Fall Design Presentation

FCAAP: AIAA Design Build Fly

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AIAA Florida A&M University - Florida State University Student Chapter

FCAAP FLORIDA CENTER FOR ADVANCED AERO-PROPULSION TECHNOLOGIES FOR THE NEXT GENERATION

Presentation Outline

- Competition Overview
- Subsystem Basics
- Design Concepts
- Current Design
- Conclusion (problems, future work)

Competition Overview

- Held in Tucson, Arizona in April, 2013
- Score based upon Three flight missions, aircraft parameters, and written report.
- Mission 1: Max completed laps in given time
- Mission 2: Max internal stores for 3 laps
- Mission 3: Random missile configuration
  3 laps, minimum time
- RAC: Minimize X and Y dimensions of the aircraft, Minimize weight
- Written Report: 60-Page maximum, Due 2/25/13

Primary Design Objectives

- Complete All Missions
  - Primary Objective is to satisfy all requirements to compete.
- Minimize Cost and Weight
  - In order to have a successful design, the smallest possible unit must be used.
- Minimize Risk
  - In order to minimize waste of time and money, we must consider reasonably safe, proven options when evaluating designs and techniques.

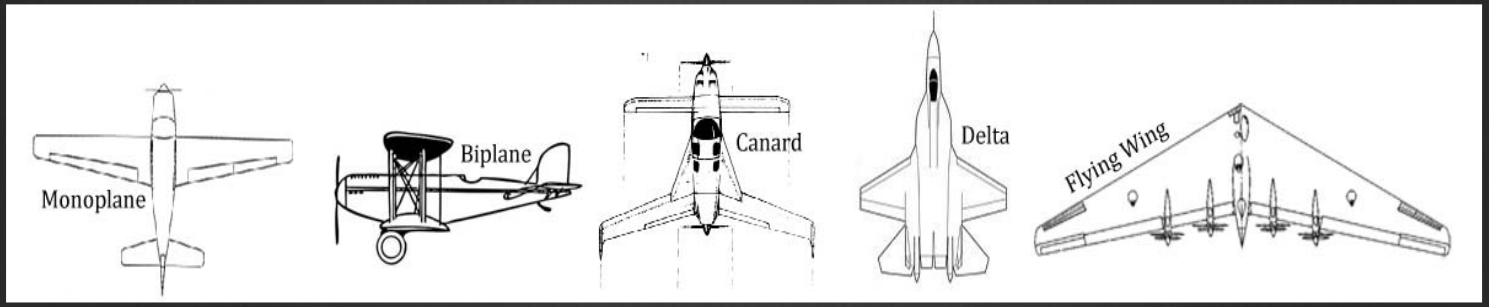
Conceptual Design

Primary Focus

- Minimize Size
- Minimize Weight
- Maximize Stability

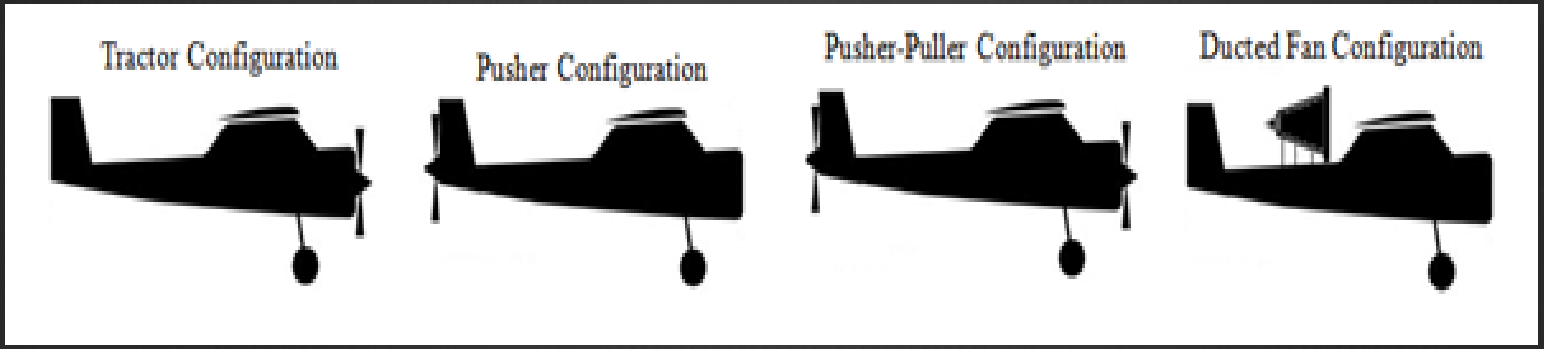
Wing Selection

Figure of Merit	Weighting Factor	Monoplane	Biplane	Canard	Delta Wing	Flying Wing
Weight	0.20	4	1	3	4	1
Drag	0.20	4	2	2	1	3
Lift	0.30	3	5	4	3	4
Stability	0.15	4	5	3	3	5
Complexity	0.15	5	4	2	3	1
Total	**1.00**	**3.85**	**3.45**	**2.95**	**2.80**	**2.90**



