



Titan Dynamics

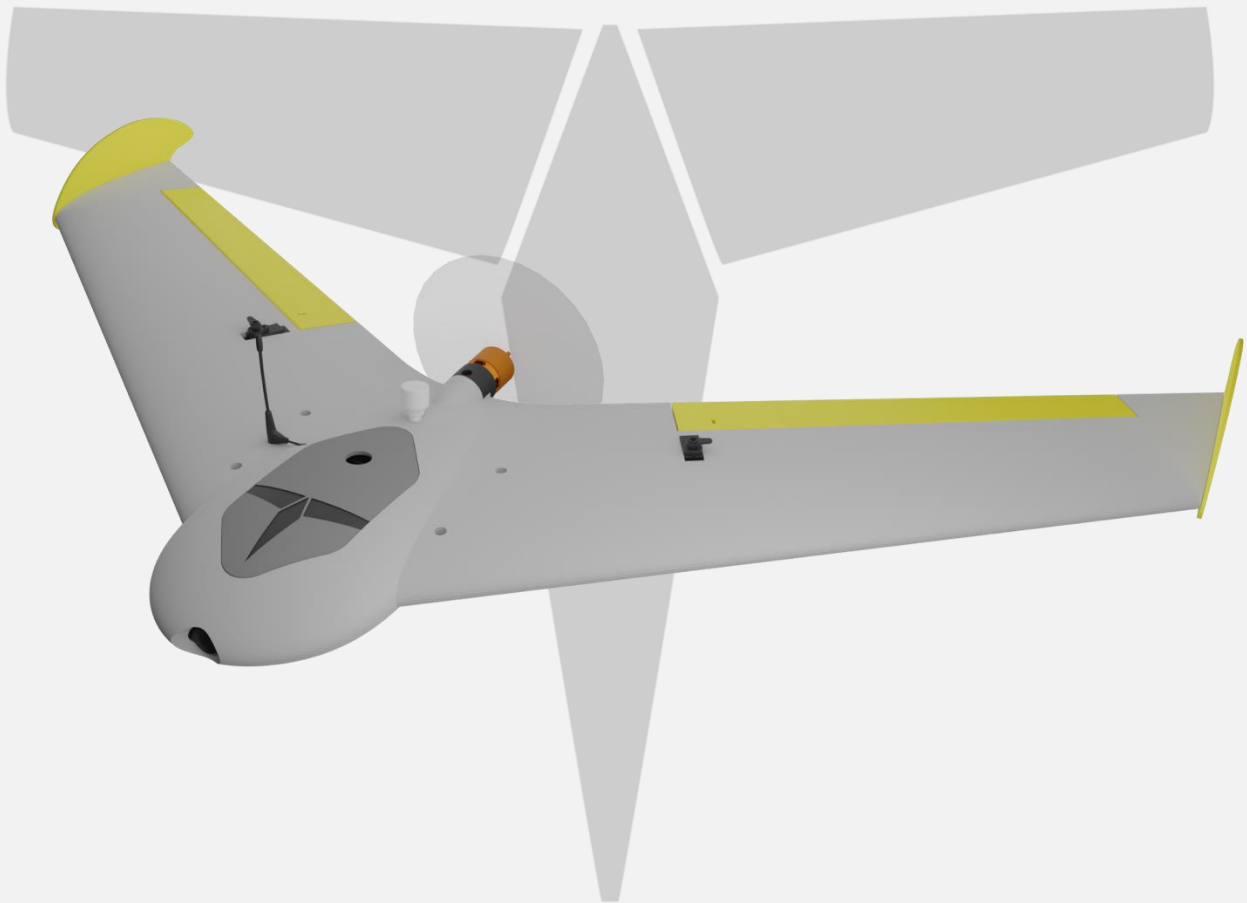
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# Titan x TBRC – Spec Racing Wing

<https://www.titandynamics.org/3dhangar/p/titan-x-tbrc-spec-wing>



Build & User Manual

Revision 1.1



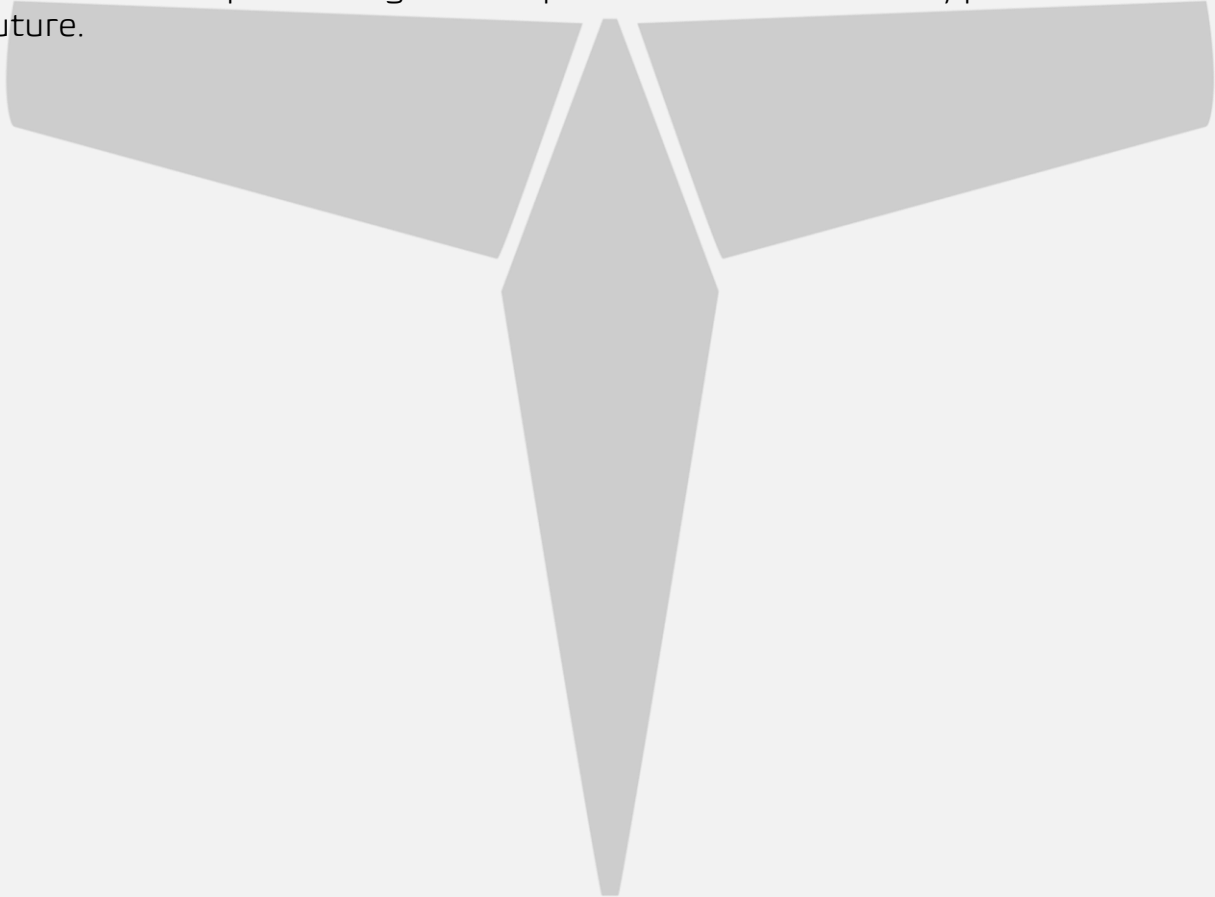
## Contents

Section 1: Model Information .....	3
Section 2: Model Specifications & Performance.....	4
2.1: Physical Characteristics .....	4
2.2: Aircraft Performance:.....	5
2.2.1: Drag, Efficiency, Power, and Angle of Attack at Varying All-up-weights: .....	6
2.2.2: Turn rate, range, endurance, and max climb rate for a variety of different battery configurations: .....	11
Section 3: Required Build Materials .....	14
Section 4: 3D printing .....	15
4.1: Things to know before you start printing.....	15
4.2: Part Orientation .....	16
4.3: Tuning "hole horizontal expansion" .....	18
4.4: Bed Adhesion and warping .....	18
Section 5: Assembly of 3D Printed Parts.....	20
Section 6: Final Setup & Tuning Tips .....	22
Section 7: Additional Images.....	23



## Section 1: Model Information

With great collaboration and input from the world renowned [TBRC Wings](#), we are proud to present the 3D printed Spec Racing Wing. You can expect the same great handling and high maneuverability as the foam versions with the added ability to print, customize and rebuild to your heart's desire. The wingtips are specifically designed to improve performance by TBRC's Anthony Lloyd Watton, inspired by the shape of a whale tail. Simplicity and ease of assembly were paramount during the design process. It's printable on smaller printers, and boasts a relatively small part count and print time compared to our other offerings. The wings are also removable for transport or easy swapping at the field. While not competition legal, we hope the rules will allow fully printed airframes in the future.





## Section 2: Model Specifications & Performance

### 2.1: Physical Characteristics

General Stats:

- Wingspan: 910mm
- Wing area: 1703cm<sup>2</sup>
- Maximum take-off Weight: 1.6kg
- Efficiency: 0.67 Wh/km @ 900g AUW
- Cruise speed: 65-75kph
- Recommended prop diameter: 6-8 inches

Designed to conform to the following:

- Wingspan: 36" +/- 1/2" Does not include winglets
- Airfoil: NACA 0014
- Wing sweep: 12" +/- 1/2"
- Chord: central- 9", tip- 6" +/- 1/2" (includes elevons!)
- Root Chord thickness: 1.25" +/- 1/4"
- Tip Chord thickness: 0.85" +/- 1/4"
- Motor: Cobra CP-2210 2200kv Motor
  - T-Motor AT2310 2200kv Motor
  - Turnigy D2826-6 2200kv Motor
- Battery: 3s 2200 (Max Charge 4.2V per Cell)
- Prop: Cobra Motor- APC 6X4, T-Motor APC 6x4, Turnigy Motor- APC 6X5.5E



## 2.2: Aircraft Performance:

Below are some plots showing aircraft performance at different all-up weights. **The values predicted are not perfect, and values like efficiency can vary greatly based on the choice of motor and propeller, among many other factors.** These just serve to give a rough idea of the sort of performance you can expect and give you an idea of the flight envelope of your aircraft before you fly it and help narrow in on the most efficient cruise speed. The stall speed assumes a  $C_{Lmax}$  of 1.3, and the minimum speed line is just 20% above stall speed. Below the minimum speed, a tailwind gust can cause the aircraft to stall unexpectedly, so be careful.

Using the drag plot can help figure out how much thrust you'll need in level flight at a given speed. This allows for the use of propeller data from companies like APC to choose the best propeller for the type of flying you want to do.

The plot depicting power required for flight can help you estimate your loiter endurance at a given speed. If you want the maximum time in the air, fly at the speed which uses the least power to stay in the air.

The efficiency plot shows you what sort of efficiency to expect at each speed. With it, it's possible to choose the best cruise speed for your setup and see how changes in that speed may affect your efficiency.

