization.
Center for Atomically Thin Multifunctional Coatings (ATOMIC) *David Estrada*	We expand potential industry innovation by developing novel coatings and functionalities enabled by two-dimensional materials. This is Boise State University's first NSF-funded center—also the first engineering-related center in Idaho funded through the industry-university research partnership (I/UCRC) program. Work in the current funding phase contributes to innovation and applied solutions in energy, healthcare, accessibility, space exploration, and the environment. **Research Summary.** We design and develop new 2D materials with unique physical, optical, electrical and chemical properties. Materials from one to a few atoms will: (1) address corrosion, oxidation and abrasion; accumulation of unwanted organisms and scale; energy harvesting and storage; and friction and wear, and (2) enable smaller, more powerful electronics, sensors and actuators; and biomedical device, water purification, and chemical reaction technologies. **Partners.** Penn State University leads with institutional partners Rice University and Boise State University as well as numerous industry and government partners. Boise State joined in 2021 concurrent with $1.5 million in phase II funding focusing on applied solutions. Industry membership fees of approximately $600,000 per year help maintain center research. **Boise State Expertise.** We contribute expertise in additive manufacturing of electronics, atomic layer deposition, and scanning probe microscopy. We use nanomaterial ink synthesis and characterization tools and materials printers in the Micron Center for Materials Research in Boise, Idaho and at the Center for Advanced Energy Studies in Idaho Falls. Recent M. J. Murdock Charitable Trust investments also provide center faculty and students with access to advanced scanning probe techniques that we use to image 2D material properties with nanoscale precision.

NAME/CONTACT	SERVICE SUMMARY
Convergent Engineering and Biomolecular Science Center of Biomedical Research Excellence (CEBS COBRE) *Jim Browning* *Ken Cornell (Chemistry and Biochemistry)*	The National Institutes of Health funded the CEBS COBRE in 2023, injecting $10M over 5 years into building regional biomedical research capacity. This university center is an important and stable funding source and phenomenal boon to campus research growth. There is also the potential to obtain additional funding for another 10 years. The theme for this COBRE is to support research and clinical applications that use biomedical devices, sensors, and systems. **The College of Engineering houses the core research facility, called the Fabrication, Characterization, and Testing (FaCT) core. It has the four parts listed below.**
1. **Biomechanics and Mechanobiology (BMMB) facility** *Sean Howard*	We provide instrumentation including: a microscope for cell culturing, a scanner that uses x-rays to generate 3D images of low-to-high density tissue such as lungs or bones to identify its internal structure, bioreactors for strain applications, and a clinostat system for adherent cells (e.g., fibroblasts, stem cells, osteoblasts). The Matrix Biology COBRE and its Biomedical Research center core facility initially put this facility in place.
2. **Boise State Center for Materials Characterization (BSCMC)** *Karthik Chinnathambi* *Paul Davis*	We provide instrumentation to advance research and education in the structural characterization of materials by addressing two primary functions through two units, the: (1) X-ray and Electron Microscopy Laboratory (XEML), and the Surface Science Lab (SSL). Capabilities include structural, chemical, and imaging offerings, and potential application areas are wide ranging. Offerings also complement additional regional microscopy support available through the Idaho National Laboratory Center for Advanced Energy Studies (CAES), which has the campus presence noted above.
3. **Idaho Microfabrication Lab (IML)** *Pete Miranda*	We provide thin film deposition, chemical processing, etching, and photolithography services to advance research and education in nano- and micro-fabrication, and in additive manufacturing microelectronic device development. Partners frequently use services for rapid prototyping and proof-of-concept development. Potential application areas are wide ranging.
4. **Research Machining and Engineering (RME) facility** *Sarah Haight*	Our engineering, manufacturing, troubleshooting, and student mentoring team offers services at minimal cost to support research and educational efforts through mechanical and system design or modification; electrical troubleshooting and repair, and metal and plastic fabrication.

COLLEGE SCHOOLS, DEPARTMENTS, AND DEGREE PROGRAMS

The remainder of this document summarizes the rich activity of researchers affiliated with the College of Engineering in Civil Engineering, Construction Management, Computer Science, Electrical & Computer Engineering, Mechanical & Biomedical Engineering, the Micron School of Materials Science & Engineering, and Organizational Performance and Workplace Learning.

In the fall of 2024, we also launched the School of Computing. It complements but is separate from our Computer Science department, and does not include researchers in this document. Given the importance of computing across disciplines and society, the school serves students across the university to provide courses, certificates and degree programs. The full college curriculum includes majors and minors, with students pursuing bachelor's, master's, and doctoral degrees and certificates through the college, or in partnership with other university colleges, schools, or other units. For more information about specific offerings, please see the college Departments and Degree Programs web page. Finally, note that just after the end of the 2023–24 academic year, the Organizational Performance and Workplace Learning department will move from the College of Engineering to the College of Education.

FUNDER LEGEND FOR THIS DOCUMENT

FUNDER TYPE	SUMMARY
FEDERAL FUNDERS	Air Force Office of Scientific Research **(AFOSR)**, Air Force Research Laboratory **(AFRL)**, Army Research Office **(ARO)**, Consumer Product Safety Commission **(CPSC)**, Department of Defense **(DOD)**, Department of Education **(ED)**, Department of Energy **(DOE)**, Department of Homeland Security **(DHS)**, Department of the Interior **(Interior)** Department of Transportation **(DOT)**, Environmental Protection Agency **(EPA)**, Federal Aviation Administration **(FAA)**, National Institutes of Health **(NIH)**, National Aeronautic and Space Administration **(NASA)**, National Aeronautic and Space Administration Established Program to Stimulate Competitive Research **(NASA EPSCoR)**, National Institute of Standards and Technology **(NIST)**, National Security Agency **(NSA)**, National Science Foundation **(NSF)**, Office of Naval Research **(ONR)**, U.S. Naval Research Laboratory **(NRL)**, and the United States Department of Agriculture **(USDA)**.
REGIONAL FUNDERS	Boeing, Center for Advanced Energy Studies **(CAES)**, City of Boise; Higher Education Research Council **(HERC)**, Gates Foundation, Idaho Department of Commerce **(ID DOC)**, Idaho Department of Education **(ID ED)**, Idaho Global Entrepreneurial Mission **(IGEM)**, Idaho National Laboratory **(INL)**, Idaho Space Grant Consortium **(ISGC; source funding from NASA)**, Idaho Secretary of State, Idaho STEM Action Center, Idaho State Board of Education, Idaho Transportation Department **(ITD)**, Idaho Workforce Development Council, Micron Technology, the M. J. Murdock Charitable Trust; the NIH Institutional Development Award **(IDeA)**, which funds both the Idaho IDeA Network of Biomedical Research Excellence INBRE, and Center of Biomedical Research Excellence (**COBRE)** programs; and Pilgrim Africa.

