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Paper

**Charles Petty**

Michigan State University

with:

Steven M. Parks, Michigan State University

Mei Zhuang, Michigan State University

Marilyn J. Amey, Michigan State University

George G. Chase, The University of Akron

Ram S. Mohan, The University of Tulsa

contact:

petty@msu.edu

## NSF Combined Research Curriculum Development on Multiphase Transport Phenomena: A CFD Design Adventure

An improved understanding of multiphase transport phenomena (MTP) has developed over the past twenty years due to the availability of laser-based flow measurement technologies, inexpensive computing systems, and improved computational protocols. This situation provides a unique opportunity to integrate completed and peer-reviewed MTP research results into the undergraduate and graduate transport phenomena curriculum.

An ongoing NSF/CRCO curriculum development project in the area of multiphase transport phenomena draws on the research accomplishments of nine laboratories at Michigan State University, the University of Akron, and the University of Tulsa. An important objective of the project is to provide training on the practical use of multiphase computational fluid dynamics. Industrial mentors are an integral part of the teaching team, which also includes advanced graduate students, postdoctoral associates, and faculty. Multidisciplinary student teams focus on a variety of multiphase problems commonly encountered in chemical engineering, mechanical engineering, and petroleum engineering. An industrial advisory board participates in designing the curriculum and selecting the team-oriented projects.

An innovative multi-tiered approach is employed to simultaneously train undergraduate and graduate student teams in the art of using commercial CFD codes and in the science of experimentally validating multiphase models. The student teams are formed during an intense MTP summer workshop. The teams continue to collaborate on an industrial problem during the summer while taking a web based course on multiphase transport phenomena. The proposed technical training provides an opportunity for a student to develop a specialization in multiphase processing that builds on the skill base acquired in the traditional junior-level engineering course offerings in fluid flow, heat transfer, and mass transfer.

A distance-learning course following the CFD summer workshop permits the student groups to continue their project-oriented learning experience at their home institutions while collaborating with team members, an industrial mentor, and a faculty advisor elsewhere. During the first two years of the CRCO project, a portfolio of student-tested multiphase CFD case studies have been developed and disseminated on the Internet. The course notes and a set of tested problems are available on the NSF/CRCO web site for the MTP project. The purpose of this presentation is to review the efficacy of this approach for advanced CFD design.