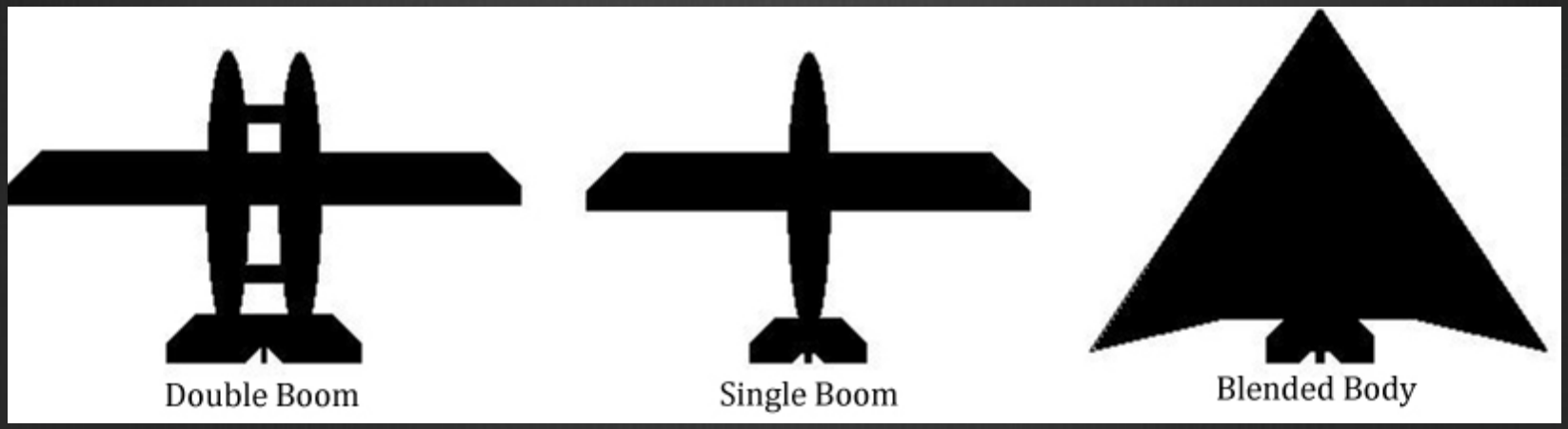
Propeller Selection

Figure of Merit	Weighting Factor	Tractor	Pusher	Pusher-Puller	Ducted Fan
Weight/Balance	0.40	5	4	5	2
Efficiency	0.40	4	4	3	3
Complexity	0.20	5	4	2	3
Total	**1.00**	**4.60**	**4.00**	**3.60**	**2.60**



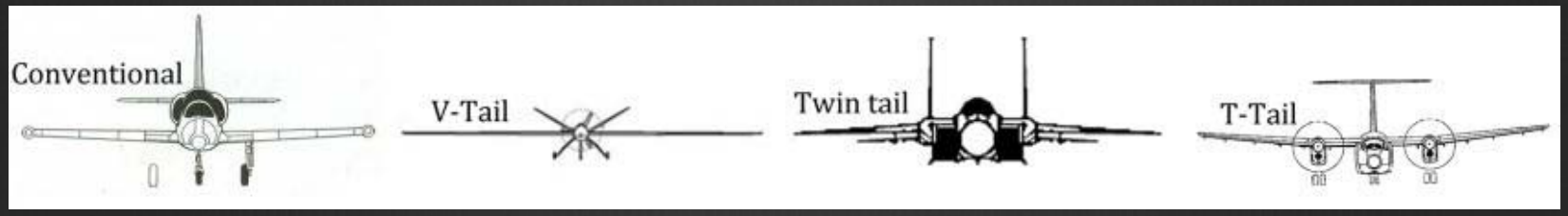
Fuselage Selection

Figure of Merit	Weighting Factor	Double Boom	Single Boom	Blended Body
Weight	0.40	1	3	4
Drag	0.20	2	4	5
Durability	0.10	3	4	5
Storage Capacity	0.30	5	4	1
Total	**1.00**	**2.6**	**3.6**	**3.4**



Tail Selection

Figure of Merit	Weighting Factor	Conventional	V-Tail	Twin Tail	T-Tail
Weight	0.15	3	4	3	3
Drag	0.20	4	5	3	3
Stability	0.35	5	2	3	3
Maneuverability	0.20	5	2	4	4
Manufacturability	0.10	4	2	3	3
Total	**1.00**	**4.40**	**2.90**	**3.20**	**3.20**



Landing Gear Selection

Figure of Merit	Weighting Factor	Tricycle	Single Wheel	Tail Dragger	Bicycle
Weight	0.30	3	4	3	2
Drag	0.10	4	4	3	3
Durability	0.15	5	2	4	4
Stability	0.10	5	1	3	3
Manufacturability	0.15	3	4	3	2
Efficiency	0.20	3	4	2	1
Total	**1.00**	**3.60**	**3.40**	**3.20**	**3.20**

