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IOWA STATE UNIVERSITY

Center for Multiphase Flow Research and Education

June 2021 CoMFRE Newsletter

Message from the Director

July 1 marks the halfway point between the spring and fall semesters at Iowa State and when faculty realize they need to start making headway on their summer to-do lists. I am no different and my summer list includes papers and proposals; I am slowly making progress on both. As we look to the fall, ISU is planning 100% in-person classes and a “new normal”. We will all be back on campus and in our offices and labs. We are also planning an in-person member meeting (see below) and in-person seminars. As we are planning for the fall, also take some time off this summer and enjoy the family and friends you could not see last year – I did that in mid-June.

Have a healthy, safe, and restful summer.



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



Jan Seibel to retire June 30



Jan, our first full-time CoMFRE employee and program specialist, is retiring on June 30. She has had a long career at ISU in many different capacities. She has set the bar high for the next CoMFRE program specialist, who will be announced in our September newsletter. Please join me in thanking Jan for her service to CoMFRE and ISU, and wish her well in her retirement.

CoMFRE Symposium & IAB Meeting, October 25-26, 2021

Barring new pandemic restrictions, the 2021 CoMFRE Symposium and Member Meeting will be held Monday and Tuesday, October 25-26, in person at the ISU Alumni Center. Industry members will receive updates on shared research and meet with CoMFRE faculty and students to discuss future research and goals for the center in a closed Industrial Advisory Board (IAB) meeting on Monday afternoon. The IAB meeting will be followed by a banquet on Monday evening and symposium on Tuesday, both of which will be open meetings. Additional information will be provided in the September newsletter and posted on our [website](#) as plans are solidified.

New CoMFRE Faculty Affiliate

We are pleased to welcome Jacqueline Reber as the newest CoMFRE affiliate. Dr. Reber is a recently promoted Associate Professor in the Department of Geological and Atmospheric Sciences. She is a structural geologist interested in the interaction and coexistence of brittle and ductile structures in rocks. To investigate the impact of complex rheologies on the formation of such structures Jacqueline is using a combination of physical modeling, numerical modeling, and field work. In the structural experiment lab at ISU, she and her team are using a wide variety of analog materials ranging from silicone and sand to polymers to simulate the behavior of rock in different deformation regimes. Her work has implications for the stability of fault zones and the formation of earthquakes.



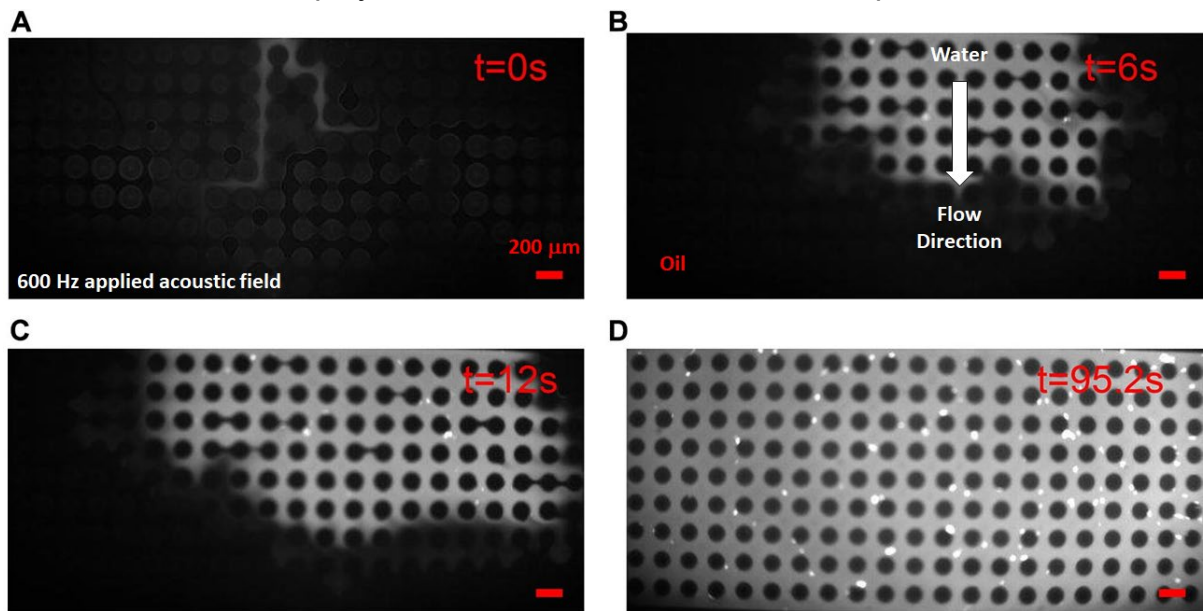
A full list of CoMFRE faculty affiliates can be found here:

<https://comfre.iastate.edu/faculty-2-2/page/1/>

CoMFRE and CoMFRE Affiliates in the News

Acoustic sound waves could enable improved oil extraction

Jaime Juárez, assistant professor of mechanical engineering, and **Michael Olsen**, professor of mechanical engineering, are exploring the use of acoustic sound waves to enable more efficient extraction of oil from shale and sandstone and to eliminate the salt and polymers used in the current extraction process.



