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

Our ever-changing world is impacted on a daily basis by countless challenges. Iowa State has identified five grand challenges that are exceptional fits for the university's areas of expertise and excellence:

- 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
- Developing global citizens and vibrant societies

Iowa State received external funding for 823 new research projects during the 2022 fiscal year. While not all these projects directly address one of these challenges, many do, particularly large interdisciplinary research efforts. These grand challenges serve as a lodestar that provides focus, cultivates innovation and yields intellectual property that fuels economic growth and supports the betterment of our state, nation and 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: Keeping Shelters in Place: Understanding the Impacts of Residential Landlord Decision-Making on Post-Disaster Housing Stability
Lead Principal Investigators: Jane Rongerude, Community and Regional Planning
Sponsor: National Science Foundation (NSF)
Award amount: $635,420; three-year project, all funds awarded

This NSF-funded study, which is a follow-up to an earlier project funded by a RAPID NSF grant, investigates how the unique characteristics of the U.S. housing system – landlord decision-making, in particular – have contributed to rental housing instability during the COVID-19 pandemic. Focusing on nine cities in Iowa, Minnesota, Ohio, Louisiana, Texas and Florida, the study will explore the factors that influenced decision-making of residential property owners during the COVID-19 pandemic. The findings will help illustrate how landlord decision-making influenced rental housing stability during the pandemic and will offer insights into how these decisions impact stability and recovery in the face of other, non-pandemic disaster-related scenarios. The team, led by associate professor of Community and Regional Planning Jane Rongerude, anticipates the study's findings will assist local government officials and planners in evaluating existing disaster policy response as well as developing new and innovative strategies for enhancing rental housing stability. The analysis will also help disaster scholars develop new risk models and community resiliency indicators useful in developing more effective responses to future economic shocks and disasters.

Grand challenge: Building sustainable human and natural ecosystems

Project name: Plant Breeding Partnership: Public Sector Coordinated Research and Breeding of Mung Bean, a High-Value Protein Crop
Lead Principal Investigator: Arti Singh, Agronomy
Sponsor: USDA-NIFA
Award amount: $727,929; three-year project, all funds awarded

Consumer demand for plant-based protein foods and beverages is increasing rapidly due to growing health and environmental concerns. Much of this demand can be met through high-protein pulse crops, and Mung bean is one of the most versatile crops because it is taste-neutral, highly nutritious, and climatically resilient. Mung bean is a short-season crop (60 to 90 days) suitable for a wide range of U.S. latitudes if the average growing season temperature is above 20 degrees C (68 F). Mung bean's ability to tolerate drought and high temperatures is especially advantageous in the U.S. as these conditions are projected to increase, thus helping mitigate losses caused by climate change. In this multi-institution partnership, Arti Singh and her team at Iowa State will collaborate with colleagues at Tennessee State University (a land-grant minority-serving institution), the University of Vermont (a National Science Foundation EPSCoR [Established Program to Stimulate Competitive Research] state institution) and USDA Agricultural Research Service (ARS). The near-term goal of this research partnership is to enhance Mung bean breeding efforts through combined genomic and phenomic approaches, optimum crop management practices and quality-trait studies. The long-term goal is to lay the groundwork for developing resilient supply chains and sustainable agriculture practices while promoting awareness and consumption of Mung bean in the U.S. This project builds on an established network of stakeholders and will foster further collaborations with industry partners and farmers across six states.

Grand challenge: Creating next-generation materials and manufacturing technologies

Project name: 3-D Printing of Flexible Electronics for In-Space Manufacturing and Investigations Via Microgravity Parabolic Flight Tests: EPSCoR Suborbital Flight Opportunity
Lead Principal Investigators: Shan Jiang, Materials Science and Engineering and Hantang Qin, Industrial and Manufacturing Systems Engineering
Sponsor: National Aeronautics and Space Administration (NASA)
Award amount: $422,000; two-year project, all funds awarded

In recent years, NASA has recognized the role of 3-D printing in supporting in-space missions. However, there are very real challenges that must be overcome before this technology can be integrated into these missions. For instance, many conventional 3-D printing techniques cannot work in microgravity environments because gravity is the driving force for most 3-D printers on earth. In addition, electronic components used in space missions are exposed to harsh environments. Assistant professors, Hantang Qin and Shan Jiang, are working to overcome these challenges and develop a versatile additive manufacturing system that can perform well and produce flexible electronic devices in a microgravity environment. Electrohydrodynamic inkjet (EHD) printing uses electrical fields and forces to effectively print in zero gravity. The Iowa State team has developed a portable EHD printer loaded with a customized ultra-stable nano-ink that it will evaluate and modify in upcoming suborbital microgravity flight tests. The ultimate goal of the project is to provide NASA with a portable EHD printer ready for in-space additive manufacturing that can be delivered to the International Space Station (ISS) in 2025.

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

Project name: Robotic Mapping of Underground Infrastructure
Lead Principal Investigator: Simon Laflamme, Civil, Construction and Environmental Engineering
Sponsor: Iowa Economic Development Authority (IEDA)
Award amount: $300,000; three-year project, all funds awarded

The unknown location of underground infrastructure is quite costly for Iowa and the U.S., as a whole, with a total estimated loss of $50 billion nationally. This loss is attributed to utility damages, project delays, traffic congestion and so on. Waldo W. Wegner Professor in Civil Engineering, Simon Laflamme, is working with cross-disciplinary co-investigators Roy Sturgill, David Eisenmann and Anne Kimber, to use widely available technologies to create a prototype system that will yield advanced underground mapping capabilities. The team will use inexpensive robots to collect data that enables intelligent mapping of underground infrastructure. This includes ground-penetrating radar (GPR) using small 4-wheel-drive rolling platforms, combined with digital images collected from recreational drones. The team will conduct data fusion through artificial intelligence (AI) to infer the locations of underground infrastructure and guide GPR data collection to validate rules and enhance map accuracy, demonstrating the value of in-field AI-assisted robotic mapping. The system also holds promise as a valuable tool for modernizing the electric grid by validating and updating existing underground utility maps and unifying them with new useful datasets.

Grand challenge: Developing global citizens and vibrant societies

Project name: Enhancing Diversity in Manufacturing
Lead Principal Investigator: Michael O'Donnell, Center for Industrial Research and Service (CIRAS)
Sponsor: National Institute of Standards and Technology (NIST)
Award amount: $919,982; two-year project, all funds awarded

The Manufacturing Extension Partnership (MEP) is a public-private partnership with Centers in all 50 states and Puerto Rico dedicated to serving small and medium-sized manufacturers. In 2020, MEP Centers interacted with more than 27,000 manufacturers, leading to $13 billion in sales, $2.7 billion in cost savings, $4.9 billion in new client investments, while helping create or retain more than 105,000 jobs. The ability to recruit top employees among an increasingly diverse workforce has become one of the greatest needs of MEP clients. This project, spearheaded by CIRAS's Michael O'Donnell, is designed to build a pipeline of diverse manufacturing leadership talent through the deployment of a MEP internship program focused on under-represented minorities. In the first year of the two-year project, the internship program will be launched through CIRAS – the Iowa MEP – and partner MEPs in Illinois (the Illinois Manufacturing Extension Center), Kansas (Kansas Manufacturing Solutions) and Ohio (MAGNET). The pilot project will expand to 10 other centers in year two. Each center will host two interns per year and will supplement the technical expertise of the internship with professional development, community building and networking. The partner centers will collaborate to design a program that fits local needs while defining and maintaining standards and best practices that work across various center models.