Group 5
Enhanced Agility of MAV's Using Adaptive Structures

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Sponsors

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Motivation

Unmanned Aerial Vehicle Limitations
Urban Warfare

Figure 1

Figure 2

Project Scope

Enhance the aerodynamic properties of a fixed wing Micro Aerial Vehicle through use of adaptive structures

Figure 3

Background

Micro Aerial Vehicle (MAV)

- Form of Unmanned Aerial Vehicle (UAV)
- Scale: 1m – 1cm
- Used for surveillance purposes

Figure 4

Adaptive Materials

- Change shape when energy is added

Project Specifications/Objective

Reynolds number <10^5

Improve Aerodynamic properties

Inexpensive materials

Withstand harsh environments

Weight < 113 grams

Previous Work

Previous Senior Design Project

- 3M-VHB Tape 4905
- Wing Frame Insert
- MAV Wing Frame

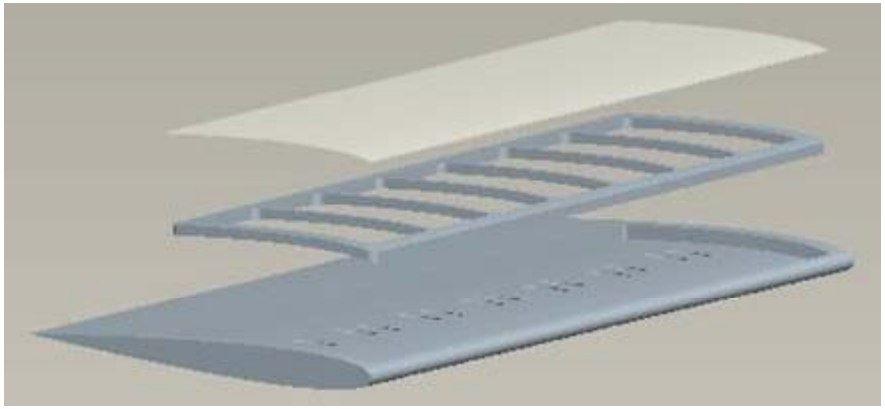


Figure 5

Wind Tunnel Test

Previous Work

Dr. Dickinson and Dr. Oates summer 2010

- Elliptical Membrane Wing
- Dielectric Elastomer VHB 4910

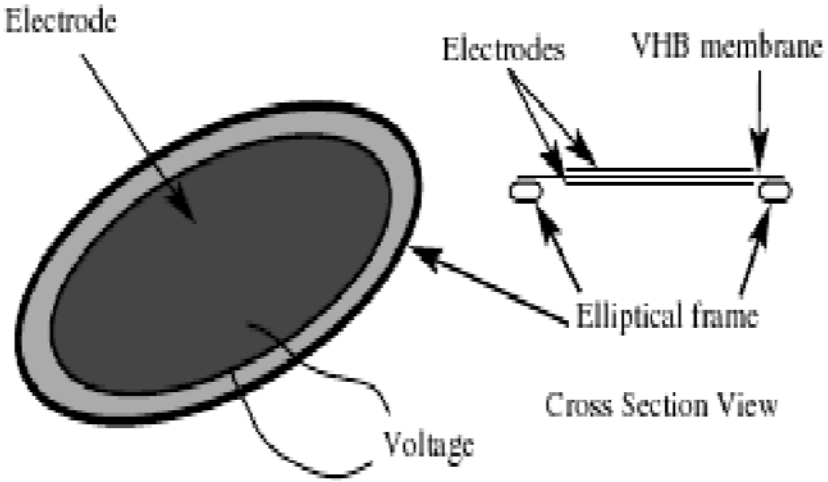


Figure 6

Concept 1

Flow Separation Comparison

- Pressure vs. Skin Friction Drag

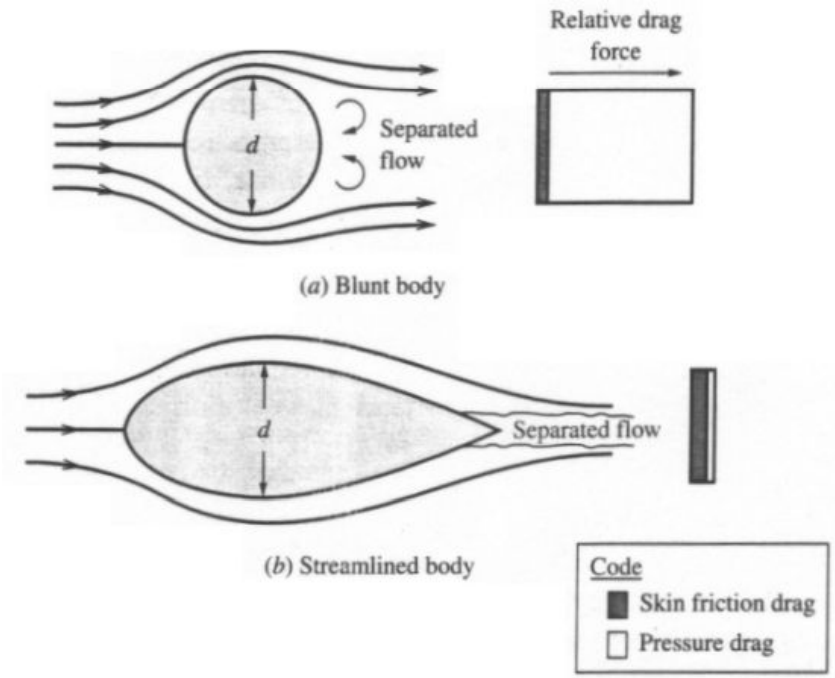


Figure 7

Concept 1

Vortex Generator

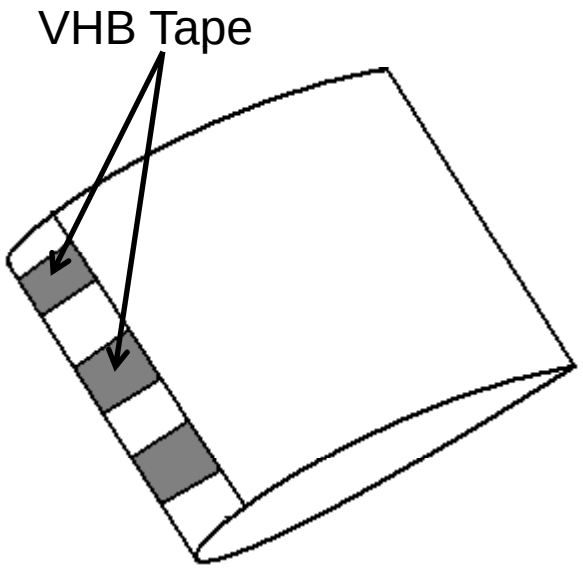
- Promotes turbulent boundary layer
- Purpose is to increase lift

