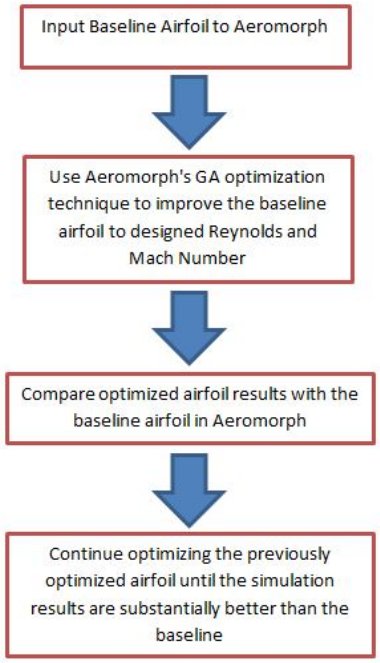
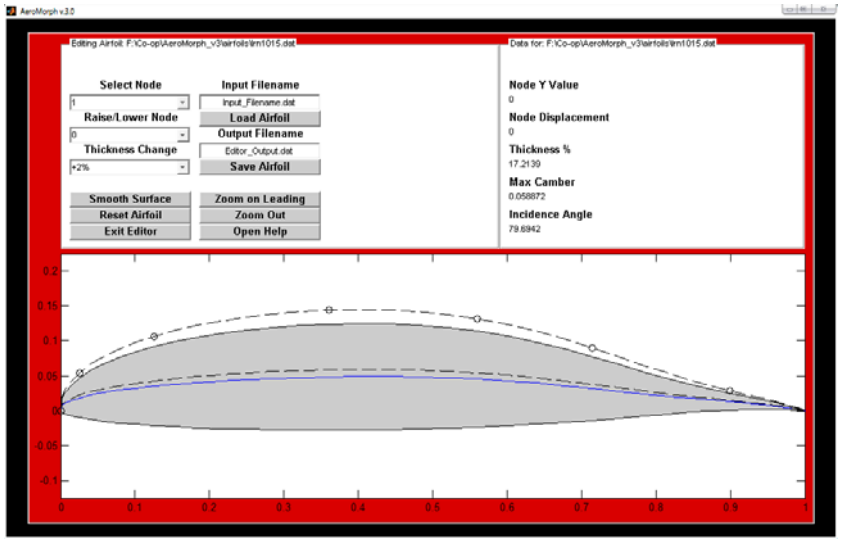
UNIVERSITY OF Cincinnati

Bio-Inspired Flight





Faculty Mentor: Associate Prof. Kelly Cohen
Graduate Student Mentor: Mr. Cody Lafountain

RET Teachers: Veronica Dean; Sherry Kembre

SUMMER RET Program, 2011

Main Goal

In this project we will study the **basic** principles of **aerodynamics** with an emphasis on airfoil design for a UAV (Unmanned Aerial Vehicles) towards more efficient flight using **bio-inspired optimization** techniques.

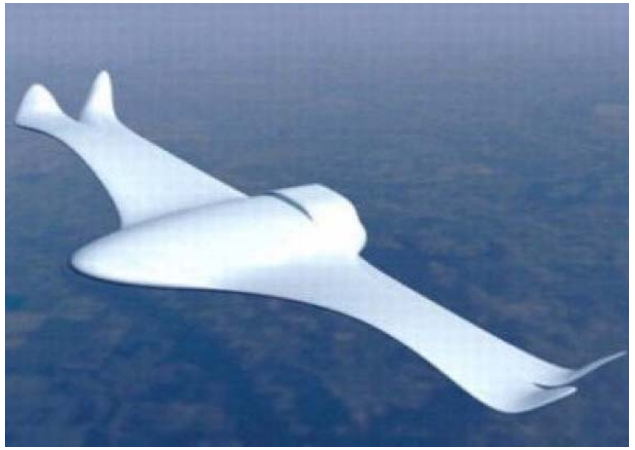
The idea is to **empower and enable teachers** to **introduce research concepts** in the **classroom** within the engineering design challenge of improving the **airfoil design**.

Aircraft of the Future

- Aircraft of the future will:
  - employ fully integrated, embedded **"smart" materials and actuators**
  - enable aircraft **wings with unprecedented levels of aerodynamic efficiencies and aircraft control**.