CIVIL ENGINEERING (CE)

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Advanced Transportation Management Lab	*Mandar Khanal*	We conduct research to improve transportation planning in cities and states, enhance public safety, and make approaches more cost effective. We address planning for balanced growth, efficient road design, traffic operations and management, and innovative roadway safety improvements. We investigate potential improvements to existing surface transportation infrastructure through management techniques such as incorporating data from connected vehicles and other newer technologies. We also apply proactive approaches to anticipate transportation demands and prepare plans to meet those needs within funding and other constraints. Finally, we adapt newer data collection technologies to facilitate efficient road design, using images from drones and mobile-terrestrial or aerial lidar—a technique that uses light to measure variable distances to the Earth—to survey physical objects and the environment.	The National Institute for Advanced Transportation Technologies (University of Idaho); The Oregon Driving and Bicycling Simulator facilities at Oregon State University (David Hurwitz); University of Washington (YinHai Wang)	ITD, Ada County Highway District, PacTrans Consortium
Air Quality Lab	*Sondra Miller*	We conduct air and water quality studies that advance healthy regions by examining the fate and transport of organic contaminants in natural and engineered systems.	City of Boise	EPA, City of Boise

CIVIL ENGINEERING (CE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Clean Soils Lab	*Arvin Farid*	Our team uses its geoenvironmental, geotechnical, and electrical engineering expertise to create a safer, more sustainable, and more resilient natural and built environment by: (1) using innovative methods to prepare for, mitigate, prevent, and respond to environmental hazards; (2) developing novel subsurface sensing sensors and algorithms for a variety of nondestructive sensing and characterization applications; (3) remediating and restoring soil and groundwater contaminated by hazardous materials or compromised by hazards such as wildfires; (4) inventing novel ways to mitigate earthquake-induced liquefaction; and (5) finding ways to recycle and reuse industrial byproducts to address environmental problems or needs.	University of Illinois Chicago (Krishna Reddy); University of Illinois Urbana Champaign (Tugce Baser); University of Missouri -Kansas City (Megan Hart); Indian Institute of Technology at Bombay (D. N. Singh); Cranfiled Research Institute in the United Kingdom (Stuart Wagland & Daniel Evans); Indian Institute of Technology at Madras (D. N. Arnapali); and many more.	NSF, Fulbright (Indo-US collaboration), various industry partners
Geo-Mechanics and Geo-Imaging Group (GMGI)	*Nick Hudyma*	We use laboratory experiments, computer simulations, and field investigations to understand the behavior of geologic materials at a variety of scales. In the laboratory, we perform highly controlled and well-instrumented experiments to identify material properties, understand fracture propagation, and determine failure modes. We use imaging and non-destructive testing methods to aid our laboratory characterization efforts. We use computer simulations (finite element and finite-discrete element methods) to augment our understanding of laboratory behaviors. In the field, we use close-range unmanned aerial vehicle (UAV) photogrammetry to assess, characterize, predict, and understand geologic hazards.	Montana Technological University (Mary MacLaughlin); Mayo Clinic (George Pujalte); University of Florida (Dennis Hiltunen); Tony Gee & Partners (B. Burcin Avar)	NSF, FL Department of Transportation

CIVIL ENGINEERING (CE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Hydroclimate Modeling and Analysis Lab	*Mojtaba Sadegh*	We use computational modeling, geospatial analysis and remote sensing to inform climate change adaptation and mitigation. Specifically, we evaluate how warming, drought, wildfires, and human actions interact with and amplify each other to create disasters, and devise strategies to minimize adverse impacts. We: (1) compare projected climate conditions against past conditions, (2) analyze water movement, management, and distribution, (3) analyze and quantify current and future regional and national climate impacts, and (4) provide meaningful information to promote balanced human and environmental health and well-being.	U.S. Geological Survey, U.S. Forest Service, Bureau of Reclamation (U.S. Department of the Interior), NASA, University of California, Merced, Riverside & Irvine; University of Utah; Oregon State University; Michigan State University; University of Oulu in Finland; McGill University, University of Saskatchewan, Canada	U.S. Department of the Interior, NSF, NASA, NOAA
Hydrologic Interfaces and Processes Lab (HIP)	*Kevin Roche*	We use experiments and computational models to explore how surface water and groundwater interact in rivers. This contributes to a healthier environment by helping us understand how rivers transform natural and synthetic chemicals. Research in hydrology, reactive transport, and ecohydrology illuminate relationships between natural aquatic systems, human decisions, and large-scale environmental change. We develop novel experiments to identify feedbacks between fluid flow, microbial growth, and reactions in groundwater. We build mathematical models to predict how river biogeochemistry will change given changes to climate and land use. Finally, we use extensive field measurements to understand the link between groundwater storage in hillslopes, and water flow in rivers.	Purdue (Antoine Aubeneau); (Politecnico di Torino, Italy (Fulvio Boano); Pacific Northwest National Laboratory (Vanessa Garayburu-Caruso, Arunima Bhattacharjee, Matt Kaufman, James Stegen); US Geological Survey (Jud Harvey); University of California, Davis (Veronica Morales, Jasquelín Peña); Notre Dame (Diogo Bolster)	Pacific Northwest National Laboratory, NSF, Fulbright Foundation, Consortium of Universities for the Advancement of Hydrologic Science

CIVIL ENGINEERING (CE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
MicroMechanics & Smart Infrastructure Lab	*Yang Lu*	We integrate microscale experimental analysis with cross-scale computational modeling to inform the design of materials and systems, mitigate natural and cybersecurity hazards, and create a safer, more resilient, and more environmentally-friendly built environment. We: (1) evaluate bridges and other safety-critical infrastructure using a novel drone-based inspection system, (2) evaluate pavement using a mobile-app to inspect roughness in real time, (3) design energy-efficient building systems, (4) design sustainable 3D-printed cements and other construction materials, and (5) design asphalt mixtures that integrate both reclaimed asphalt pavements as well as rejuvenators for enhanced performance.	NIST (Edward Garboczi); Georgia Tech (Kimberly Kurtis); Iowa State University, Kejin Wang; INL (Binghui Li); University of Idaho (Emad Kassem); Pitch Aero (Zach Adams)	IDT, ID Department of Commerce, INL, NIST
Sustainable and Resilient Geotechnical Engineering Lab (SURGE)	*Bhaskar Chittoori*	We conduct geotechnical assessment and engineering to drive ground improvement and sustainable and resilient design for a safer and more resilient civil infrastructure, and a healthy environment. To mitigate soil shrinkage and expansion that can significantly damage property and infrastructure like roads and bridges, we apply an environmentally friendly approach by using bacteria in the soil to precipitate calcite and alter soil engineering and its behavior. We also develop frameworks to assess civil infrastructure sustainability and resiliency. We design new engineering approaches such as superior and more economical foundations for tall, slender, and lightweight structures. Finally, we conduct finite element simulations of geomechanical behaviors, and life cycle assessments for civil engineering applications.	University of Houston (Debora Rodrigues); University of Idaho (Hasan Jamil); Idaho State University (Mustafa Mashal); EnGioganic, Inc. (Malcolm Burbank)	NSF, ITD, MT Dept. of Transportation, UT Transit Authority, National Cooperative Highway Research Program, Taminco, Inc.

COMPUTER SCIENCE (CS)

The school maintains this research overview.

