Wichita State University

Team 17 Hurrycane

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Mission

- The Bronze Propeller Competition
  - *Storable Semi-Autonomous Emergency Supply Aircraft*

- General Mission Profile:
  - Deliver the plane in (11×7×36) inch box
  - Assemble and hand-launch within 5 minutes
  - Fly with full onboard payload for 2 laps
  - Autonomously drop payload(s) after 2nd lap within target zone
  - Complete 5 total laps and land safely

Responsibilities of Members

Chun Yu Lim (barrychunyu@gmail.com, 316-253 9611)

- Primary: Stability and controls, Secondary: Aerodynamics

Jongwon Lee (jxlee15@shockers.wichita.edu, 316-518-1814)

- Primary: Propulsion, Secondary: CAD

Rebecca Rogers (becky.rogers26@yahoo.com, 651-285-0651)

- Primary: OIA, Secondary: Structures

Scott Thompson (Scottmath13@gmail.com, 316-648-4172)

- Primary: Structures, Secondary: CAD

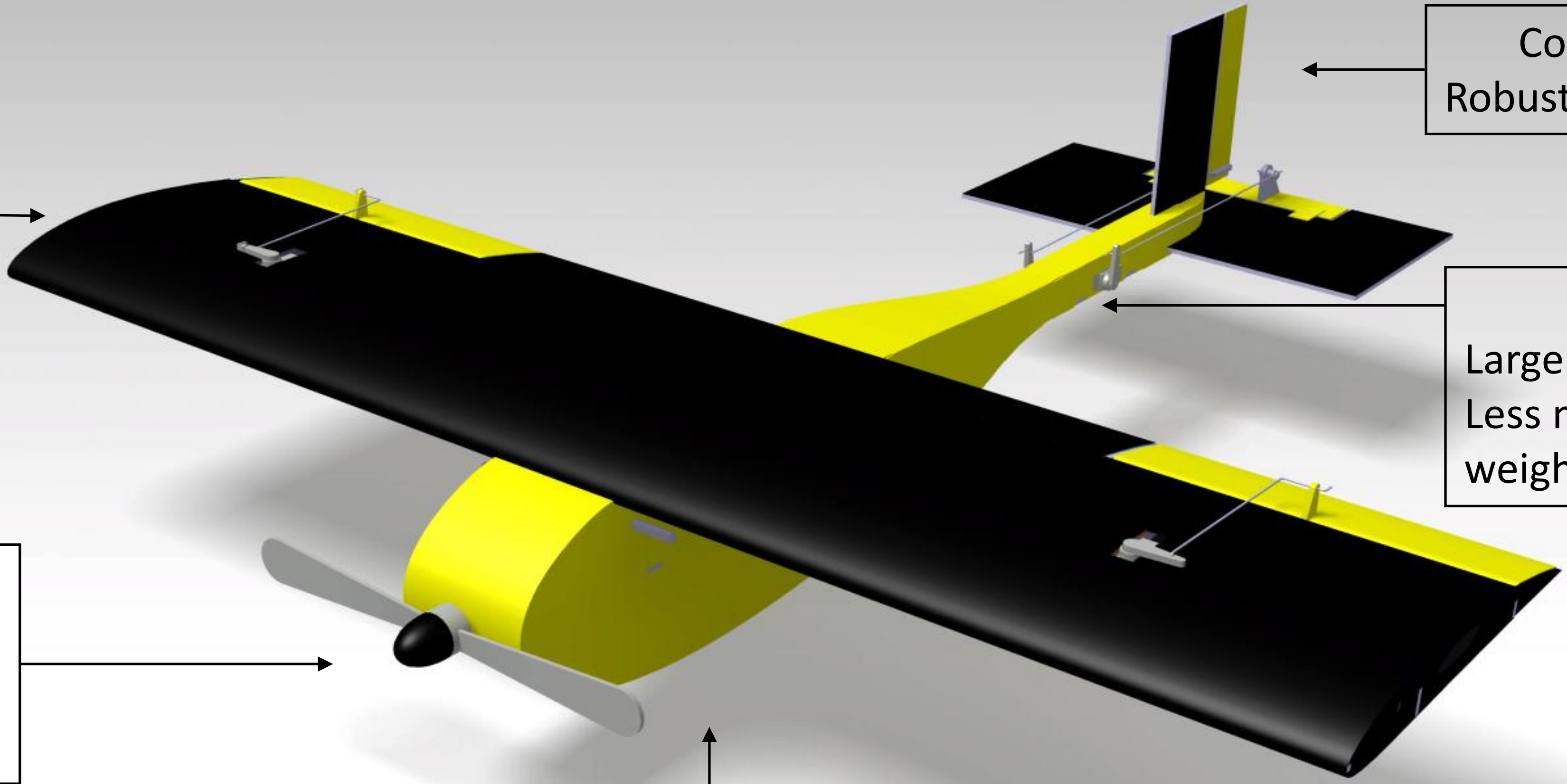
Yee Min Choo (ymchoo97@hotmail.com, 316-226-5906)