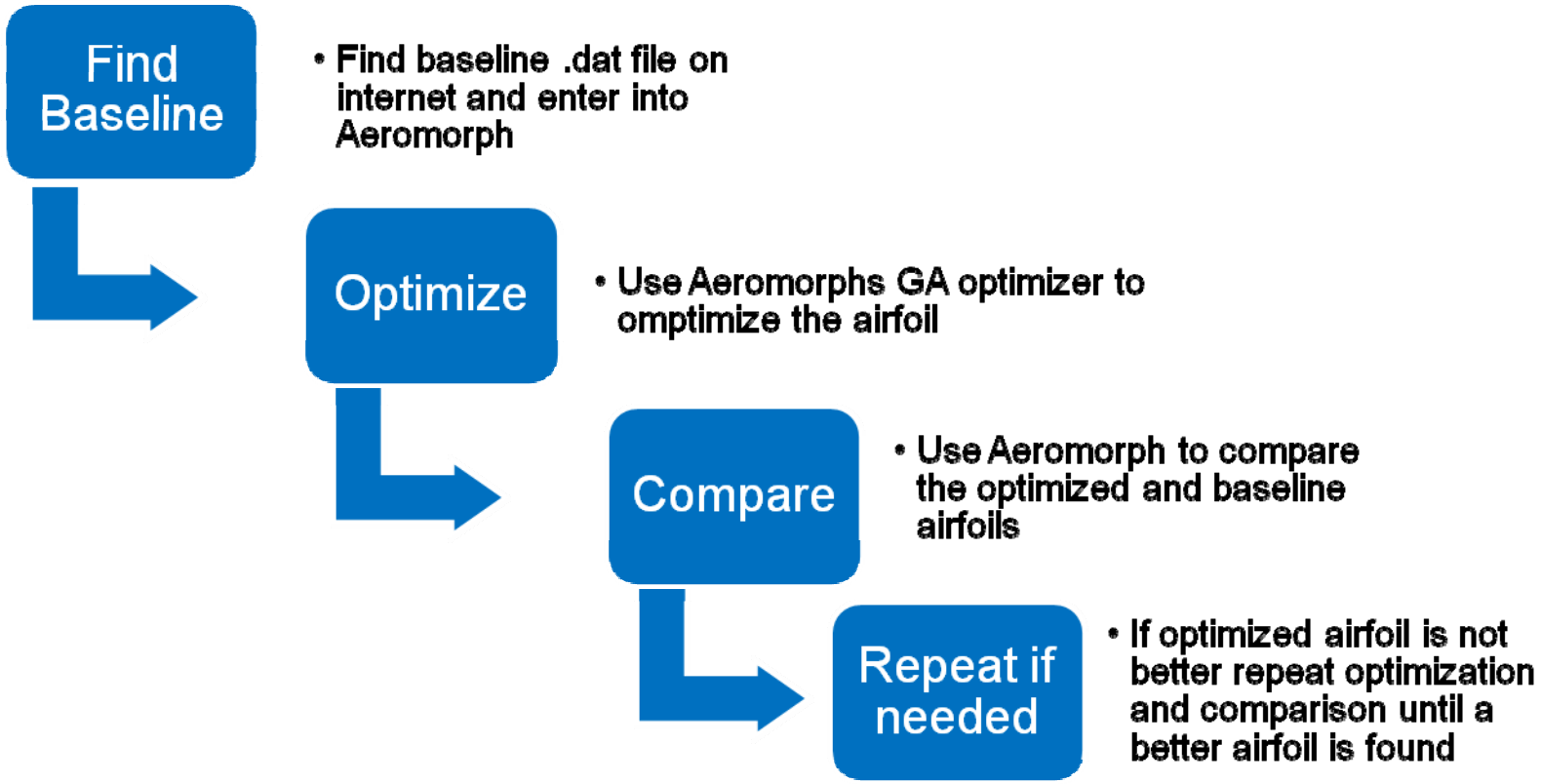
- **NASA** is aggressively promoting research on bio-inspired flight.

