The Breadbox

"Aviation is our bread and butter"

Bronze Propeller Competition 2020

Sponsored by: BOEING

Wichita State University

Team Members:

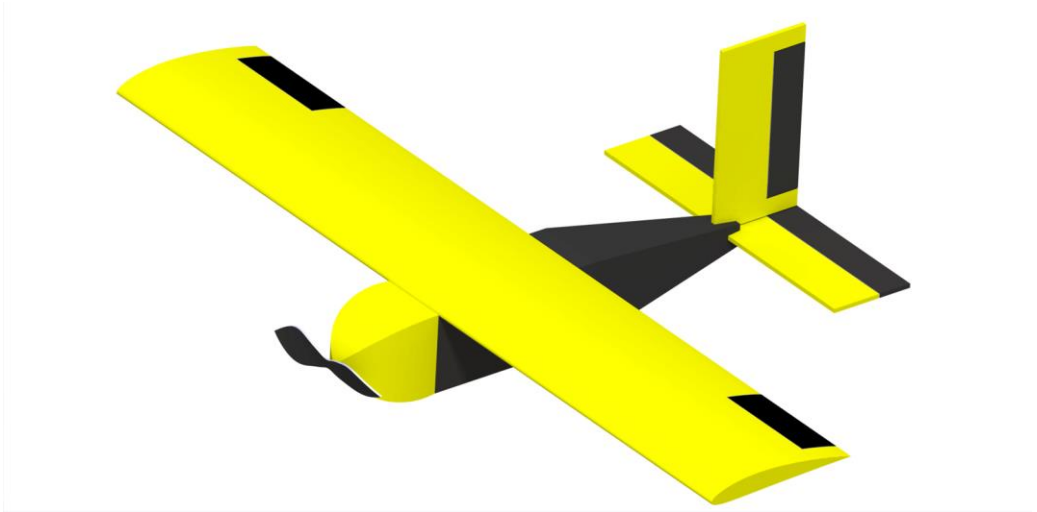
Jun Wei Ng

Zhao Heng Tan

Cameron Fitzgerald

Bik Sheng Sia

Surrendiran Thiagaraja Pillai



The Bronze Propeller Competition 2020

Mission:

Design a semi autonomous aircraft that can carry and release emergency supplies accurately which are represented by tennis balls.

Score:

NB = Number of balls dropped in the particular zone (40*40 = 1 point, 20*20 = 2 point)

MT = Mission time that the aircraft takes to complete the mission (in second)

MSCR = NB*(120/MT)^4 => Mission Score

Final Score = Sum of all mission scores - (Number of out)^2

Mission Requirements

1. Single Li Po battery needs to be used for propulsion.
2. The model aircraft can only be hand launched.
3. Fuse must be within 6 inches of propeller.
4. Entire aircraft must fit inside 11x7x36 inch box.
5. All aircraft components must remain attached.
6. Tennis balls must be released independently.
7. Restrictions on building supplies (no exotic materials, only certain wood thickness & glues allowed).
8. No actuating doors or pilot maneuvers to release payload.
9. Payload must be dropped autonomously in either 40’x40’ zone (1 point) or 20’x20’ zone (2 points).
10. Plane must fly 5 complete laps.

Design Strategy

Based on a scoring analysis, our design strategy is to carry a moderate payload at high speed. The Breadbox's payload ejection system was designed to keep the payload from "floating" in the payload area due to unfavorable pressure once the retractable payload cover is retracted. This increases our drop zone accuracy, to guarantee that the payload will land in a small drop zone, every time.