Figure 8

Concept 1

Vortex Generator

- Pros:
  - Proven Concept
- Cons:
  - Displacement
  - Viability
  - Weight



Concept 2

Leading Edge Extension (LEX) Fence

- Delays flow separation near stall
- Increases stall angle

Figure 9

Concept 2

Leading Edge Extension (LEX) Fence

- Trailing Vortices

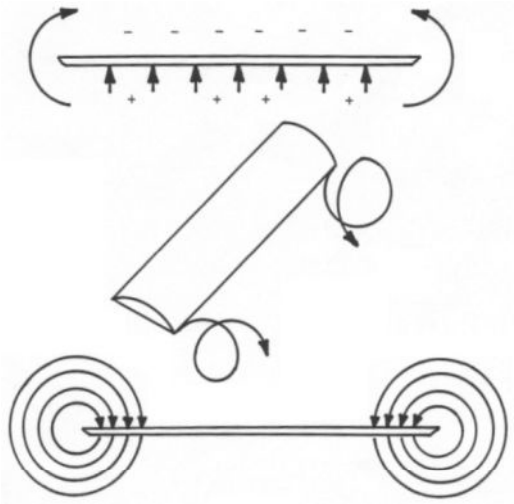


Figure 10

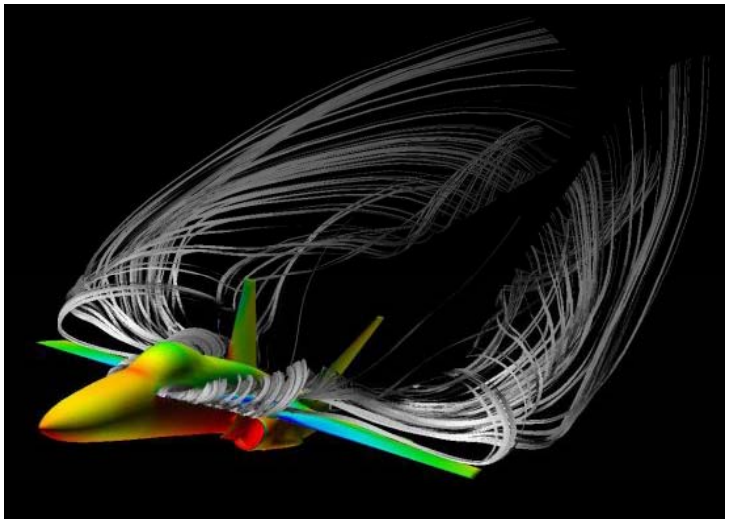


Figure 11

Concept 2

Leading Edge Extension (LEX) Fence

- LEX Fence Location

