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Iowa State Research: Discovering Solutions to Society's Greatest Challenges

Iowa State and university faculty are committed to purposeful research, whether it's foundational research that contributes the building blocks to greater exploration and understanding, or translational research that leads to new innovations and technologies that benefit society. The purpose that drives most research at Iowa State is defined by these five grand challenge themes that are core to the university strategic plan:

- Enabling healthy lives (plants, animals, people, communities);
- Building sustainable human and natural ecosystems;
- Creating next-generation materials and manufacturing technologies;
- Advancing data-driven discovery and secure cyber systems; and
- Developing global citizens and vibrant societies.

Iowa State received external funding for 769 new research projects during the 2021 fiscal year. Many are shaped and framed to address at least one of these challenge themes. This focus helps cultivate innovation and the creation of intellectual property that fuels economic growth and supports the betterment of the communities the university serves, from across the state to around the world. Here are just a few examples of how Iowa State faculty are implementing big ideas to tackle these grand challenges.

Grand challenge: Enabling healthy lives

Project name: WeCanPROSPER: An Online Training Approach to Rural Behavioral Health Resilience and Resource Enhancement in a COVID-19 Context
Lead Principal Investigator: Richard Spoth, Human Development and Family Studies
Sponsor: USDA National Institute of Food and Agriculture (NIFA)
Award amount: $392,862

This project, led by Richard Spoth, Scientist III in the department of Human Development and Family Studies, is framed to respond to the need for enhancing rural community resilience in confronting current adversities – stress related directly to the COVID-19 pandemic, in particular. It does so by improving access to science-based resources for addressing opioid/substance misuse and other behavioral health issues. Previous work – PROSPERing Step-by-Step, State-by-State (P2S) – funded by USDA NIFA's Rural Health and Safety Education (RHSE) competitive grants program, will be augmented with supplemental online training that is innovative, timely and will expand P2S reach. The primary goal is to increase the number of rural youth and adults receiving science-based resilience training and enhanced behavioral health resources to address stress, anxiety and depression. This project will reach a total of 20 counties in three states, with an estimated population of up to 530,000 residents impacted.

Grand challenge: Building sustainable human and natural ecosystems

Project name: Modeling and Control of Novel Variable-Shape Converters for Natural Harvesting of Ocean Wave Energy
Lead Principal Investigator: Ossama Abdelkhalik, Aerospace Engineering
Sponsor: National Science Foundation (NSF)
Award amount: $354,883

The oceans of the world are a colossal reservoir of largely untapped energy. The total theoretical ocean energy potential exceeds the electric power needs of the U.S. in 2018. One of the key reasons why ocean energy has traditionally accounted for a very small portion of overall renewable energy is that most existing Wave Energy Converters (WECs) use rigid fixed bodies or fixed shapes (e.g. buoys) to harvest power from the ocean kinetically before it is converted to electric power. Very few WEC designs allow the rigid body shape to change, at intervals, in response to varying wave conditions, for the purpose of load-shedding to avoid extreme conditions or to improve performance. The purpose of this project, led by Aerospace Engineering associate professor Ossama Abdelkhalik, is to explore the development of Variable-Shape Buoy WECs designed to continuously change shape – like a jellyfish – to harvest more energy. The project also includes a rigorous outreach program to raise the knowledge level of high school students regarding the concepts of ocean wave energy conversion.

Grand challenge: Creating next-generation materials and manufacturing technologies

Project name: Design Iteration Support Tool to Sustain Remanufacturability
Lead Principal Investigator: Gül Kremer, Industrial and Manufacturing Systems Engineering
Sponsor: Sustainable Manufacturing Innovation Alliance Corporation (The REMADE Institute)
Award amount: $248,637.

Engineering a solution that improves the remanufacturing of key engine components can help manufacturers achieve improved sustainability goals by reducing energy consumption and carbon dioxide (CO_2) emissions. However, interviews Gül Kremer and her team conducted with remanufacturers of agricultural machinery components (John Deere, Danfoss and Midwest Cylinder Head and Machine) revealed there has been a sharp decrease in remanufacturability of critical components in recent years. One of the main reasons is a propensity to use less material – cast iron, for instance – in the initial design and manufacturing of components. While this practice lowers upfront costs, it also effectively shortens the overall life cycle by diminishing the ability to remanufacture these components. Kremer and her collaborators (Drs. Matt Frank, Chao Hu and Jo Min) are working with industry to create a new software plugin for mainstream computer-aided design (CAD) software to more effectively enable design for remanufacturing consideration of high-value components. This tool will use realistic real-life estimates to automatically generate design alternatives for sustained manufacturability, thereby reducing energy, emissions, material consumption and cost.

Grand challenge: Advancing data-driven discovery and secure cyber systems

Project name: CAREER: Learning Smart Meter Data to Enhance Distribution Grid Modeling and Observability
Lead Principal Investigator: Zhaoyu Wang, Electric Power Research Center, College of Engineering
Sponsor: National Science Foundation (NSF)
Award amount: $396,264. Five-year project; estimated award total of $500,714

Achieving and maintaining a reliable and environmentally sustainable electricity supply is vital to the nation's economy and our people's wellbeing. A major stumbling block standing in the way of optimizing the efficiency, flexibility and resiliency of our power grids is an overall lack of systematic situational awareness due to limited sensor data and incomplete or incorrect grid models. Smart Meters (SMs) are a widely deployed but largely under-utilized tool that could help U.S. utilities deliver electricity more reliably, more efficiently and at lower lost. In this five-year NSF CAREER project, Zhaoyu Wang, will lead an effort to provide the theoretical and computational foundation that will unlock the untapped potential of SMs and radically enhance distribution grid observability in both normal and outage conditions. Another key component to the project is forging strategic alliances with power industry participants in Iowa State's Electric Power Research Center to help facilitate industry adoption of the innovative developments the research produces.

Grand challenge: Developing global citizens and vibrant societies

Project name: Developing Faculty Resources of Evidence-based Practices That Improve Learning and Equity in STEM
Lead Principal Investigators: Ben Van Dusen, School of Education
Sponsor: National Science Foundation through Chico State Enterprises
Award amount: $554,362

With support from the Improving Undergraduate STEM Education: Hispanic-Serving Institutions (HSI) Program, this Track 1 project aims to support faculty at HSIs developing and using evidence-based instructional strategies and materials that improve learning and equity in STEM courses. The project addresses the need of developing STEM education research methods and instruments that focus on diverse students at HSIs. First, the project seeks to support HSI faculty in implementing, adapting and assessing evidence-based instructional strategies that support equitable outcomes. Second, the project will research potential bias in research-based assessments. Third, the project will use the Learning About STEM Student Outcomes (LASSO) online assessment platform to establish baselines for equity in STEM disciplines. By achieving these three goals, the project aims to build the framework and the set of resources on the scholarship of teaching and learning in a culturally diverse and equitable learning environment.