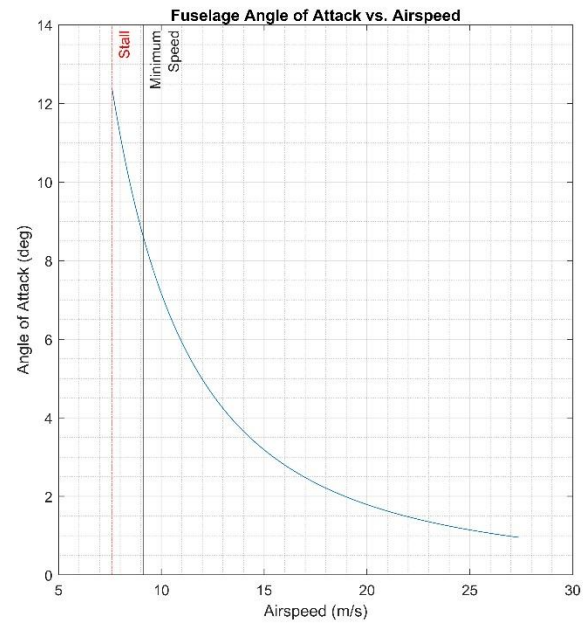
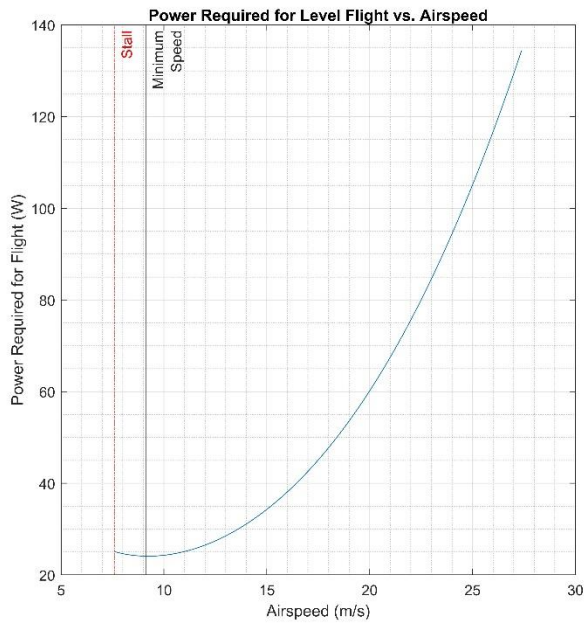
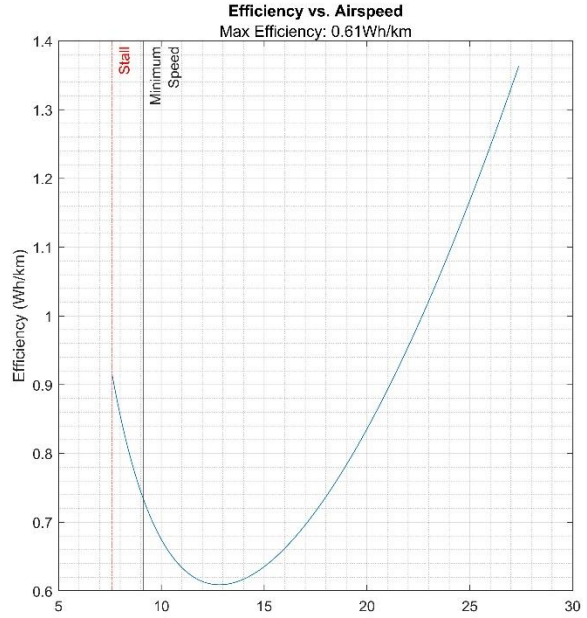
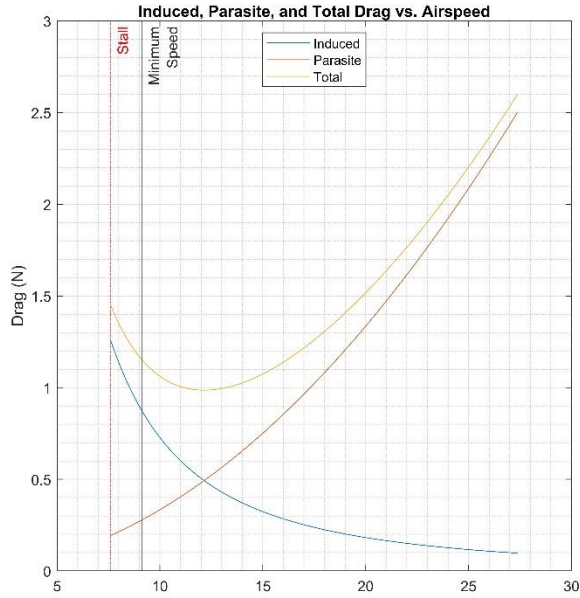
The fuselage angle of attack plot shows you what angle of attack the fuselage will be at a given speed. This can be useful when setting the TRIM\_PITCH\_CD parameter in Arduplane to the angle of attack value that corresponds with your cruise speed.

The plots in section 2.2.2 are just to give an idea of the sort of performance that can be expected for certain battery configurations. **They are not a guarantee of performance,** as there are too many variable to account for when individuals build the aircraft. Extra draggy antennas, inefficient motors, print quality, etc. can all change flight performance drastically.



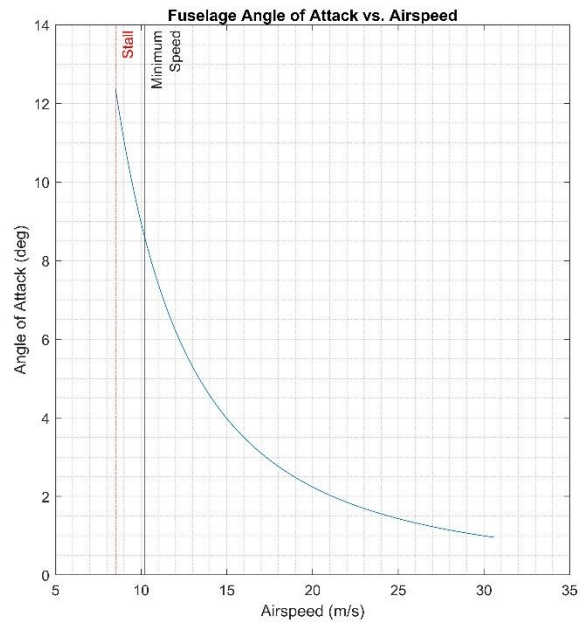
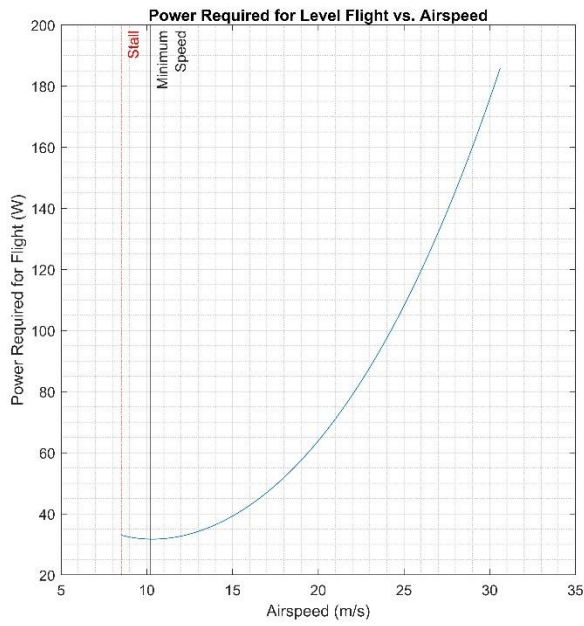
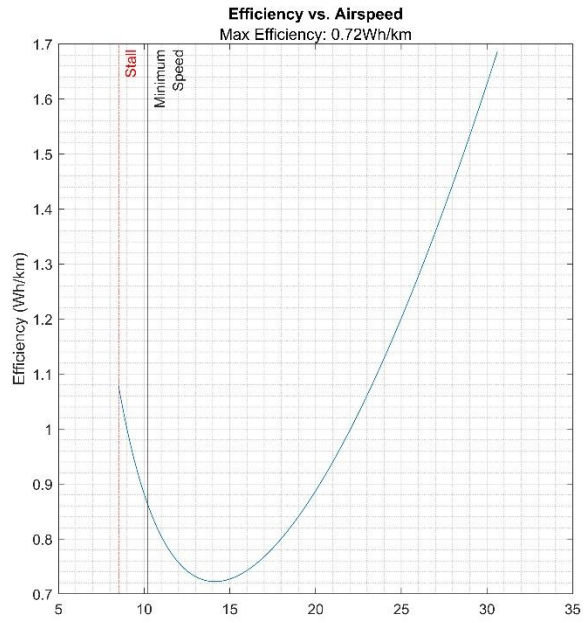
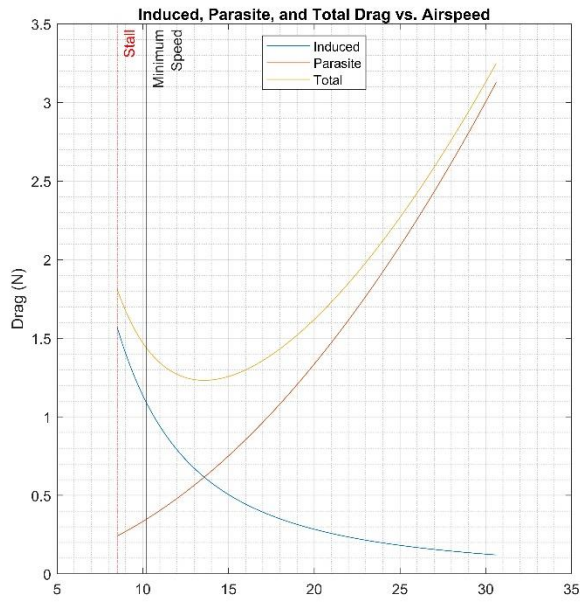
## 2.2.1: Drag, Efficiency, Power, and Angle of Attack at Varying All-up-weights:

Titan Spec Wing | AUW = 0.8kg | Avionics: 5W | Propulsion Efficiency: 55%



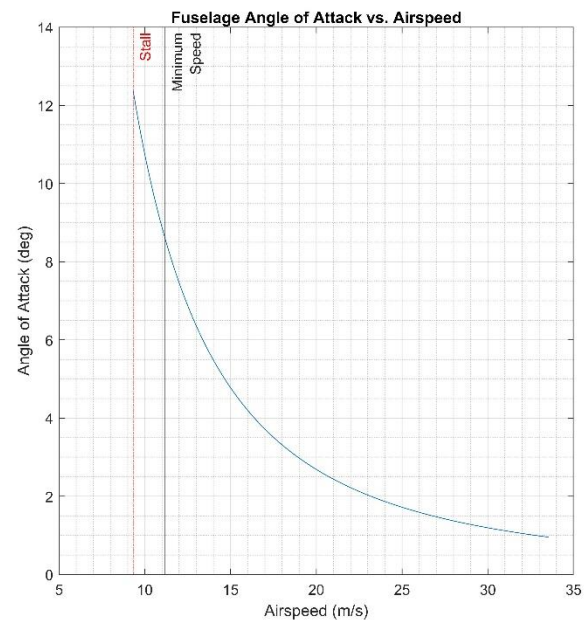
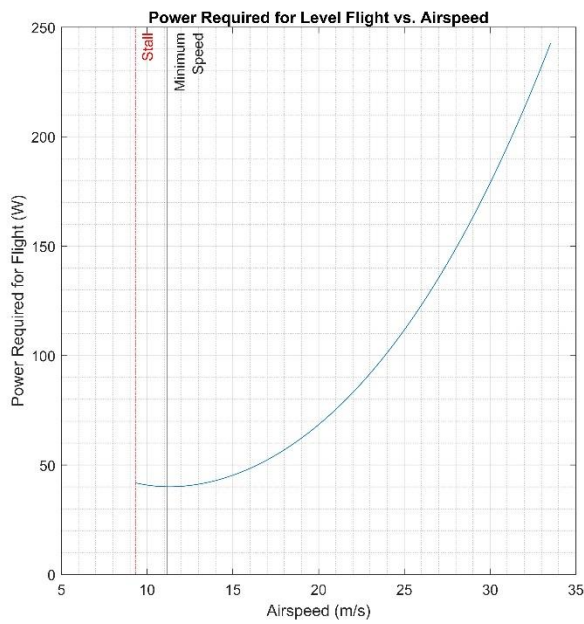
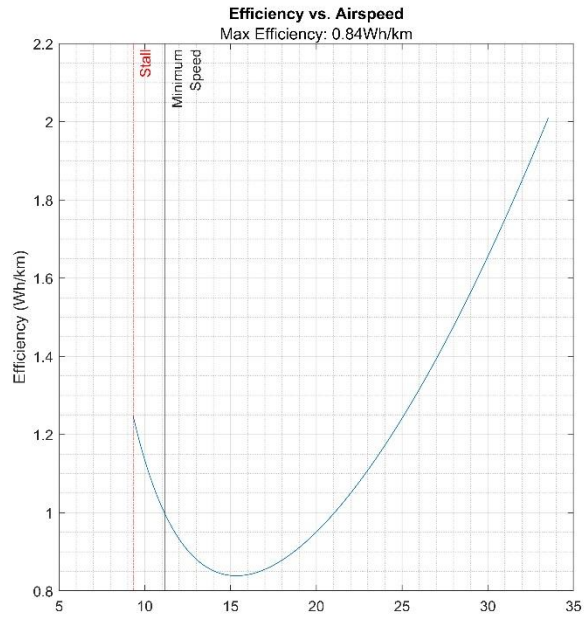
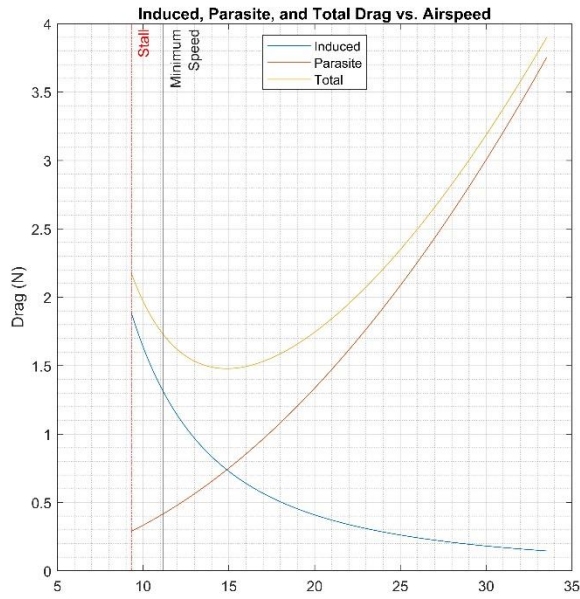


Titan Spec Wing | AUW = 1kg | Avionics: 5W | Propulsion Efficiency: 55%





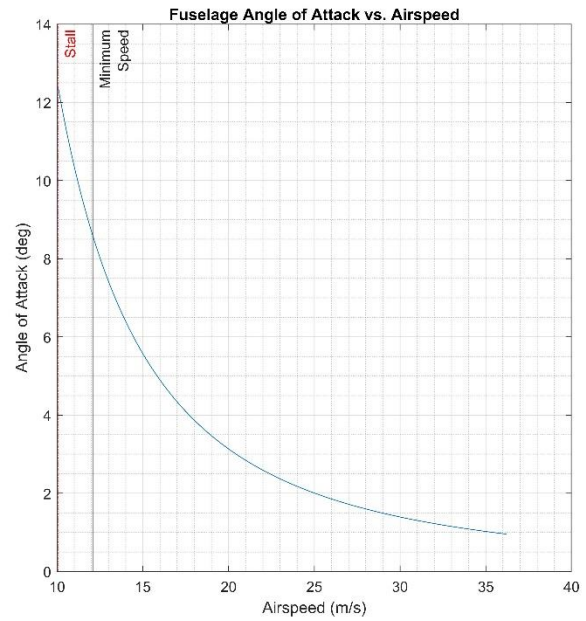
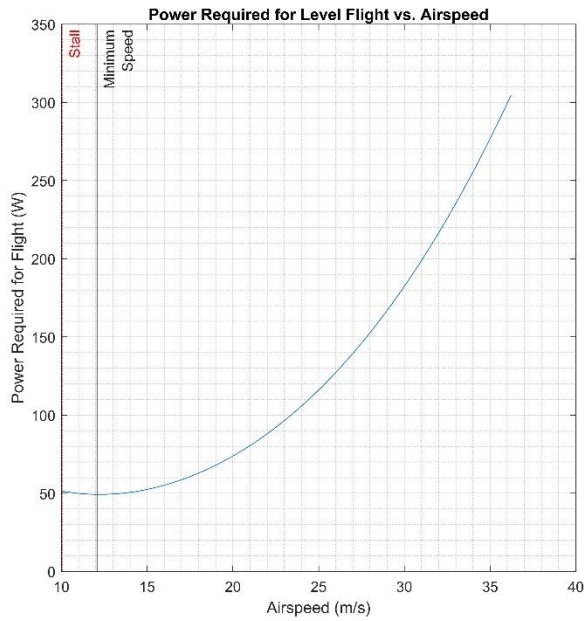
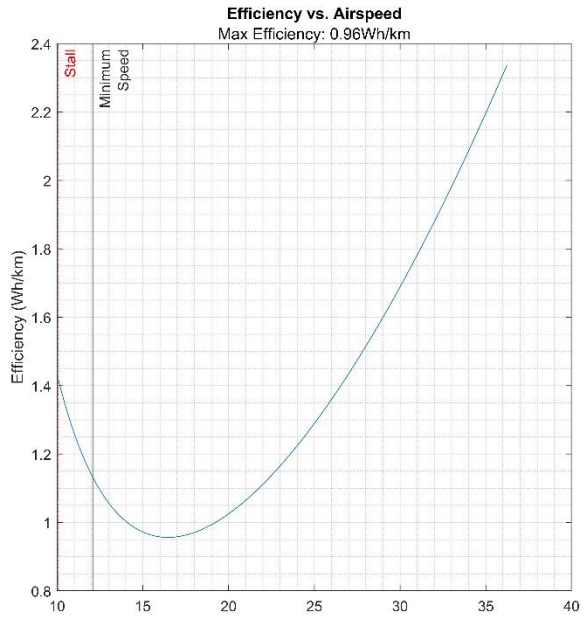
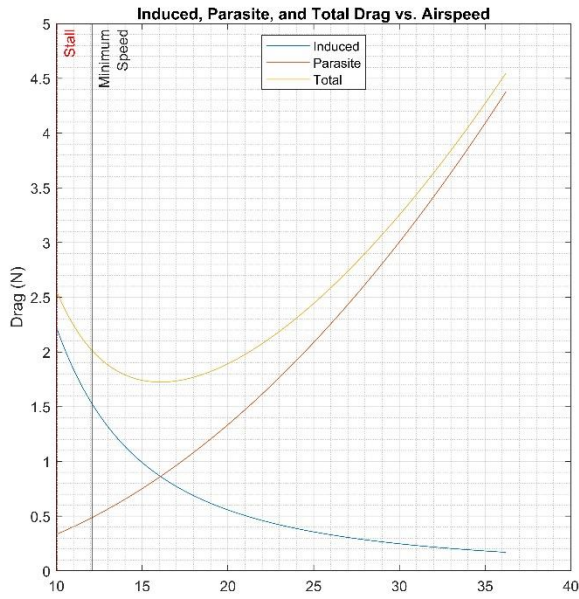
Titan Spec Wing | AUV = 1.2kg | Avionics: 5W | Propulsion Efficiency: 55%





