Structure/Aero Design Document

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1. Balsa Wood Information

1.1 Current new piece inventory

- $4\,(\frac{1}{16}" \times 3" \times 36")$
- $4\,(\frac{1}{8}" \times 3" \times 36")$
- $4\,(\frac{1}{16}" \times 4" \times 36")$
- $4\,(\frac{1}{8}" \times 4" \times 36")$

1.2 Material Properties

$\rho_{avg} \simeq 225\frac{kg}{m^3}$

This was obtained by finding the total volume of the balsa wood from section 1.1, and then weighing the wood to find a mass. The rest was done using the basic equation of density, mass over volume, to find a density.

2. Design Approaches

2.1 List of Fuselage Approaches

- Payload box
- Full length Fuselage
- Tapered Fuselage
- Open Fuselage

2.2 Fuselage Approaches Analysis

The *payload box* is a small rectangular box that is in the front of the craft. This will house the battery, microcontroller and any other necessary parts. It will have smaller supports run to the empennage of the craft. The wings will be attached to this payload box. The motor will attach to a frustum attached to the front of the payload box. This design will reduce overall weight by not having the whole fuselage run the full length of the aircraft. It will also have equal structural strength to the full length and tapered fuselage, and will have a greater structural strength to the open design.

The *full length fuselage* is just like the box above however it will run the full length of the fuselage. This will make the manufacturing process easy and provide good structural strength compared to the other designs.

The *tapered fuselage* is the same as the full length but it will taper to a point at the end of the fuselage. This would have a lower weight than the full length fuselage and could have equal or greater structural strength. It would however be the most difficult to produce with the materials available.

The *open fuselage* could look like the payload box or the full length fuselage. The diffeces it the sides, top, and select parts of the bottom would be cut out. Some supports would be periodically added to increase the structural strength. This design could massively cut down on weight of the craft. It would also help with any heating issues the battery or esc could have. It would be very time consuming to manufacture and design. Making sure cuts are done in correct spots, and that it could have the support to handle normal operation.

An AHP could be used to determine the best design mathematically, but it will not be used instead there will just be a discussion. The tapered design can be ruled out at the start because of the manufacturing challenges it presents. The full length fuselage can also be ruled out as it is the same as the payload box but heavier. The full length fuselage would be the easiest to produce, and give a little lift over the other options. These pro's don't beat out the other two remaining design ideas. Between the last two ideas the open fuselage pros are similar to the payload box, but it has an increased design complexity. This make the choice the payload box

2.3 List of Chord Length Approaches

- 4 inch chord
- 3 inch chord

2.4 Chord LengthApproaches Analysis

The wingspan will be 36 inches to maximize lift capabilities. The reason it is 36 inches and 24,50, etc is due to the size of the balsa wood pieces. The difference in chord length will change the overall aerodynamic capabilities of the craft. A 3 inch chord would return an aspect ratio of 12, vs the 4 gives an aspect ratio of 9. An aspect ratio of 12 is quite extreme and will reduce the overall maneuverability of the craft. A chord length of 4 inches is the option.

2.5 List of Airfoil Approaches

- Wedge
- Flat plat

2.5 Airfoil Approaches Analysis

The flat plat only offers a reduction in the manufacturing difficulty, and the wedge gives more aerodynamic performance. The wedge also allows for a range of different configurations to create different aerodynamic profiles. The wedge is the option, more details about the size of the design will be included later.