- Primary: Aerodynamics, Secondary: Stability and controls

T-17 Configuration

High Wing:
High stability and Better ground clearance

Conventional Tail:
Robust, Simple to analyze

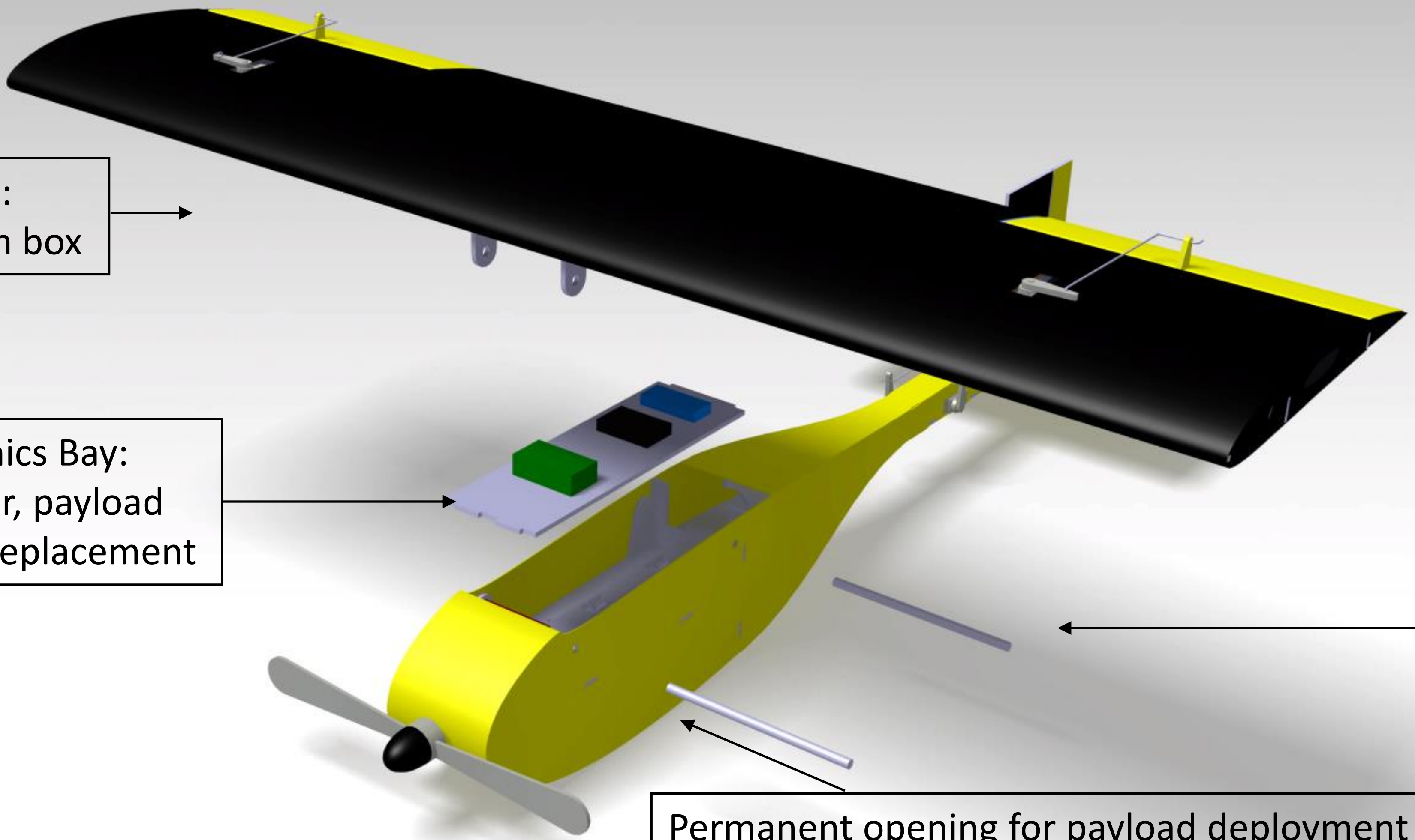


Boom Design:
Larger payload capacity, Less material, Lower weight

Tractor Propulsion:
Safe for hand launch, Prevents motor from over-heating.