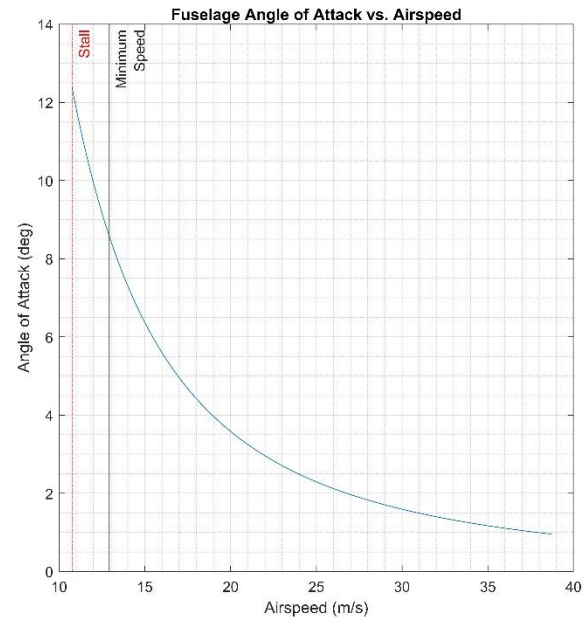
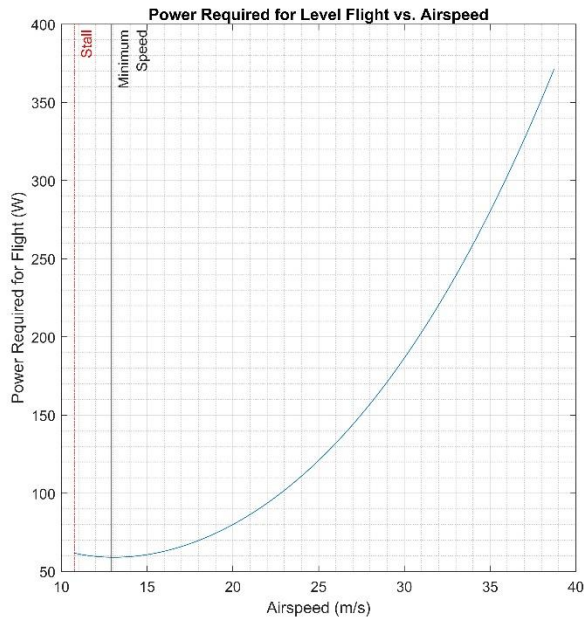
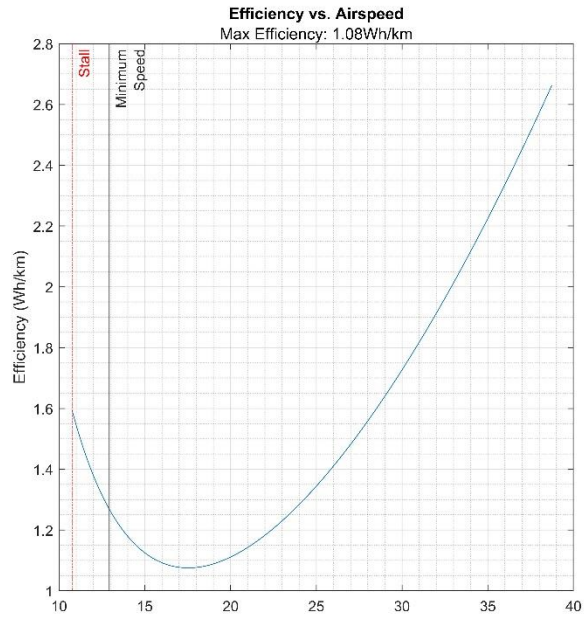
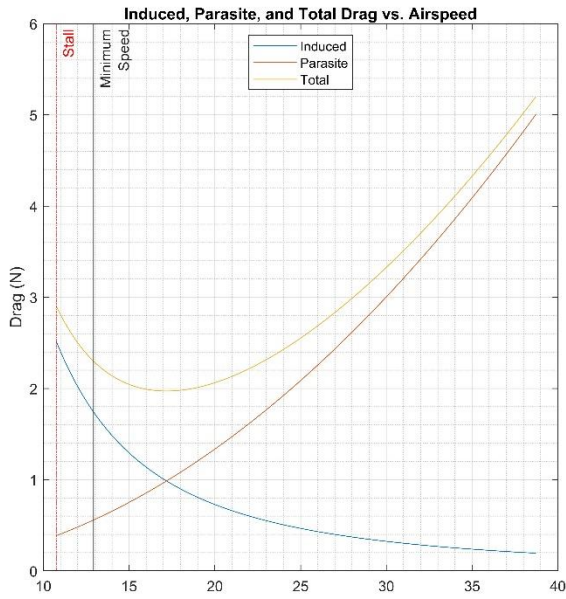


Titan Spec Wing | AUW = 1.4kg | Avionics: 5W | Propulsion Efficiency: 55%





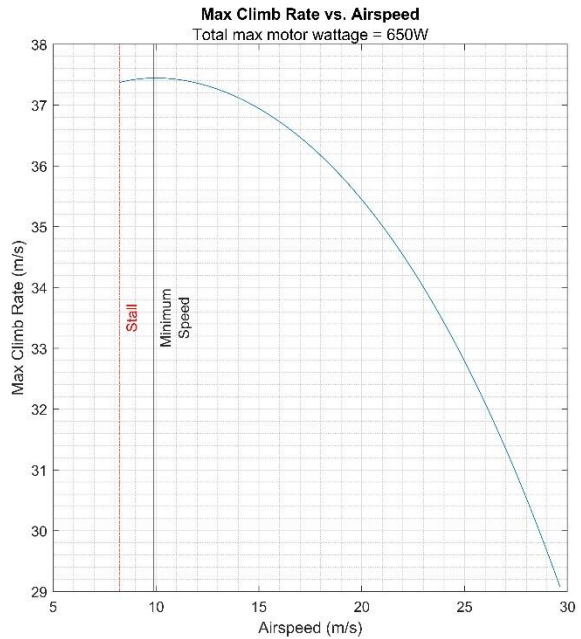
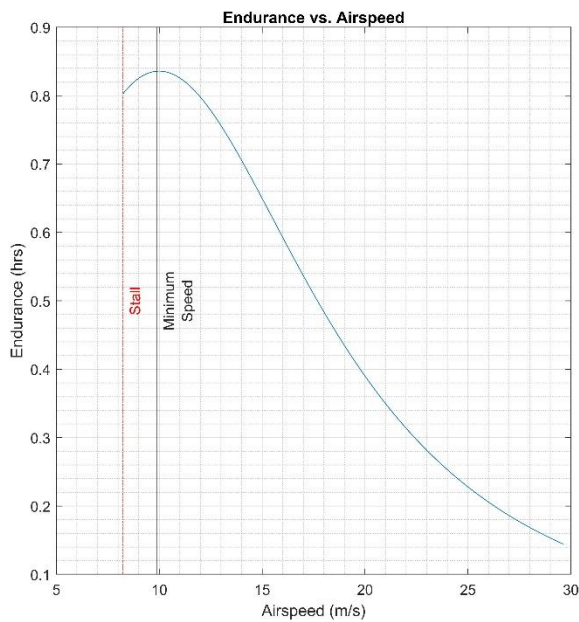
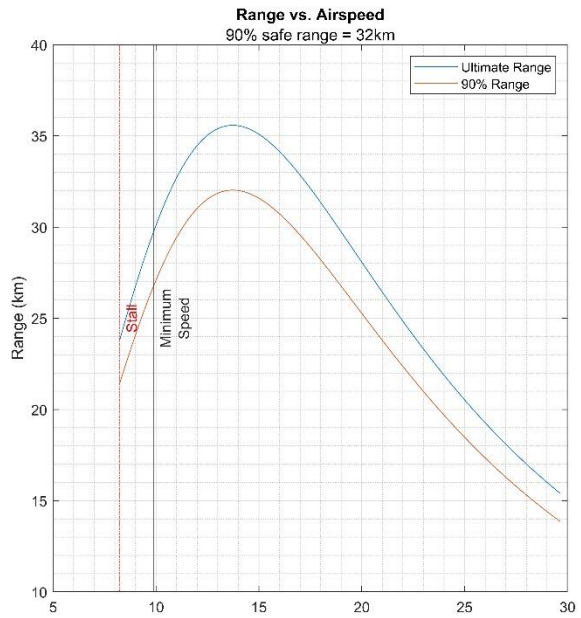
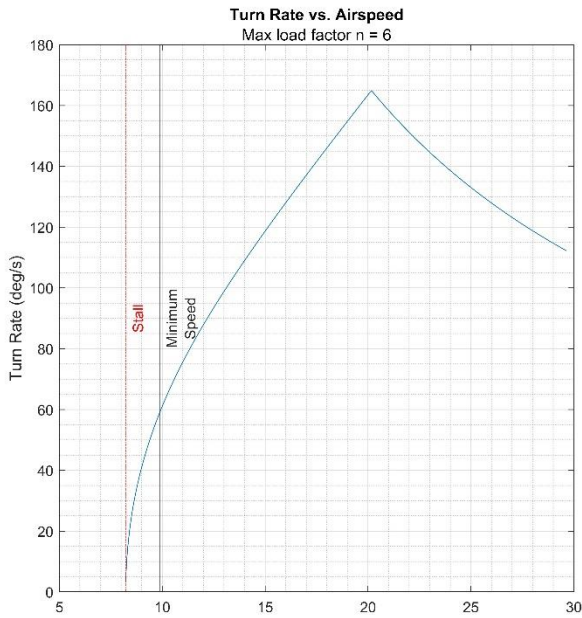
Titan Spec Wing | AUV = 1.6kg | Avionics: 5W | Propulsion Efficiency: 55%





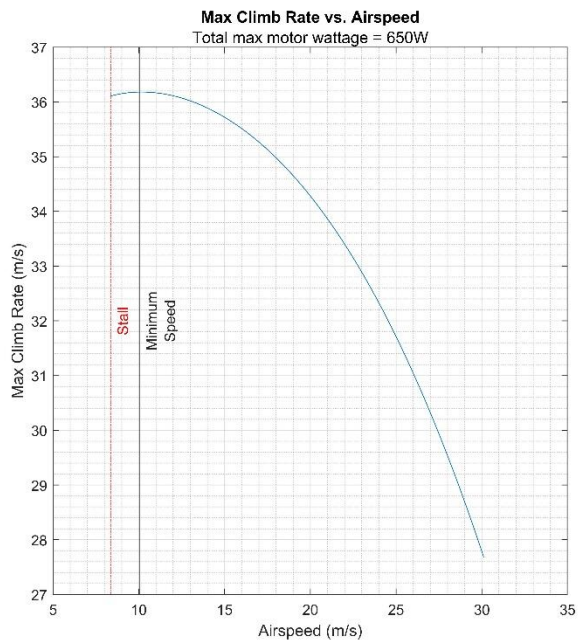
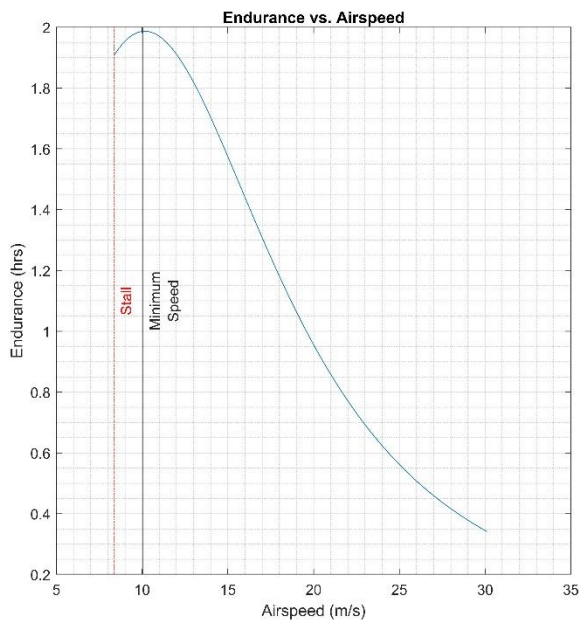
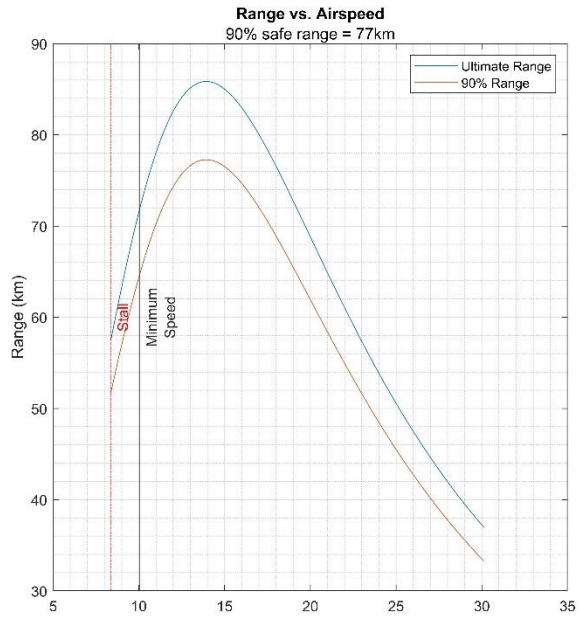
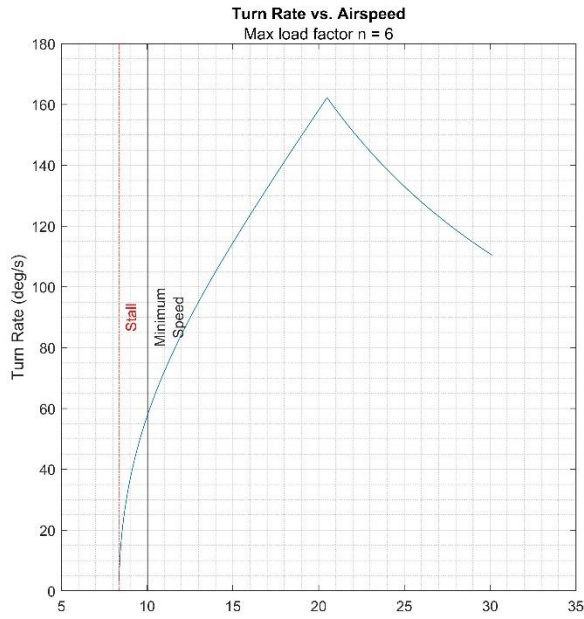
## 2.2.2: Turn rate, range, endurance, and max climb rate for a variety of different battery configurations:

Titan Spec Wing | AUW = 0.94kg | 3S 2200mAh LiPo | Payload: 0kg 5W | Empty Mass: 0.749kg | Propulsion Efficiency: 55%



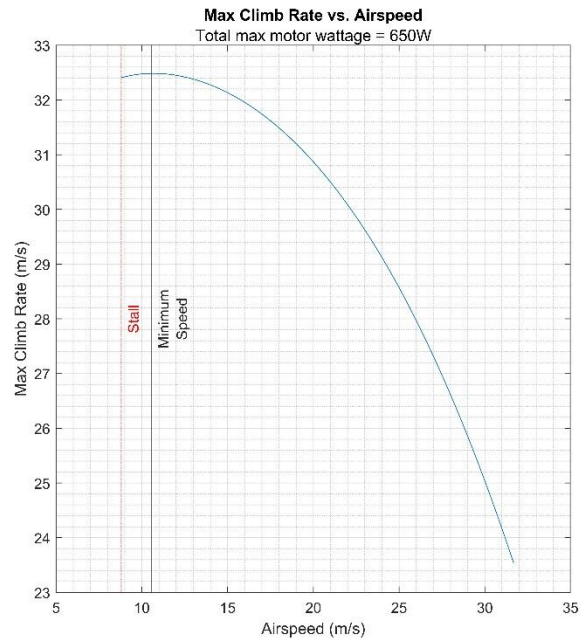
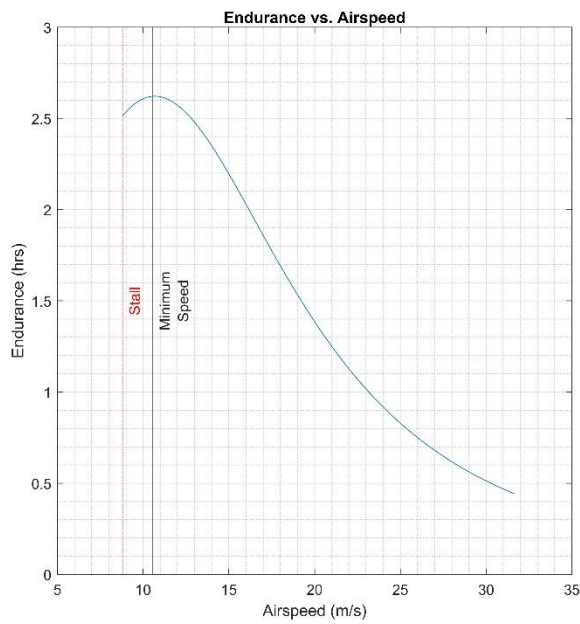
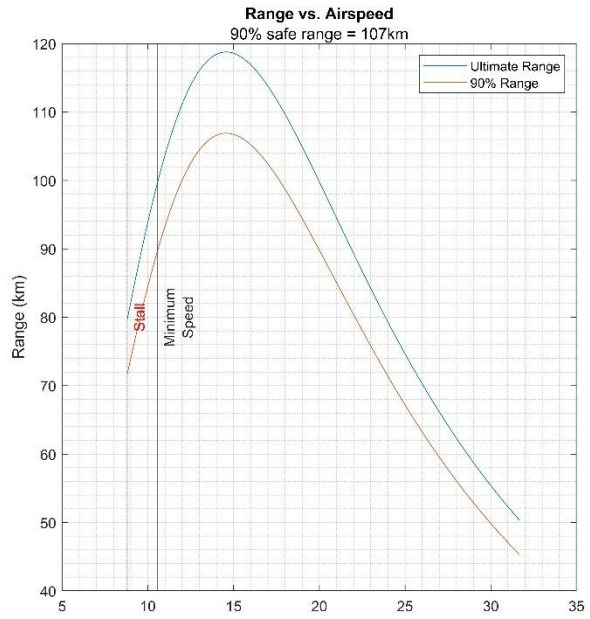
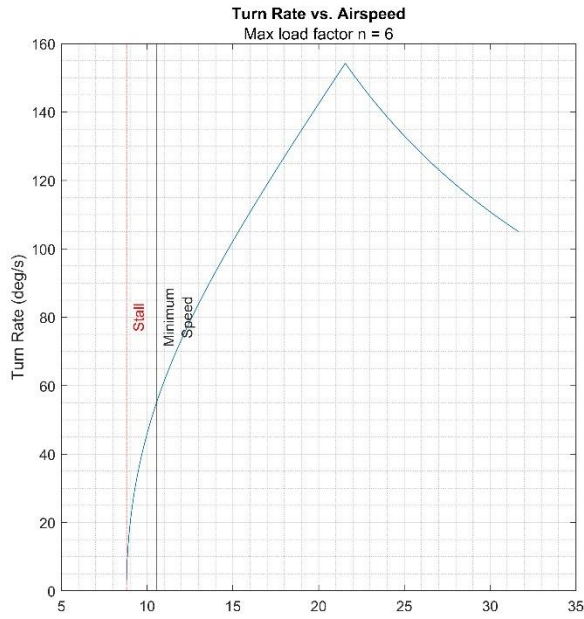


Titan Spec Wing | AUW = 0.97kg | 4S1P Molicel P42A | Payload: 0kg 5W | Empty Mass: 0.749kg | Propulsion Efficiency: 55%





Titan Spec Wing | AUW = 1.07kg | 6S1P Molicel P42A | Payload: 0kg 5W | Empty Mass: 0.749kg | Propulsion Efficiency: 55%





## Section 3: Required Build Materials

### Spars needed:

- 8x400mm (wing spar)
- 8x400mm (leading edge support)
- 3x400mm (elevon hinge)

### Recommended motor & prop:

- 16-19mm mounting pattern
- Cobra CP-2210 2200kv
- T-Motor AT2310 2200kv
- Turnigy D2826-6 2200kv
- 6-8 inch propeller (can also use 7x4/5/6 or up to 9), use of folding propeller strongly encouraged

### Recommended electronics:

- TBS crossfire / ELRS
- 5.8ghz / 1.2ghz analog or digital (19x19 camera)
- Matek F405-WTE flight controller or similar (optional)
- Matek M8Q-5883 GPS/Compass or similar (optional)
- 35a BLHeli ESC
- (2) Emax ES08MAII servos
- Battery: 3s 2200mah Lipo or 4S1P 21700 4200mah Li-ion

### Misc:

- Polymaker Polylite prefoamed LWPLA
- Polycarbonate or other high-temp filament for the motor mount
- Medium CA glue
- 250x210x210 minimum size print bed (works with Prusa Mk3)
- Control horns (this one).
- M3 threaded inserts (max 6mm height)
- M3 bolts of various sizes
- 6x3mm magnets



## Section 4: 3D printing

### 4.1: Things to know before you start printing.

1. Titan Dynamics strongly recommends using Polymaker Polylite prefoamed LWPLA for the best results. This filament is much easier to tune your printer for and has less stringing than active foaming filaments. If you aren't able to purchase Polymaker filament, many members of our Facebook group and Discord server have had success
2. You likely will not get good results unless your printer is well maintained and calibrated, we would suggest learning how to check and adjust your printer to perform at its absolute best before starting. This website has useful guides: <https://teachingtecht.com/calibration.html#intro>.
3. **All the below guidance should be taken as a starting point only. Print a test piece** and check things like retraction settings and fitment of the carbon rods in the wings for yourself as every printer is different. If the carbon rods are too tight, increase the "Hole Horizontal Expansion" setting in Cura (or the equivalent setting in other slicers).
4. All our models are designed to be printed predominantly in LW-PLA filament. All fuselage, tail, and wing parts should be printed in LW-PLA unless otherwise noted in the file name.

There are 3 levels of infill / wall settings that we recommend for the LWPLA parts:

1. Maximum efficiency: 3% cubic subdivision, single wall
2. Balanced efficiency and strength: 5% cubic subdivision, single wall
3. Maximum strength: 8% cubic subdivision, single wall

**WE RECOMMEND PRINTING SPEC RACING WING WITH 3% CUBIC SUBDIVISION INFILL**

#### Notes:

- For the best flight characteristics and maximum range, LWPLA parts should be printed with single wall and 3% cubic subdivision infill.
- Cubic subdivision infill can be increased to 5 or 8% to increase durability, but this will have an impact on maximum payload capacity (battery), and range by extension. We recommend and use 3% cubic subdivision infill as it has been tested to survive 6.4G in flight, but some may desire greater general durability when handling/carrying the model around etc. It will still break if you crash it!
- Because the fuselage takes the most abuse during landings, some may choose to just print the fuselage sections in higher infill. Using a higher infill just for the fuselage (4%-8%) can greatly increase the longevity of the plane without as much of a weight penalty as printing the entire plane in high infill.
- Gyroid infill brings a significant weight penalty with it even at the same percentage. For the highest strength-to-weight ratio part, stick to cubic



subdivision or cubic. A part printed at 3% gyroid is comparable weight to the same part printed at 7% cubic subdivision.

Polycarbonate, PETG or other high-temp filament should be used for the motor mounts and wing bay covers.

