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PREFACE

Special issue featuring selected papers from the Mini-Symposium on Biomimetic & Bio-Inspired Propulsion (Boulder, CO, USA, 26 June 2006)

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Living organisms provide a vast resource to derive new and innovative designs. As aquatic and aerial organisms have adapted to movement through water and air over millions of years by the evolutionary process of natural selection, these organisms have been subjected to a severe cost–benefit analysis. Having survived this natural experimentation, a number of varied and effective solutions for propulsive systems has been attained. Animals swim and fly by employing combinations of paddling, flapping, jetting, and vortex control. Furthermore, animals use materials that are compliant and self-adjusting. Emulations of these systems can provide innovative, bioinspired propulsive mechanisms that perform better than conventional human-designed systems. Acceleration, speed, efficiency, maneuverability, and stealth in manufactured systems can potentially be improved by copying nature. The fusion of biology and engineering through biomimetics and bioinspiration presents a means to future technological improvement in marine and aerial systems.

What appears in this issue of *Bioinspiration & Biomimetics: Learning from nature* are selected papers from the Mini-Symposium on Biomimetics & Bio-Inspired Propulsion held in Boulder, CO, USA, on 26 June 2006. The symposium was held during the 15th US National Congress of Theoretical and Applied Mechanics on 25–30 June 2006 and was planned with the primary objective of bringing together a multidisciplinary group of researchers involved in all different aspects of biological propulsion. Fourteen groups presented in three separate sessions in the morning and afternoon. Most participants were from US institutions, while a few groups from Canada and Europe also attended.

In this special issue, you will find a series of papers that covers various aspects of biopropulsion. The breadth of these manuscripts—ranging from flow visualization/characterization, and computational/theoretical fluid dynamics, to biological aspects of swimming and flying—demonstrates the significance of and interest in biopropulsion. These topics are often covered in different journals and conferences aimed at particular disciplines. Holistic discussion of this subject, where various perspectives and tradeoffs are investigated, is rarely considered. This special issue tries to bring these disparate disciplines together to address key topics and potential future thrusts.

The articles in this issue are grouped into three categories: flying, swimming, and more general theory. The first paper in the flying category by R J Bomphrey 'Insects in flight: direct visualization and flow measurements' considers smoke flow visualization and digital particle image velocimetry in the investigation of kinematic parameters such as wingbeat frequency and amplitude and wing design in insects. Experimental investigation of bat flight is reported by X Tian *et al* in 'Direct measurements of the kinematics and dynamics of bat flight' where the wake structure during the entire wing beat cycle was constructed. The manuscript by J D Eldredge 'Numerical simulations of undulatory swimming at a moderate

Reynolds number' employs a dynamically coupled flow simulation around a simple three-linkage system. The next two papers by G V Lauder *et al* and R Mittal *et al* present results from a coordinated experimental–computational study of pectoral fin swimming in a sunfish, where the focus of these papers is on detailed quantitative experimental measurements of flow and kinematics in freely swimming fish and high-fidelity three-dimensional numerical simulations of pectoral fin swimming that provide a comprehensive view of the flow field and force production. Changes in the three-dimensional geometry of a wing-like, aquatic propulsor and their hydrodynamic performance are investigated by F E Fish *et al* in 'Passive cambering and flexible propulsors: cetacean flukes'.

The first paper on wake estimation methods is 'Measurement of propulsive power and evaluation of propulsive performance from the wake of a self-propelled vehicle' by P S Krueger. This paper considers the propulsive performance and proposes a method for measuring mechanical power and how to evaluate propulsive performance arising from it. Finally, the article by K Mohseni 'A formulation for calculating the translational velocity of a vortex ring or pair' examines the calculation of velocity from a vortex ring or pair generated by any actuator from its characteristics, including the rate of energy, impulse, and circulation generation.

Although this symposium does not provide all the answers in addressing bioinspired propulsion, it does serve as a starting point to provide direction for future research. As the need for higher levels of performance for propulsive systems increases, inspiration from animal systems can offer new avenues for the development of innovative technologies.