Experimental and Numerical Approaches to
Acoustic Noise, Droplet Impacts and Foil Oscillations

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This presentation is an overview of the recent and ongoing investigations conducted in the Fluid Mechanics Laboratory at the University of Victoria. The three projects represent a range of applications, physical and temporal scales, as well as experimental and numerical approaches:

1. Underwater radiated noise from marine shipping vessels has increasingly become a topic of concern, as understanding of its negative environmental effects has grown. Shed vorticity in the wake of propellers induces fluctuating pressure that contributes to radiated noise, as well as influences the dynamic and acoustic aspects of cavitation. We present a multi-simulation solution designed as a relatively inexpensive and effective approach to simulating fluctuating pressure in the wake of marine propellers. The methodology relies on three increasingly high-fidelity solutions at decreasing physical length scales applied to a model-scale ship with a generic hull and propeller geometry and compared the numerical fluctuating pressure results to experimental measurements.
2. Droplet impact and splashing in a controlled environment has applications in various fields, including spray coatings, fuel systems and bioprinting. In this study, the effects of the ambient pressure on the dynamics of the impact of a Newtonian droplet on a dry surface are investigated experimentally using high-speed photography. The results have shown that, under the ambient pressure of 4 atm, small secondary droplets (on the order of 50 μm in diameter) were ejected during impact, while no secondary droplets were observed under the atmospheric ambient pressure. The secondary droplets were ejected at approximately 0.25 μs after the droplet impact, well before the formation of the droplet corona.
3. The influence of flow confinement on the kinematics and hydrodynamic performance of a fully-passive oscillating-foil turbine prototype was investigated experimentally at a Reynolds number of 19,000. The positions of the heave and pitch degrees of freedom were measured using rotary encoders, and quantitative flow patterns were obtained using particle image velocimetry (PIV) at several blockage ratios, ranging from 22% to 60%. The turbine performance metrics were then adjusted using two existing blockage correction models, which are based on the actuator disk theory. Both corrections were deemed unacceptable for the case of a fully-passive oscillating-foil turbine. In contrast to the case of a kinematically-constrained turbine, where these corrections were successful, the kinematics of the oscillating foil changed with the changing confinement due to the passive nature of the turbine, making the different operating conditions incomparable. In a separate study, we investigated the effects of a sweep angle on the energy harvesting performance of a passively oscillating turbine with a flat plate profile. Tomographic PIV measurements provided basis for quantifying the effects of three-dimensional vorticity transport on stability of the leading edge vortex, which is critical to establishing consistent, high-amplitude foil oscillations.