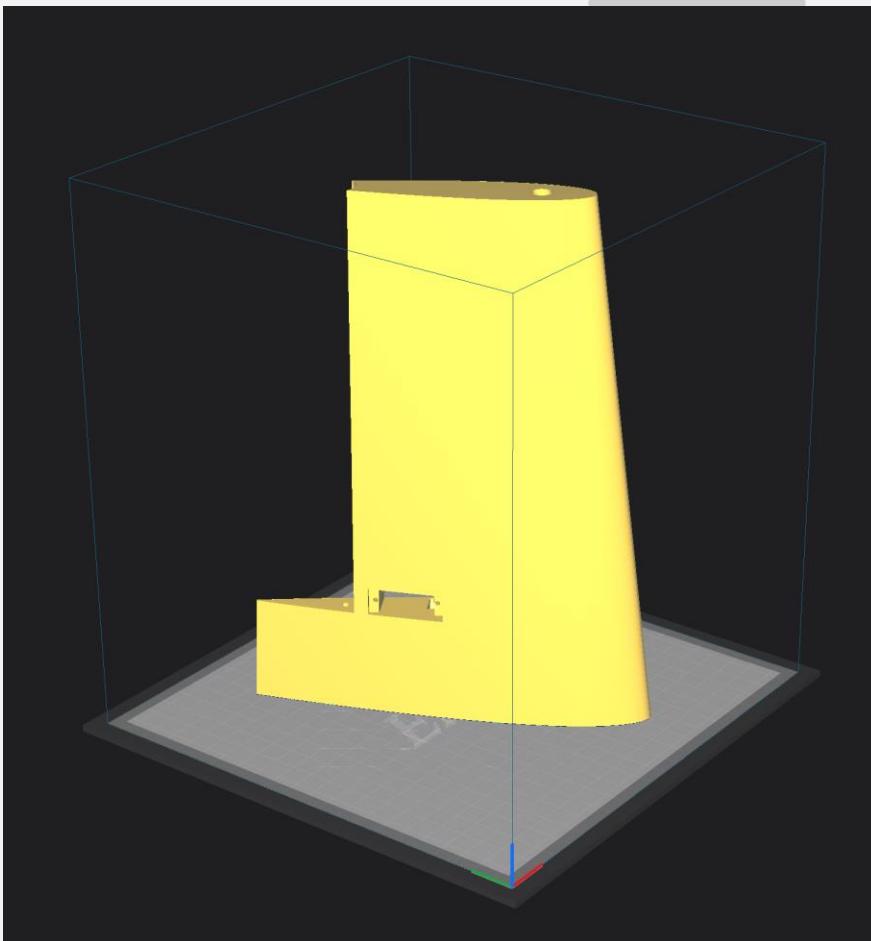
- High temp Polycarbonate or PETG parts should be double wall and high infill (25%).

We recommend using the newest version of Ultimaker Cura. [This link](#) can be used to download our own slicer profile.

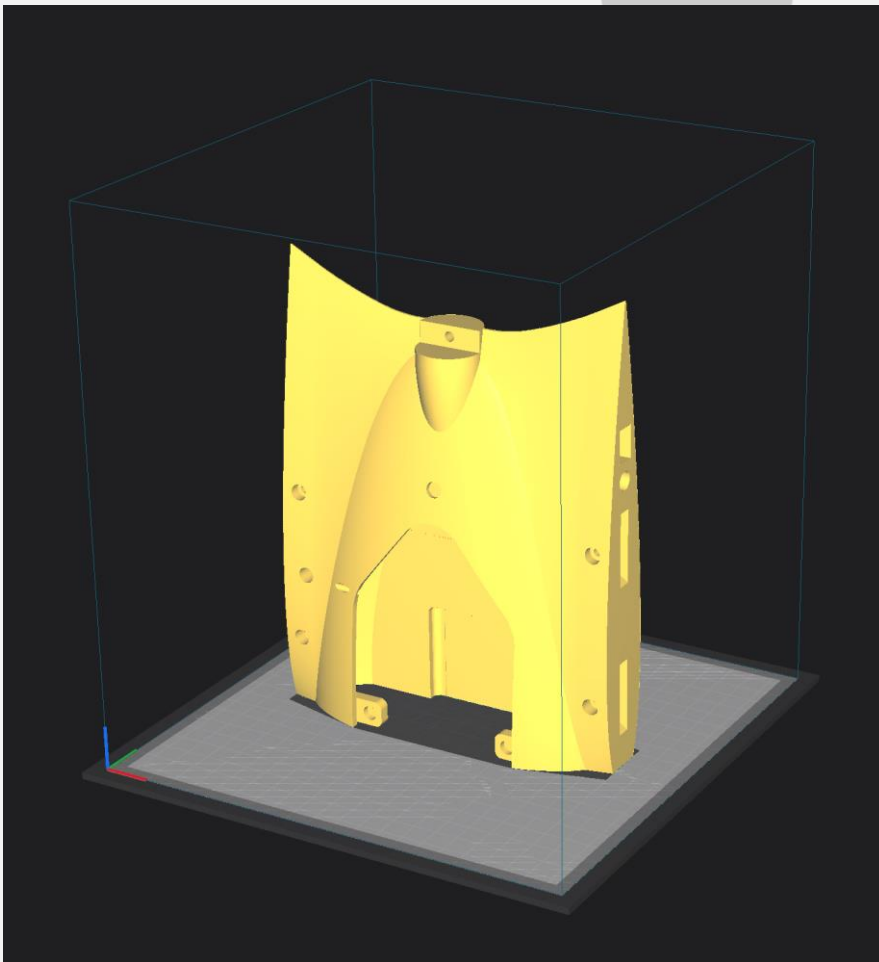
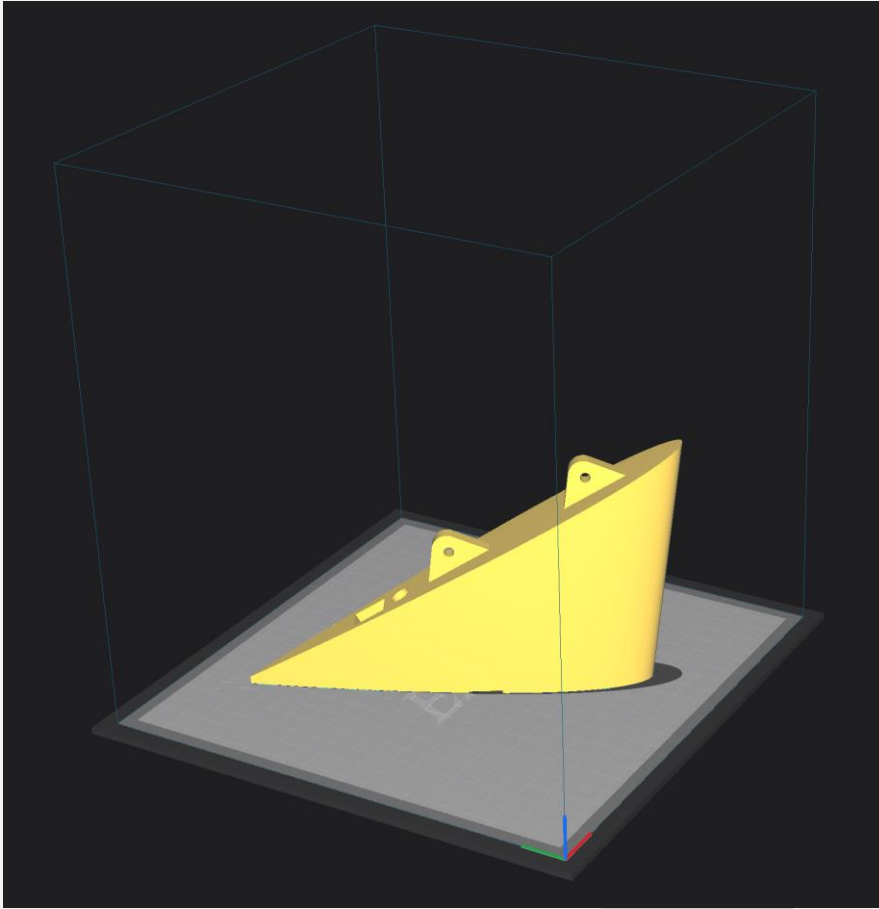
## 4.2: Part Orientation

It is necessary to orient each part correctly on the build plate to avoid disconnected overhangs. Take care when doing this as the entire model is designed to be printed with no supports. If you orient some parts wrong, the print will fail. It may also be necessary to rotate and carefully position some parts to fit within the build area on smaller printers.

Examples for part orientation:









### 4.3: Tuning “hole horizontal expansion”

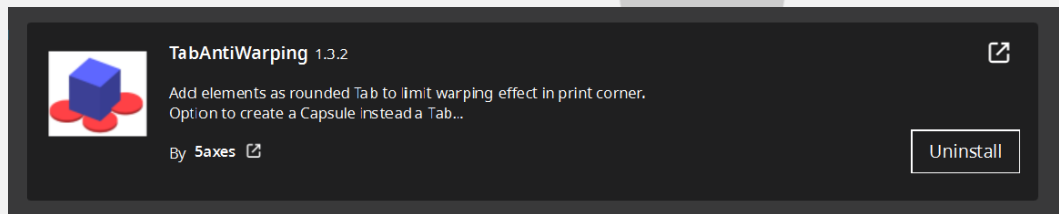
It is very important to check the fitment of the carbon rods in their holes on the first parts you print. Because everyone may be using different printers, materials and slicer settings, it is not possible to provide the models with a slicing profile and hole size that will work for everyone.

Print your first part with carbon spar hole and check fitment, if it is too tight increase the hole horizontal expansion setting in the “walls” section in Cura (or your slicer’s similar setting). A good starting point is 0.25mm. If it is too loose, just decrease the setting until you can reliably push the rods in and still get a snug fit.

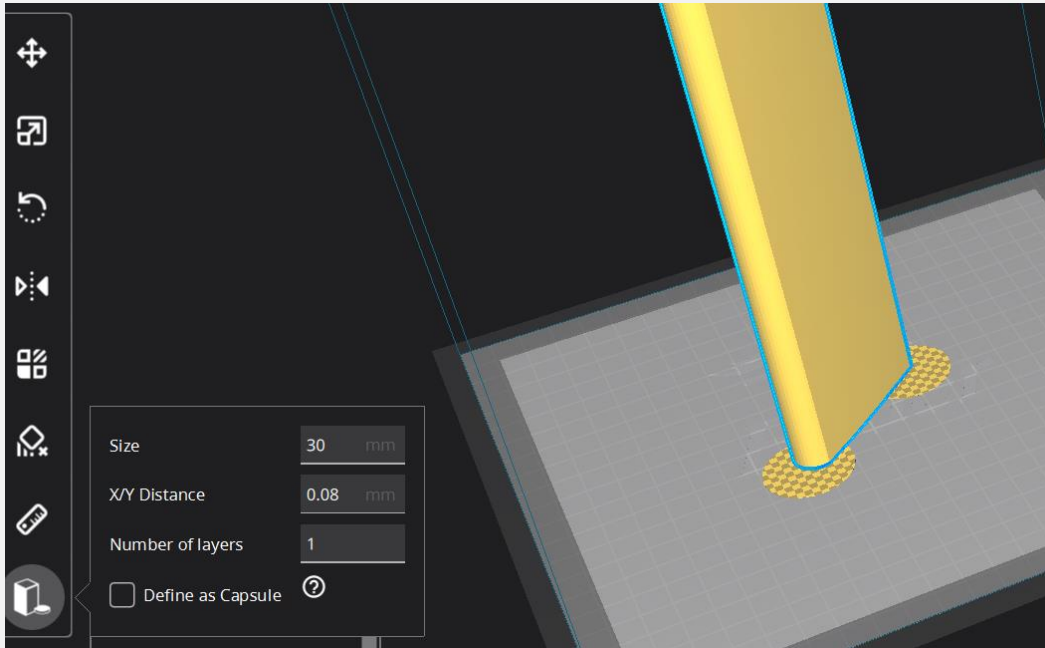
### 4.4: Bed Adhesion and warping

When printing tall parts like this and other models require, having good print adhesion to the bed is a necessity. Ideally you will print each part without any extra aids, however this may not be possible for many, especially those printing without an enclosure for their printer. A full brim can be used but this will typically have mixed results. If it works for you, use a glue stick on the print surface to improve adhesion. Cura also has a plugin that can be used to help with bed adhesion and to avoid warping.

