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December 2021 CoMFRE Newsletter

Message from the Director

The fall semester and 2021 is coming to a close. Although some things were close to normal (we taught classes in-person), many things were still not back to normal (virtual meetings and masking). We all have struggled this past year at one point or another, but I am still grateful to CoMFRE and the support provided by the College of Engineering. We continue to grow with college support, and have some new staff announcements below. We have also developed new collaborations and fostered existing collaborations. Some of the collaborations are highlighted below and some will appear in future newsletters as our successes grow.

With winter now upon us, remember that the multiphase flow of snow falling can be very beautiful, but it can also be dangerous. Stay healthy and safe as we wrap up the year and start a new one.

Theodore (Ted) J. Heindel
Director, Center for Multiphase Flow Research and Education
University Professor
Bergles Professor of Thermal Sciences

New CoMFRE Support Staff

Abby Regenwether
Program Specialist I - Engineering Research Institution & Center of Multiphase Flow Research and Education

Abby Regenwether is the new Program Specialist working with both the Engineering Research Institute (ERI) and the Center for Multiphase Flow Research and Education (CoMFRE). In her new role, she will be providing aid in grant and award assistance, primarily for the CoMFRE. She will also be providing CoMFRE communication, publishing the CoMFRE quarterly newsletters, updating the CoMFRE

webpage, and managing CoMFRE membership accounts.

Joyce Hammen
Pre-Award Grant Specialist - Engineering Research Institution
Joyce Hammen is a new pre-awards Grants Specialist in the Engineering Research Institute (ERI), with one of her primary duties of providing proposal development and pre-award grant services to CoMFRE faculty. She began her role in early November 2021, and is excited to return to ISU. Her pre-award services include: reviewing program guidelines; assisting with budget preparation; creating and monitoring internal routing processes; uploading data into sponsor systems; and, serving as a liaison with subrecipients and ISU departments. She will also provide assistance with processing CoMFRE memberships.

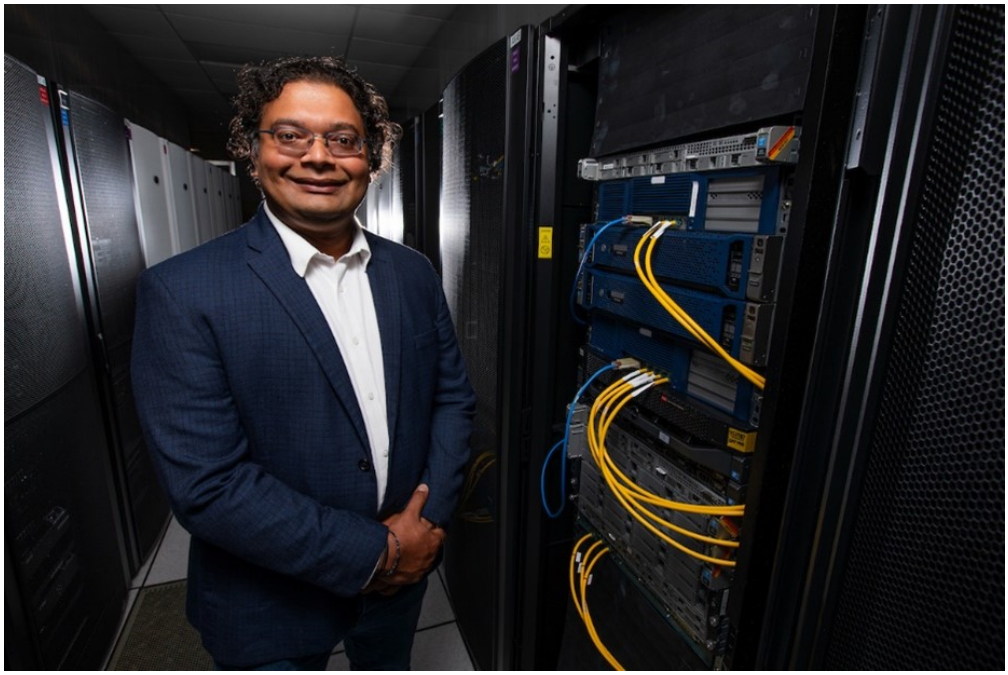
A full list of CoMFRE faculty can be found here