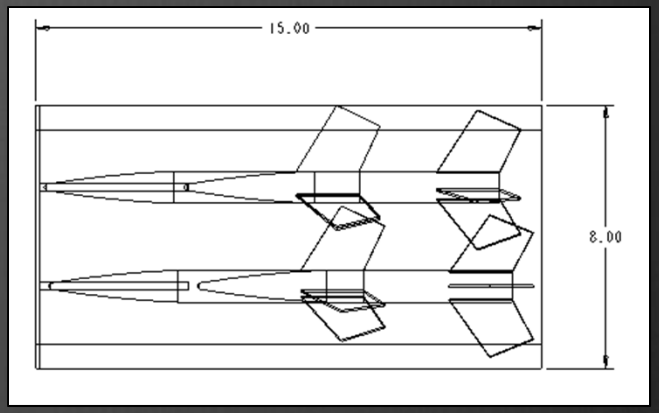
Internal Stores

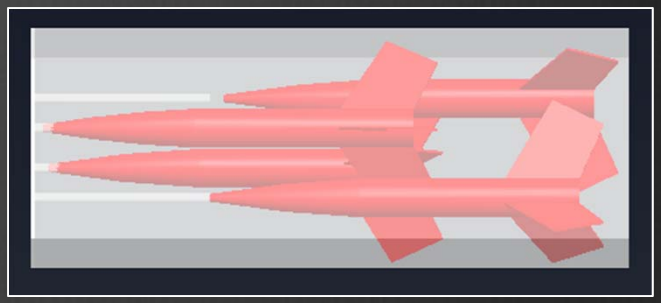
The focus here is to

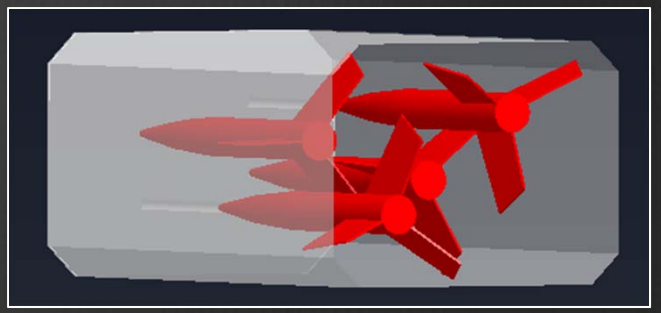
- Complete mission two
- Minimize RAC (Rated Aircraft Cost)
  - Reduce required material to house stores
  - Reduce volume of stores

Internal Store Configuration #1

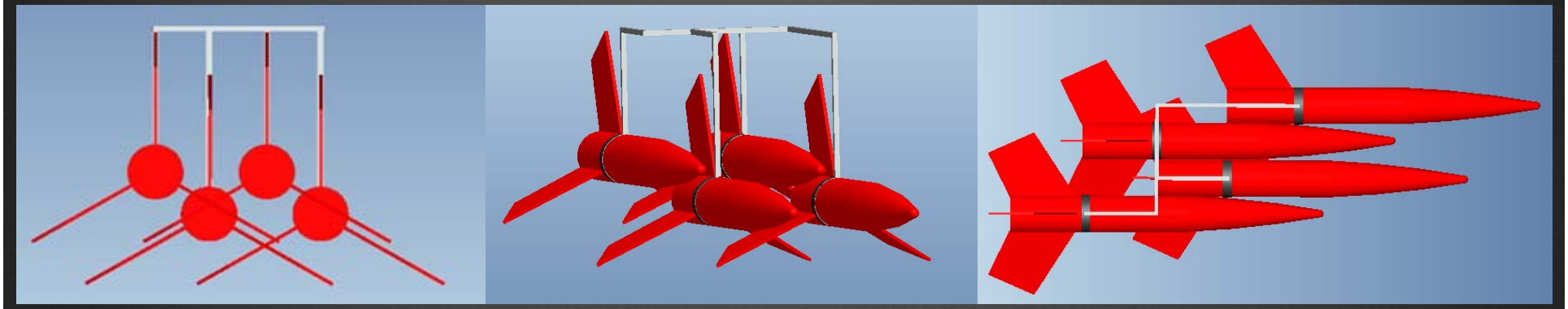
- Overall Outer Dimension : 15in x 8in
- Holds 4 Mini Max rockets (minimum)
- Design would need modification in order to conform to updated rules (top mount)
- Considerable size/weight savings over configurations with additional stores