Streamlined Fuselage:
Reduced drag and flow separation

T-17 Wing Removal



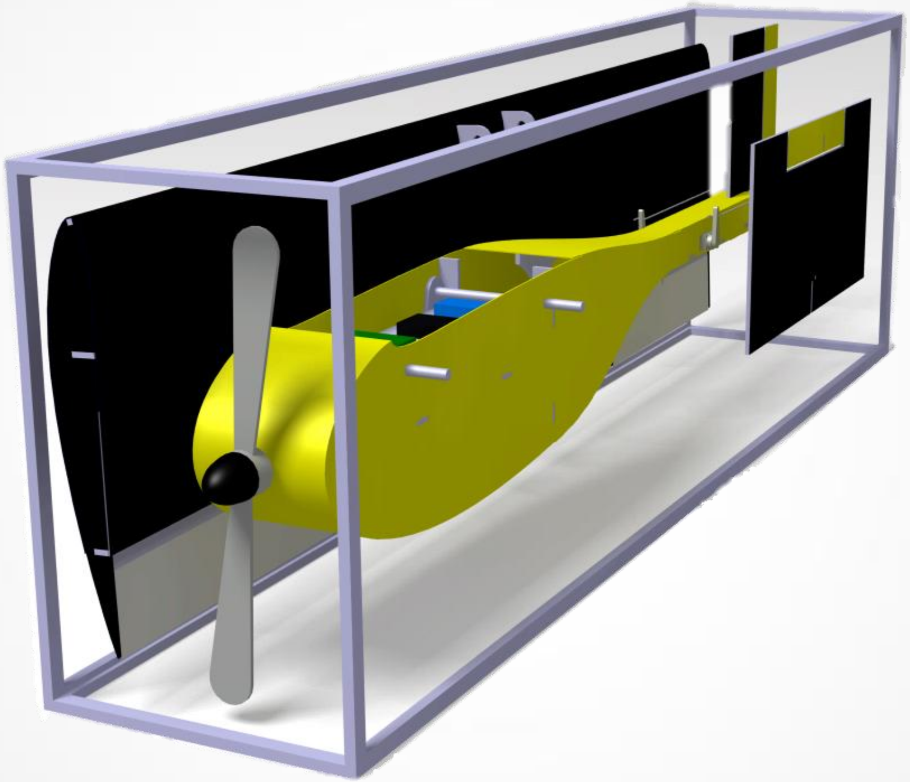
Removable Wing:
Easy to assemble from box

Removable Avionics Bay:
Quick access for repair, payload loading, and battery replacement

Dowel Rod Connectors:
Holds the wing and avionics floor in place

Permanent opening for payload deployment

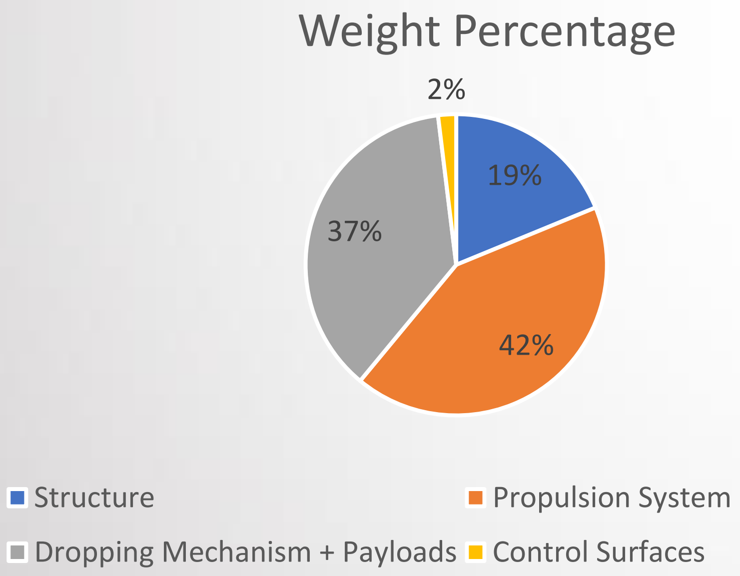
Pre-Assembly View

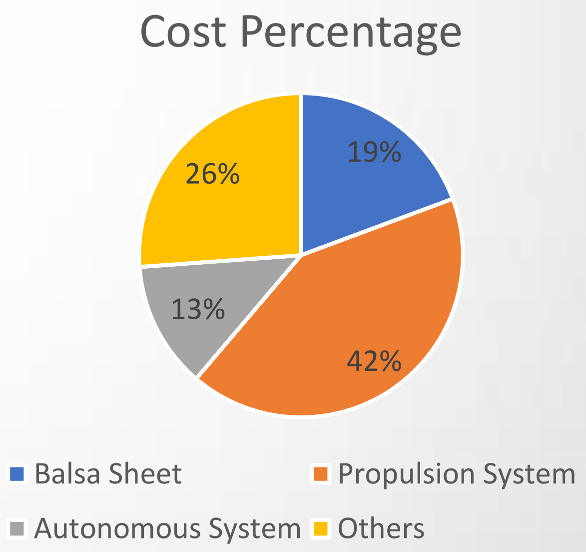


- Detachable wing, fuselage and tail fits inside a (11×7×36)inch box as required in mission

