March, 6 2015 | 2:00 PM | DeWalt Seminar Room, 2164 Martin Hall

**ABSTRACT:** This seminar we focus on emulsions in which the dispersed component has a lower boiling point than the carrier fluid. The unusual behavior of boiling dilute emulsions makes them potentially useful cooling of power electronics and other small scale thermal systems. An emulsion of a non-soluble dispersed phase component in water would be well-suited to this application. The emulsion retains the high specific heat and thermal conductivity of water, while boiling of the refrigerant enhances the heat transfer coefficient at temperatures below the saturation temperature of water. Recent measurements of boiling on a thin wire and flat vertical plate will be described that give a better understanding of boiling process. The range of the experiments is extended to include enhanced boiling of the continuous component, which has not previously been observed, in addition to boiling of the dispersed component. In both regimes the heat transfer coefficient is enhanced compared to that of water. Observations reveal the presence of large attached bubbles on the heated wire, the formation of which coincides with the inception of boiling in the heat transfer data. The large attached bubbles represent a new boiling mode that has not been reported in previous studies and is, under some circumstances, the dominant mode of boiling heat transfer. Recently obtained measurements for flow boiling in narrow gap channels are also presented. We find that a twenty percent enhancement of heat transfer coefficients can be obtained in certain situations. A model of boiling is developed based upon the Euler-Euler model of multiphase flows, and the general balance equations provide a rigorous and physically consistent framework. The model contains three phases that represent the continuous component, liquid droplets of the dispersed component, and bubbles that result from boiling of individual droplets. Mass, momentum, and energy transfer between the phases are modeled based upon the behavior of and interaction between individual elements of the dispersed phases. One-dimensional simulations of a single boiling droplet in superheated liquid are also performed, and the results are used to develop the closure equations of the larger model. Simulations of boiling match several trends observed in the experiments. The model thus provides a physically consistent and partially validated platform for future analytical and numerical work.

**BIO:** Frank Kulacki received his education in mechanical engineering at the Illinois Institute of Technology and the University of Minnesota. His current research and scholarly interests include coupled heat and mass transfer in porous media, two-phase flow in micro-channels, natural convection heat transfer, heat transfer in metal foams, hybrid renewable energy systems, thermal energy storage technology, energy policy, management of technology, and the adaptation of computer-based technologies in engineering education. He has published 200 articles and 14 book chapters and has given 200 seminars and invited lectures. Eight of his 21 doctoral students now hold academic positions. He is Editor of the SpringerBriefs in Thermal Engineering and Applied Science which has 30 titles in the past two years and Editor in Chief of the forthcoming Springer Handbook of Thermal Science and Engineering. He has served as department chair at the University of Delaware and dean of engineering at Colorado State University and the University of Minnesota. He has served as Chair of the Heat Transfer Division of the American Society of Mechanical Engineers and was member of the ASME Board on Professional Development, Board on Engineering Education, and Board of the Center for Education. He chaired an ASME Task Force on Graduate Education and was a member of the ASME Vision 2030 project which addresses the body of knowledge for mechanical engineers in the 21St Century. Dr. Kulacki is a Fellow of ASME and the AAAS.