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Artificial Intelligence-based Security Lab	Edoardo Serra, Francesca Spezzano	We conduct social network analysis and mining to detect online misbehavior, mitigate misinformation, and promote national security.	Not specified	NSF, DOD, ID State Board of Education, NSA
Computer Graphics and Visualization Group	Steven Cutchin	We build technology that lets you step into photographs to allow for real-time navigation in photo realistic environments. In addition to a number of other projects, I am currently working with the Boise State University School of the Arts on an Immersive Theatre Luminary installation called the Stein Luminary. This installation includes 87-foot digital touch-activated glass walls to invite the Boise State community to explore creative arts, cultural sites, and scientific phenomena from around the globe. The installation also enables my research group to explore interaction within a very large format high-resolution theatre to prompt planning and decision-making for a variety of data spaces.	Not specified	NSF
Computing and Artificial Intelligence Lab for Physical Sciences	Min Long	We are keenly aware of the massive quantity of data that modern instrumentation produces, so strive to build a strong multidisciplinary research program that uses this data to accelerate discovery in the physical sciences. Thus, our research focuses on data science such as intelligent algorithms and their application in fundamental science; computational science and engineering; scientific programming; high-performance computing; multi-scale modeling of nuclear materials; hydrodynamics and magnetohydrodynamics; and computational high-energy physics.	Not specified	NSF, DOE, CAES, Idaho National Laboratory (INL)

COMPUTER SCIENCE (CS) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Cybersecurity for Cyber-physical Systems Lab (CCS)	*Huadi Zhu*	We design and implement cybersecurity to make every day tools safer to use. Innovative cyber-physical systems like smartphones, computers, virtual reality and augmented reality devices, drones, and autonomous vehicles connect us to the wider world through the internet. This provides both convenience and power, but comes at a cost given increased security and safety risks such as making personal data vulnerable to theft. Further, rapidly emerging new technologies and often-underdeveloped defensive measures face continuous and evolving threats. By analyzing multi-channel sensory data from these devices alongside human behavior patterns, we identify and correct for potential or existing security vulnerabilities, while ensuring that these systems remain easy to use.	**Major:** Clemson University (Linke Guo), Hunan University (Wenqiang Jin), University of Texas Arlington (Ming Li), Indiana University Bloomington (Xiaojing Liao) **Minor:** University of Texas Arlington (Shuchisnigdha Deb), Meta (Hongbo Guo), Indiana University Bloomington (L. Jean Camp)	NSF, DOT
Data Security-preserving Computing Lab	*Jyh-haw Yeh*	We conduct security research, and also develop educational materials to grow student interest in this domain. (1) We develop computational solutions for improved network security, cloud security, and applied cryptography. A current project preserves location-based service privacy by enabling individuals to hide their locations when using a mobile app to find out about nearby points of interest. (2) In addition, we are interested in supporting primary school education by developing cybersecurity lessons and hand-on activities. Materials can support formal or informal education among children in kindergarten through twelfth grades.	Not specified	NSA, NSF, NASA, Google, Amazon

COMPUTER SCIENCE (CS) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Human-computer Interaction and Kidsteam Lab	*Jerry Alan Fails*	We improve how people engage with technology by designing technology tools and methods both *with* and *for* children and families. This research advances technologies related to human-computer interaction, user interfaces, educational technology, mobile devices, and ubiquitous computing by directly engaging children, families, and older adults through user-centered, participatory and cooperative inquiry. We are currently researching: (1) a child adaptive search tool (CAST) to enable children to find the resources they need online, (2) the interdependence between families and the environment, and how fears about technology affect individual family members and the family as a whole, (3) tools that offer children better passwords and other superior security and privacy protections, (4) methods to design technologies in collaboration with children, and (5) tools to engage children in physical activities, exploring their environment, and sharing their observations.	Collaborators across 6 projects: **United States**. Northeastern Univ (Meryl Alper); Univ of Baltimore (Greg Walsh); Univ of Iowa (Juan Pablo Hourcade), Univ of MD (Elizabeth Bonsignore, Tamara Clegg); U of MN (Lana Yarosh); U of WA (Jason Yip). **Australia**. Univ of Queensland (Jessica Korte). **Brazil**. Voxar Labs/Federal U of Pernambuco (Manoela M. Oliveira da Silva). **Denmark**. Aarhus Univ (Eva Eriksson). **Israel**. UG Labs; Tel-Aviv Univ (Ariel Leventhal, Shuli Gilutz, Yair Felig) **Italy**. U degli Studi di Milano-Bicocca (Emiliana Murgia). **The Netherlands**. Delft Univ of Technology (Maria Soledad Pera); Univ of Amsterdam (Judith Good), Univ of Twente (Theo Huibers). **Switzerland**. U della Svizzera Italiana (Monica Landoni). **United Kingdom**. Univ of Central Lancashire (Janet C. Read, Gavin R. Sim); Univ of Edinburgh (Aurora Constantin, Cara Wilson, Cristina Alexandru, and Valentina Andries); U of Newcastle (Erica Southgate)	NSF
Idaho Election Cybersecurity Center	*Hoda Mehrpouyan*	Our aim is to recommend and develop tools, technologies, and policies to protect fair and democratic election processes from cyber and information attacks. Note: The investigator directs a second lab, below.	Chad Houck, the Idaho Chief Deputy Secretary of State	Office of the Idaho Secretary of State; DHS
Information Security, Privacy, and Mining Lab (ISPM)	*Gaby Dagher*	We improve cybersecurity by: (1) designing secure and privacy-preserving protocols for distributed data mining, integration, and publishing, and (2) developing tools and systems to solve real-world problems with cyberforensics, genomic privacy, Bitcoin and other digital currency, and cloud computing.	Not specified	NSA, NSF

COMPUTER SCIENCE (CS) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Privacy and Industrial Control Systems Security Lab	Hoda Mehrpouyan	We conduct research to: (1) ensure safety, security, and survivability of mission-critical cyber-physical systems, and (2) design and develop mechanisms to ensure security and privacy rights management in mobile and ubiquitous computing environments. Note: The investigator directs a second lab, above.	Not specified	NSF, NSA, State of Idaho
Performant, Intelligent, Scalable Computing with Evolving Systems Lab (PISCES)	Jianshu Liu	We analyze and improve emerging cloud computing environments to make them more secure, resilient, and better for the environment. By reducing power use and optimizing resource efficiency, performance, and scalability, we can contribute to numerous sectors—from healthcare, to manufacturing, to smart cities. Our team focuses on: (1) timeline analysis to investigate the factors driving performance variations, and (2) framework design and development to respond to system weaknesses with intelligent, automated frameworks that boost system performance.	Louisiana State University, Augusta University, University of Chicago	Currently targeting NSF, Fujitsu, and Micron Technology
Program Analysis for Software Verification	Elena Sherman	We make software more efficient, robust, and safe by developing techniques for software engineers so they can better understand what the software they build actually does when executed. We conduct static program analysis, develop decision procedures to advance program analysis, obtain programs to use in empirical evaluations of program analysis techniques, and engage with industry to close what are typically large gaps in software verification knowledge.	Not specified	NSF

COMPUTER SCIENCE (CS) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Software Engineering and Analytics Lab	*Nasir Eisty*	We conduct software engineering and testing for research software developers and the researchers across a wide spectrum of domains who make use of this software as an essential analysis tool. Research software grows increasingly robust to support critical and potentially world-changing studies in areas such as numerical relativity, weather forecasting, high-energy physics and cancer research. To help ensure that this software performs reliably and produces trustworthy results, we address: (1) empirical software engineering, (2) research software engineering, and (3) software quality assurance testing, peer code review, and metrics.	Not specified	DOE, Sloan Foundation
Speech, Language & Interactive Machines Group (SLIM)	*Casey Kennington*	We improve how individuals and workers engage with technology by advancing both theoretical and practical research in spoken dialogue systems. We draw inspiration from linguistics and psychology to develop computational models. We then evaluate and refine these models by implementing practical dialog systems for use with personal or industrial robots, personal assistants, conversational chatbots, and in-car dialog systems. For example, in recent work, we used a dialogue system that we developed on the Cozmo robot platform. We found that when people interacted with Cozmo and it showed emotional behaviors, the people tended to speak with it and help it learn more.	Not specified	NSF

