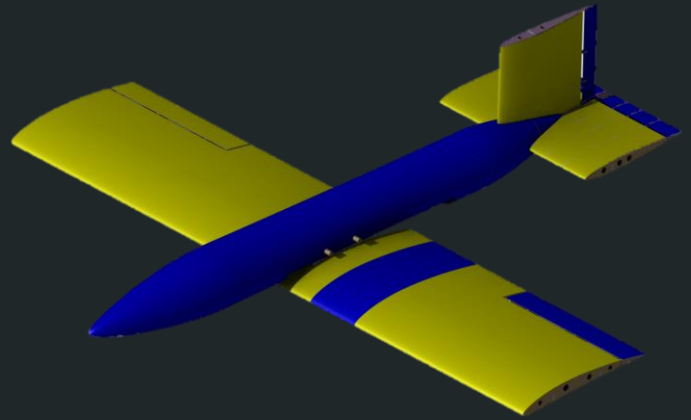
Team 8: The Greater Frigates

The Northern Screamer

Vola cito, parvus avis

“Fly quickly, small bird”



Team Members

Shane Grode

Wing Structure / Delivery System Lead
Interning at Airbus Americas in the Static Stress group

Jordan Kerr

Propulsion Lead / Team Coordinator
Interning in the Design and Modifications Lab at National Institute for Aviation Research.

Jacob Kimble

Wing Structure
Interned as a stress engineer at Airbus, Textron, and National Institute for Aviation Research Engineering Design and Modification lab.

Jackson Lechner

Stability and Controls Lead
Interned at Bombardier and National Institute for Aviation Research as a design engineer.

Trenton Sample

Aerodynamics Lead
Interning at the National Institute for Aviation Research, Engineering Design and Modification lab in the Flight Sciences Group.

Bronze Propeller Competition

The Bronze Propeller website states, “This year's design competition is for ‘*A Storable Semi-Autonomous Emergency Supply Aircraft*.’” The mission consists of flying a specified number of laps while autonomously delivering a payload. Competition scoring places a heavy emphasis on time taken to complete the mission. Specific mission requirements include:

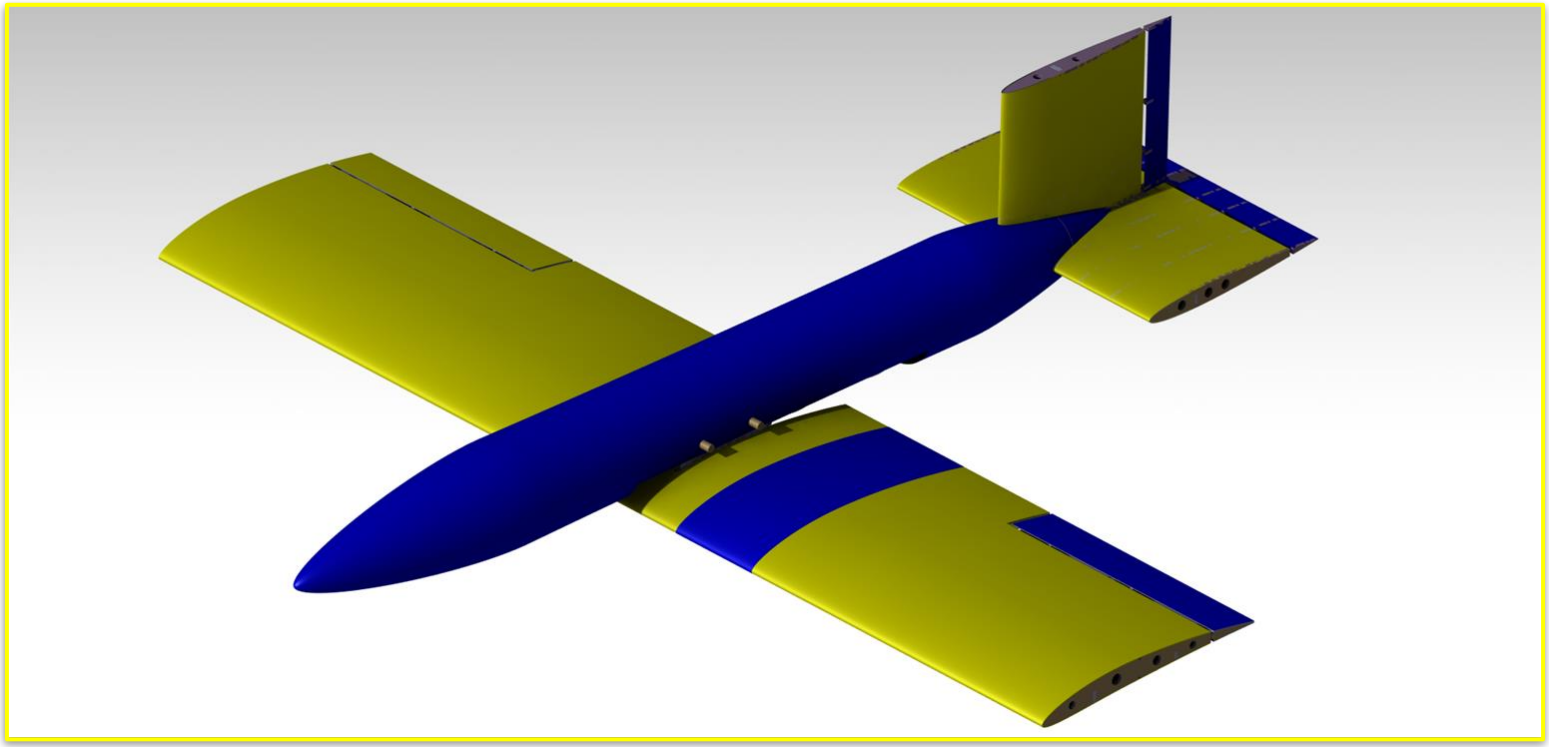
- 5 minute pre-flight and launch
- Hand launch
- Autonomous payload release
- 5 laps
- Successful landing