- We anticipate rapidly changing the way we think about air transportation:
  - incorporation of these new technologies
  - research methods,
  - human **creative and exploratory spirit**

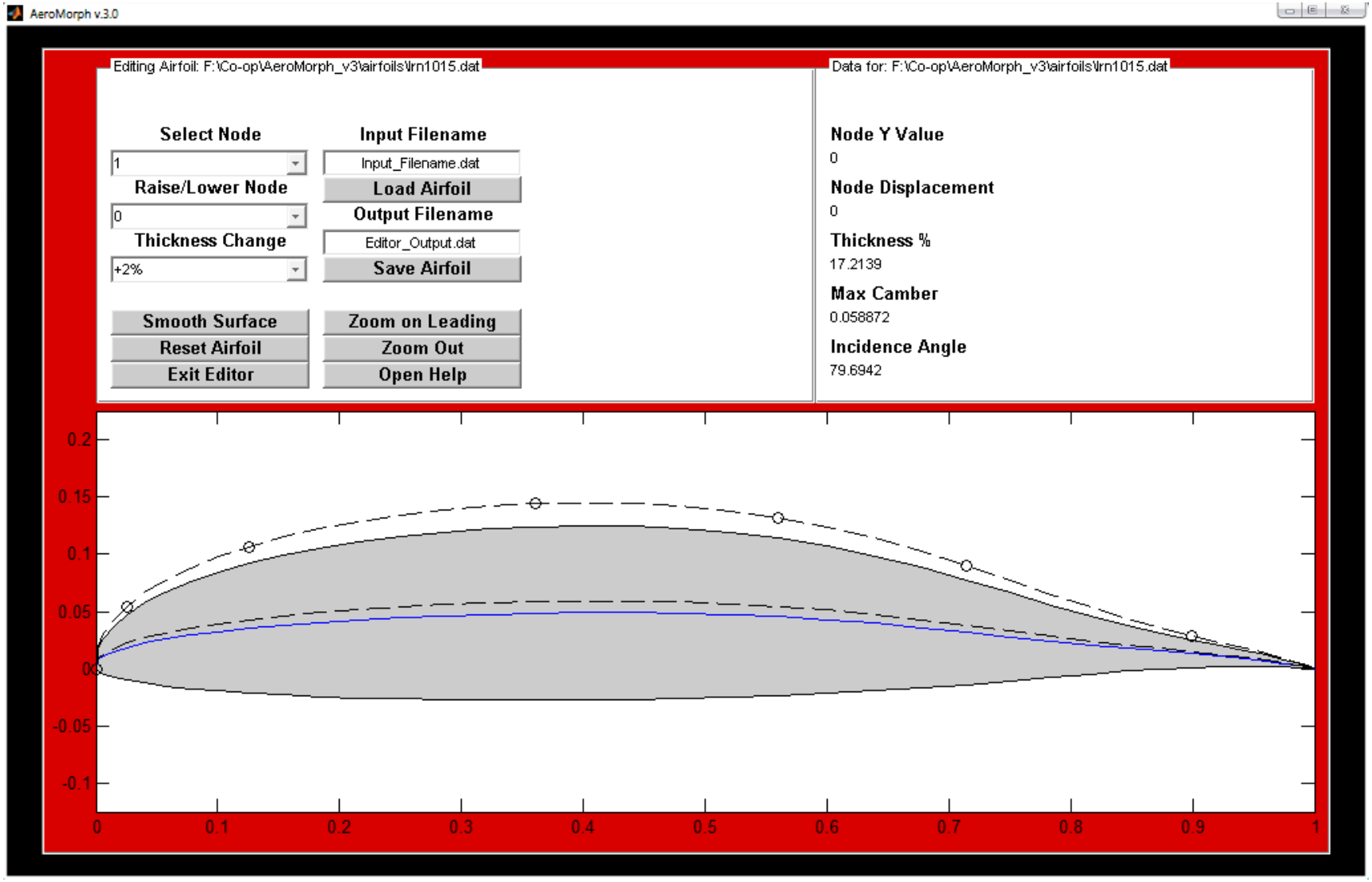


