



Titan Dynamics

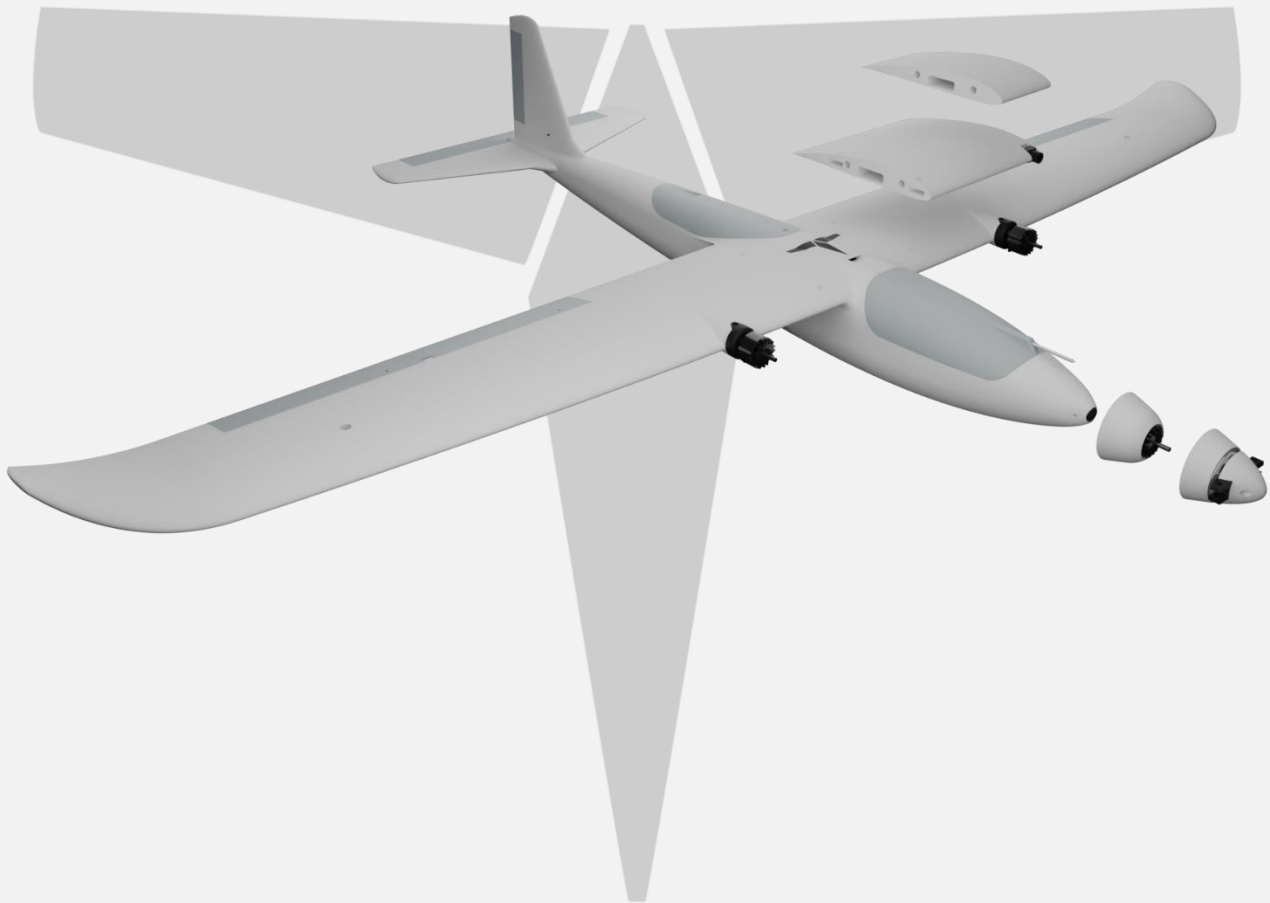
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Titan Dynamics – Recon

<https://www.titandynamics.org/3dhanger/p/titan-recon>



Build & User Manual
Revision 1.0



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Section 1: Model Information

The Titan Recon is a 2 meter wingspan plane that can either be a twin-tractor or single engine puller. The files include multiple options to allow for flexibility during the build process. The Recon holds the current flight time record for a 3D-Printed plane at 5h34min (at the time of release). It also features a payload bay with space for mapping cameras or other accessories. The wings feature large bays for RF equipment and FPV camera mounting options for the single-puller variant. The Recon's design was primarily focused on maximum drag reduction while keeping a large size, making it the ideal choice for long range flying.