Team Strategy

The team has designed this aircraft to be as fast and maneuverable as possible in an attempt to maximize scoring. Specific design features selected to achieve this strategy include:

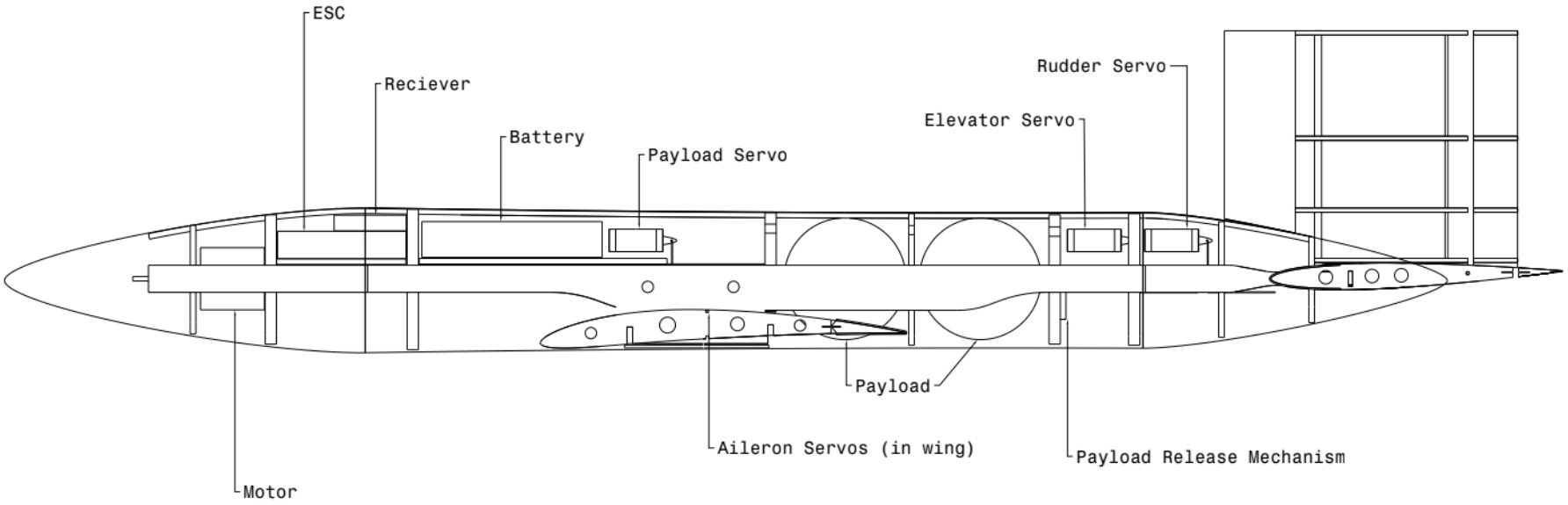
- Take-off weight of ~ 2 lbs
- Structural capability to sustain 10 g’s
- 80 ft/s flight speed in straightaways
- Low wing to minimize drag and maximize maneuverability
- Narrow fuselage