COMPUTER SCIENCE (CS) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Trustworthy and Robust Artificial Intelligence Lab	*Jun Zhuang*	Our work contributes to the robustness and reliability of advanced computer algorithms and systems. Artificial Intelligence (AI) techniques are widely applied in numerous real-world scenarios, and their presence is only increasing. Robust AI systems can help users obtain reliable results under a variety of conditions, even those that may introduce noise to the data or disturb the AI systems. Therefore, our lab aims to design trustworthy and robust AI systems using generative models and Bayesian inference models in multiple domains, such as images, text, graphs, and quantum computing. For example, our recent research proposed the Bayesian label transition model, a statistical model that helps improve or recover the node classification accuracy of graph neural networks when the graph structure data is noisy or disturbed.	—	—

CONSTRUCTION MANAGEMENT (CM)

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
WorkConstruction.org	*Anthony Perrenoud*	This multi-institutional group conducts and applies research to promote the construction industry, educate its workers, and attract future workers. Some project examples: advancing collaborative efforts across construction industry organizations to reduce workplace shortages; understanding and engaging young homebuilders; succession planning; and project management training for the electrical industry.	Not specified	Not specified

ELECTRICAL AND COMPUTER ENGINEERING (ECE)

The department maintains this research overview.

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Applied Magnetics and Photonics Lab	*Karthik Srinivasan*	We design and develop magnetic and photonic materials and then integrate them into our own microchip-scale devices. Both areas of study enable more efficient, faster, and more powerful computers and communication systems. Our goal is to move beyond CMOS, a type of semiconductor in most microchips today, by using photons rather than electrons. To manipulate photons effectively, we need materials with magnetic and optical properties, integrated into photonic devices that generate, manipulate, or detect light. We: (1) synthesize and characterize phase change and ferrimagnetic materials to study phase transformations and magneto-optical properties, and (2) fabricate nanoscale devices for photonic computing and high-performance terahertz wireless communications using a variety of computational, experimental, and characterization tools.	NIST; Argonne National Laboratory: Characterization facility at the University of Minnesota	Institute of Electrical and Electronics Engineers (IIEE) Magnetics Society
Biomedical Imaging Research Lab	*Neal K. Bangerter*	We improve medical imaging capability and cost, primarily for Magnetic Resonance Imaging (MRI). MRI is one of the most effective and widely used imaging techniques in high-income nations, but not widely available to most of humanity due to high capital equipment and running costs, as well as scarce image acquisition and interpretation expertise. To overcome these limitations, we seek to improve: (1) **Speed**—Use novel image acquisition and sampling to reduce image acquisition time and costs, and (2) **Image processing quality & automation**—Expand the range of contrasts that an MRI exam can provide by using novel signal processing, and develop and apply novel machine learning and artificial intelligence techniques to improve image quality, reduce MR facility reliance on scarce specialists for image reconstruction, analysis, and diagnosis; and improve the MRI installation cost/benefit ratio.	Stanford University Radiology department; Imperial College London Bioengineering department; University of Oxford Orthopaedics department; University of Utah Radiology department; Brigham Young University Electrical & Computer Engineering department; University of Cambridge Radiology department	NIH, U.K. Engineering and Physical Sciences Research Council (EPSRC), Siemens Healthcare

ELECTRICAL AND COMPUTER ENGINEERING (ECE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Electronic and Neuromorphic Devices and Systems Lab (ENDS)	*Kurtis Cantley*	We investigate the unique properties of electronic spiking neural networks and neuromorphic architectures for applications such as healthcare, defense, energy, and data science. Using electronics to emulate brain plasticity and cognitive abilities is enabling new computing paradigms. We simulate, design, fabricate, and characterize devices, circuits, and sensors that behave like brain neurons and synapses, or communicate with biological neurons. We are especially interested in: (1) using nanoscale devices and circuits that mimic biochemical processes to capture learning modalities such as spike timing-dependent plasticity, and (2) integrating these circuits into micro- and nano-scale systems that interface with the environment. Note: See below for another Cantley lab.	Idaho National Laboratory, Micron Technology, University of Washington, University of Pittsburgh, Eastern Washington University	NSF, DOE
Electronics and Natural Sciences Research Lab	*Kris Campbell*	We research electrical responses of natural systems (such as plants) and examine how various chemicals in the environment affect electrical devices. The goal is to identify electrical signatures so we can build sensors and systems that create a "smart" interaction with our environment. Two main research projects are: (1) **Electrical communication in plants**—Can we understand what plants are "telling" us? Can we identify electrical responses to pests, nutrient deficiencies, and growth conditions? Can we build a deployable field sensor to enable more efficient agriculture?, and (2) **New devices that detect chemicals for environmental cleanup**. We use an optically-gated transistor technology to detect chemical contaminants in water, air, and soil. Our goal is to develop this technology to address many environmental contaminant chemicals, and eventually produce detection devices for industrial and personal use.	Knowm, Inc.; Pearlhill Technologies, LLC	Not specified

ELECTRICAL AND COMPUTER ENGINEERING (ECE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Hartman Systems Integration Lab	*Sin Ming Loo*	We conduct research in embedded systems, hardware/software co-design, sensor systems, reconfigurable computing, cyber-physical systems security, and cyber-informed engineering. Our team also examines how to design resilience systems.	Not specified	Not specified
Heterogeneous and Memory-centric Computing Lab	*Purab Sutradhar*	We use novel architectural design solutions to advance digital computing hardware technologies. A major limitation of today's digital processors is the memory-to-processor data movement bottleneck, which compromises data bandwidth, performance, and energy efficiency. Our memory-centric processing architectures overcome these compromises, facilitating computing within the memory device to work more efficiently than traditional processors. We: (1) **Design and develop**—Create efficient in/near processing architectures with energy-efficient, massively parallel computing abilities, (2) **Adapt and implement**—Accelerate newer data-parallel and data-intensive applications to run on such architectures, and (3) **Ensure seamless integration**—Advance such architectures within existing computing protocols and infrastructures.	Rochester Institute of Technology (Amlan Ganguly, Mark A. Indovina, Ke Xu); George Mason University (Sai Manoj Pudukotai Dinakarrao)	Currently targeting the NSF and AFRL
High Performance Systems on Reconfigurable Chips	*Nader Rafla*	We research and design improved systems and computer architectures, including: (1) complete systems implemented on Field Programmable Gate Arrays (FPGA) for high-profile applications to enhance security, speed, reliability, power consumption, and efficiency, and (2) new computer architectures for data processing and computation within memory platforms.	Not specified	Not specified

ELECTRICAL AND COMPUTER ENGINEERING (ECE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Integrated Bioelectronic Medicine Lab	*Benjamin Johnson*	We design and develop integrated circuits for novel sensors, neurotechnologies, and medical devices. Our integrated solutions sense, compute, and control electrical and chemical biomarkers to implement safe, chronic, and intelligent medical devices. Research areas include closed-loop neuromodulation as for Parkinson's disease and epilepsy, implantable bioelectronics medicine, and lab on a chip.	Not specified	Not specified
Low-Power Integrated Circuits and Embedded Systems Lab (LPiNS)	*Omiya Hassan*	Our research goal is to use low-power algorithms, artificial intelligence, and machine learning to model and design energy efficient integrated circuits and computer hardware architectures. Foundational and applied work extends across diverse audiences and applications. For example, our real-time wearable biomedical devices detect sleep apnea in adults and premature infants, and predict when pregnant women are at increased diabetes risk. Other "smart" devices seamlessly engage directly with the internet to support individuals and businesses. In short, our laboratory: (1) develops energy-efficient algorithms for machine learning on hardware, (2) designs low-power integrated circuits and devices for critical healthcare applications, and (3) models and designs cyber-physical systems that integrate sensors.	University of Missouri (Syed Kamrul Islam); Bangladesh University of Engineering and Technology (Orchi Hassan)	NSF, NIH, DOE, NASA