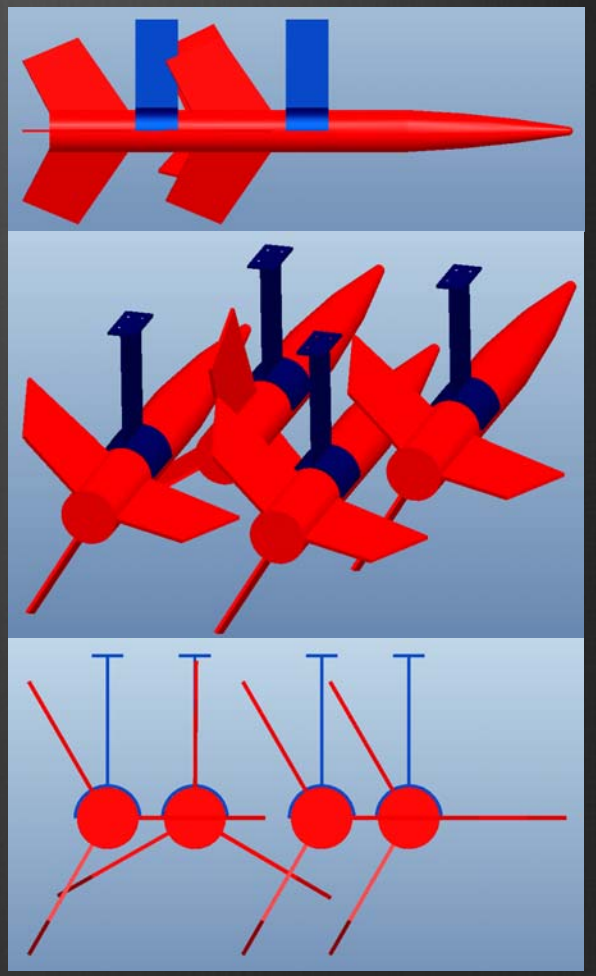
Internal Store Configuration #2

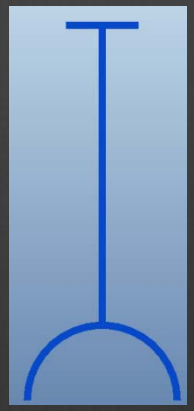


- System suspended from a top-mounted "cradle"
- Cradle mounted to bay of aircraft
- Rockets attached by circular metal clips
- Total space required:
  4.57 inches high X **7.24** inches wide X **15.57** inches long

Internal Store Configuration #3

- Overall Outer Dimension : 9.5in x 15.5in x 5.5in
- Holds 4 Mini Max rockets (minimum)
- Design would need a machined part that would attach top the fuselage and be able to strap store to the mount.





Materials Selection

Primary Focus

- Minimize Material Weight
  - Allow for minimal empty weight to complete short take-off
- Maximize Material Strength
  - Landing and wing-tip tests must be successful

Materials Selection

- The best materials that are available consist of ceramics and composite materials.

- Minimize cost and maximize efficiency to meet product specification goals.

- Due to brittleness of ceramics, a natural material like balsa wood is the next best option to use

Materials Optimization

What do we know?

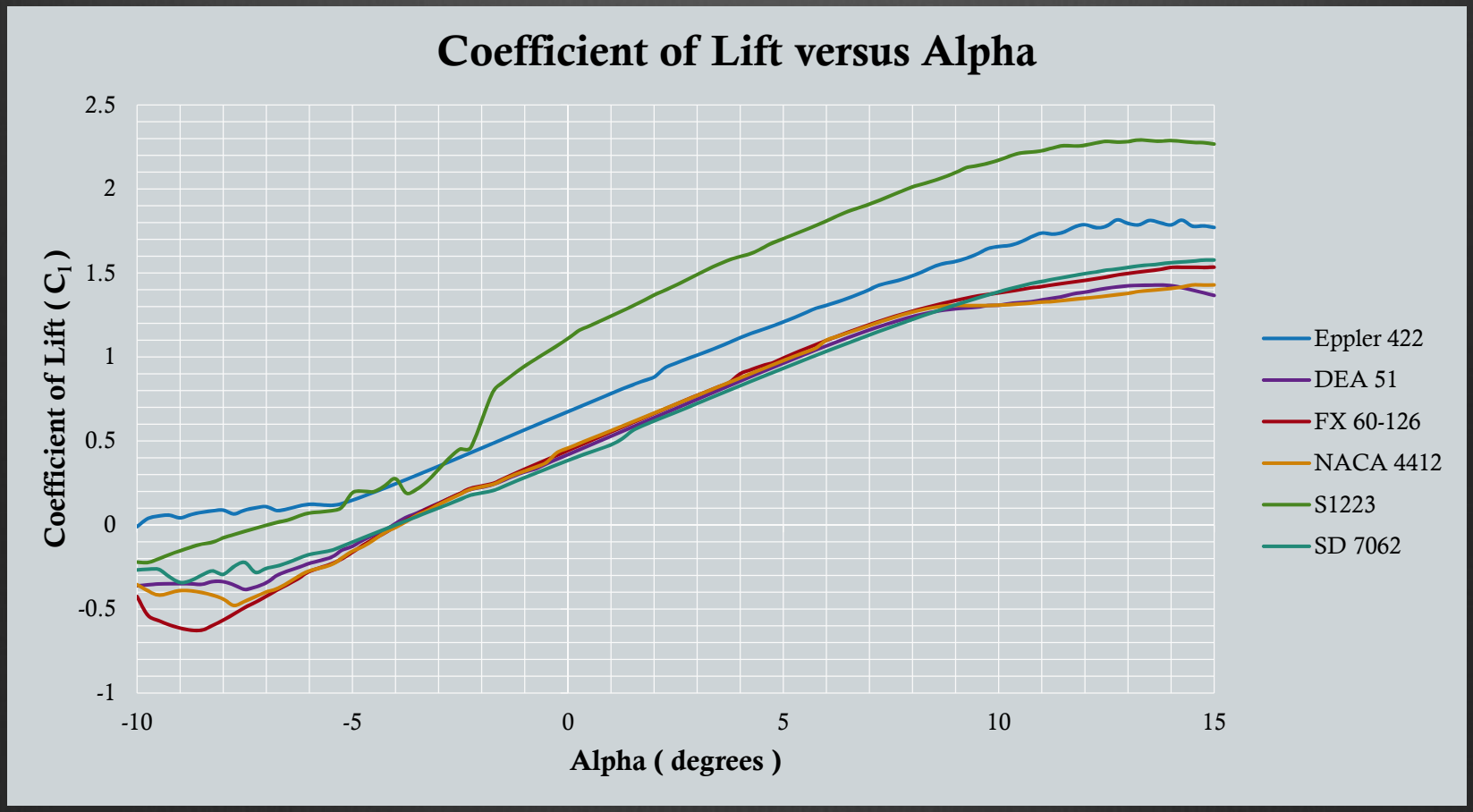
- The yield strength of carbon fiber is greater in tension than in compression.
- Wood is stronger when it is loaded longitudinal direction.