Final Aircraft Design



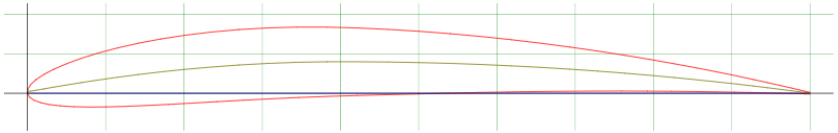
Aircraft Layout

- The battery is placed near the CG to improve maneuverability.
- Payload is placed just aft of the wing, causing a slight CG shift upon release.

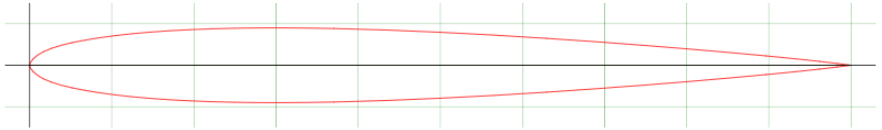


Aerodynamics

- The wing is designed using a NACA 4409 airfoil
  - The high camber of this airfoil allows the aircraft to reach a maximum CL value near 1.3
  - The low thickness of the airfoil contributes only 128 drag counts to the aircrafts total drag count of 390.
- The horizontal and vertical tails also were designed to reduce drag.
  - The horizontal tail using a NACA 0009 contributes 13 drag counts
  - The vertical tail also using a NACA 0009 contributes 6 drag counts.



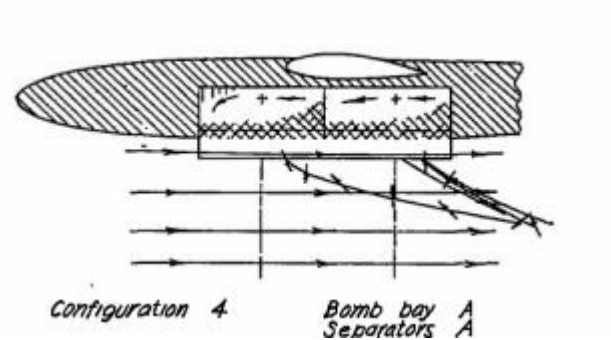
NACA 4409

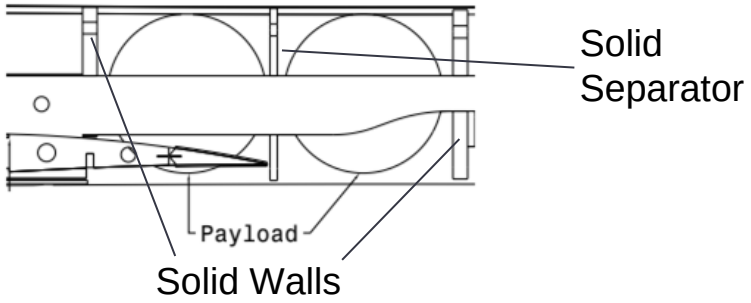


NACA 0009

Aerodynamics (cont.)

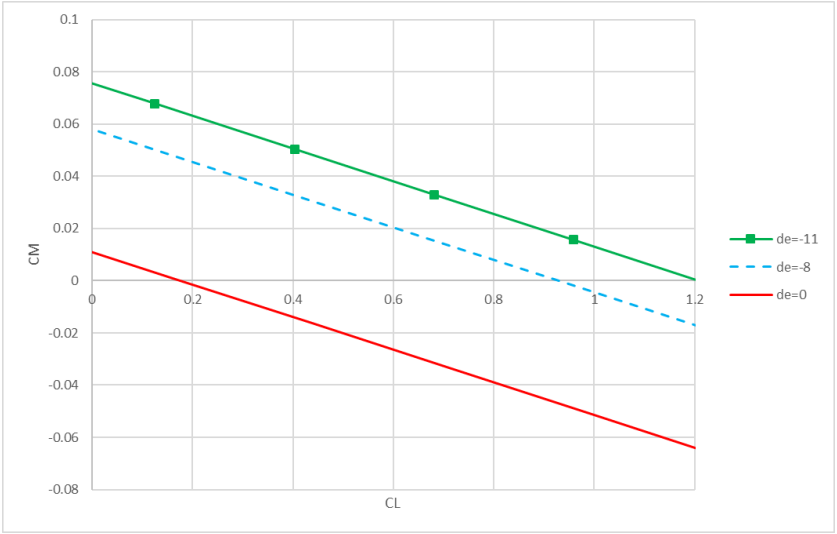
- In keeping with the design strategy of minimizing drag, a large concern for the Aerodynamics area was the drag contribution of the payload bay
  - NACA Research Memorandum L7D11 contains a wind tunnel study of several different payload bay openings, payload dividers, and aircraft features upstream of the payload bay to minimize drag.
  - In an effort to maintain all constraints configuration 4 was chosen, where the payload bay has a solid forward and aft wall, with a solid separator between the tennis balls.