Section 2: Model Specifications & Performance

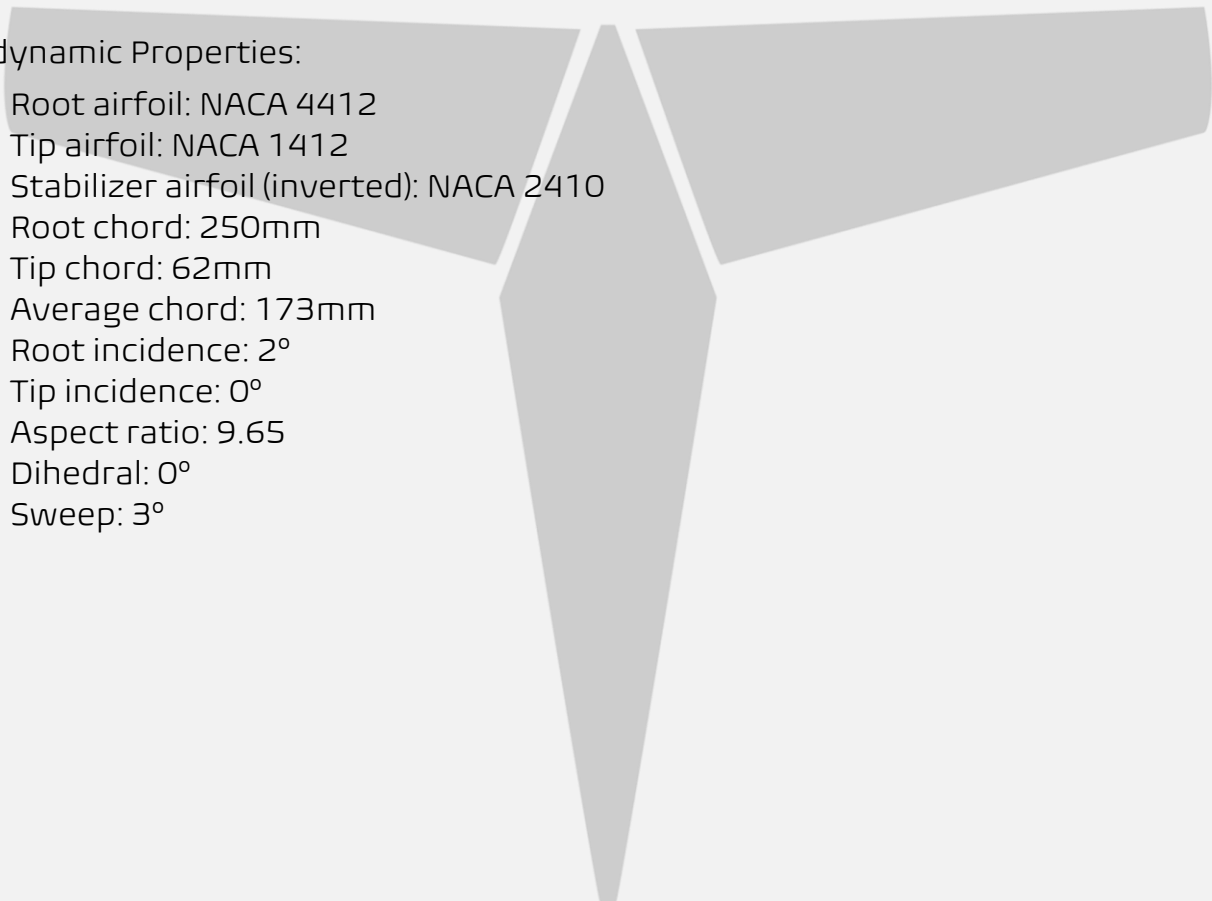
2.1: Physical Characteristics

General Stats:

- Wingspan: 1995mm
- Wing area: 4124cm²
- Maximum take-off Weight: 6kg
- Efficiency: 1.75 Wh/km @ 3.5kg AUW
- Cruise speed: 50-70kph
- Recommended prop diameter: 11-14 inches

Aerodynamic Properties:

- Root airfoil: NACA 4412
- Tip airfoil: NACA 1412
- Stabilizer airfoil (inverted): NACA 2410
- Root chord: 250mm
- Tip chord: 62mm
- Average chord: 173mm
- Root incidence: 2°
- Tip incidence: 0°
- Aspect ratio: 9.65
- Dihedral: 0°
- Sweep: 3°





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 1.4, 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.

