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Maximizing the efficiency of a flexible propulsor using experimental optimization[1] DANIEL QUINN, Princeton University, GEORGE LAUDER, Harvard University, ALEXANDER SMITS, Princeton University, Monash University — Experimental gradient-based optimization is used to maximize the propulsive efficiency of a heaving and pitching flexible panel. Optimum and near-optimum conditions are studied via direct force measurements and Particle Image Velocimetry (PIV). The net thrust and power are found to scale predictably with the frequency and amplitude of the leading edge, but the efficiency shows a complex multimodal response. Optimum pitch and heave motions are found to produce nearly twice the efficiencies of optimum heave-only motions. Efficiency is globally optimized when (1) the Strouhal number is within an optimal range that varies weakly with amplitude and boundary conditions; (2) the panel is actuated at a resonant frequency of the fluid-propulsor system; (3) heave amplitude is tuned such that trailing edge amplitude is maximized while flow along the body remains attached; and (4) the maximum pitch angle and phase lag are chosen so that the effective angle of attack is minimized.

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