CoMFRE and CoMFRE Affiliates in the News

2021 CoMFRE Annual Meeting Recap

CoMFRE hosted its annual meeting on October 26, 2021, marking another year of successful collaboration and discovery. CoMFRE affiliates gave 11 presentations on member-supported research projects as well as federally-supported research – and students participated in a research pitch competition. Nearly 50 researchers, graduate students and industry partners attended the virtual event. Look for details about the planned 2022 annual meeting in the next issue of the newsletter.
https://news.engineering.iastate.edu/2021/12/09/comfre-annual-meeting-presentations-and-pitches/

$20 million federal grant launches AI institute for better crops, agricultural production



CoMFRE affiliate **Baskar Ganapathysubramanian** leads a new five-year, $20 million AI institute that will accelerate the productivity and sustainability of agriculture using artificial intelligence. This project could help identify challenges and provide opportunities for harnessing multiphase flow phenomena for resilient agriculture. The NSF and USDA-NIFA-funded project brings together expertise of researchers at eight universities and organizations across the U.S., including CoMFRE's **Adarsh Krishnamurthy**. https://www.news.iastate.edu/news/2021/07/29/aiiralaunch

Review of respiratory protection devices research published

An interdisciplinary team of CoMFRE affiliates led by **Guowen Song**, professor of apparel, events and hospitality management and Noma Scott Lloyd Chair in Textiles and Clothing, published a review article in *Polymers* about research on the area of respiratory protection devices (RPDs). The paper, titled "What We are Learning From COVID-19 for Respiratory Protection: Contemporary and Emerging Issues," summarizes past research on the effectiveness of RPDs protection devices and identifies emerging current and future research in the area. https://news.engineering.iastate.edu/2021/12/09/comfre-team-publishes-review-of-respiratory-protection-devices-research-the-past-and-the-future/

Award-winning plunging jet research: Roy Pillers, CoMFRE Ph.D. student

Roy Pillers is a Ph.D. student in mechanical engineering in CoMFRE director's **Ted Heindel's** research group studying plunging liquid jets, work that has won multiple national awards.
https://news.engineering.iastate.edu/2021/12/28/award-winning-plunging-jet-research-roy-pillers-comfre-ph-d-student/

Faculty Honors and Awards

- The **Heindel lab** received 2nd place, best video in the Who's Who Competition for their video "The Experimental Multiphase Flow Lab at Iowa State University," presented at *the ASME Fluids Engineering Division Summer Meeting*, Virtual, August 10-12, 2021, Paper Number: FEDSM2021-74595 (authors: **Theodore J. Heindel**, Nick Fetty, Roy Pillers, Tom Morgan, and Tom Dahlstrom) (virtual lab tour video found at https://iastate.box.com/s/1jchpxvmrwwju2gbxy4vsd45qcsadg7j

Student Honors and Awards

- Roy Pillers received 2nd place, best presentation video for his paper "Stereographic Backlit Imaging and Bubble Identification From a Plunging Jet With Floor Interactions," presented at the *ASME Fluids Engineering Division Summer Meeting*, Virtual, August 10-12, 2021, Paper Number: FEDSM2021-65313. (co-author **Theodore J. Heindel**)
- Roy Pillers received 2nd place, Flow Visualization Video Competition, for his video "Stereographic Backlit Videos of a Plunging Jet With Floor Interactions," presented at the *ASME Fluids Engineering Division Summer Meeting*, Virtual, August 10-12, 2021, Paper Number: FEDSM2021- 65316 (co-author **Theodore J. Heindel**).
- Roy Pillars received 1st place, Research Pitch Competition at the *2021 CoMFRE Annual Meeting* for his presentation "Plunging liquid jet floor interactions" (Advisor: **Theodore J. Heindel**)
- Nick Schnoebelen received 2nd place, Research Pitch Competition at the *2021 CoMFRE Annual Meeting* for his presentation "Fabrication development of multiphase microfluidic channels" (Advisors: **Todd Kingston** and **Pranav Shrotriya**)
- Krishnamurthy Ravichandar received 3rd place, Research Pitch Competition at the *2021 CoMFRE Annual Meeting* for his presentation "Droplet breakage in turbulent flow: Experiments and theory" (Advisors: **Mike Olsen** and **Dennis Vigil**)
- Olivia Tyrrell received Outstanding Senior in Mechanical Engineering while currently working on a multiphase project for imaging of underwater blast waves supported by the Naval Engineering Education Consortium Program sponsored by Naval Surface Warfare Center Indian Head. (Advisor: **James Michael**) https://news.engineering.iastate.edu/2021/12/06/olivia-tyrrell-outstanding-senior-in-mechanical-engineering/

Recently Funded Research Awards

Feel free to contact the PI directly if you have any questions on the projects below.