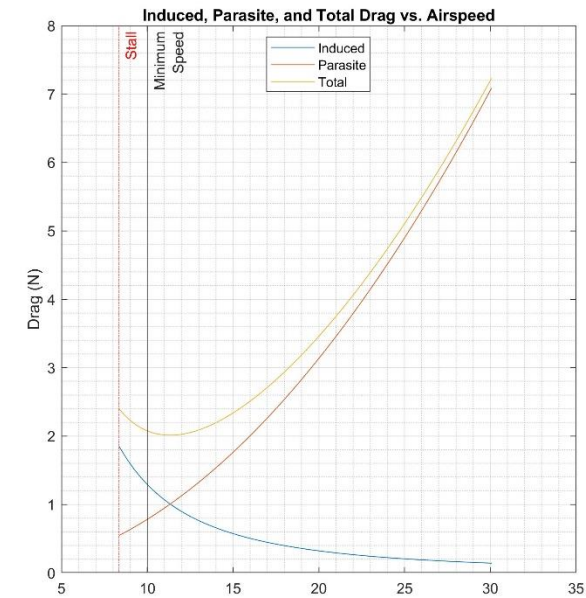
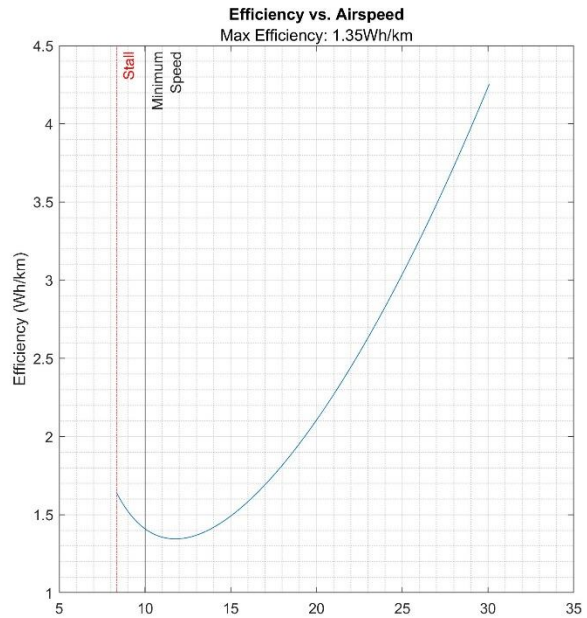
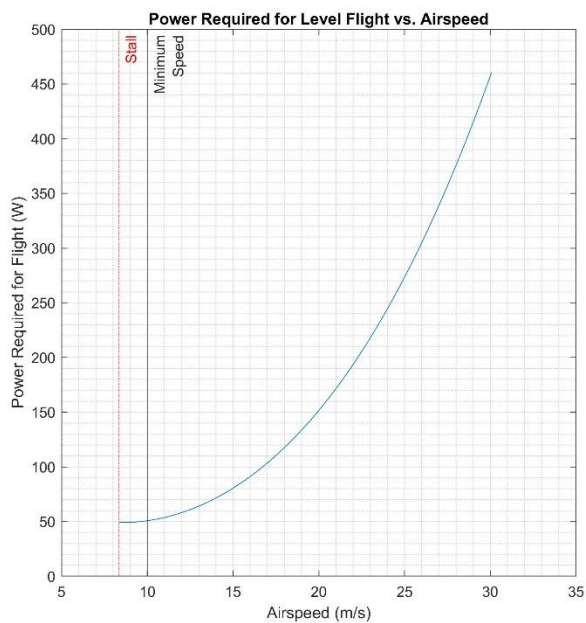
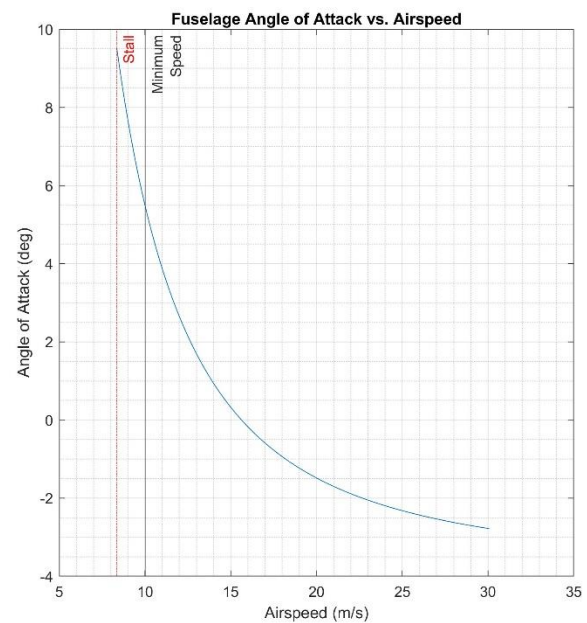
The fuselage angle of attack plot shows you what angle of attack the fuselage will be at a given speed. This can be useful when setting the TRIM_PITCH_CD parameter in Arduplane to the angle of attack value that corresponds with your cruise speed.