http://www.nasaexplore.com/extras/cof/cof.html

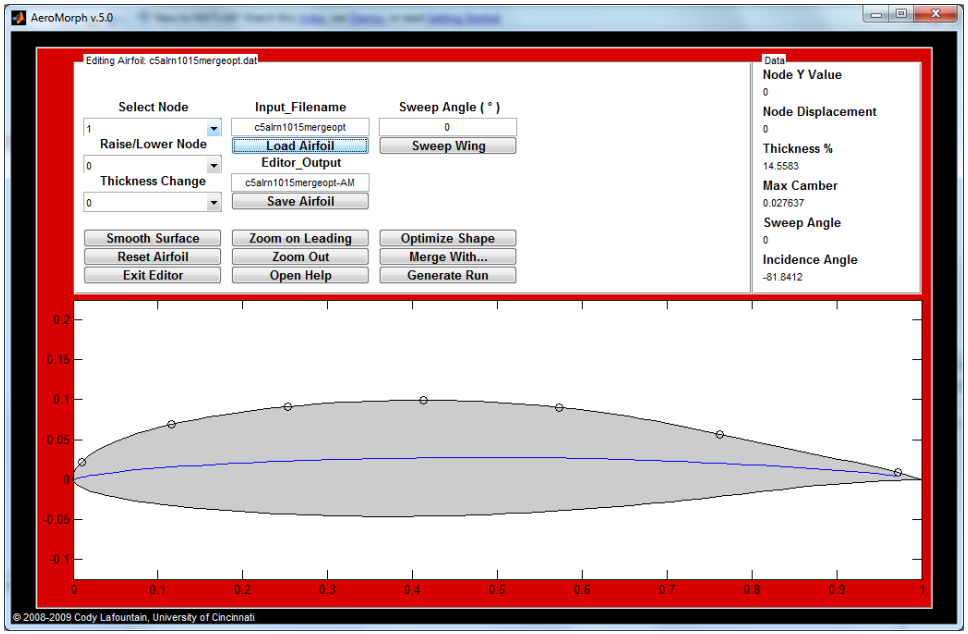
Design Process

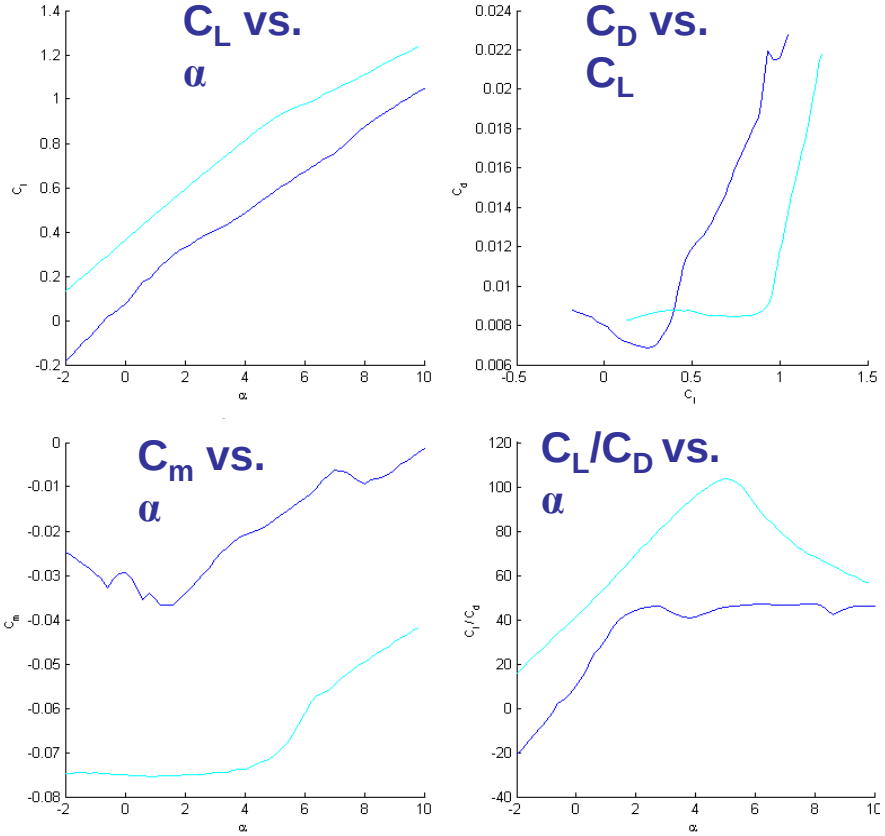


In-House Morphing Airfoil Design Software – AEROMORPH
Developed by Mr. Cody Lafountain