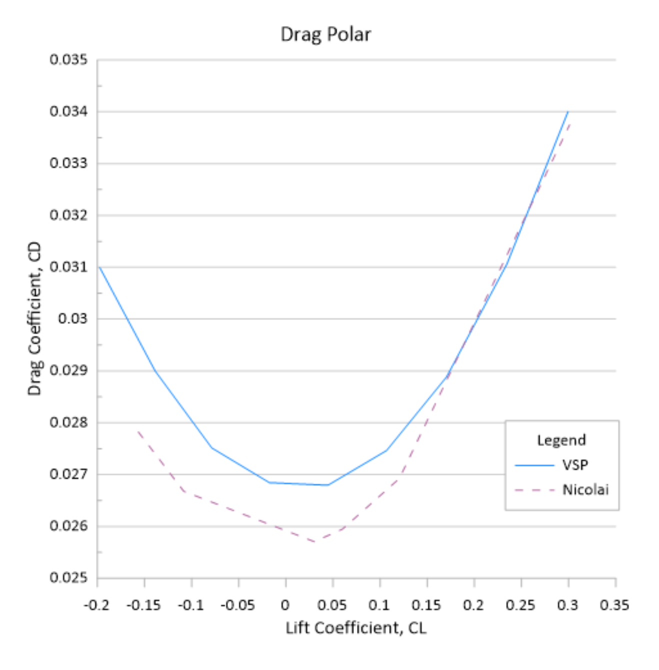
T-17 Advantages

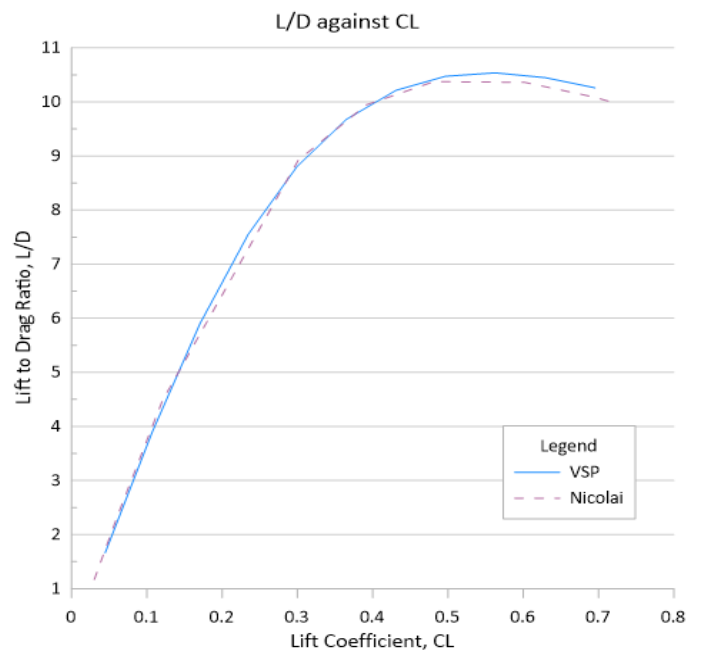
- Lightweight Aircraft – 1.65 lb. (With 3 payloads)
- Low material cost – $ 603.24
- Quick assembly and payload loading





Aerodynamics



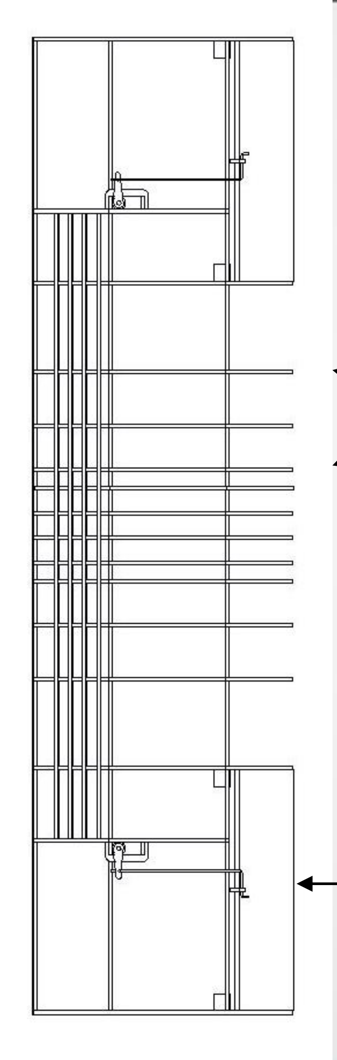


Aerodynamic Performance	
C_{Lmax}	0.984
Stall angle	AOA 12°
C_{Do}	0.0256
$(L/D)_{max}$	10.5

- NACA4412 Fix Wing (no taper/sweep)
  - Gradual stall characteristics with high lift performance.
- NACA0024 airfoil shaped Fuselage
  - Create a smooth streamline to decrease drag.
- Drag prediction methods
  - Flat Plate Assumption, Nicolai drag
- VSPAero software for validation
  - Designed digital aircraft model and computed plots of aerodynamic performance.