<https://news.engineering.iastate.edu/2021/06/10/engineers-aim-to-improve-oil-extraction-using-acoustic-sound-waves/>

Collaboration leads to improved printing process



CoMFRE researcher **Thomas Ward**, associate professor of aerospace engineering, Martin Thuo, associate professor of materials science and engineering, and Andrew Martin ('17 PhD mat sci and engr), a postdoc at Lawrence Berkeley National Laboratory, joined forces to investigate a problem that occurs when slurry material (metal and solvent) evaporates in Thuo's work in flexible electronics. The group, led by Ward, developed a new self-filtration process to create an almost smooth surface in core-shell particles after the carrier solvent evaporates. <https://news.engineering.iastate.edu/2021/06/22/joining->

[forces-to-find-the-flow-in-printing-core-shell-metals/](#)

Faculty promotion

- To Associate Professor with Tenure: **Jacqueline Reber**, Geological and Atmospheric Sciences

Recent Degrees Granted to Students Working on Multiphase Projects

- Thomas J. Burnett, MSME Degree, “A Movable Experimental System for Observing Pressurized Sprays,” Advisor: **Ted Heindel**.
- Emily L. Johnson (PhD in ME/WESEP), “Isogeometric modeling and analysis for complex science and engineering applications,” Advisor: **Ming-Chen Hsu**.
- Danyu Li, PhD Degree, “Quantitative Analysis of a Canonical Coaxial Two-Fluid Spray Based on X-ray Imaging Techniques,” Advisor: **Ted Heindel**.
- Humair Nadeem, PhD Degree, “Characterization of Granular Mixing in Vertical Axis Bladed Mixers Using X-ray Imaging Systems,” Advisor: **Ted Heindel**.

Faculty Honors and Awards

- **Jaime J. Juárez**, assistant professor of ME, is the 2021 McNair Mentor of the Year. Each year, the Ronald E. McNair Scholars Program at Iowa State awards the McNair Faculty Mentor of the Year achievement to one faculty member in recognition of his or her work for the program and for exceeding the program’s mentor expectations. The McNair Scholars Program is designed to prepare qualified undergraduate students to enter a Ph.D. program following their graduation, and supports students



from traditionally underrepresented groups in higher education, including first-generation and low-income students.

Recently Funded Research Awards

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

- “Coupled Modeling and Simulation Framework for Multiphase Blast;” **Rodney Fox**; Funding Agency: DOD – Air Force; New Funding Amount: \$175,000.
- “Acoustically activated release of organic liquids in porous media: a multiscale experimental investigation using laser-based optical diagnostics,” supplemental award; **Jaime Juárez** and **Michael Olsen**; Funding Agency: NSF; New Funding Amount: \$14,000.
- “Modeling and Simulation of Electrostatically Levitated Multiphase Liquid Drops,” supplemental award; **Jonghyun Lee**; Funding Agency: NASA; New Funding Amount: \$73,368.
- “Development of Novel Molecule-Based Measurement Techniques to Characterize Aero-Thermo-Elastic Interactions of Super-/Hyper-sonic Flows and Solid Surfaces;” **Thomas Ward** and **Hui Hu**; Funding Agency: DOD – Air Force Office of Scientific Research (AFOSR); New funding amount: \$600,000.

Recent Journal Publications

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

- Awate, D.M., C.C. Pola, G.L. Gomes and **J.J. Juárez**, “3D printed imaging platform for portable cell counting,” *Analyst*, online 24 May 2021. <https://doi.org/10.1039/D1AN00778E>
- Codoni, D., G. Moutsanidis, **M.-C. Hsu**, Y. Bazilevs, C. Johansen, and A. Korobenko, “Stabilized methods for high-speed compressible flows: toward hypersonic simulations,” *Computational Mechanics*, 67:785–809, 2021. https://ui.adsabs.harvard.edu/link_gateway/2021CompM.67..785C/doi:10.1007/s00466-020-01963-6

