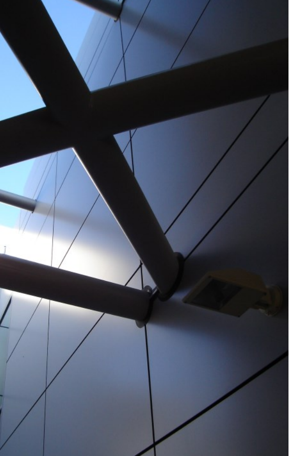

MECHANICAL ENGINEERING

The Department of Mechanical Engineering presents:

The Ph.D. Dissertation Defense of

Campbell Dinsmore

Monday, June 29, 2015, 2PM
in Bourns Hall A265

Bubble Dynamics in Shear Flows: Impact on Energy Dissipation and Thrust Production

Doctor of Philosophy, Graduate Program in Mechanical Engineering
University of California, Riverside, June 2015
Dr. Marko Princevac, Chairperson

With terms like "globalization" and "export driven economy" as part of our modern lexicon, clearly international trade is an important part of the world's economic landscape. By necessity, much of this trade involves maritime transport. Even though goods can be transported efficiently by ship, improving those efficiencies would help reduce the corresponding transportation costs and fuel consumption, thereby, reducing the emission of associated pollutants and their impact on the environment. Numerous studies have investigated the introduction of air bubbles along a ship's hull in order to reduce the drag on a ship through the shearing of a water/air mixture rather than water alone. This technique is called "air lubrication" of the ship's hull, and some of the associated studies have shown significant improvements in the propulsion system efficiencies when these systems were tested. Hardly any of these studies, however, included an investigation of the bubbles' impact on the operation of the propeller. Consequently, this research investigated the interaction between a propeller and bubbles from three different perspectives. Initially, tests were run on a remote controlled boat to quantify a bubbly mixture's impact on the propeller. These tests indicated that the bubbles reduced the thrust developed by the propeller by 4.5%. Additionally, theoretical investigations into the nature of the bubble/water interaction were also undertaken. This work broadened the investigation and led to the development of general creeping flow equations describing flow fields and energy dissipation in spherical bubbles and the liquid that surrounds them. These equations and a series of simple experiments indicated that bubbles will enhance the dissipation in creeping linear shear flows. Finally, high speed video of the propeller jet was shot to characterize the interaction between the bubbles and the turbulent flow field in the jet. The videos captured at least four bubble breakup modes and showed how these modes were related to the relative turbulent intensity in the fluid surrounding the bubble. These experiments and investigations, developed a more comprehensive understanding of the interactions (1) between a bubble and its surrounding liquid and (2) between a bubbly mixture and a propeller.