ELECTRICAL AND COMPUTER ENGINEERING (ECE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Plasma and Vacuum Electron Devices Lab	*Jim Browning*	We use computational simulation and experiment to examine two areas: (1) **plasma**, its unique characteristics, performance with our novel source array, and use to remove or kill bacteria and viruses from wounds and surfaces for improved healthcare and food safety on Earth or in space, and (2) **vacuum electron** devices for high temperature and high radiation environments such as military radar. We use gated field emission arrays as the electron source for magnetrons and crossed-field amplifiers to improve performance and operation and vacuum nano-transistors in harsh environments.	Massachusetts Institute of Technology (Tayo Akinwande, Tomas Palacios, and Karl Berggren); Purdue University (Allen Garner); Southern Methodist University (Bruce Gnade); University of Colorado (John Cary); Stellant Systems (Mike Worthington); Confluent Sciences (Jack Watrous); TechX (David Smithe)	USDA, NIH, NASA, AFOSR, ONR, IGEM –HERC
Power Research Lab	*Said Ahmed-Zaid – Emeritus Faculty*	We conduct research in power systems, electric machines and drives, power electronics, and neural network applications. Work informs arenas such as electronics development and healthcare.	Not specified	Not specified
Sensors for Agriculture and the Environment (SAGE)	*Carol Baumbauer*	We design and develop low-cost sensor systems to monitor the natural, managed, and built environment to expand access, improve plant and animal agriculture, and mitigate environmental damage to our air, soil, and water. We integrate solution processing, additive manufacturing, and conventional electronics processing to make compact, sustainable sensors. We have used them to detect excessive nitrates in the soil from industrial fertilizers. We will expand detection to include carbon dioxide, methane, and nitrous oxide.	University of California Berkeley (Ana C. Arias, Whendee Silver, Kris Pister); University of Colorado Boulder (Greg Whiting); University of California Davis (Isaya Kisekka)	DOE (ARPA-e)

ELECTRICAL AND COMPUTER ENGINEERING (ECE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Smart Energy and Control SystemsZaid	*Eklas Hossain*	We address energy use, with a particular interest in tools to mitigate climate change and help advance a net-zero "smart" electrical grid that effectively integrates renewable energy sources. We integrate electrical and mechanical systems engineering expertise as we conduct research in power and energy systems, renewable energy, energy storage, and control systems. We pursue both fundamental as well as applied research, and use both modeling and experimental approaches.	Not specified	Not specified
Translational NeuroTechnology Lab	*Omid Yaghmazadeh*	The brain is a complex electrochemical system. Unfortunately, one out of six people worldwide suffer from brain disorders such as Epilepsy, Alzheimer's, Depression, and Autism. A high percentage have drug-resistant conditions, making the search for novel therapies increasingly important. Our main research examines how the brain interacts with electromagnetic influences either when exposed to ambient fields, or when intentionally perturbed by fields for therapeutic purposes. We integrate basic and translational science, and are particularly interested in developing non-invasive brain stimulation methods and their translational applications for brain disorder treatment. Our multidisciplinary research sits at the interface of neuroscience, engineering, and medicine, and applies a wide range of tools to record and/or modify neuronal activity.	Not specified	NIH
Transport Characterization Lab	*Kurtis Cantley*; *David Estrada,* *(MSMSE)*	We use a variety of testing methods to probe and measure material structures and properties, and gain foundational knowledge of thermal and electrical transport in nanoscale materials. Note: See above for other Estrada labs.	Not specified	Not specified

MECHANICAL AND BIOMEDICAL ENGINEERING (MBE)

The department maintains this research overview. The College of Health Sciences Center for Orthopaedic & Biomechanics Research (PI Tyler Brown) is affiliated, and several faculty members share equipment.

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Boise Applied Biomechanics of Infants Lab (BABI)	*Erin Mannen*	We address musculoskeletal development and product safety issues for infants. There are well-established approaches for researching and improving musculoskeletal health in children and adults, but not babies. As a result, this is a vastly understudied research area. Research contributes towards health improvements that can affect people over their lifetimes, and toward the design and manufacture of safe consumer infant products. Research has contributed directly to product recalls and federal policy changes.	Arkansas Children's Research Institute (John Carroll, Brandi Whitaker), Embry-Riddle Aeronautical University (Victor Huaymave); University of Southern California (Kathryn Havens); University of California, San Diego (Vidyadhar Upasani)	United States Consumer Product Safety Commission
Biomaterial & Musculoskeletal Engineering Lab (BMEL)	*Sophia Theodossiou*	We help people maintain healthy and well-functioning bodies so they can lead full lives without the pain of damaged musculoskeletal tissues. To do so, we use experiments to better understand normal tissue development, explore how tissues form from cells, and examine the role of mechanical and biochemical signals. Outcomes help inform tissue repair and replacement options following injury or disease. We pursue both foundational and applied work with a particular focus on muscles and tendons, and collaborate with computational researchers as needed. We employ several interdisciplinary approaches, including: (1) animal and human cellular physical models, (2) custom biomaterial scaffolds, and (3) 3D printing.	University of Idaho (Nate Schiele); Idaho Veterans Research and Education Foundation (Mary Cloud Ammons); Idaho State University (Michelle Brumley); Tufts University (David Kaplan); UT Southwestern (Kevin Dean)	NIH (COBRE)

MECHANICAL AND BIOMEDICAL ENGINEERING (MBE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Computational Biosciences Lab (CBL)	*Clare Fitzpatrick*	We strive to improve people's musculoskeletal health and quality of life by applying computational models to: (1) understand mechanisms of disease, injury, and degeneration, and (2) design targeted treatment options and surgical interventions to aid clinicians and overcome physical limitations for a wide range of individuals, workers, military personnel, and athletes. We collaborate closely with surgeons and experimentalists to gather data to develop and validate our models, and use the models to predict how the body will behave during different activities, or change as a result of injury or surgical intervention.	Idaho Sports Medicine Institute (Nathan Grimm); University of Denver (Paul Rullkoetter, Chadd Clary, Casey Myers, Kevin Shelburne)	NIH, NSF, Stryker Orthopaedics
Computational Materials Design Lab (CMD)	*Mahmood Mamivand*	We develop computational models for a wide variety of aerospace, biological, and energy materials to accelerate discovery and design with a more robust understanding of material microstructures. Our physics-based and data-driven models help us understand inter-relationships between material chemistry, processing, structure, and properties. We use state-of-the-art machine learning techniques such as deep learning to quantify properties and have examined areas such as martensitic transformation, permanent magnet alloys targeting electric vehicle and wind generator traction motors, shape memory material durability, and shape memory ceramics targeting energy harvesting, and extreme environments.	Not specified	NSF