- **Geredeli, P.G.**, “Bounded semigroup wellposedness for a linearized compressible flow structure PDE interaction with material derivative,” *SIAM Journal on Mathematical Analysis*, 53 (2):1711-1744, 2021.
<https://doi.org/10.1137/20M1345840>
- Johnson E.L., D.W. Laurence, F. Xu, C.E. Crisp, A. Mir, H.M. Burkhart, C.-H. Lee, and **M.-C. Hsu**, “Parameterization, geometric modeling, and isogeometric analysis of tricuspid valves,” *Computer Methods in Applied Mechanics and Engineering*, 384:113960, 2021.
<https://doi.org/10.1016/j.cma.2021.113960>
- Li, G., N. Sliefert, **J.B. Michael**, and A.L. Yarin, “Blood backspatter interaction with propellant gases,” *Physics of Fluids*, 33:043318, 2021.
<https://doi.org/10.1063/5.0045214>
- McNamara, M.C., S.S. Aykar, R. Montazami, and **N.N. Hashemi**, “Targeted microfluidic manufacturing to mimic biological microenvironments: cell-encapsulated hollow fibers,” *ACS Macro Letters*, 10, 6:732–736, 2021.
<https://doi.org/10.1021/acsmacrolett.1c00159>
- Orlando Jr., A.E., L.F. Barca, **T.J. Heindel**, T.S. Klein, and R.A. Medronho, “Gas holdup and flow regime in a bubble column that includes enhanced oil recovery chemicals,” *Journal of Petroleum Science and Engineering*, 204: Paper 108675, 2021. <https://doi.org/10.1016/j.petrol.2021.108675>
- Saurabh, K., B. Gao, M. Fernando, S. Xu, B. Khara, M.A. Khanwale, **M.-C. Hsu**, **A. Krishnamurthy**, H. Sundar, and **B. Ganapathysubramanian**, “Industrial scale large eddy simulations (LES) with adaptive octree meshes using immersogeometric analysis,” *Computers and Mathematics with Applications*, 97:28-44, 2021. <https://doi.org/10.1016/j.camwa.2021.05.028>
- Scheirer, N., S. Holland, and **A. Krishnamurthy**; “Fiber layup generation on curved composite structures,” *Computer-Aided Design*, 136:103031, 2021.
<https://doi.org/10.1016/j.cad.2021.103031>
- Shabaniverki, S., A. Alvarez-Valdivia, and **J.J. Juárez**, “3D printed self-propelled composite floaters,” *Smart Materials and Structures*, 30, paper 075015. <https://doi.org/10.1088/1361-665X/ac01a9>
- Sliefert, N., G. Li, **J.B. Michael**, and A.L. Yarin, “Experimental and numerical study of blood backspatter interaction with firearm propellant gases,” *Physics of Fluids*, 33:043319, 2021.
<https://doi.org/10.1063/5.0045219>

- Xu, F, E.L. Johnson, C. Wang, A. Jafari, C.H. Yang, M.S. Sacks, **A. Krishnamurthy**, and **M.-C. Hsu**, “Computational investigation of left ventricular hemodynamics following bioprosthetic aortic and mitral valve replacement,” *Mechanics Research Communications*, 112:103604, 2021. <https://doi.org/10.1016/j.mechrescom.2020.103604>

Recent Conference Publications

- Deva Prasad, A., A. Balu, H. Shah, and **A. Krishnamurthy**; “A deep learning framework for NURBS-aware CAD reconstruction from point clouds,” NVIDIA GPU Technology Conference, S31506, 2021. <https://www.nvidia.com/en-us/on-demand/session/gtcspring21-S31506/>
- **Heindel, T.J.**, “Characterizing the spray near-field region using X-rays,” 5-6th Thermal and Fluids Engineering Conference, Virtual, May 26-28, 2021. Invited keynote speaker.
- Jignasu, A., S. Ghadai, and **A. Krishnamurthy**; “Direct 3D printing of computer-aided design (CAD) models,” National Council of Undergraduate Research Conference, 2021.
- Khara, B., A. Balu, A. Joshi, **A. Krishnamurthy**, S. Sarkar, C. Hegde, and **B. Ganapathysubramanian**; “Field solutions of parametric PDEs,” Proceedings of the AAAI 2021 Spring Symposium on Combining Artificial Intelligence and Machine Learning with Physical Sciences, 2021.
- Morgan, T.B., and **T.J. Heindel**, “An Automated System for Systematic Spray Expansion Angle Measurements,” ILASS-AMERICAS 2021, 31st Annual Conference on Liquid Atomization and Spray Systems, Virtual, May 16-19, 2021, Submission ID: 43.
- Rade, J., A. Balu, S. Sarkar, and **A. Krishnamurthy**; “Deep learning-accelerated topology optimization,” NVIDIA GPU Technology Conference, S31593, 2021. <https://www.nvidia.com/en-us/on-demand/session/gtcspring21-s31593/>
- Vu, V., N. Machicoane, D. Li, T.B. Morgan, **T.J. Heindel**, A. Aliseda, and O. Desjardins, “Validation of inflow modeling strategies for numerical simulations of air-blast atomization against experimental backlit imaging and radiographs,” ILASS-AMERICAS 2021, 31st Annual Conference on Liquid

Atomization and Spray Systems, Virtual, May 16-19, 2021, Submission ID:
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