Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Enhancing propulsive efficiency through proper design of bending patterns of a flexible pitching foil[1] SAMANE ZEYGHAMI, EMRE AKOZ, KEITH MOORED, Lehigh University — Many aquatic animals propel themselves efficiently through water by oscillating flexible fins. These fins are, however, not homogeneously flexible, but instead their flexural rigidity varies along their chord and span. To detail the flow structures and propulsive performance of these functionally-graded propulsors a simple model of an unsteady pitching airfoil with a flexible hinge of varying location is examined. This acts as a first-order model of a functionally-graded fin by varying both the flexibility and bending pattern of the propulsor. Recent experiments have shown that adding a flexible 'tail' with the proper stiffness to a rigid pitching foil can effectively delay/suppress the formation of a deflected wake thereby enhancing the cycle-averaged wake momentum in the swimming direction. To extend these observations, we investigate the dependency of the wake pattern of a hinged pitching airfoil to the location and flexibility of the hinge by employing a fast boundary element method solver that is strongly coupled with a torsional spring structural model. The observed wake patterns are further connected to the thrust production and propulsive efficiency with the goal of determining the proper combinations of parameters that yields the maximum gain in efficiency.

[1]Supported by the Office of Naval Research under Program Director Dr. Bob Brizzolara, MURI grant number N00014-14-1-0533.

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Date submitted: 01 Aug 2016 Electronic form version 1.4