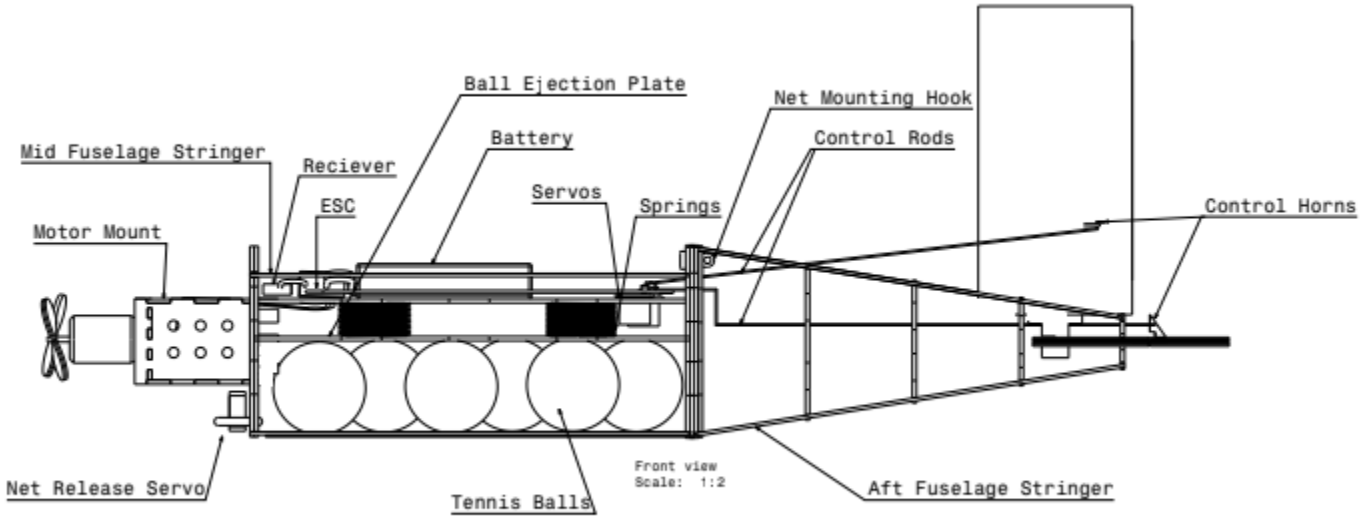


Figure 1 : Side View of the aircraft

Aircraft Unique Features

- **Automated payload ejection**

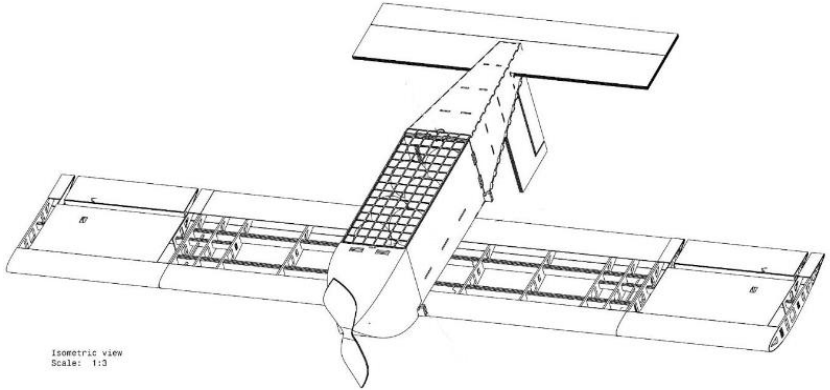
  With GPS equipped, Payload is ejected autonomously once designated drop zone is detected
- **Automated payload area cover**

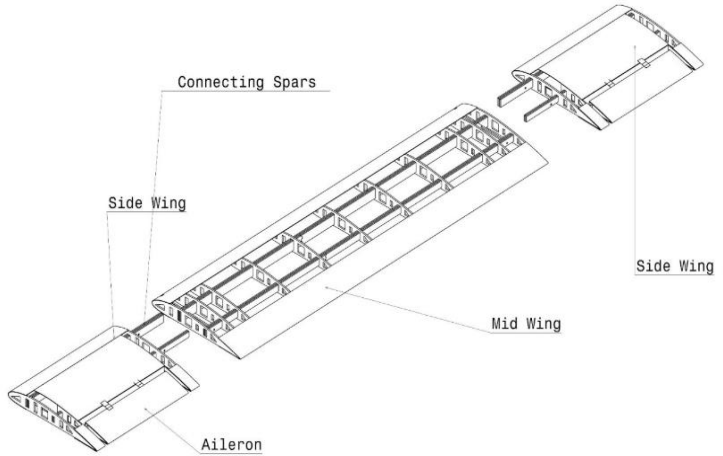
  Payload cover will be closed after payload ejection, which create streamlined airflow.
- **Retractable payload deployment cover**

  The net will be retracted back into the fuselage to decrease drag.
- **Payload flexibility**

  The space can be used for any other payload with any volume within 8.35 x 6.2 x 2.7 in
- **Multi-section detachable wing for easy storage**