- "Controlling Spray Formation and Dispersion – Year 6 extension," **Ted Heindel**, Funding Agency: Cornell University (flow through from ONR); New Funding Amount: $258,258.

Recent Journal Publications

Note that CoMFRE affiliates are identified by **bold** names

- Ghadai, S., Lee, X., Balu, A., Sarkar, S., **Krishnamurthy, A.,** "Multi-resolution 3D CNN for learning multi-scale spatial features in CAD models," *Computer Aided Geometric Design*, 91(102038):1-13, 2021.
- Rade, J., Balu, A., Herron, E., Pathak, J., Ranade, R., Sarkar, S., **Krishnamurthy, A.**, "Algorithm consistent deep learning for structural topology optimization," *Engineering Applications of Artificial Intelligence*, 106(104483):1-19, 2021.
- Shah, H., Huang, X., Bingol, O., Rajanna, M., **Krishnamurthy, A.,** "GPU-accelerated post-processing and animated volume rendering of isogeometric analysis results," *Computer-Aided Design and Applications*, 19(4):779-796, 2021. doi: 10.14733/cadaps.2022.779-796

Recent Conference Publications and Presentations

Note that CoMFRE affiliates are identified by **bold** names

- Balu, A., Botelho, S., Khara, B., Rao, V., Sarkar, S., Hegde, C., **Krishnamurthy, A**., Adavani, S., Bakar **Ganapathysubramanian, B.;** Distributed multigrid neural solver on megavoxel domains, *2021 Supercomputing Conference*, St. Louis, MO, November 14-19, 2021.
- Balu, A., Botelho, S., Khara, B., Rao, V., Sarkar, S., Hegde, C., **Krishnamurthy, A.,** Adavani, S., **Ganapathysubramanian, B**.; "Distributed multigrid neural solver on megavoxel domains," *Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering & Technology*, Hyatt Regency Mission Bay, San Diego, CA, September 26-29, 2021.
- Belekar, V.V., Nere, N.K., Sinha, K., **Heindel, T.J.,** and **Subramaniam, S.,** "Continuum simulations of multiphase heat and mass transfer in wet granular mixtures modeled as separated phases," *2021 AIChE Annual Meeting*, Boston, MA, November 7-12, 2021, Abstract #628310.
- Belekar, V.V., **Passalacqua, A., Heindel, T.J.,** Sinha, K., and **Subramaniam, S.,** "Continuum simulations of granular flow near the maximum packing limit using a novel solution approach to address realizability," *2021 AIChE Annual Meeting*, Boston, MA, November 7-12, 2021, Abstract #628330.
- Cho, M., Balu, A., Joshi, A., Deva Prasad, A., Khara, B., Sarkar, S., **Ganapathysubramanian, B., Krishnamurthy, A.,** Hegde, C.; "Differentiable spline approximations," *Neural Information Processing Systems*, December 7-10, 2021.
- Deva Prasad, A., Balu, A., Shah, H., Sarkar, S., Hegde, C., **Krishnamurthy, A**.; NURBS-Diff: "A differentiable programming module for NURBS," *Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering & Technology*, Hyatt Regency Mission Bay, San Diego, CA, September 26-29, 2021.

- Nadeem, H., Jamdagni, P., **Subramaniam, S**., Sinha, K., and **Heindel, T.J.,** and “Mixture homogeneity measurements in a vertical bladed mixer using tracer particles,” *2021 AIChE Annual Meeting*, Boston, MA, November 7-12, 2021, Abstract #625043.
- Rade, J., Balu, A., Herron, E., Pathak, J., Ranade, R., Sarkar, S., **Krishnamurthy, A.;** “Algorithm consistent deep learning for structural topology optimization,” Mechanistic *Machine Learning and Digital Twins for Computational Science, Engineering & Technology*, Hyatt Regency Mission Bay, San Diego, CA, September 26-29, 2021.
- Rade, J., Zhang, J., Sarkar, S., **Krishnamurthy, A**., Ren, J., Sarkar, A.; “AI guided measurement of live cells using AFM," *2021 Modeling, Estimation and Control Conference*, Austin, TX, October 24-27, 2021.
- Saurabh, K., Ishii, M., Fernando, M., Gao, B., Tan, K., Hsu, M., **Krishnamurthy, A.,** Sundar, H., **Ganapathysubramanian, B.;** “Scalable adaptive PDE solvers in arbitrary domains,” *2021 Supercomputing Conference*, St. Louis, MO, November 14-19, 2021.