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 variables to account for when individuals build the aircraft. Extra draggy antennas, inefficient motors, surface quality, etc. can all change flight performance drastically.



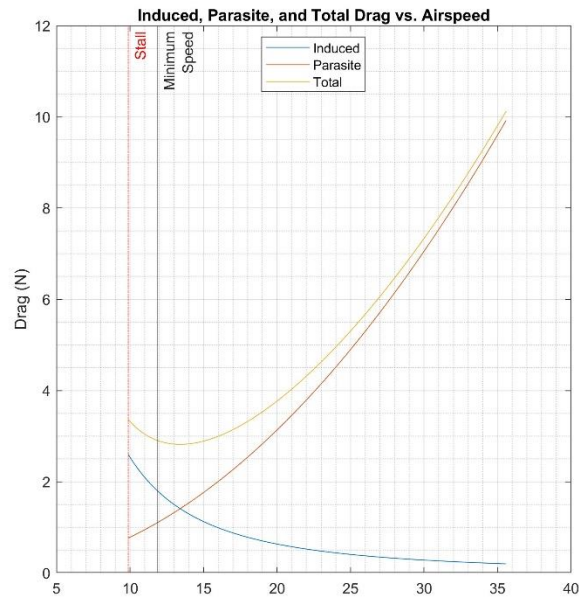
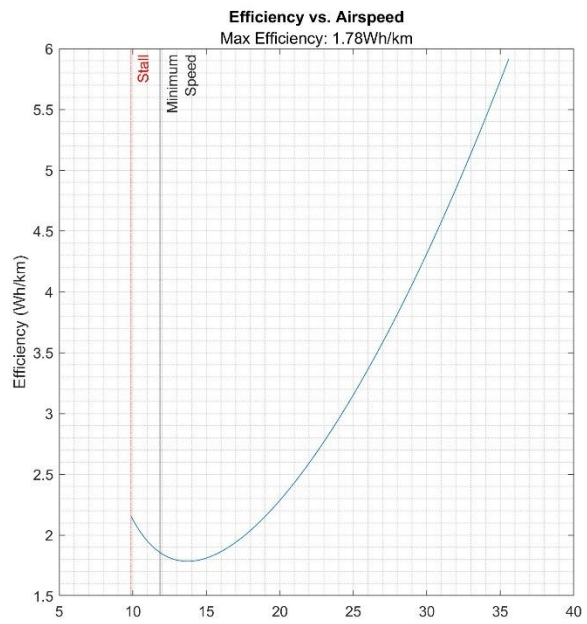
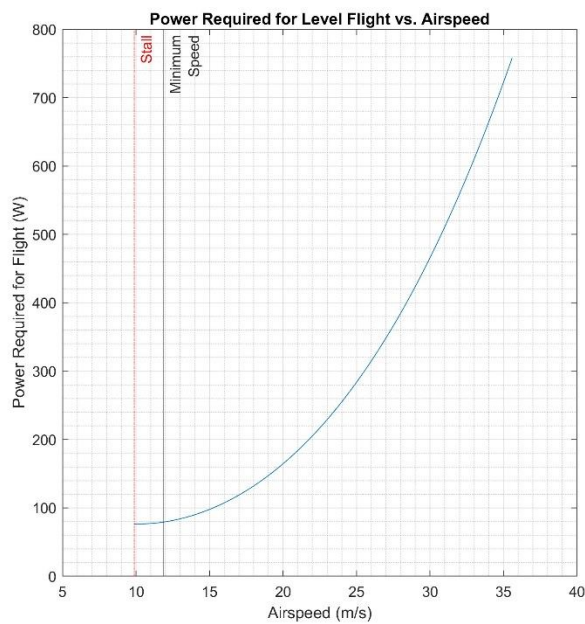
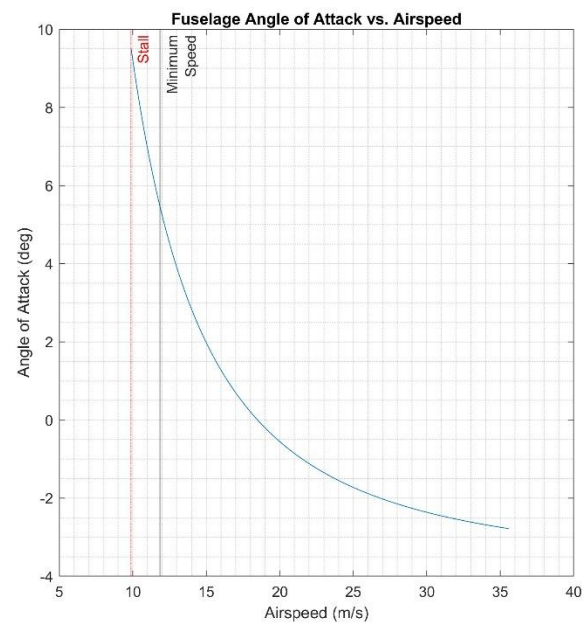
2.2.1: Drag, Efficiency, Power, and Angle of Attack at Varying All-up-weights:

Titan Recon | AUW = 2.5kg



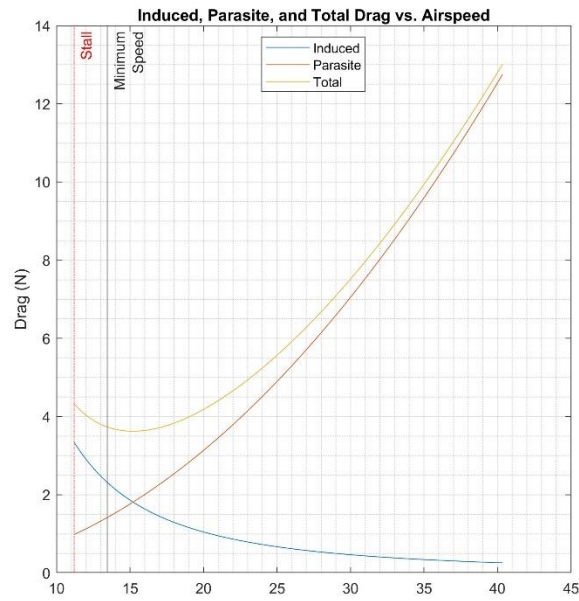
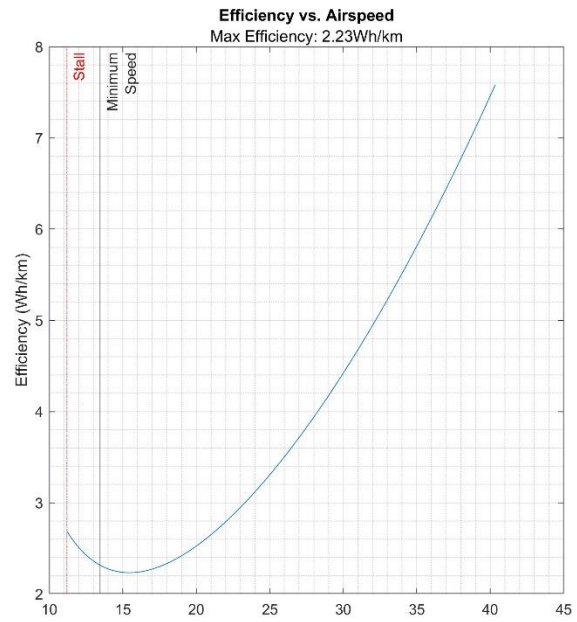
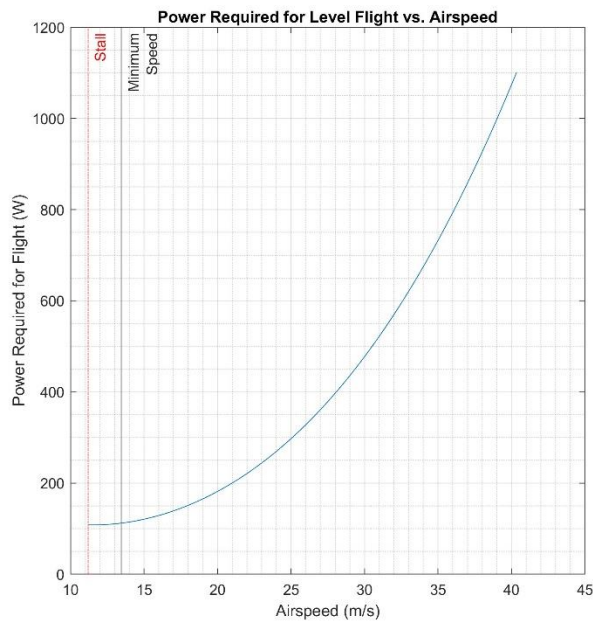