Stability and Control

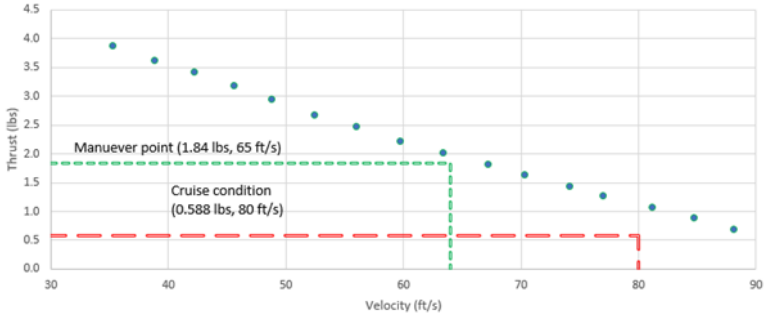
- Wing and tail incidences were set to trim the aircraft at cruise for the mission.
  - Wing incidence: -1.5 deg
  - Tail incidence: -2.0 deg
- The elevator was sized to 25% to maximize control while retaining servo accuracy for trim.
  - Cruise: 0.0 deg
  - Maneuver: -8.0 deg
  - Takeoff: -11.0 deg
- Ailerons were sized to 20% chord to allow for a 90 deg/sec roll rate.



C_M vs C_L for various elevator deflections (in degrees) during mission

Propulsion

- The main propulsion requirement was to reach a T/W ratio of 0.85 in a turn.
  - This required thrust of about 1.84 lbs to be applied at a speed of 65 feet per second.
  - The team was also interested in limiting the weight of the propulsion system, and limiting the size of the components to fit in the narrow fuselage.
- Major components:
  - 3S 2200mAh battery
  - 1200 kV motor
  - 11x7 propeller
    - By utilizing a smaller battery with a high kV motor, the team was able to balance weight and power effectively.

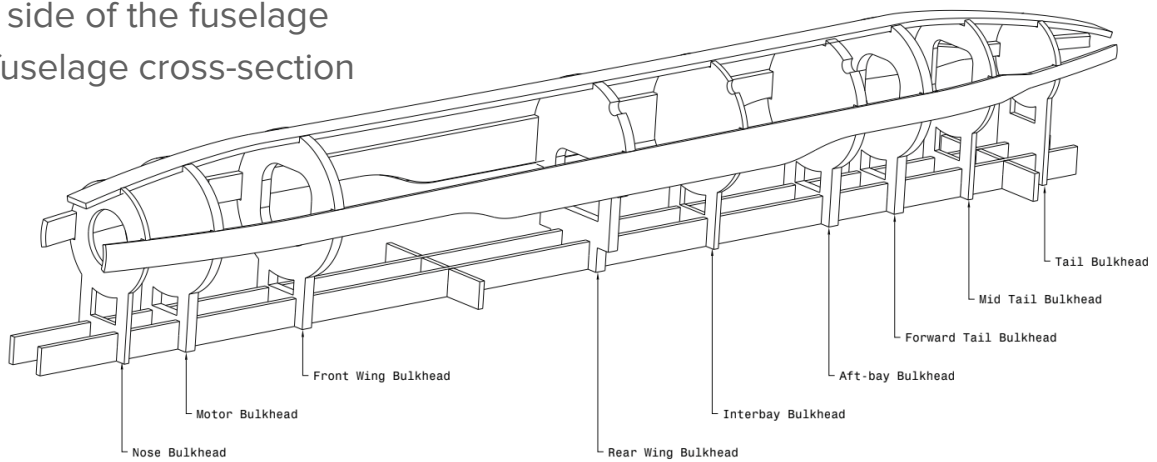


Thrust vs Velocity showing the critical Maneuver Design Point and the Cruise condition at 10,000 RPM.

