

Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Efficiency is designed into free swimming¹ MEHDI SAADAT, HOSSEIN HAJ-HARIRI, University of Virginia — In free swimming the swim speed and Strouhal number (St) are outputs. St alone is insufficient to decide optimal motion because many inefficient combinations of amplitude and frequency lead to the same St . This is manifested by the coincidence of the iso-lines for speed, St , and thrust. For a given combination of propulsor and body, St of motion is essentially independent of amplitude, frequency, and speed, and is only a function of shape. Some motions are efficient, and some are not. But they all have the same St . For a simple swimmer, there is a sweet spot in the dimensionless amplitude vs. frequency plane (for a fixed U) where the power efficiency is maximized. That is the place where the swimmer lives. And as long as the swimmer modulates its speed by keeping its amplitude fixed, and modulating the frequency, then the animal will always swim efficiently. So nature is efficient not because the animals are monitoring their motion in real time, but because the design of the animal is such that it cannot be inefficient.

¹supported by ONR MURI

Hossein Haj-Hariri
University of Virginia

Date submitted: 05 Aug 2013

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