MECHANICAL AND BIOMEDICAL ENGINEERING (MBE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Digital Design and Automation Lab	*Daicong Da*	Our lab is committed to the progress of structural and materials engineering that contributes to energy conservation and overall quality of life. Through an interdisciplinary approach combining computational and experimental research, we explore the complex interplay between mechanics, materials, design, and data science. By investigating different physics and length scales, we enable multifunctional materials and structures with dramatically improved or entirely new properties, paving the way for innovative solutions. By using state-of-the-art manufacturing techniques, we aim to facilitate tangible real-world impact.	INL; Siemens; Gustave Eiffel University, France	CAES
Mechanical Adaptations Lab (MAL)	*Gunes Uzer*	We contribute to healthcare on Earth and in space environments by using computational methods, optical metrology, and other techniques to study how mechanical factors affect human tissue. We examine how aging, exercise, microgravity, and other mechanisms that alter mechanical load, regulate stem cell function and tissue performance. Projects include: (1) quantifying how external mechanical signals regulate nuclear structure, (2) examining the linker of nucleoskeleton and cytoskeleton complex and its effect on stem cell mechanosignaling and aging, and (3) studying the effect of microgravity on bone marrow analog stem cells.	Stony Brook University (Stefan Judex, Clint Rubin); University of North Carolina (Janet Rubin); Indiana University (William R. Thompson); Virginia Tech (Andre R. Van Wijnen); University of Texas (Mary Farach-Carson); University of Colorado at Boulder (Corey Neu); University of Idaho (Nathan Schiele)	Alliance for Regenerative Rehabilitation Research and Training, NASA International Space Station, NIH, NSF **Idaho**. NIH INBRE, NASA ISGC, NIH COBRE in Matrix Biology

MECHANICAL AND BIOMEDICAL ENGINEERING (MBE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Northwest Tissue Mechanics Lab (NTM)	*Trevor Lujan*	We strive to improve the well-being of individuals and societies by addressing persistent problems in musculoskeletal health. A core focus is to investigate how soft tissue responds to force during injury and repair, and to then translate this research into innovative medical solutions that are effective, practical, and affordable. Examples include study of meniscal tears and ligament and tendon injuries. Work incorporates experimental and computational methods, imaging, biochemistry, and mechanobiology, and we engage in interdisciplinary collaborations with biologists, engineers and clinicians.	Not specified	NSF
Robot Control Lab	*Aykut Satici*	We strive to enable robots to efficiently and robustly perform manipulation and locomotion tasks by designing low-level feedback control and estimation algorithms. We use tools from applied math, machine learning, and optimization in order to design low-level controllers that enable robots to perform these complex tasks. We employ both theory and experiment to engage in research that intersects dynamical systems, robotics, control, and applied mathematics.	Bastian Solutions, Pitch Aeronautics	NSF, NASA, NIH

MECHANICAL AND BIOMEDICAL ENGINEERING (MBE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Smart Materials and Systems Lab (SMSL)	*Zhangxian "Dan" Deng*	We integrate the multifunctional capabilities of smart materials with advanced manufacturing techniques and multiphysics modeling to tackle challenging engineering problems. Smart materials offer potentially transformational advances over traditional materials. Adjustments in stress, temperature, electrical or magnetic field, light, moisture, or other external stimuli can change material size, shape, or other features, or even return a material to its original state. We focus on magnetostrictive, piezoelectric, and shape memory materials. Research outcomes have stimulated innovations in energy harvesting, sensor use in extreme environments, morphing structures, and monitoring human structural health.	American Semiconductor, FlexTech	DOE, NASA, NIH; CAES, INL, Idaho State Board of Education
Thermal Transport and Solar Energy Lab	*Todd Otanicar*	We focus on the intersection of thermal and mass transport in a variety of different energy systems. Our research has investigated radiative properties of nanoparticles, erosion in high temperature environments, desalination, and the design of hybrid thermal/photovoltaic solar collectors. Recent work examines high temperature solid particles for use in next generation solar thermal energy systems, carbon fiber materials for solar receivers, and the development of a high flux solar simulator.	University of Tulsa (Michael Keller, Sia Shirazi); Sandia National Labs (Kevin Albrecht)	DOE, NASA, NSF, CAES, Interior (US Bureau of Reclamation)

MICRON SCHOOL OF MATERIALS SCIENCE AND ENGINEERING (MSMSE)

The school maintains this research overview.

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Advanced Materials Lab	*Brian Jaques*	We research materials processing and materials performance in extreme environments with a particular focus on nuclear-enabling technologies, including advanced materials development and sensor development for in-situ nuclear reactor applications and other extreme environments. We also examine: materials interactions for additive manufacturing applications; ceramics, graphite, and high temperature materials; synthesis of powders and novel structures and alloys; modeling and measurement of thermodynamics and kinetics; materials processing and structure-property relations; failure analysis; novel joining methods, carbon dioxide sequestration, and ion transport membranes.	Advanced Ceramic Fibers, Boeing, Ceramatec, Emisense, General Atomics, HiFunda, Iris Light, Pratt and Whitney Aerospace **National Labs**. Idaho, Oak Ridge, Los Alamos, Argonne	DOE, NSF, ONR, U.S. Navy, State of Idaho, DoD
Advanced Nanomaterials and Manufacturing Lab (ANML)	*David Estrada*	We develop material and manufacturing solutions to address urgent engineering problems confronting our world. In collaboration with multi-scale computational modelers, we synthesize and characterize nanoscale building blocks to develop materials, material inks, devices, and systems for healthcare, defense, and energy. We also actively engage with promising small business partners to translate research and practical devices to the market. Research addresses materials transport, material property design, energy conversion and storage, printer technology, additive electronics manufacturing, flexible hybrid electronics, single-molecule analysis for cancer detection and drug-development, tissue engineering, water purification and filtration, and sensors for extreme environments. Note: See below for other Estrada labs.	Oregon State University (Harish Subbaraman), American Semiconductor, IrisLight Technologies, Applied Nanotech, Fiberguide/Molex, PakSense/ Emerson, Boeing, INFlex Labs, Northrop Grumman. **Federal Labs**. INL, Pacific Northwest National Lab, AFRL Wright-Patterson Air Force Base; NASA Ames Research Center, Marshall Space Flight Center, Goddard	DOE, AFOSR, AFRL, NASA, NIH, NSF, Nextflex, Micron Technology, Boeing, Northrop Grumman, M.J. Murdock Charitable Trust, Osher Lifelong Learning Institute **Idaho**. IDeA Network of Biomedical Research Excellence, ISGC, and IGEM (Commerce and HERC)

MICRON SCHOOL OF MATERIALS SCIENCE AND ENGINEERING (MSMSE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Applied Electrochemistry and Corrosion Research Lab	*Mike Hurley*	We conduct research to understand and mitigate the pervasive and damaging effects of corrosion on materials. Our team: (1) improves materials for use in aerospace, marine, and other environments by examining materials cost, performance, and reliability, (2) develops characterization and monitoring techniques by combining sensors with studies of conditions that contribute to corrosion, (3) conducts scanning electrochemical microscopy to perform local corrosion analysis on various metal systems, and (4) conducts failure analysis to determine the root cause of premature materials failure or performance loss in various applications.	Cal Poly Pomona, Australian National University **Federal Labs**. INL, NIST, Las Alamos	NSF, NASA ISGC, DOE
Atomic Films Lab	*Elton Graugnard*	We research and provide thin film deposition and characterization services, applying thin film coatings to benefit a range of applications, such as new materials for microelectronics with improved performance and lower energy consumption, and advanced energy storage materials with greater capacity retention and efficiency. We are particularly interested in advancing promising materials with potentially useful properties by developing atomic layer deposition (ALD) and atomic layer etching (ALE) processes such as for atomically-thin two-dimensional (2D) materials of only a few atoms in thickness.	Not specified	Not specified