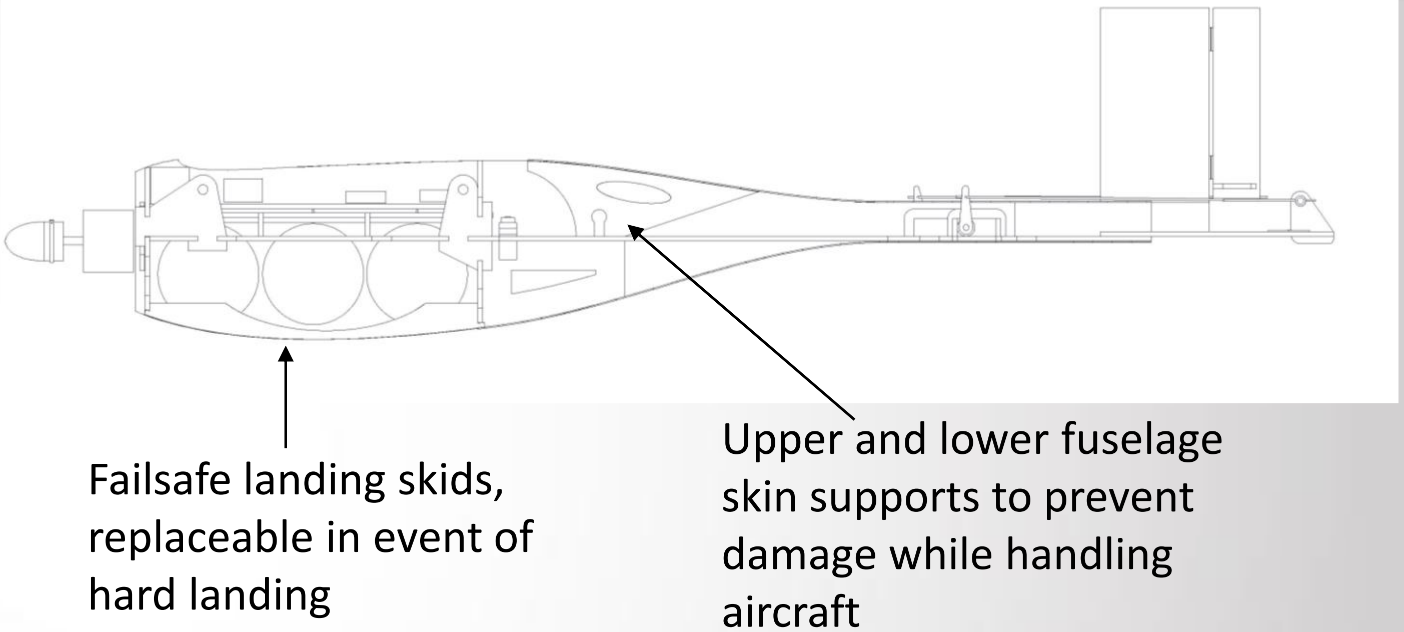
Structures- Wing Design

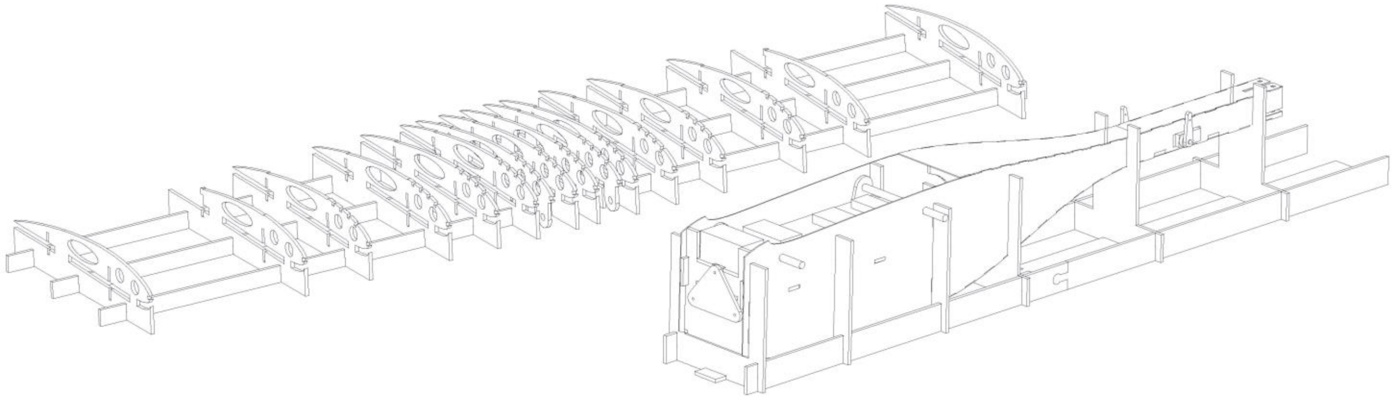
- Semi-monocoque design
  - Primary loads carried through balsa skins
  - Balsa ribs to maintain shape and prevent buckling
  - Stringers and secondary upper skin to prevent buckling
- Attachment to fuselage through specialized ribs
  - Dowels used to attach wing to fuselage