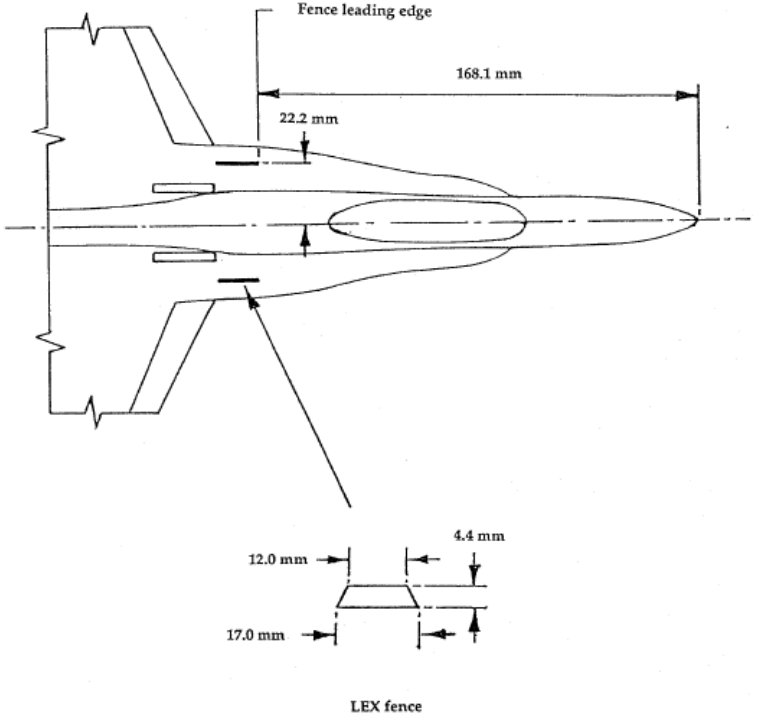
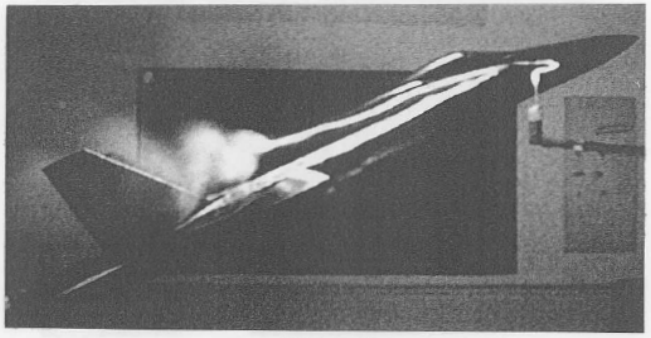


Figure 12

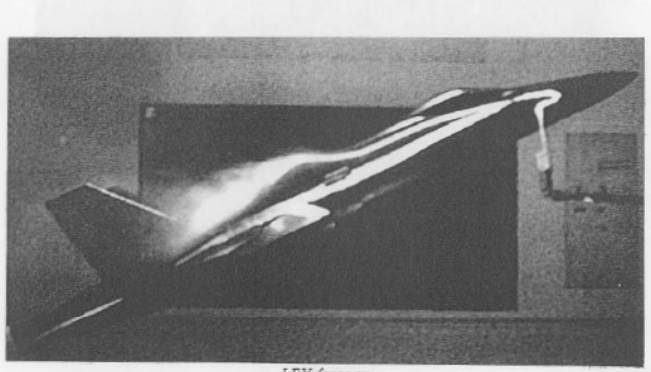
Concept 2

Leading Edge Extension (LEX) Fence

- Flow Visualization & Wind Tunnel Testing



LEX fence off



LEX fence on

Figure 12

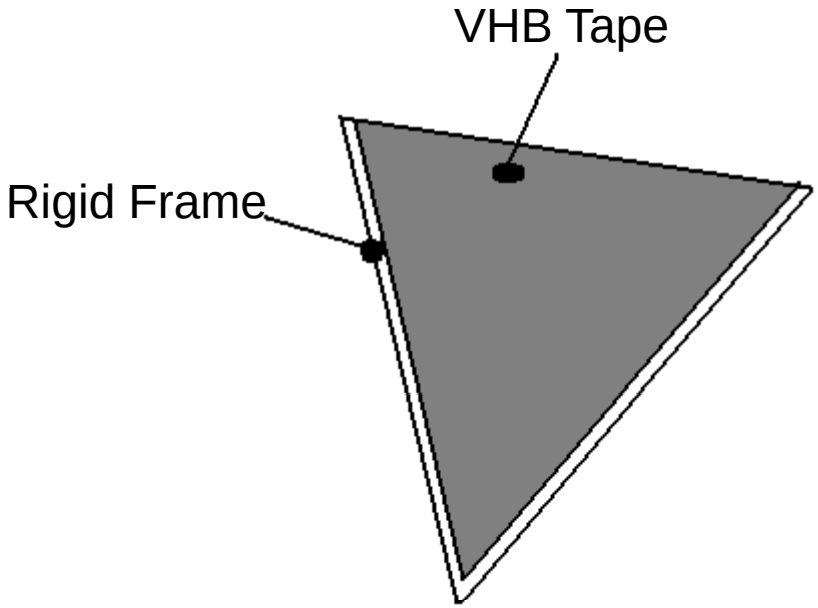
Concept 2

Lex

- Pros:
  - Proven Concept
- Cons:
  - Implementation
  - Weight

Concept 3

Delta Wing

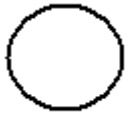


Pros:

- Low Drag
- Light Weight
- Inexpensive

Cons

- Low lift

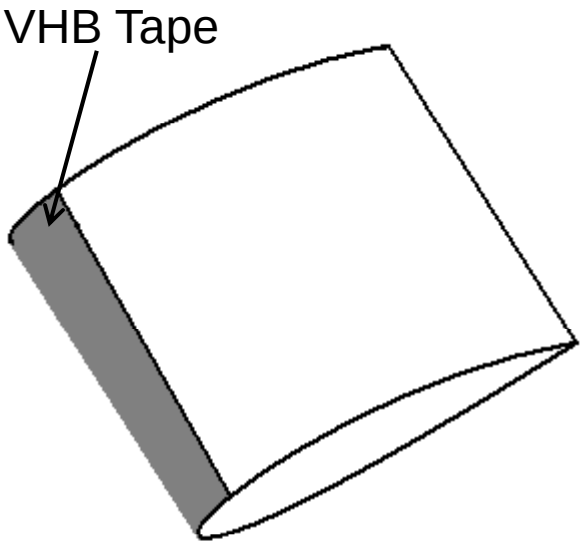


Frame Cross Section

Concept 4

Adaptive Leading Edge

- Pros
  - Continuation
  - Durable
- Cons
  - Weight



Concept 5

Shape memory vortex generator

- Pros:
  - Durable
  - Proven
- Cons:
  - Expensive
  - Large Power Source
  - Weight

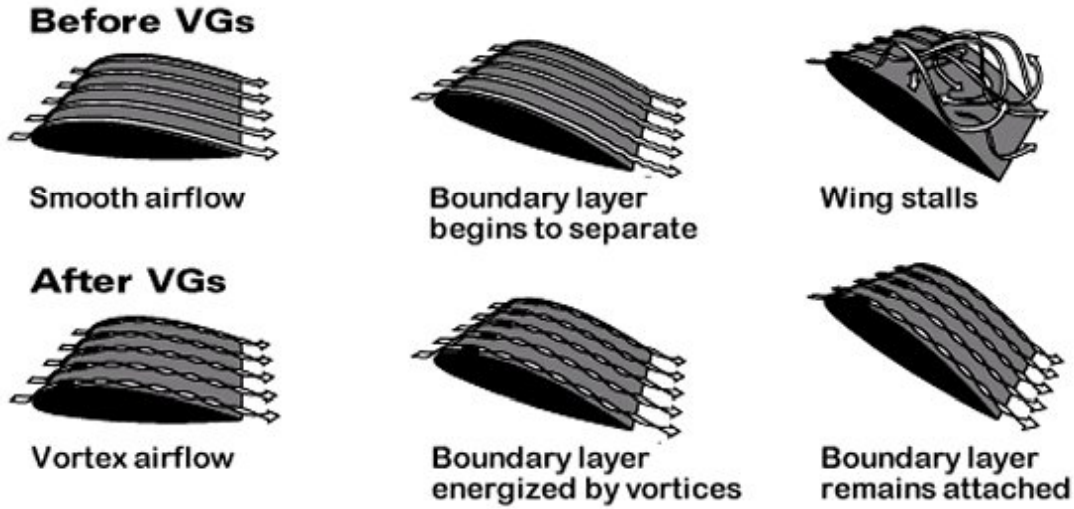


Figure: 14

Concept Selection

Shape Memory Vg

Delta Wing

Questions

Sources

Figure 1: http://www.skilluminati.com/research/entry/there_is_only_one_war_and_it_is_a_class_war/

Figure 2: http://defense-update.com/products/p/predator.htm

Figure 3: http://thefutureofthings.com/pod/6015/air-force-micro-aerial-vehicle.html

Figure 4: http://www.mil.ufl.edu/~nechyba/mav/

Figure 5: http://www.eng.fsu.edu/~khamead/site/index.html

Figure 6: Dr. Oates unpublished

Figure 7-8: http://www.aerospaceweb.org/

Figure 9-13: http://dspace.dsto.defence.gov.au

Figure: 14: http://www.aerospaceweb.org/question/aerodynamics/q0255.shtml