MICRON SCHOOL OF MATERIALS SCIENCE AND ENGINEERING (MSMSE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Computational Materials Design Lab (CMD)	*Mahmood Mamivand*	We develop computational models for a wide variety of aerospace, biological, and energy materials to accelerate discovery and design with a more robust understanding of material microstructures. Our physics-based and data-driven models help us understand inter-relationships between material chemistry, processing, structure, and properties. We use state-of-the-art machine learning techniques such as deep learning to quantify properties and have examined areas such as martensitic transformation, permanent magnet alloys targeting electric vehicle and wind generator traction motors, shape memory material durability, and shape memory ceramics targeting energy harvesting, and extreme environments.	Not specified	NSF
Computational Materials Engineering Lab (CME)	*Eric Jankowski*	We pursue collaborative work in both materials science research and engineering education. **Materials Science**—By understanding self-assembly with molecular simulations, we engineer materials to generate energy, manufacture aircraft, and store information. Specific areas include organic solar cells, DNA self-assembly, colloids, and polymer composites. **Education**—We: (1) develop accessible molecular simulation and computational literacy training through evidence-based instructional practices, and (2) We study how personal storytelling improves university culture and classroom learning and retention. A broad set of NSF and NASA programs support these projects.	The Story Collider; University of Southern Mississippi (polymer processing); University of South Carolina (composite manufacturing); Software Carpentry; large computation/simulation-related list: Vanderbilt, Michigan, Delaware, Colorado, Houston, Mississippi State, Minnesota, Wayne State, Wisconsin, Oklahoma State, and Benedict College	NSF, Boeing, NASA, INL

MICRON SCHOOL OF MATERIALS SCIENCE AND ENGINEERING (MSMSE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Computational Modeling for Advanced Epidemiology Lab	*Richard Elliott*	We strive to eliminate malaria, a global health problem affecting millions worldwide despite being a simply and inexpensively cured infection. Research integrates knowledge of materials, physics, and computational modeling—particularly using statistical field theories. Since policy and control program limitations present obstacles, we collaborate with clinicians and policy makers to provide rich computational modeling and simulation to expand control options and improve strategy and policy. Work fills a research gap in epidemiological modeling by offering insights on vector-based disease transmission (where an insect is the carrier) that use physical mechanisms and methods.	Not specified	Bill & Melinda Gates Foundation (now the Gates Foundation), Pilgrim Africa
Electrochemical Energy Materials Lab	*Claire (Hui) Xiong*	We integrate electrochemistry, surface chemistry, interfacial chemistry, and materials science and engineering to address the urgent need for high-performance, cost-effective and sustainable energy storage technologies and to examine the effects of radiation. Storage technologies can advance energy production options to mitigate climate change. We primarily: (1) synthesize and characterize new nano-architectured electrode materials for energy storage and conversion, and also (2) expand knowledge of structure-property-processing-performance relationships to advance functional material development; and expand knowledge of surface reactivity, interfaces, and the dynamics of electrode materials through in situ/operando characterizations. Finally, we (3) study how radiation affects electroceramics.	Not specified	NSF, DOE, CAES, INL

MICRON SCHOOL OF MATERIALS SCIENCE AND ENGINEERING (MSMSE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Functional Ceramics Group	*Rick Ubic*	We examine processing-structure-property relationships in functional ceramics as well as irradiation damage evolution in graphite. Studies have a bearing on a variety of industries, including microelectronics, mobile telecommunications, and nuclear energy. Work includes: (1) addressing electroceramic development by modeling the effect of point defects in perovskites, (2) developing room-temperature fabrication methods for electroceramics, and (3) linking volume expansion in irradiated graphite to crystallographic changes.	Not specified	Not specified
Macromolecular Sciences Lab	*Scott Phillips*	We are reinventing how people think about plastics by using them in new ways—to expand renewables and smart materials, and create safe and healthy homes. Our team combines fundamental polymer chemistry with materials science to design and create sustainable soft materials. We: (1) design polymers and plastics for energy-efficient recycling, (2) invent material classes based on renewable resources, (3) examine additives to enhance sustainability, (4) identify low-energy alternatives to glass and ceramics, (5) design plastics that respond to stimuli, and (6) design sustainable building materials that reduce health contaminants in our homes.	Not specified	Not specified

MICRON SCHOOL OF MATERIALS SCIENCE AND ENGINEERING (MSMSE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Magnetic Materials Lab	*Peter Müllner*	We develop magnetic materials in two areas: smart materials, and rare-earth-free magnets. (1) **Smart materials** bend or change shape in response to magnets, enabling lighter, smaller mechanical devices across wide-ranging applications such as in medicine or for space exploration. We focus on Ni-Mn-Ga alloys, where we conduct experimental studies from bulk single crystal growth through alloy fabrication and device development. We examine magneto-mechanics across metallic foam, thin films, fibers, nanostructures and other materials. (2) **Rare-earth-free magnets** are essential to energy sustainability. Wind turbines currently require strong rare-earth magnets, and only one source exists globally. To mitigate national vulnerability, we develop manganese based “gap magnets” that fill price and property gaps between strong and costly rare-earth magnets and weak and cheap ferrites. We focus on ternary and quaternary Mn-Al-X-Y alloys.	Not specified	NSF, DOD, DOE, NASA EPSCoR, Idaho State Board of Education
Materials Theory and Modeling Group	*Lan Li*	We are computational modelers who work closely with experimentalists to develop and apply computer-based theoretical methodologies to capture structure-property-performance relationships. We design materials towards desired device performance across a wide range of application areas such as: (1) nuclear materials for reactors and sensors, (2) DNA network arrays for quantum entanglement and computing, and (3) low-dimensional materials growth, properties, and performance. Our team employs multiscale modeling techniques, including first-principles modeling, molecular dynamics, and phase field modeling, coupled with machine learning and experiments.	INL, CAES, NIST, NRL, University of Idaho, Idaho State University	DOE, DOD, ONR, NSF, INL, CAES

MICRON SCHOOL OF MATERIALS SCIENCE AND ENGINEERING (MSMSE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Nucleic Acid Memory Group (NAM)	*Team Led - Contact Tim Andersen, Eric Hayden, or Ben Johnson*	We research emerging memory storage using nucleic acid memory and develop non-biological and non-volatile applications. Nucleic acid memory is a potential alternative to silicon-based memory because its volumetric density is 1000 times greater and its energy of operation is 100M times less than flash memory— the industry standard. Given the ever-increasing volume of digital information, analysts estimate that the global memory demand will exceed the projected silicon supply by 2040.	Not specified	Not specified
Quantum DNA Research Group (qDNA)	*Bill Knowlton*	Composed of five research teams in multiple Boise State departments and colleges and involving an extensive group of core personnel with more than 30 faculty, professional staff, and students across 10 academic disciplines, we are pioneering the use of deoxyribonucleic acid (DNA) as a programmable, self-assembling architecture that organizes light-absorbing dye molecules to achieve quantum entanglement. We are extending our understanding of quantum molecular theory to better measure entanglement and advance methodologies to create, measure, and control it. Research advances quantum information science, including quantum simulation, quantum communication and quantum computing. Potential application areas include the energy sector (such as solar), human and animal medical diagnostics, and future computers that will be faster, more capable, and use less power. Our five teams focus on DNA construct synthesis; dye synthesis; ultrafast spectroscopy; single molecule characterization; and theory and simulation.	Not specified	DOE EPSCoR, ONR