Cura Marketplace: TabAntiWarping Plugin.



When installed, use the new icon at the bottom of the left menu to choose tab diameter and thickness, then click on the model to add a tab at each point you think is at risk of warping or poor adhesion (typically parts with low surface area in contact with the print surface in relation to their height). These new tabs can now be moved around to fine tune their position using the normal move controls on Cura.



Once completed, be careful when removing these tabs from the print as they are quite strong and can damage the bottom of your part if not removed carefully. Re-open any holes the tab may have filled on the bottom of the print.

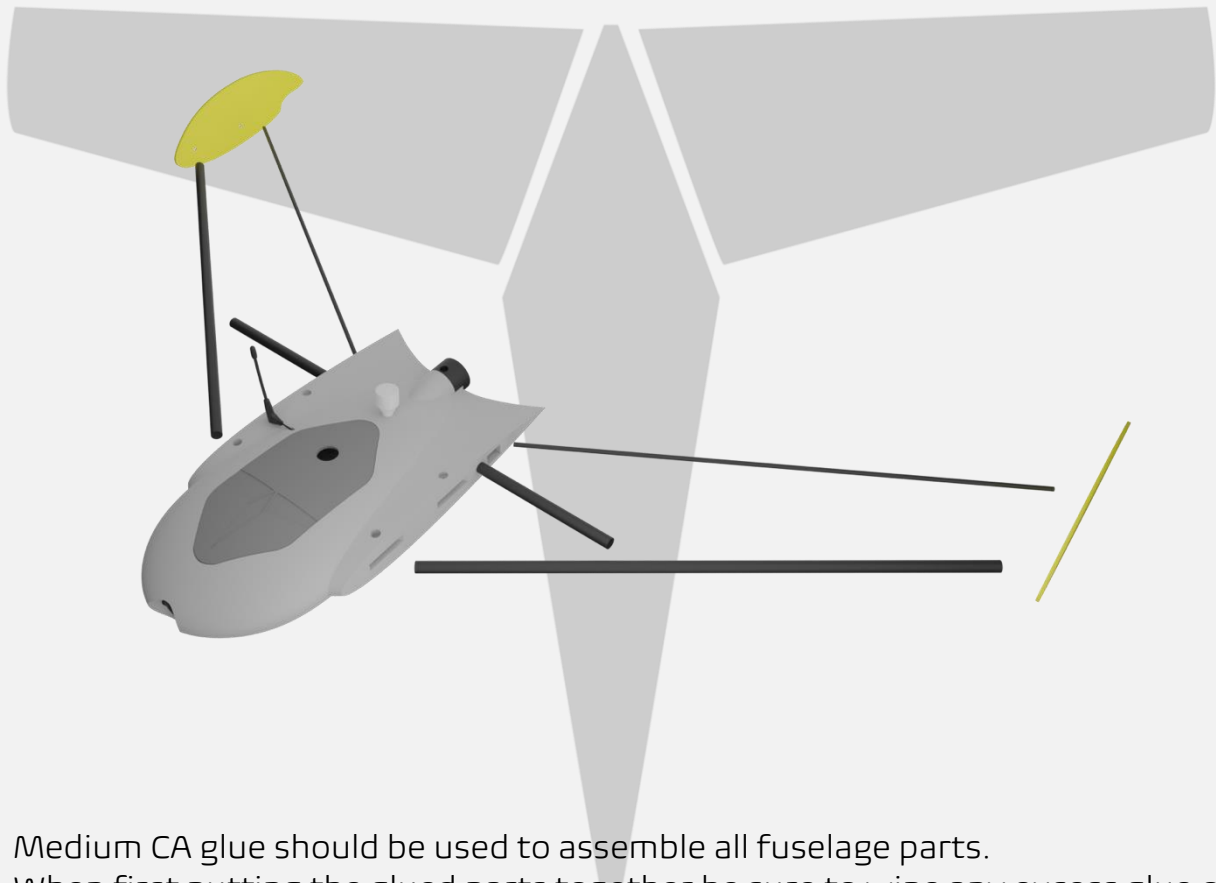
If you find these hard to remove from the print bed, select the “Define as Capsule” option. This makes the edge of the tabs raised, so you can get a scraper underneath them.



## Section 5: Assembly of 3D Printed Parts

Below are a few exploded views of the Spec Racing Wing to help with assembly.

The spar layout for Spec Racing Wing is as depicted below. None of the spars need to be glued in, they will all be retained by the printed parts. The small grey "spars" are just filament used as guide pins.



- Medium CA glue should be used to assemble all fuselage parts.
- When first putting the glued parts together be sure to wipe any excess glue off before it sets. A kicker may then be used to speed up the setting time; technically this results in a weaker joint, however it will still be stronger than the base material LW-PLA.
- Use care when aligning parts for gluing. With medium CA, you should have a few seconds to get alignment right. Small mistakes in alignment can stack up and eventually lead to a part not fitting perfectly. We have taken care when designing the aircraft to make sure there is tolerance for some minor mistakes but try to be as perfect as possible when gluing.
- When gluing the wings together, use the carbon rods to ensure alignment however be careful not to glue them in, they should not be glued in on the final product.



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- **IMPORTANT!** - Do not glue the wing tips on until you have the carbon rod and aileron/flap installed as it's the wing tip that secures these in place. If you glue the wing tip on before inserting the control surfaces + carbon rod you will not be able to insert them afterwards.
- Threaded inserts can be properly installed by using a soldering iron at low heat setting, a good guide for doing this can be found at [this link](#).





## Section 6: Final Setup & Tuning Tips

- Titan Dynamics strongly recommends the use of Arduplane for all our models. If you encounter an issue in flight, the data logs Ardupilot creates are invaluable for finding the root cause of any issue and increasing future chances of success.
- Give all control surfaces +/- 30 degrees or more throw.
- CG is marked under the wing and can be experimented with. The default location is where most Spec Racing Wing racers run their CG for best performance.
- Add duct tape or other abrasion resistant material to bottom of the fuselage to increase durability if landing on rough surfaces.





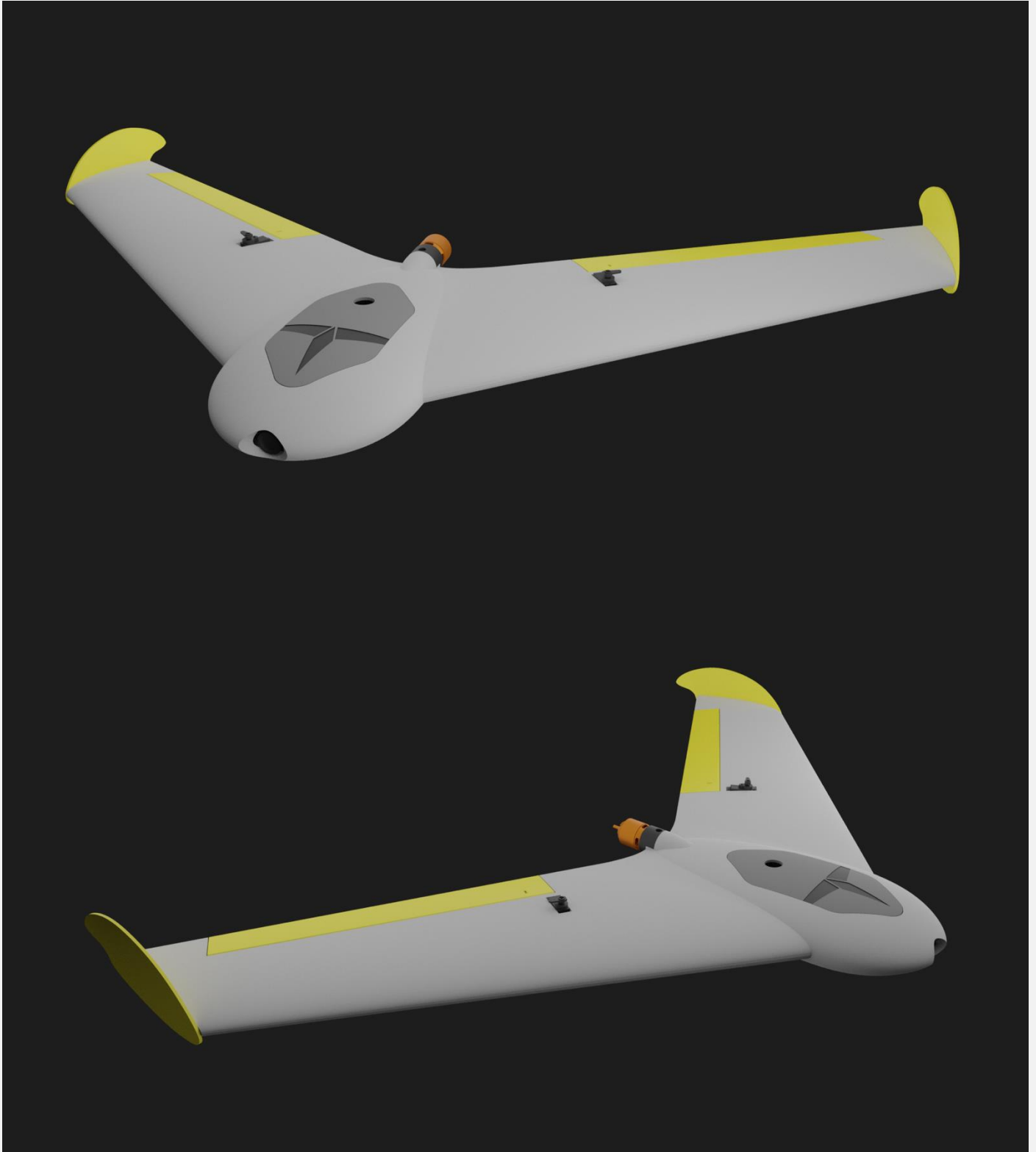
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## Section 7: Additional Images



