

## Five Year Strategic Research and Hiring Opportunities (2022 – 2027)

Department of Mechanical Engineering, Iowa State University

October 28, 2021

**Overview.** This strategic research and hiring guidance is based on the October 19, 2021 report provided by the Mechanical Engineering Strategic Research Planning Committee consisting of members: Xianglan Bai (committee chair); Shan Hu, Reza Montazami, Soumik Sarkar, and Ethan Secor to assist the department in hiring and investment decisions over the next 5 years (FY 2022-2027). The committee developed the report by incorporating feedback from the department based on the ME faculty retreat, individual meetings with lead faculty members in each research area, and discussions at faculty meeting.

### **Prioritized list of strategic research and opportunities over next 5 years**

*Audience:* Iowa State Mechanical Engineering Faculty.

*Charge:* identify potential opportunities and directions over the next five years that are aligned with the strategic goals of the department, College of Engineering, and the university; and state and national priorities from industry and government that are likely to generate research funding opportunities that will have a positive long-term impact on the lives and well-being of the people of Iowa, U.S. and the world.

***Cyberphysical Systems, AI, Machine Learning and XR*** (extended, virtual, augmented and mixed reality) with applications in energy systems, design and manufacturing, agriculture, autonomy and robotics.

Justification: Numerous funding opportunities including NSF, NIH, NIST, USDA, DoT, DoD, DARPA, ARPA-E, I-ARPA, FAA, DOE, and industry partners (e.g., John Deere, the Boeing Company). Significant growth opportunities have been created by the National AI Initiative Act, and ISU is in an excellent strategic position to become nationally recognized in this area with the recent NSF award and establishment of the Translational AI Center (TRAC). Additionally, the Mechanical Engineering department has a leading role in the new CPS minor (possibly a major in the near future). XR has long been a strength of the ME department, especially the relationship to the Virtual Reality Applications Center.

***Energy & Environmental Sustainability*** with *Energy* focus on energy storage, low-energy technology, energy-efficient systems, low-carbon fuels, energy system modeling, health monitoring for distributed energy and hybrid propulsion systems, and with *Environmental Sustainability* focus on carbon sequestration, carbon neutral technologies, renewable electricity-based technologies, repurposing/recycling of materials, reducing the energy and material consumption of critical manufacturing processes, the design, modeling, fabrication, and manufacturing of sustainable engineering systems and reducing land impact of agriculture. Justification: With increasing climate change related challenges in the world, it is anticipated that demand for technological solutions to mitigate and adapt to climate change impacts will keep growing. There are already significant funding opportunities from NSF, DOE, USDA, NASA for the research areas.

***Materials and Manufacturing for Bioengineering:*** with a focus on biomanufacturing (bioprinting, and soft materials), bioinstrumentation, bio-inspired materials and systems, prosthetics design and biomedical devices. Justification: Aligned with the National Academy grand challenge on engineered medicines as well as the new college of engineering biomedical engineering program. There are significant funding opportunities through NSF, NIH, DOD, DOE and NASA. Our department's strong computational science capability can lead to a significant growth.

***Thermofluids*** with a focus on hypersonic propulsion, UAV propulsion systems, propulsion/ energetics, multiphase interactions, theoretical kinetics, experimental thermofluids, biological spray modeling, droplet surface interaction, rheology, and computational modeling for extreme conditions such as hypersonic propulsion. Justification: Increased funding opportunities as evidenced by multiple MURI calls from DOD and large DARPA efforts. Centers such as CoMFRE and TRAC position Iowa State and Mechanical Engineering to compete for these opportunities with a high chance of success. The addition of more experimentalists may benefit the department.

In addition to the areas above design & manufacturing should continue as a strategic foci in the next 5 years.