MICRON SCHOOL OF MATERIALS SCIENCE AND ENGINEERING (MSMSE) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
qDNA Research Group: Ultrafast Laser Complex	*Ryan Pensack, Daniel Turner, Bill Knowlton*	We characterize the structure and dynamics of optically active (i.e., 300–1600 nm) materials with ultrafast laser-based, time-resolved (i.e., fs–s) absorption and fluorescence spectroscopy methods. We recently established one-of-a-kind instrumentation capable of measuring unique properties of optically-active materials, including: (1) <5 fs laser pulses (500-800 nm spectra) capable of generating and detecting superpositions and measuring transition energy correlation maps; and (2) an electro-optical spectrometer capable of measuring the difference dipole and change in polarizability with light absorption.	U.S. Naval Research Laboratory (Igor Medintz, Joseph Melinger); Temple University (Robert Stanley); Southern Utah University (Jacob Dean); California State University, Chico (Paul Arpin); University of Kentucky (John Anthony); SETA BioMedicals (Ewald Terpetschnig)	DOE EPSCoR, ONR
W. M. Keck NanoEngineering Lab	*Committee Led. Please contact the MSMSE Director*	Most used by the NAM and qDNA groups listed just above, we conduct DNA nanotechnology research to examine its potential use as a template for functional nanomaterials, and as a biomedical diagnostic tool. We use DNA to build biosensors and biological signal amplifiers to then integrate with gold nanoparticles as colorimetric signal outputs. In addition, for the qDNA group we use DNA nanostructures to create dye aggregates with controlled exciton delocalization properties toward quantum information systems.	University of British Columbia (Will Hughes); Naval Research Labs (Igor Medintz, Sebastian DIaz)	MSMSE, DOE EPSCoR, ONR
Tissue Engineering and Bioprinting Lab (Affiliated with the Biomedical Research Institute in the College of Arts and Sciences)	*David Estrada; Julie Oxford, (Biological Sciences)*	Engineers, biologists, and others collaborate to advance tissue engineering and other biological engineering studies and applications. We: (1) print advanced bioscaffolds seeded with stem cells to advance a variety of research in tissue engineering, and (2) study the interaction between graphene and human cells, with the goal of using tissue engineering to rebuild damaged tissue, particularly in the case of osteoarthritis.	Not specified	NIH IDeA: COBRE, and Idaho INBRE
Transport Characterization Lab	*David Estrada; Kurtis Cantley, (ECE)*	We use a variety of testing methods to probe and measure material structures and properties, and gain foundational knowledge of thermal and electrical transport in nanoscale materials. Note: See above for another Cantley lab.	Not specified	Not specified

ORGANIZATIONAL PERFORMANCE AND WORKPLACE LEARNING (OPWL)

The department maintains this research overview.

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Human Resource Development and Strategic Partnerships Lab (HRDSP)	*Jelena ("Yelena") Pokimica*	We partner with regional, national, and international organizations to strengthen their human resource and organizational development strategy, research, and solutions. Dr. Pokimica brings a unique understanding of international and multicultural environments, having engaged in academic and industry partnerships and NIH- and NSF-funded projects in the United States, Serbia, France, Denmark, and Hong Kong. U.S. lab members in multiple states offer quantitative, qualitative, and mixed method research, as well as interdisciplinary project approaches. Dr. Pokimica is currently collaborating on an NSF-funded project with partners from several Boise State colleges and a colleague from Utah State to improve graduate education in science, technology, engineering, and math. Key components include organization development, change management, and curriculum development. Lab members are also beginning to examine the impact of artificial intelligence on human resource development.	We are currently exploring collaborations with the University of Belgrade in Serbia, and joint projects with Organizational Development and Workplace Learning department alumni.	NSF
Interactive Learning Design Lab (ILD)	*Rafael da Silva*	We create and evaluate engaging and highly interactive learning to inform and improve performance in organizations and other adult learning contexts. We can help troubleshoot the efficacy of current training, or put new materials in place. Our clients use our videos, linear e-Learning modules, interactive scenarios, and serious games to better understand and improve training for individuals, teams, and whole organizations. In addition to design and development, we also conduct and assist on iterative, design-based research that results in context-specific, "humble" theories about learning and training practices.	The Process Management Lab	—

ORGANIZATIONAL PERFORMANCE AND WORKPLACE LEARNING (OPWL) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Learning Strategy Lab	*Seth-Aaron Martinez*	We help organizations develop better leaders by integrating psychology, neuroscience, and organizational behavior to: (1) advance leadership knowledge through original research, and (2) design learning solutions to strengthen their internal leadership bench. We partner closely with organizations to collect data to develop models of optimal leader development, and then to further apply, test, and refine our models in different contexts.	—	Not specified
Performance Support for Accessibility Lab	*Donald Winiecki*	We make workplaces that support performance by helping organizations provide media and adapt equipment so it is accessible to disabled workers. It can be mysterious and puzzling to identify how to put accommodations in place should you suddenly need to meet Americans with Disabilities Act requirements (so all employees are able to independently access needed workplace tools and resources whether they have visual, auditory, or motor impairments, or any intersection of these and other conditions). To provide support, we offer consultation that introduces essential requirements; show you how to use built-in or purchased accessibility tools and features; use standard and special purpose software to create accessible media and assess its efficacy; and provide independent assessment of your results.	National Federation of the Blind; National Braille Association; Handid Braille Services; City of Boise; Boise Art Museum; Tayseer Seminary (Knoxville, Tennessee)	Handid Braille Services

ORGANIZATIONAL PERFORMANCE AND WORKPLACE LEARNING (OPWL) – CONTINUED

RESEARCH AREA OR LAB	PI	RESEARCH SUMMARY	EXTERNAL COLLABORATORS	KEY FUNDERS
Process Management Lab (PML)	*Steve Villachica – Emeritus Faculty*	We offer process and workplace performance improvement services specifically for small-to-midsized nonprofit organizations. Nonprofits face a difficult challenge. All well-functioning organizations need some infrastructure. However, such investments can draw resources from mission-critical goals and limit organizational ability to best serve community needs. Our team can help build the infrastructure you need to more efficiently and effectively meet your mission and serve your community. We offer low- or no-cost planning, process redesign, and implementation services to help you build capacity and meet the challenges of today and tomorrow. We can also work with you to manage any needed work process changes, and build solutions to support them.	We launched with the Idaho Foodbank as our central partner for over 1.5 years. We have worked with the Downtown Boise Association and the MA-based Center for Human Development. We are always seeking new clients we can help.	—
Workplace-Oriented Research Central Lab (WORC)	*Seung Youn (Yonnie) Chyung*	Workplace performance improvement interventions and ongoing initiatives are of limited value unless they actually work. We offer expertise and practical tools so you are able to validate that your organization gains from effective solutions. You can also confirm that tools you are using, such as survey questionnaires, are both reliable and valid. Just as you would use a measuring tape to identify changes in length, and a scale to determine weight changes, so you need to bring the right tools to bear on measuring organizational learning and performance changes in employees. Using approaches such as statistical testing and survey design and development, our team can help you conduct evidence-based program evaluations, improve existing evaluation methods, and build new evaluation methods and tools.	We have collaborated with three Idaho-based organizations: Jannus, Inc. (Boise); Family Advocates (Boise), and Nampa Family Justice Center (Nampa)	Wirtgen America

BOISE STATE UNIVERSITY