AEROMORPH Optimized Airfoil and Performance Graphs





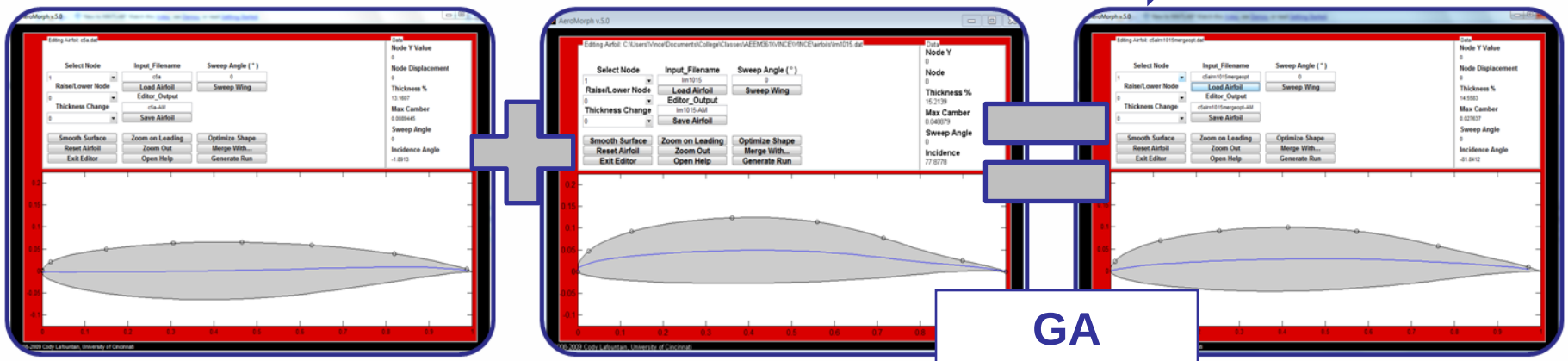
❖ **Airfoil presents higher lift over whole range of angle of attack.**

❖ **The airfoil also presents a higher lift over drag ratio over the whole range of angle of attack.**

The teal line represents the optimized airfoil.

The blue line represents the baseline airfoil.

Developing Unique Airfoil Shape



Start with baseline airfoil.

- The baseline airfoil
- AEROMORPH will be used to merge and optimize this airfoil.
- The program has been validated and will create simulation results.

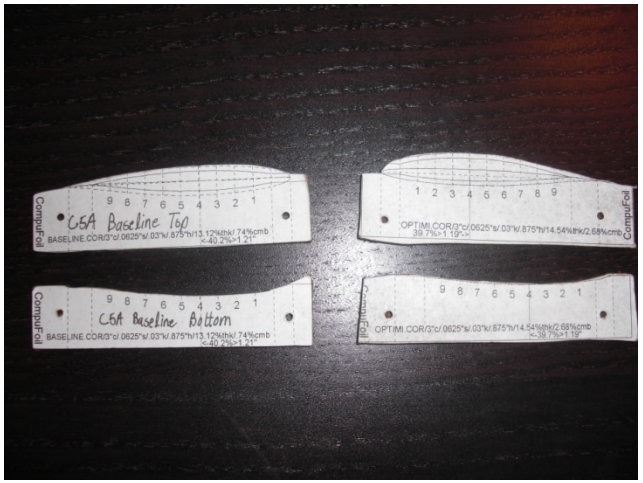
Merge with another better performing airfoil.

- The baseline airfoil was merged with high performing existing airfoil.

Optimize merged airfoil with genetic algorithm.

- Optimized the merged airfoil to produce final design.
- Final design shows elements of both airfoils and has the optimal thickness for maximum performance.

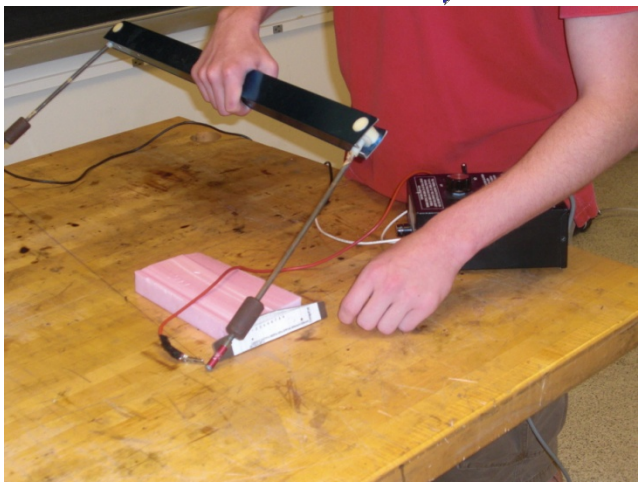
Design Process

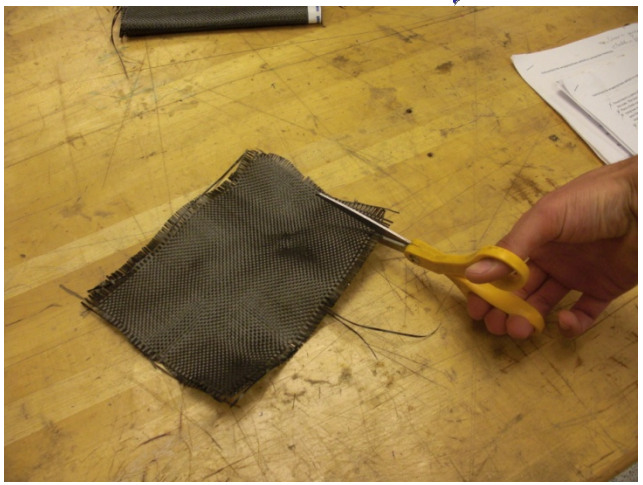


Print templates for baseline and optimized airfoils.

