Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Swimming simply: Minimal models and stroke optimization for biological systems[1] LISA BURTON, Department of Mechanical Engineering, Massachusetts Institute of Technology, JEFFREY S. GUASTO, ROMAN STOCKER, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, A.E. HOSOI, Department of Mechanical Engineering, Massachusetts Institute of Technology — In this talk, we examine how to represent the kinematics of swimming biological systems. We present a new method of extracting optimal curvature-space basis modes from high-speed video microscopy images of motile spermatozoa by tracking their flagellar kinematics. Using as few as two basis modes to characterize the swimmer's shape, we apply resistive force theory to build a model and predict the swimming speed and net translational and rotational displacement of a sperm cell over any given stroke. This low-order representation of motility yields a complete visualization of the system dynamics. The visualization tools provide refined initialization and intuition for global stroke optimization and improve motion planning by taking advantage of symmetries in the shape space to design a stroke that produces a desired net motion. Comparing the predicted optimal strokes to those observed experimentally enables us to rationalize biological motion by identifying possible optimization goals of the organism. This approach is applicable to a wide array of systems at both low and high Reynolds numbers.

[1]Battelle Memorial Institute and NSF

Lisa Burton
Department of Mechanical Engineering,
Massachusetts Institute of Technology

Date submitted: 08 Aug 2012 Electronic form version 1.4