  Wing is built in 3 sections

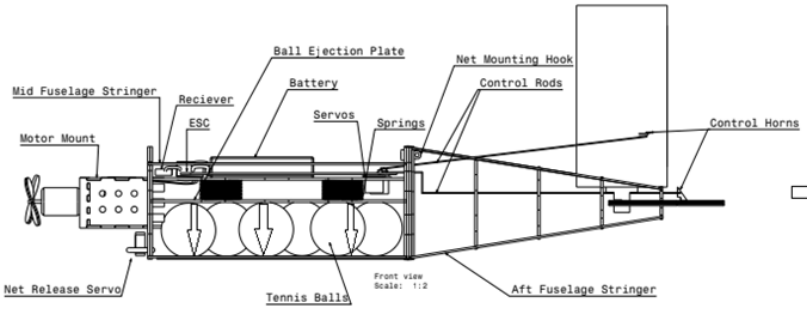




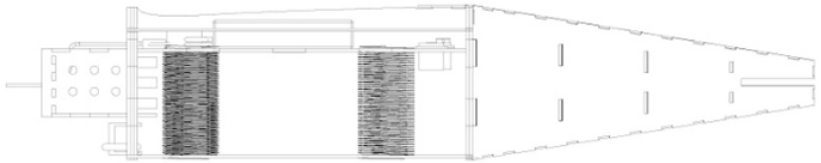
Payload Release Mechanism

- Once the net has been released, the springs will extend to eject the tennis balls using the Ball Ejection plate.
- The released net will be retracted back into the fuselage through a pre-cut hole using a rubber band that is attached to the Net Mounting Hook inside the fuselage.
- The Ball Ejection Plate will be stopped by the two stringers at the bottom of the fuselage and cover the payload area, providing a flat bottom for a streamlined flow. The springs will keep the ejection plate in place throughout the flight.

Before



After



Performance Specifications

Aerodynamics

Parameter	Design Prediction
Airfoil	NACA 4412
Maximum Lift Coefficient	1.17
Wing Area	4.3 sqft
Span	5'
Aspect Ratio	5.8
Drag Coefficient at zero AOA	0.02
Stall Speed	25 ft/s
Cruise Speed	90 ft/s

Structures

Parameter	Design Prediction
Empty Weight	2.2 lb
Maximum Payload	0.8 lb
CG Location	10.8" from Ref. Point
Maximum Wingtip Deflection	+0.41"
Maximum Load Factor	+7g
Minimum Load Factor	-2g

Aircraft Component	Material
Wing Spar	Bass Wood
Wing Ribs	Balsa Wood
Fuselage Longerons	Balsa Wood
Fuselage Ribs	Balsa Wood
Skin (Wing)	Coverlite
Skin (Fuselage)	Balsa Skin

Performance Specifications (Cont'd)

Propulsion

Parameter	Design Prediction
Max Power Available	393W
Propeller Diameter	11"
Total Propulsion System Weight	1.53 lb
Battery Pack	14.8 V, 4s, 2700 mAhr
Maximum Current Draw	48 A
Endurance	90 s
Stall Speed	25 ft/s
Max Speed	92 ft/s
Corner Speed	70 ft/s
Minimum Turn Radius	127.37 ft

Stability and Control

Parameter	Design Prediction
H-Stab Volume Ratio	0.87
V-Stab Volume Ratio	0.04
H-Stab Area	134.6 sqin
V-Stab Area	80.7 sqin
Elevator % Chord	40
Rudder % Chord	38
Elevator Deflection Angle	+/- 15 deg
Rudder Deflection Angle	+/- 15 deg
Aileron Deflection Angle	+/- 10 deg
Static Margin With Payload	14%
Static Margin Without Payload	20%
Max Crosswind	10 mph
Max Turn Load	5g

Other Important Aspects

- The wing are attached to the fuselage rib mountings using rubber bands
- In the event of a crash, the rubber band would stretch or snap after absorbing a large amount of energy, minimizing damage to the wings and fuselage.
- The aircraft wing is built with a safety factor of 1.5
- A 50A fuse is used to protect the electronic components in case of a short and as a safety device during assembly, to keep the propeller from spinning prematurely while the aircraft is being handled
- The fuselage skins are interlocked together using a castle joint, to better transfer the tensile loads and to ease the alignment of parts during the building process

Team Composition

Aerodynamics: **Bik Sheng Sia**

bxsia@shockers.wichita.edu

Structures: **Zhao Heng Tan**

zxtan@shockers.wichita.edu

Stability and Control: **Jun Wei Ng**

jxng4@shockers.Wichita,edu

Propulsion: **Cameron Fitzgerald**

cpfitzgerald@shockers.wichita.edu

Mission related aspects: **Surrendiran Thiagaraja Pillai**
sxthiagarajapillai@wichita.edu