Cut templates out.

Finished templates.





Use hotwire to cut foam airfoils.

Finished foam foils

Cut carbon fiber to cover entire airfoil.

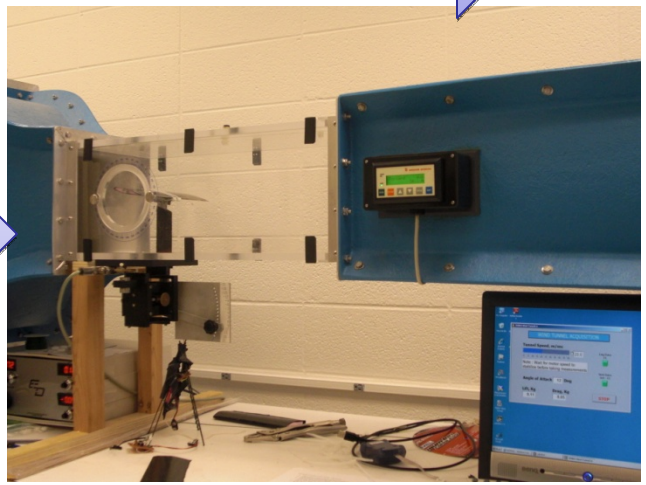
Weigh harder and epoxy. Mix together.

Apply epoxy to airfoil and wrap airfoil with carbon fiber.

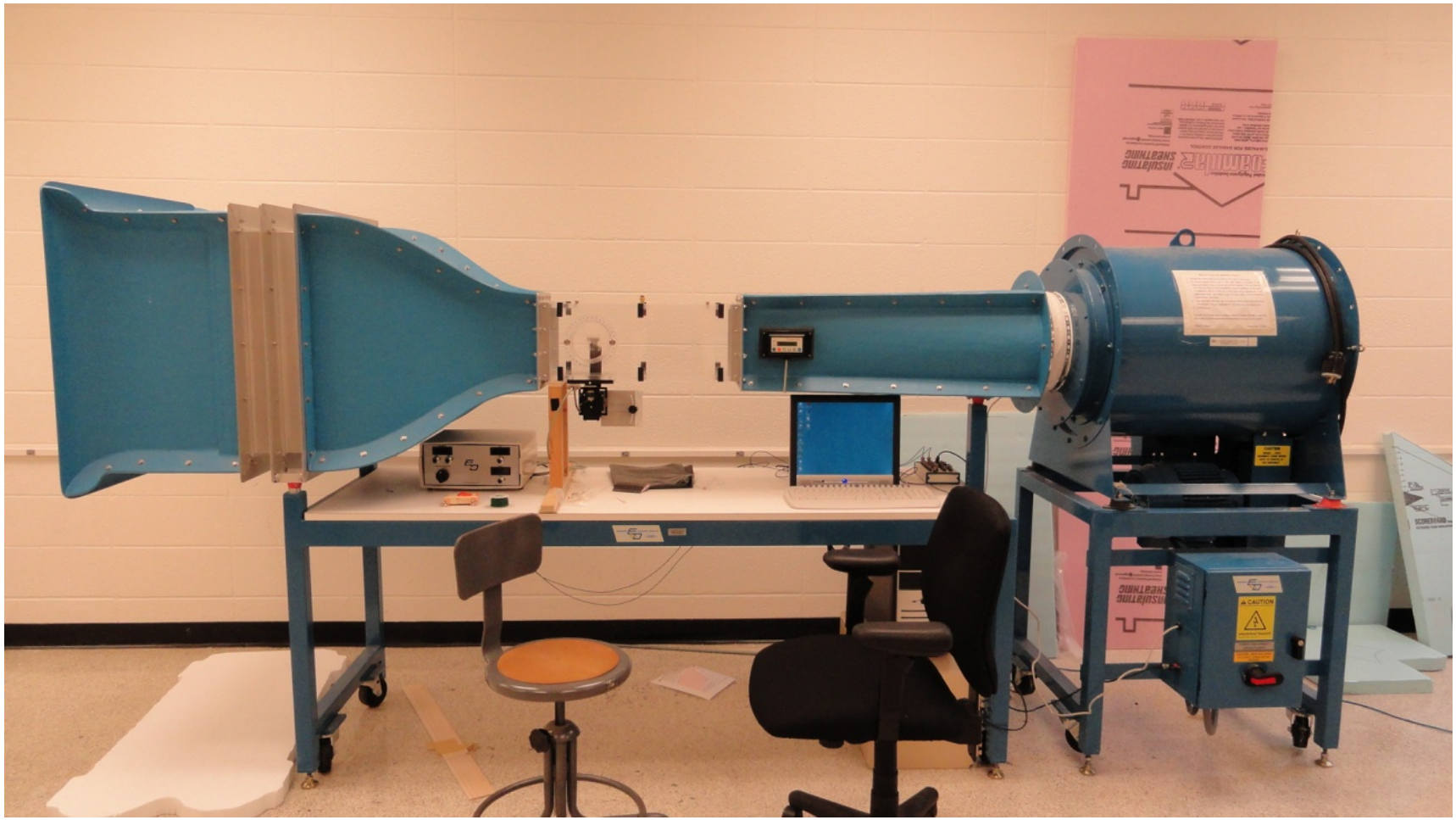
Finished carbon fibered airfoils.

