Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Using a hybrid cyber-physical system in the study of body motion due to vortex dynamics A. MACKOWSKI, C.H.K. WILLIAMSON, Cornell University — We are interested in the effect of vortex dynamics causing vibration of bodies in a flow. In these studies, one needs to select essential parameters for the body, such as mass, spring stiffness, and damping. Normally, these parameters are set physically by selecting mechanical elements. However, in our approach, which utilizes a computer-controlled XYΘ towing tank and a force-feedback control system, we impose mass- spring-damping parameters in virtual space and in three degrees of freedom. [A similar concept, in one degree of freedom, was pioneered by a group at MIT (Miller 1996; Hover, Techet, Triantafyllou 1997), in studies of vortex-induced vibration of cables.] Although the use of a cyber-physical system has clear advantages over using a fixed, physical experiment, there are serious challenges to overcome in the design of the governing control system. The presence of noise in the dynamic force measurements and the effects of a finite time delay in controller response cause problems both for the implementation and physical accuracy of such a setup. In this presentation, we explore a new methodology for creating a controller suitable for systems with several degrees of freedom. Our controller, based on a discretization of Newton's laws, makes it straightforward to add and modify any kind of nonlinear, time-varying, or directional force, virtually. We shall present applications of this approach to problems in flow-induced vibration.

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Date submitted: 10 Aug 2009 Electronic form version 1.4