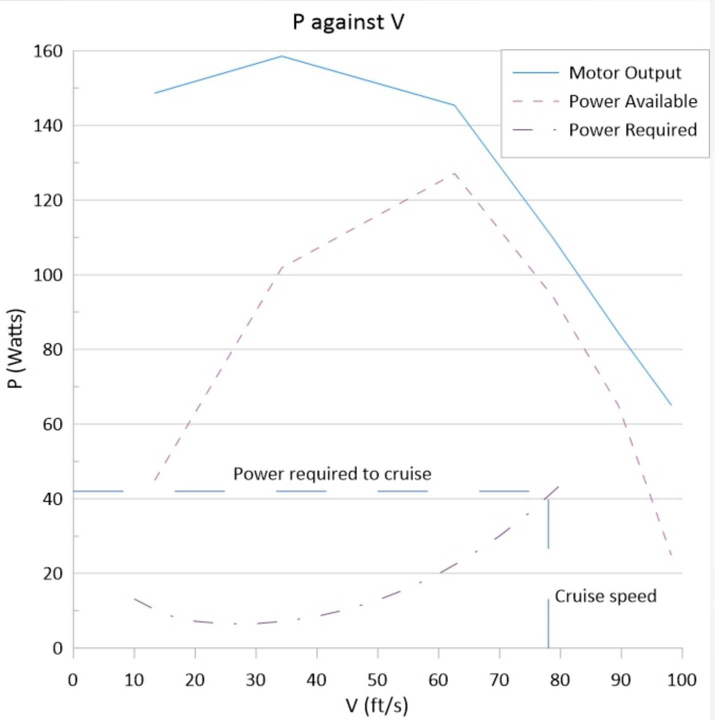
Structures- Fuselage and Tooling

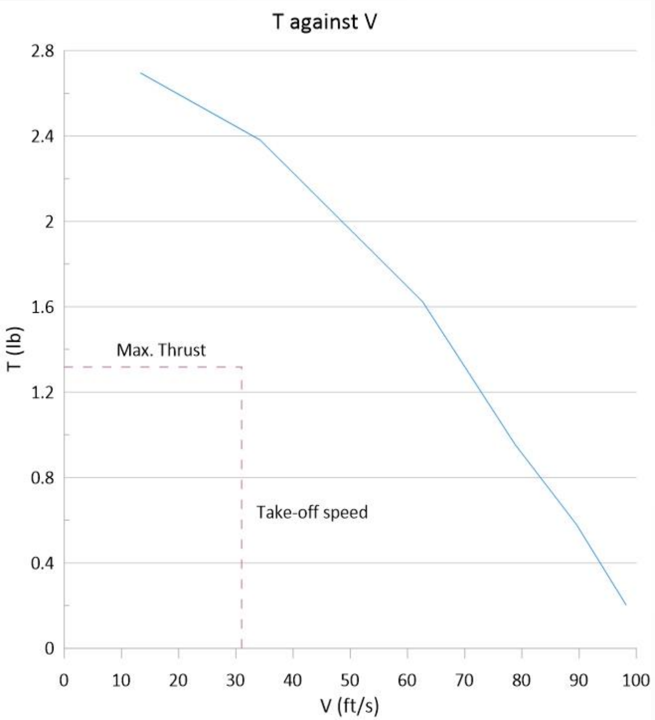
- Simple streamlined fuselage design
  - ➢ Side skins carry load with internal keelson structure
  - ➢ Removable horizontal stabilizer for storage
  - ➢ Removable avionics mounting for ease of maintenance and setup
- Tooling
  - ➢ Tooling for Wing and Fuselage outer skins
  - ➢ Provides support for structures to ensure alignment and shaping of aerodynamic surfaces
  - ➢ Wing tooling acts first as rib spacing and alignment then as a lower wing skin former