Vacuum bag carbon fibered airfolls.

Trim excess carbon fiber and test in wind tunnel.

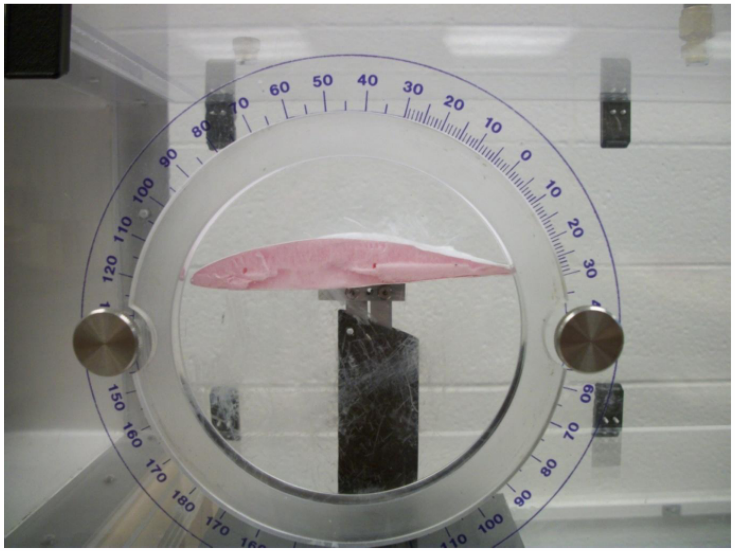


Wind tunnel Facility at UC

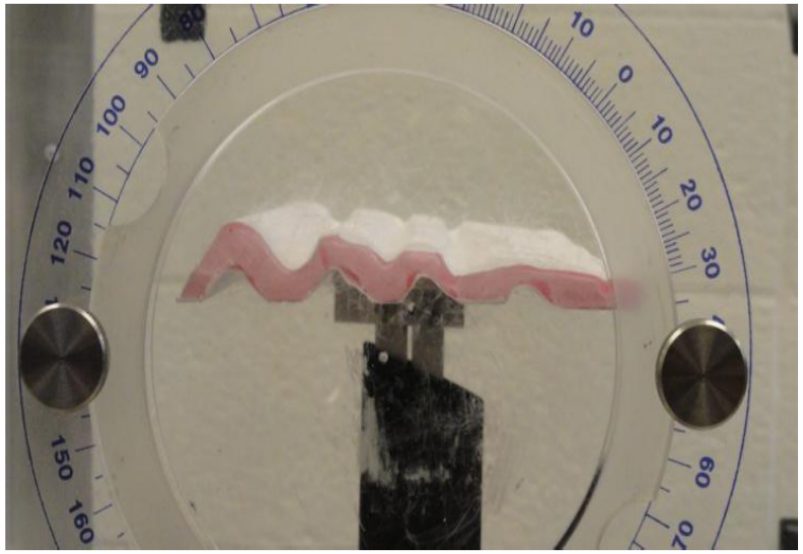


Experimental Strategy (Quantitative)

