

Contact: Rachel Boon

**REQUEST TO CREATE NEW CENTER AT IOWA STATE UNIVERSITY:  
CENTER FOR MULTIPHASE FLOW RESEARCH AND EDUCATION**

**Action Requested:** Consider recommending approval of the request by Iowa State University to establish the Center for Multiphase Flow Research and Education (CoMFRE) in the College of Engineering.

**Executive Summary:** The purpose of the proposed center is to formalize an interdisciplinary research venture established in 2014 via the College of Engineering's *Accelerating Collaboration in Research Initiative (ACRI)*. Establishment as a center will allow it to move to a higher level of funding and productivity. The Council of Provosts and Board office have reviewed the proposal and recommend approval.

**Background:** The goal of the proposed CoMFRE is to foster and coordinate research programs that will result in transformative multiphase flow science which enables technological breakthroughs with global impact, provide unique educational opportunities to ISU students, and increase ISU's national and international visibility in this field.

The current venture includes 18 established and emerging research leaders at ISU who are working on closely related sub—problems. Many team members have national prominence and on-going national and international collaborations. The proposed CoMFRE builds on existing strengths and provides a truly unique opportunity for the integration of different activities and skill-sets of its research members to accelerate knowledge transfer from fundamental scientific advances in multiphase flow to industrial applications and commercial end-users.

**Need for proposed center.** The multiphase flow research area encompasses the flow of solid particles in air as encountered in tornadoes, the formation of sprays in liquid droplets in air found in nasal sprays, and gas bubbles in liquid as in carbonated beverages. Multiphase flows have a wide range of applications in industries including energy generation, advanced manufacturing, critical infrastructure such as roads and bridges, transportation, healthcare, agriculture, design of novel materials, and sustainability and the environment. Multiphase flow processes play a fundamental role in these fields, with each field including several multi-billion dollar industries.

Our understanding of how solid particles, droplets and bubbles flow and affect the end-product is still deficient. There is a significant knowledge gap between scientific breakthroughs in multiphase flows and their use in technological development. This has led to inefficient technologies and over-design in industry, as well as the lack of technically informed governmental policy on safety.

Since individual researchers can lead only in specific areas of this complex problem, the rate of knowledge transfer from academia to industry is slow. This points to the need for an interactive, interdisciplinary approach involving multiple investigators with complementary skill-sets who can comprehensively address the challenges of understanding, simulating, and manipulating complex multiphase flows that underlie important industrial and societal problems.

**Proposed center activities and objectives.** The proposed CoMFRE will establish:

1. A scientific platform that engages and supports interdisciplinary, collaborative interaction among researchers from several engineering departments and other

colleges and ISU with industrial partners and national laboratories in the innovative development and application of multiphase flow science to technological problems.

2. A forum for interdisciplinary collaboration aimed at developing theoretical models and computational and experimental tools for analysis and design of multiphase flows with industrial applications.
3. A focus on deploying these research tools from laboratory-scale studies to commercial-scale plants by building partnerships with the private sector and by providing open-source software to industry partners as well as offering short courses and other educational training opportunities.

A supporting infrastructure for faculty to pursue external funding from diverse sources, supported by grant administration staff and grant writing experts for large-scale, multi-investigator research proposals.

- ◇ Relationship of proposed institute to University's Strategic Plan. The proposed center aligns well with ISU's mission to "create, share and apply knowledge to make Iowa and the world a better place" by using transformational basic and applied research in the multiphase flow processes and devices that play key roles in understanding and optimizing our use of energy, food and water resources, as well as in the manufacture of designer materials and pharmaceuticals, while caring for our environment. The proposed CoMFRE emphasizes education and workforce development. Federally- and industrially-funded research projects will aim to design tools and infrastructure that will create entrepreneurial opportunities. The proposed vision fits well with the College of Engineering strategic plan.
- ◇ Relationship of proposed institute to existing centers/institutes. The CoMFRE will report to the Office of the Dean in the College of Engineering, which reports to the Office of the Senior Vice President and Provost.
- ◇ Existence of proposed institute at other Iowa institutions. None.
- ◇ Unique features of Iowa State University to support the proposed institute. ISU has a history of excellence in computational fluid dynamics (CFD) since the 1970s that has led to collaboration between multiple engineering departments. ISU collaborations between Mechanical Engineering and Aerospace Engineering faculty founded a CFD center in the late 1970s that was recognized as a NASA center of excellence in 1980 and fostered several fruitful interactions. However, the NASA center of excellence no longer exists. More recently, this activity evolved into multiphase flow science. ISU is in a unique position to integrate disparate researcher activities and skill-sets to accelerate knowledge transfer in this area.
- ◇ Personnel. The principal administrative support staffing needs of the proposed center and its associated faculty are pre- and post-award, operations, industrial liaison, and communications. Affiliated faculty will continue to use their existing offices and lab spaces.
- ◇ Facilities. No additional facilities are needed.
- ◇ Equipment. No additional equipment is needed.
- ◇ Expected need for center. The CoMFRE will be in place as long as scientific need for it and sufficient external funding exists. Given the breadth of the area, there is substantial opportunity for realignment of focal areas as funding patterns shift in time. CoMFRE is expected to justify its existence for many years into the future.

- ◇ Communication with existing campus structures. The proposed center has been reviewed and approved by the College of Engineering, the Vice President for Research, and the Senior Vice President and Provost.
- ◇ Cost. Funding will be entirely by extramural grants. No state appropriations or tuition revenue will be used to support the center. CoMFRE’s researchers have a stable funding portfolio of greater than \$1.5M per year. Major sponsors are NSF, DoE and DoD. External funding is expected to grow as an outcome of further collaborative research grants and large multi-collaborator proposals. In addition, the proposed center intends to seek memberships from industry. We expect the annual research expenditures to increase to \$3M over the next seven years. We expect industry support to reach about \$0.5M over this period.

To support CoMFRE administrative staff and operational costs not allowable by external grants, the College of Engineering will reallocate a portion of indirect cost recovery that flows directly from the external research funding expenditures. Incremental increases are in tune with the expected rise in the cost of doing business.

Total Costs	Total New Costs	Total Costs	Sources of Funds
Year 1	\$5,000	\$190,000	College of Engineering, ICR
Year 2	\$5,000	\$195,000	College of Engineering, ICR
Year 3	\$5,000	\$200,000	College of Engineering, ICR
Year 4	\$5,000	\$205,000	College of Engineering, ICR
Year 5	\$5,000	\$210,000	College of Engineering, ICR

- ◇ Evaluation plan. Each spring, CoMFRE’s activities, metrics, progress and goals will be reviewed by the College of Engineering. The Director will receive a written performance assessment based on that review. In addition, the center will be reviewed in depth in its fifth year and every seven years thereafter.