Wing and Tail Design

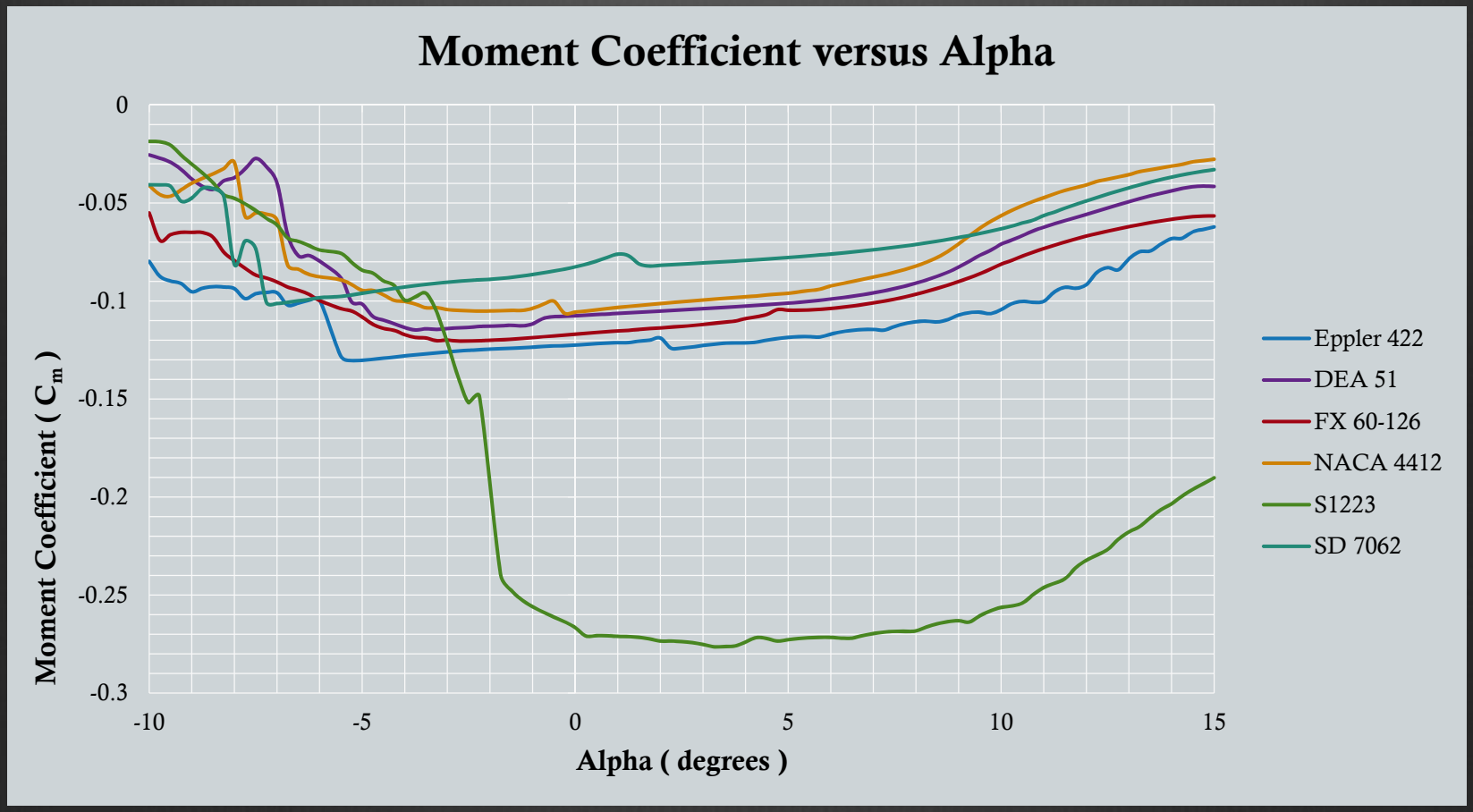
Primary Objectives

- Based upon wing materials, wing weight must be minimized
- Given 7-lb maximum take-off weight, lift must be optimized
- Provide stability and control to the aircraft