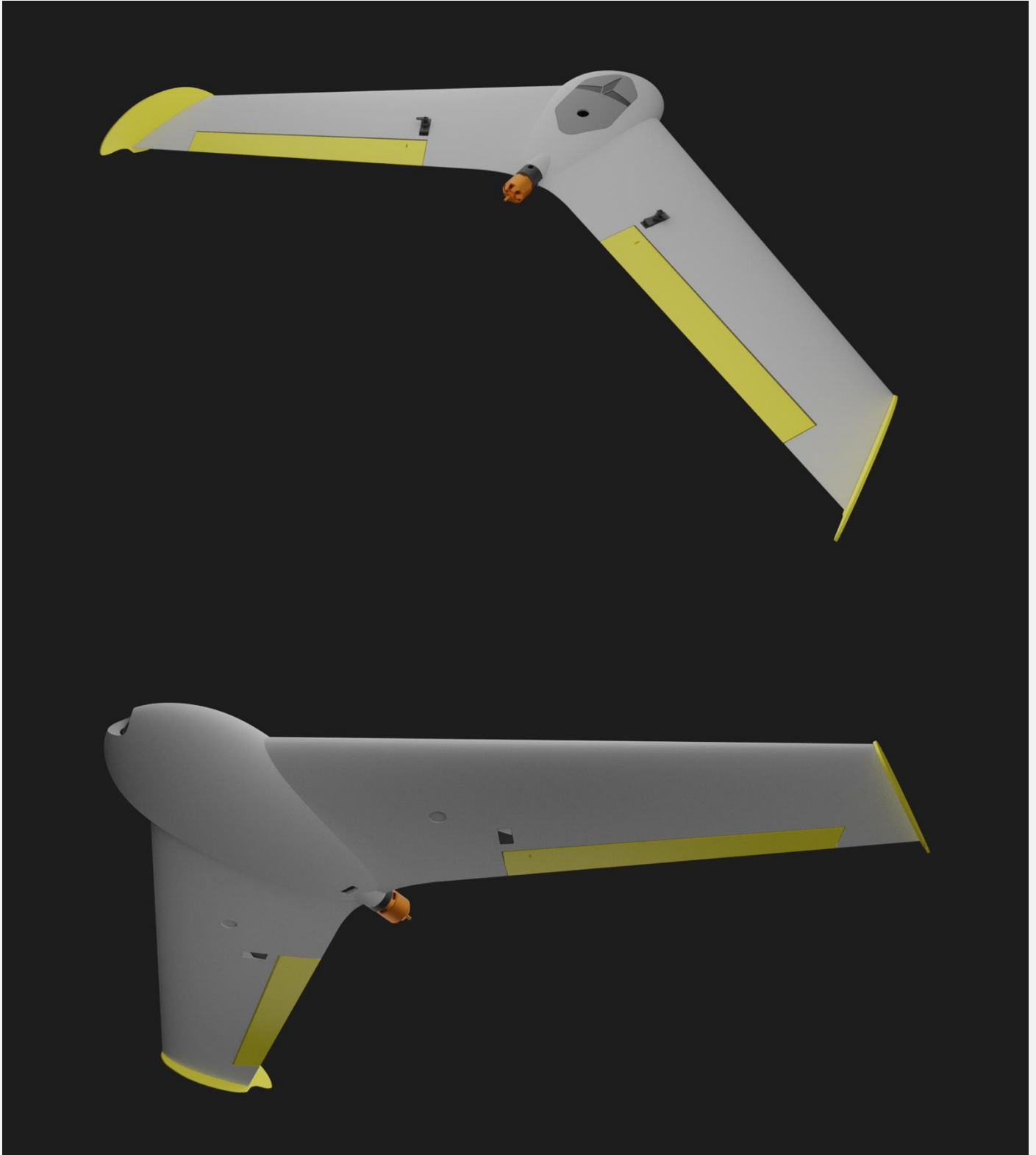


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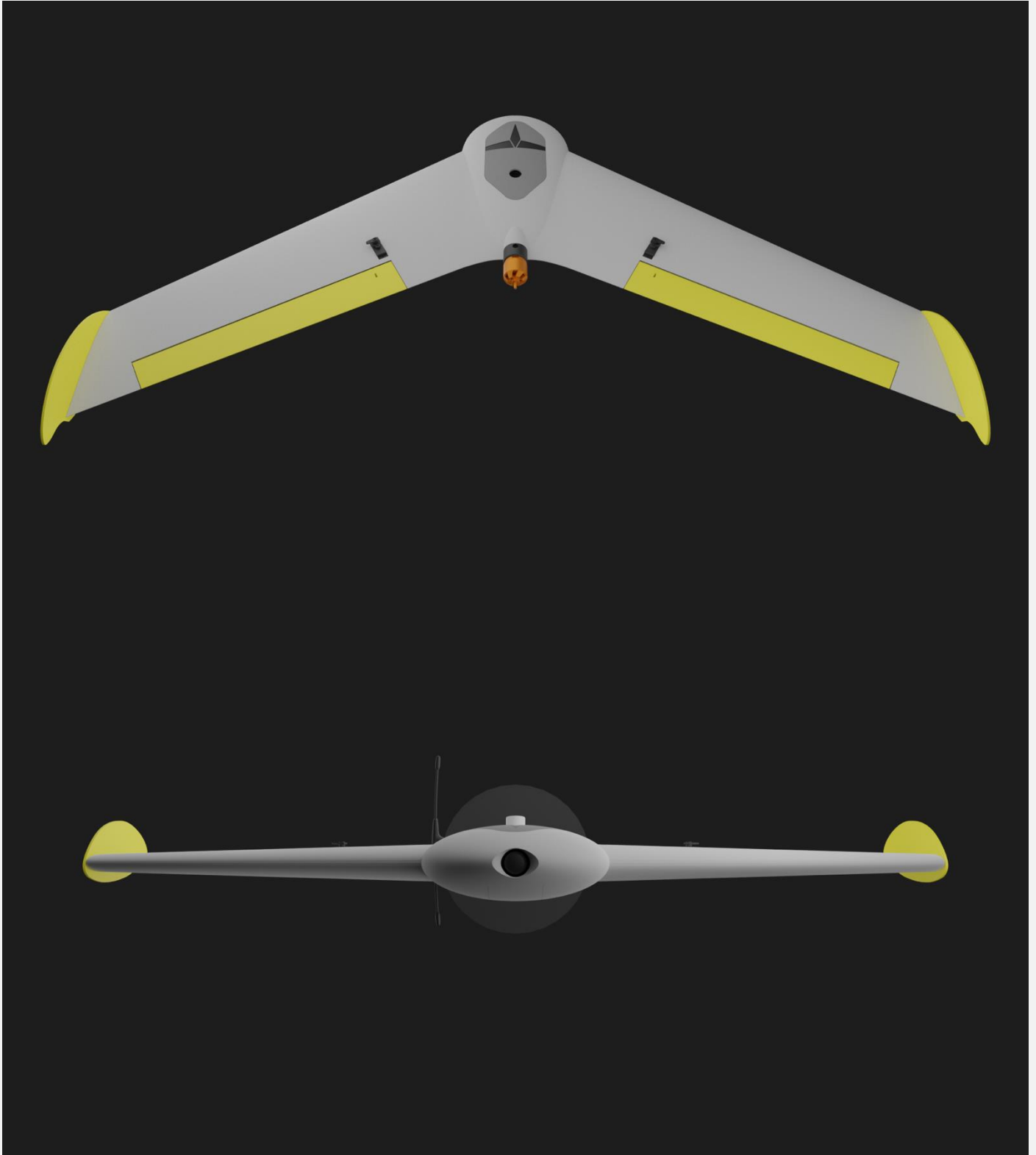


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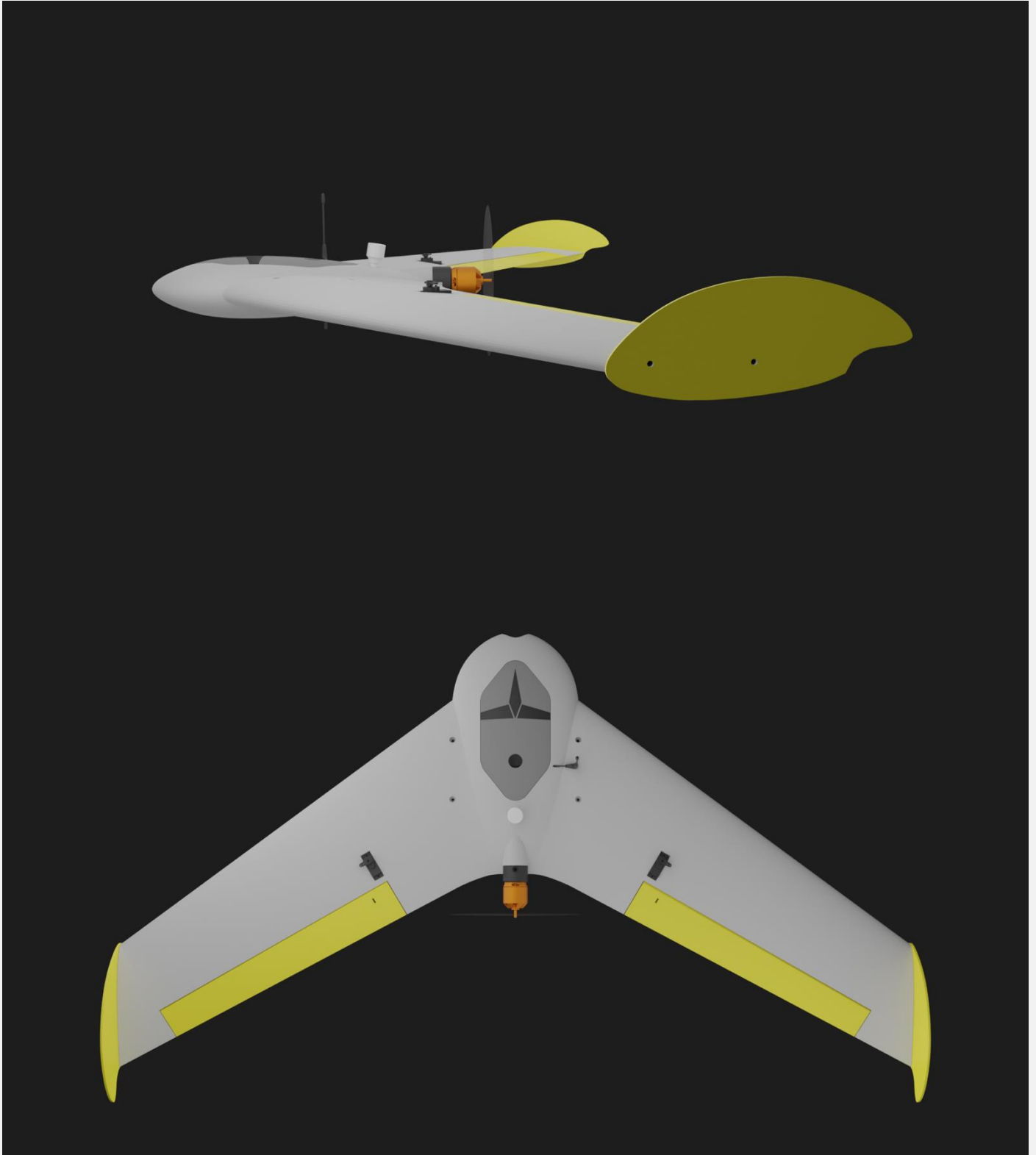


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