

# Bart-Smith Labs\*



Since joining the University of Virginia in 2002, Bart-Smith has founded the Multifunctional Materials and Structures Laboratory (MMS Lab) and the Bio-inspired Engineering Research Laboratory (BIER Lab), and generated over \$10M of research funding, including support from the DoD, MURI program.

## Research interests:

- Bio-inspired engineering design (biomechanics of batoid rays, artificial muscle actuators, underwater sensors, synthetic central pattern generators)
- High authority morphing structures (statically and kinematically determinate structures/tensegrity structures)
- Ultra-light multifunctional materials
- Electroactive and electrostrictive polymers
- Nanoporous thin films
- Deployable space structures
- Cellular flow sensor technology

Hilary Bart-Smith

[hb8h@virginia.edu](mailto:hb8h@virginia.edu)

[www.bartsmithlabs.com](http://www.bartsmithlabs.com)

Dept. of Mechanical & Aerospace Engineering  
University of Virginia  
Charlottesville, VA  
434.924.0701

"We want to learn from the biology. We want to understand how and why Nature does what it does—in our case underwater swimming in rays—and then try to engineer systems that have the potential to outperform their inspiration.

Can we recreate a robotic manta ray that swims as fast and effortlessly as the real manta ray?

I think we can."



### **\*BIER LAB**

The Bio-Inspired Engineering Research Laboratory (BIER Lab) is an internationally recognized center for biologically inspired engineering research, with the primary goal of designing an autonomous robotic manta ray. Current research teams are engaged on a broad array of issues related to reverse engineering of biological systems, including: central pattern generator control, active tensegrity structures with integrated actuation, electro-active polymers (artificial skin/muscle), and hydrodynamics.

### **\*MMS LAB**

The Multifunctional Materials and Structures Laboratory (MMS Lab) is focused on two main areas, lightweight metallic structures and morphing structures. The MMS Lab studies the mechanics of lightweight lattice truss structures for their use as load-bearing structures and impact amelioration systems as well as their possible morphing and thermal management capabilities. The MMS Lab uses the principles of static determinacy and tensegrity, with their superior mechanical properties such as stiffness and strength, to develop three-dimensional morphing foils. Through collaborations with scientists and engineers at the National Institute of Aerospace, NASA Langley and a grant through the Rising Stars Fellowship program, the MMS Lab is also involved in the area of deployable space structures. This work is also being expanded to look at the problem of morphing wings in aircraft and micro air vehicles.

### **\*MURI Project – “Towards a Mission-Configurable Stealth Underwater Batoid”**

BIER Lab has received major funding from the Department of Defense (DoD) Multi-disciplinary University Research Initiative (MURI) program. The overarching objective of the MURI, “Towards a Mission Stealth Underwater Batoid”, is to fully elucidate, actuate and control the dynamics and hydrodynamics of a stealthy, autonomous shape-morphing synthetic batoid wing, capable of propulsion, maneuvering, and station keeping using a combination of undulatory and flapping motions; ultimately to engineer a solution inspired by, but unconstrained by nature. To achieve this, a team consisting of participants from the University of Virginia, Princeton University, UCLA, and West Chester University have been assembled. The Team combines expertise in marine biology, experimental and numerical hydrodynamics and hydroacoustics, neural control, and active structures. This experience will be fully utilized in the development of an innovative artificial batoid vehicle.

### **RECENT RESEARCH DEVELOPMENTS**

- [The Amazing Mechanical Manta Ray: Engineers Copy Nature](#) ABC News
- Elizabeth Pennisi, "Manta Machines," *SCIENCE* **332**, 1028-1029 (2011)
- [The Mantabot](#)
- International Patent Application No. PCT/US2013/036109

### **RECENT GRANTS**

- ONR – Hybrid Cellular Structures for Penetration Mitigation: Analysis and Experiment
- ONR – Study of Structural Response of Curved Sandwich Panel Columns
- David & Lucile Packard Foundation – Fellowship for Engineering
- ONR MURI– Towards a Mission Configurable Stealth Underwater Batoid

**SEAS Research Information**  
Pamela M. Norris, Associate Dean  
University of Virginia  
Box 400242  
Charlottesville, VA 22903  
[pamela@virginia.edu](mailto:pamela@virginia.edu)  
434.243.7683