Fabricate a model of the dragonfly wing, test it in the wind tunnel and compare to the Global Hawk UAV airfoil (LRN1015)

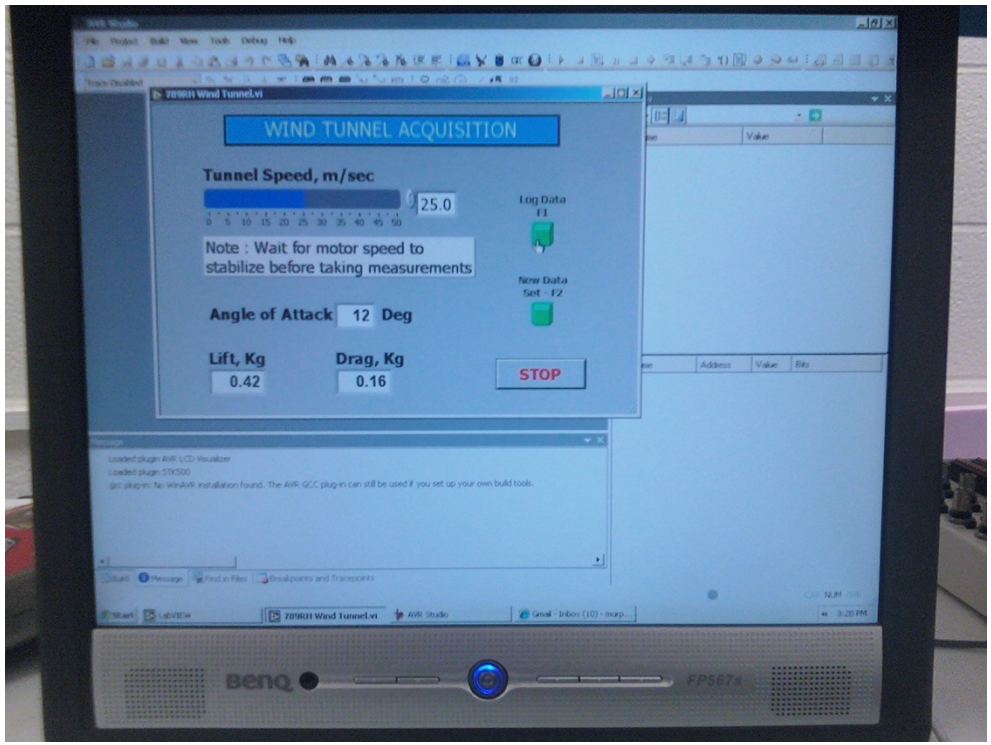


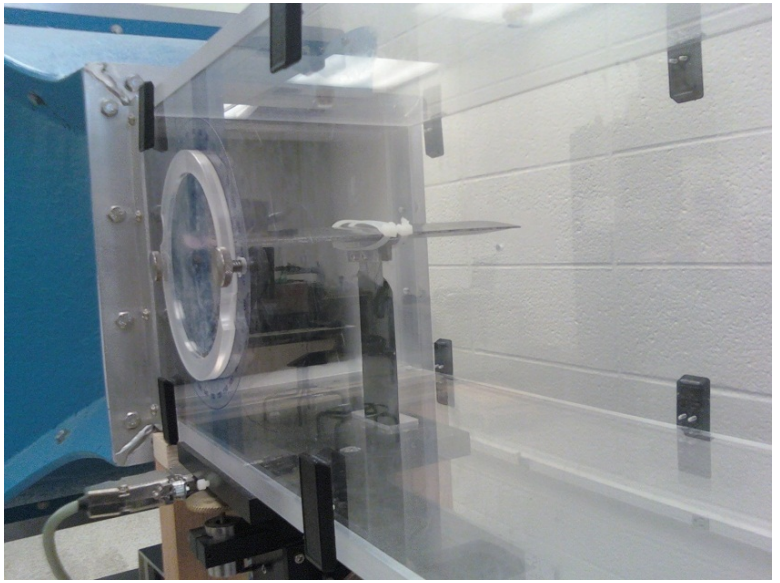
LRN1015 smooth airfoil at Alpha = 0



Dragonfly-inspired airfoil in the wind tunnel at Alpha = 0

Development Program





Summary and Project Goals

- The proposed study will:
  - review the basic principles of flight
  - investigate the trends in airfoil design as we move towards bio-inspired optimization yielding enhanced performance.
  - Provide teachers with required material to prepare exciting classrooms lessons on this topic