Propulsion



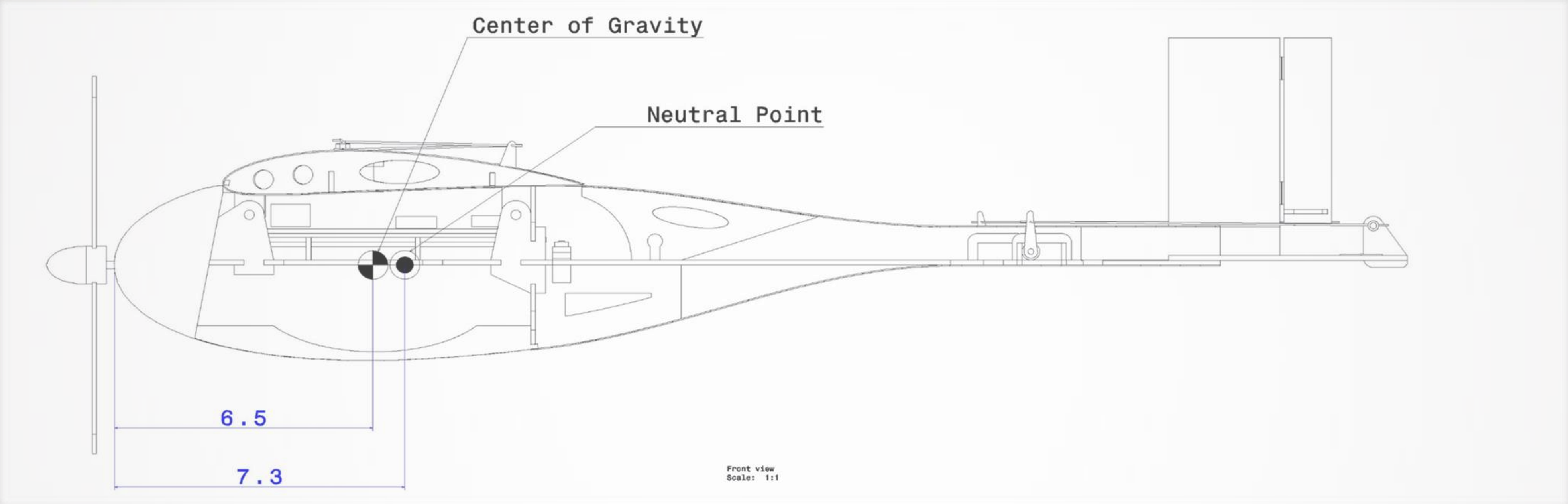


- A single battery powers both propulsion and autonomous system.
- The propulsion system has max current draw of 25Amp to produce cruise speed of 78ft/s.
- Following the strategy, system was optimized to maximize cruise speed to reduce mission time.
- System provides sufficient power and thrust for all flight phases

Battery	Venom LiPo 3 Cell, 11.1V, 35C, 1500mAh
Motor	Eflite 480BL 910Kv Brushless
Propeller	Electric APC 10X7

Cruise Speed	78ft/s
Stall Speed	26ft/s
Endurance	240 seconds

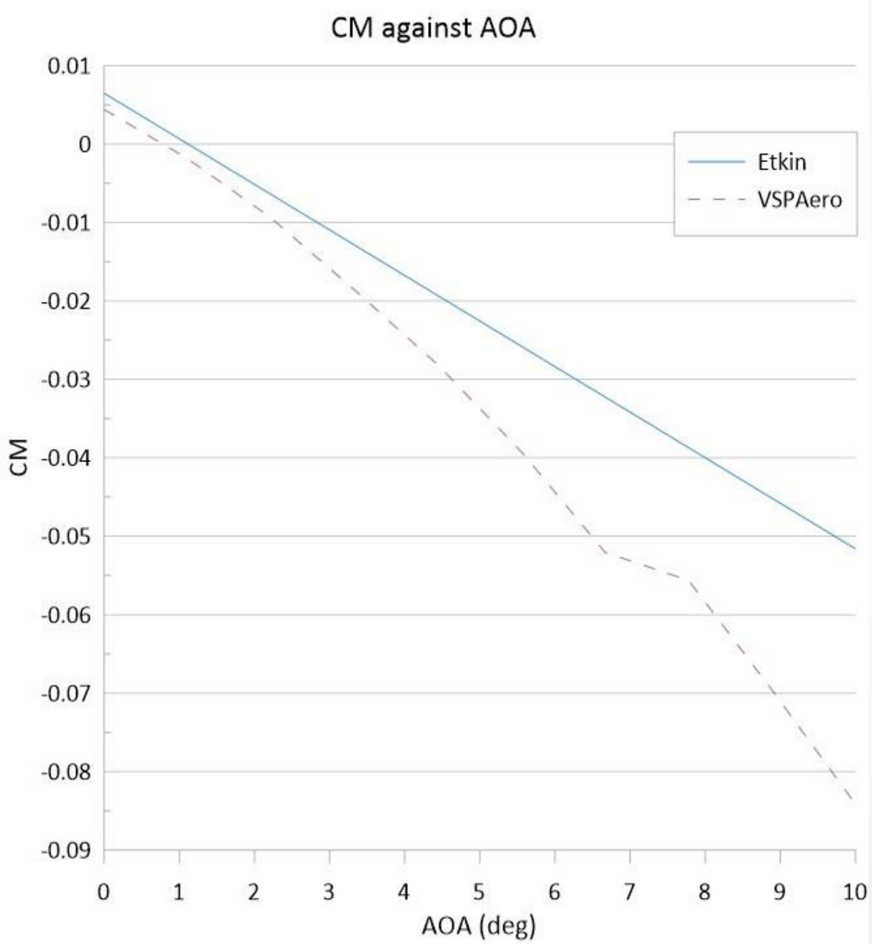
Stability



	Location from Nose
Neutral Point, N.P	7.3”
Center of Gravity, C.G	6.5”
Static Margin	9%

- Low positive static margin
  - ➢ More maneuverability while remaining stable.
- Payload was placed at target C.G
  - ➢ Prevents shifting of C.G before and after payload release.