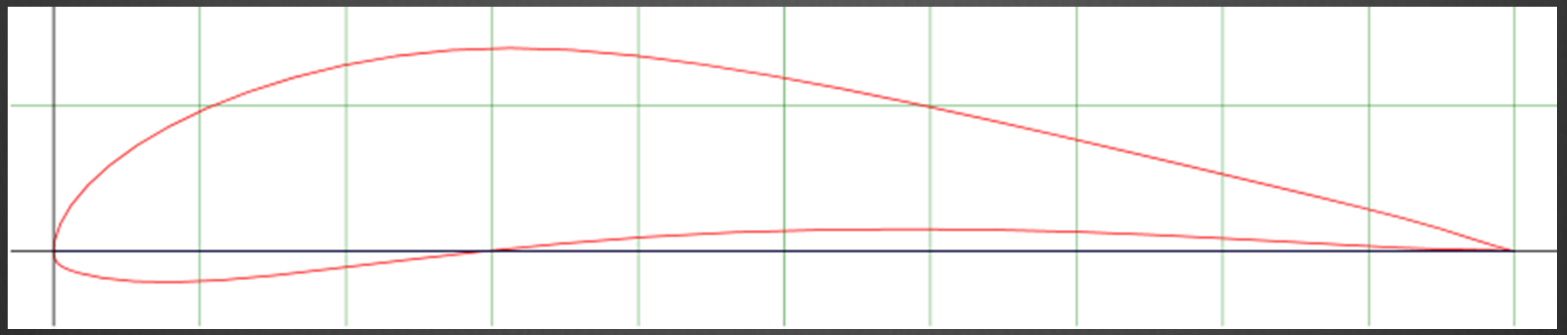
Wing Selection



Wing Selection



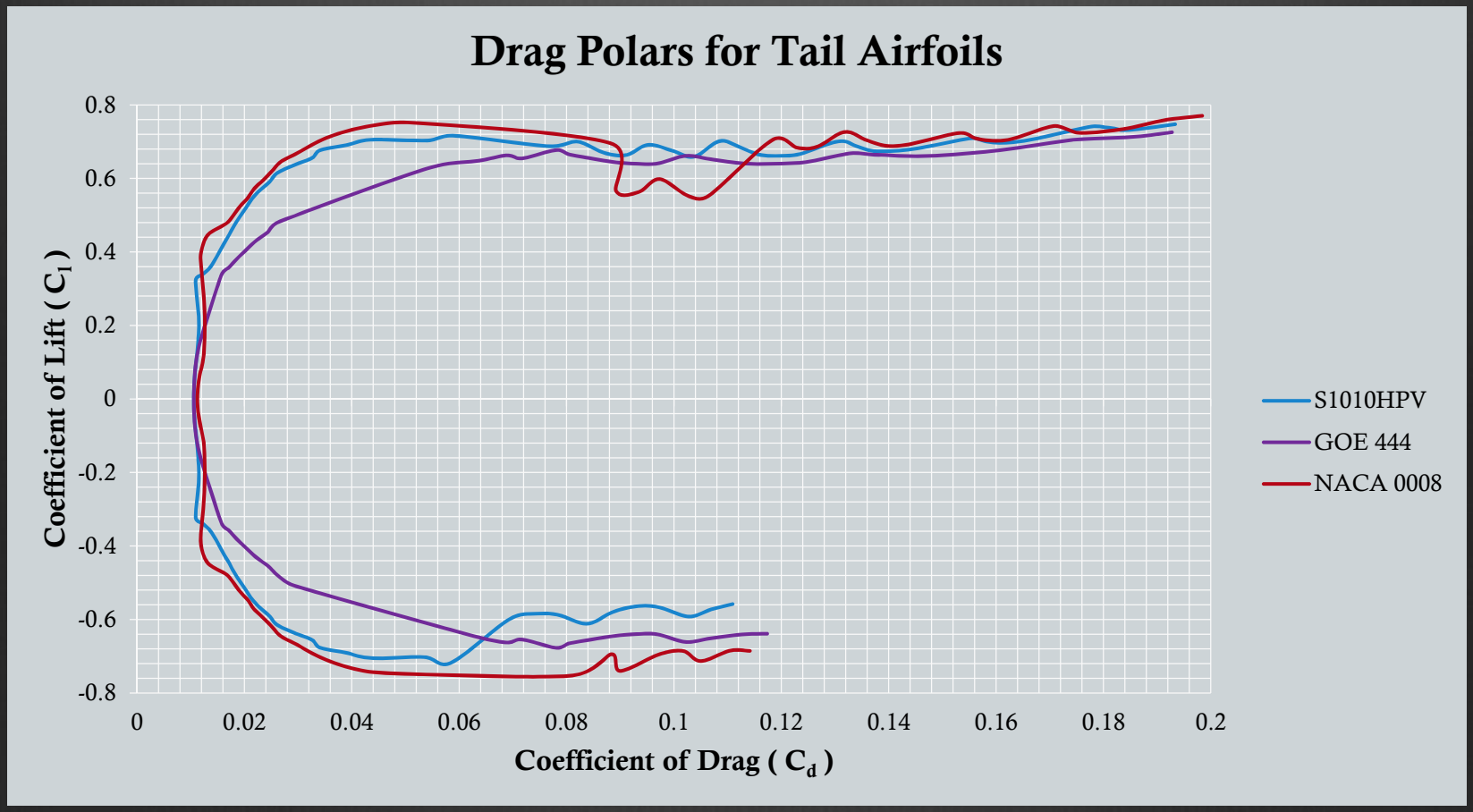
Wing Selection



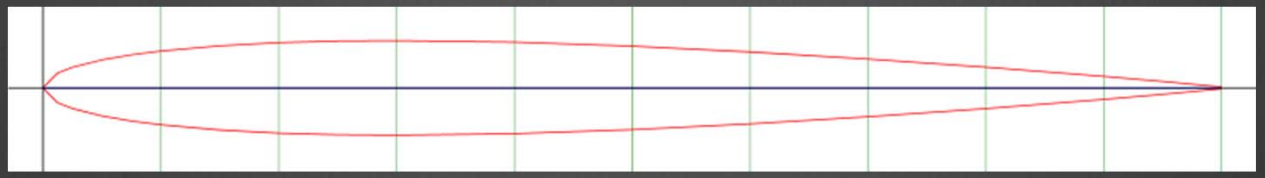
Eppler 422 Profile

Max C_l	1.8159
Stall Angle (deg)	15
Max C_l/C_d	60.0429
C_l at Max C_l/C_d	1.2609
Angle at Max C_l/C_d (deg)	5.5

Tail Selection



Tail Selection



NACA 0008 airfoil profile

Vertical Span	**10.25 inches**
Vertical Chord	**7.9 inches**
Horizontal Span	**23.75 inches**
Horizontal Chord	**7.9 inches**
Moment Arm	**31.1 inches**

Propulsion System

- Based upon estimated aircraft weight and lift provided, take-off thrust must be optimized.

- Based upon lift provided and estimated weight, the amount of static thrust required to take off within the prescribed area is 11 N of force.

- This section discusses how that is optimized

Propulsion System Selection

Research Combinations of

- Motors
- Propellers
- Controllers
- Batteries

Combine Theoretically

Propulsion System Selection

Based upon prior research

- Purchase (2) motor candidates
- Purchase several propellers
- Purchase (1-2) motor controllers
- Purchase (1-2) batteries

Propulsion System Selection

- Bring best candidates to laboratory
- Test ALL combinations of candidates
- Analyze results
- Experimentally determine best combinations available

Controls System

Primary Focus

- Be capable of successfully controlling the motor
- Be capable of successfully controlling the control surfaces
- Be capable of operating within the same frequency range in order to communicate effectively

Electronics Selection: Controls

Transmitter

Hitec Aurora 9

- AFHSS 2.4GHz
- 9 Control Channels
- Programmable Failsafe

Receiver

Hitec Optima 7

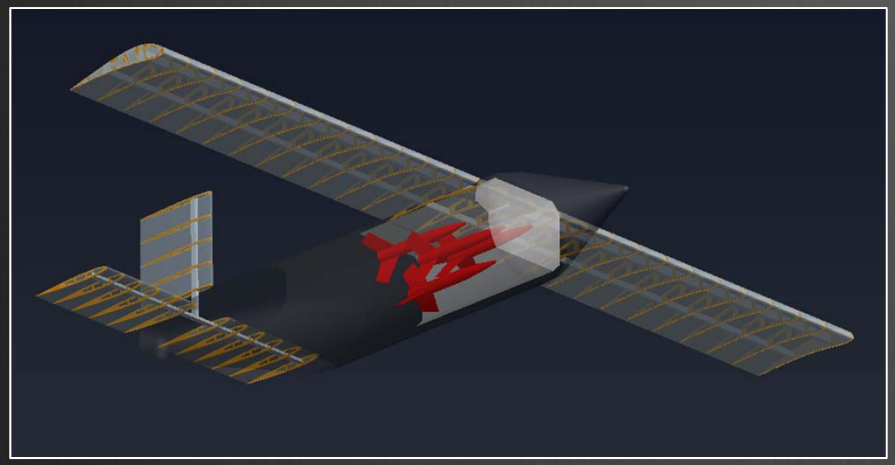
- AFHSS Compatible
- Boosted Omni Directional Antenna

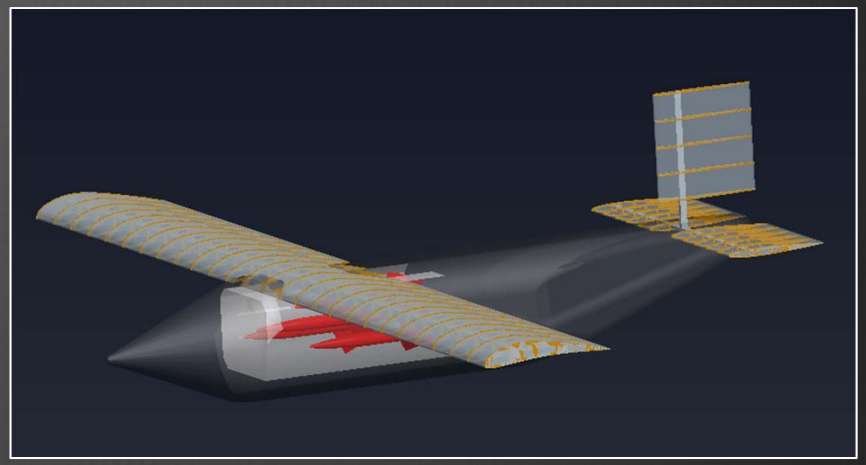
Servos

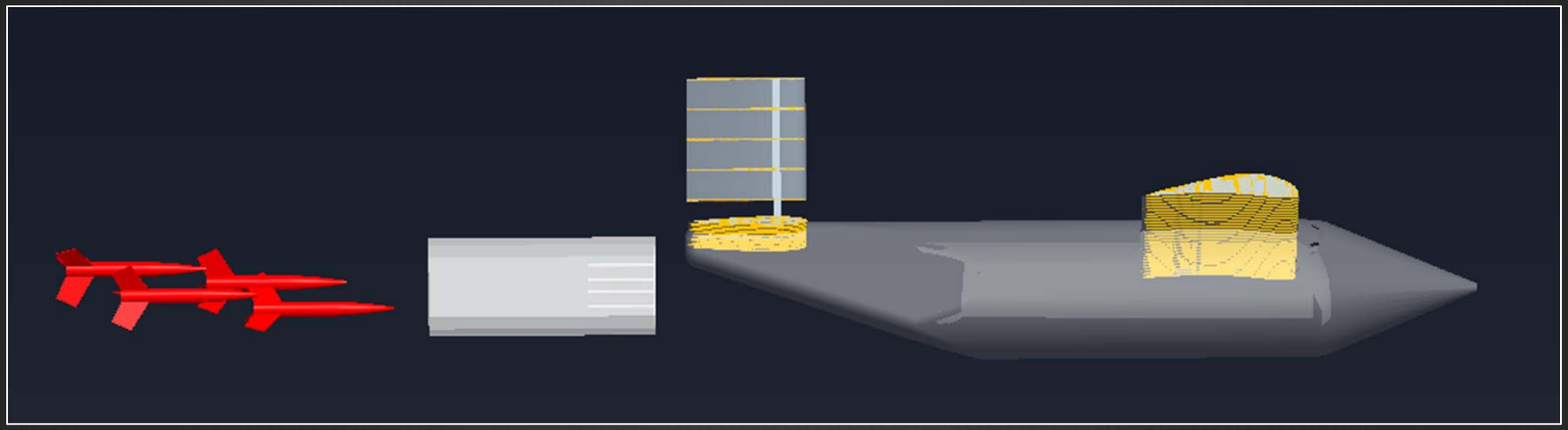
Hitec HS325

- High Torque
- Light weight
- Full system compatibility

A Current Prototype Design







Aircraft Specifications

- Wing Span: 78 inches
- Vertical Tail Span: 10.25 inches
- Horizontal Tail Span: 23.75 inches
- Overall Length:~ 75 inches (Depending on nose cone)
- Max Empty Weight: 3.5 pounds

Environmental Considerations

Steps taken to reduce possible environmental impact

- Use NiMH batteries for recyclability
- Use bio-degradable balsa wood where possible

Safety Considerations

Steps taken to increase safety

- Fail safe mode required
- Batteries will be shrink wrapped
- Safety arming system

Budget and Schedule

Maximum allowed budget is $1,500

- Nothing spent to date

Project Design Report due date is February 25, 2013

- Prototype completion scheduled for February 1st

Other Design Concerns

- Fuselage Design
- Landing Gear
- Wing attachment method
- External Store Attachment Method
- Finalized Propulsion System

Questions?