Structures (Fuselage)

Fuselage structure was designed to maximize internal volume while providing adequate strength to sustain 10 g’s. Specific design elements include:

- 3 spruce longerons
  - 1 longeron on each outboard side of the fuselage
  - 1 longeron on the top of the fuselage cross-section
- 9 balsa bulkheads
- 1/32” balsa skin

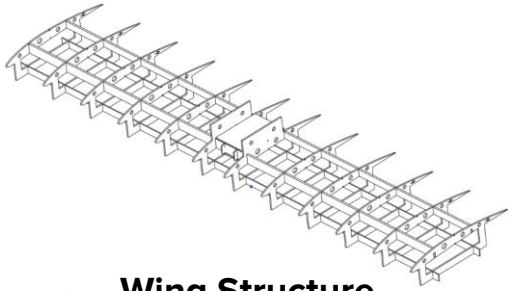


Fuselage tooling drawing - skin is hidden

Structures (Wing & Tail)

Wing structure was sized to handle all bending, shear, and torsion loads resulting from 10g flight. Specific design elements included:

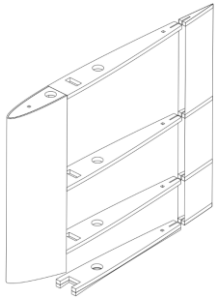
- 2 spruce spars
- 12 balsa ribs
- 1/32” balsa skin



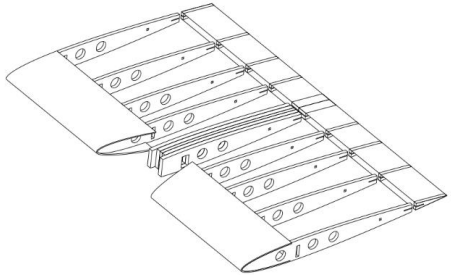
Wing Structure

The tail structure includes:

- 1 spar on the horizontal and vertical tails
- 1/32” balsa leading and trailing edges
- 8 ribs on H-tail, 4 ribs on V-tail
- MonoKote coating



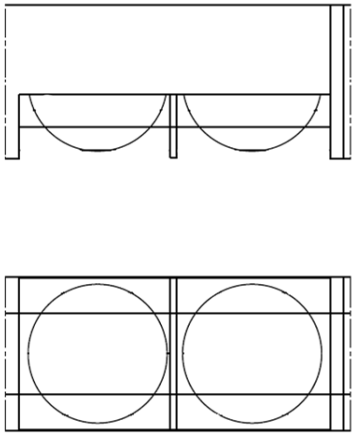
Vertical Tail



Horizontal Tail

Delivery System

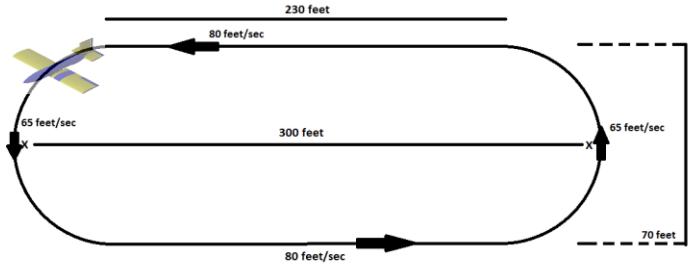
- The hardware of the delivery system involved a GPS module, an Arduino Uno, and a servo to release the retractable cords holding the payload in the aircraft.
- The software responsible for controlling this hardware was written to use the GPS position to determine aircraft heading, lap count, and distance to the target
- The release point is calculated from the velocity using kinematic equations and assumptions for roll distance and hardware response time.



Delivery System Hardware Drawing

Scoring Predictions

- The team designed the plane to fly at 80 feet per second down straightaways, and 65 feet per second in turns.
  - These two parameters give times of about 29 seconds for the straight sections and about 17 seconds around the corners
  - Total time: 46 seconds.
  - Total score per flight: 190 points
- Given the accommodations for additional flights like the landing skid, the team predicts scores of well over 350 points.



Flight Plan Diagram

Team Contact Information

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