Sizing of Control Surfaces

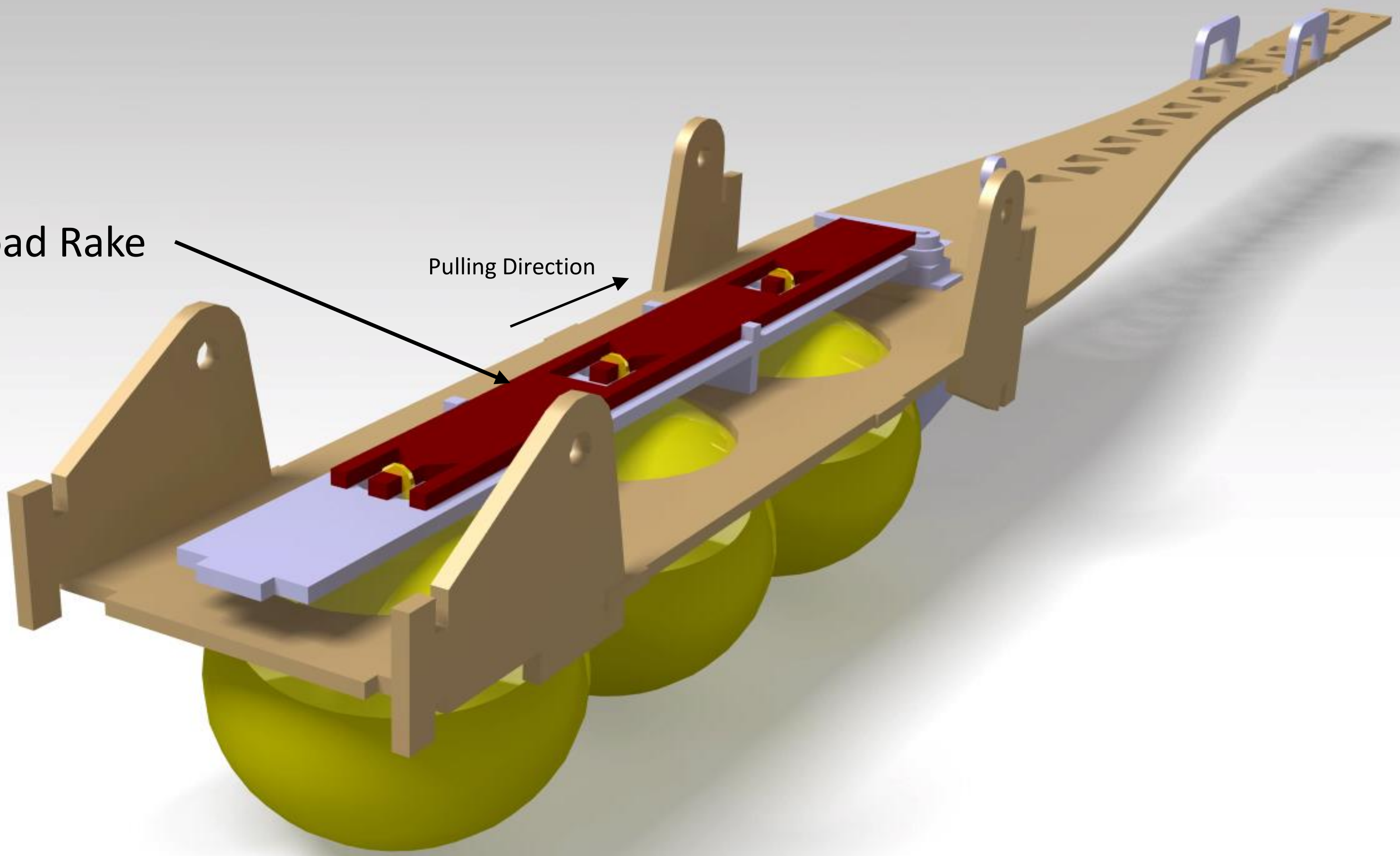


	Size (Span x Chord)	A.C. Location from Nose
Wing (NACA 4412)	34” x 9”	6.5”
Ailerons	8.6” x 2.2” (50% x 25%)	-
H-tail (1/8" Flat Plate)	12” x 6”	28”
Elevator	6” x 1.2” (50% x 20%)	-
V-tail (1/8" Flat Plate)	5” x 4”	28”
Rudder	5” x 1.2” (100% x 30%)	-

Trim Point	Elevator Deflection
Take - off	-5.2°
Cruise	-0.3°
6 g’s Maneuver	-6.8°

- ±15° as maximum control surface deflections
  - Low Reynold’s number condition.
- VSPAero software for validation
  - Utilized wind tunnel testing model to validate with VSPAero results.
  - Obtained stability data from digital model to compare with analytical data.

Dropping Mechanism



- Simultaneous payload release prevents loss of stability from non-synchronous deployment.
- Payload will be attached to mechanism using rubber band and small ring.

Autonomous Logic & System

- Control board: Arduino Micro
- Sensor: MPU-6050 6-axis gyroscope and accelerometer
- Multiple algorithms running parallel ensure payload drops where and when it needs to
  - Timer
  - Track number of turns
  - Triangulate drop zone location & detect when flying over
- All three must agree to drop
- Failsafe timer guarantees drop if primary algorithms do not reach consensus by a certain time

Flight path: