Biomechanics in Zoology

Department of Zoology

The UW Zoology Biomechanics Laboratory is concerned with the mechanics and dynamics of animal movement. Our current projects include:

- Integrating computer electronics in freely flying insects to understand the dynamics of neuromuscular control in locomotion
- Finite element analyses of wing aero-elastic mechanisms
- Molecular mechanics of coupled motor systems in muscle
- Analyses of non-linear biomaterials in animal movement
- Mechanics of myosin motors in a compliant 3D filament lattice

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Animal and human locomotion emerges from the complex interactions among neural control systems (e.g. pattern generators and feedback components), sensory input, active force generation by muscle, and elastic and inertial dynamics of propulsors such as wings, legs and fins. We hope to understand how all of these systems interact to determine control of movement. We see this as a useful venue for studying diverse biological systems and for providing design criteria for biologically inspired devices. We currently focus on flight in the giant hawkmoth (*Manduca sexta*) , among the largest insect flyers capable of carrying a payload.

Our current emphasis on insect flight uses collaborations with labs in EE and CSE to develop implantable micro-electronics. We are keenly interested in the patterns of muscle activation on freely flying insects. Accordingly, we are developing a small "flight data recorder" that will log muscle activity during hovering and steering maneuvers.

We also look at a variety of problems related to swimming and flight in animals, with an eye towards design rules for animal movement. Projects range from non-linear dynamics and fluid-coupling in jellyfish swimming, to aeroelastic problems in insect flight, to control theory and visual sensory encoding in insect flight.

In collaboration with Bryant Chase, we are developing theoretical models of muscle force generation using home-brew molecular finite-element models coupled with Monte-Carlo simulation. This work is particularly focused on how the mechanics of the filament lattice determine force generation, ATP utilization, and Ca regulation.

Selected Publications

Combes, S. and T.L. Daniel. 2001 Aquatic flight from flexing fins. J.Exp. Bio. In press

Daniel, T.L. and M.S. Tu 1999 Animal movement, mechanical tuning and coupled systems. J. Exp. Biol. 202:3415-3421

Daniel, T.L. A.C.Trimble, and P.B.Chase. 1998 Compliant realignment of binding sites in muscle: transient behavior and mechanical tuning. Biophys. J. 74:1611-1621

See
<http://faculty.washington.edu/danielt.