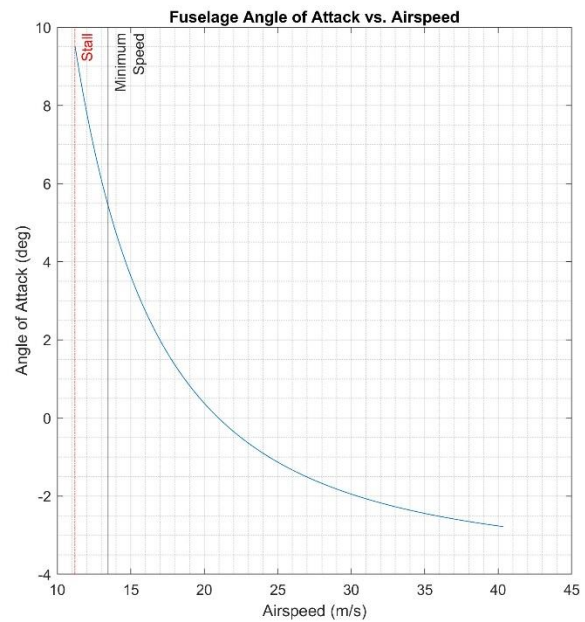


Titan Recon | AUW = 3.5kg



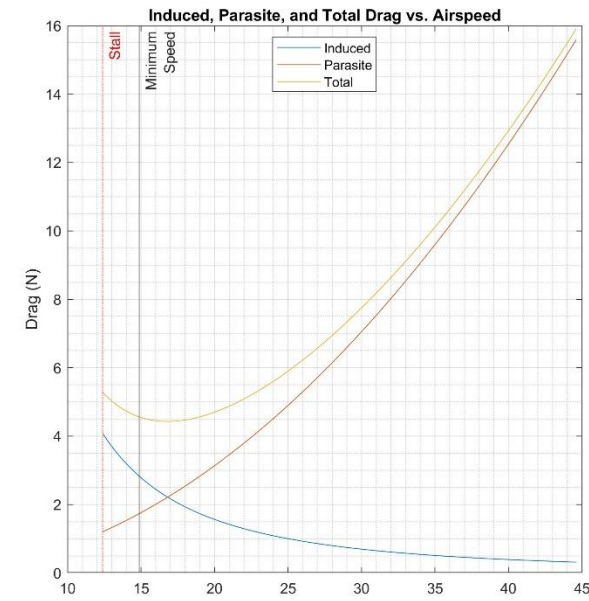
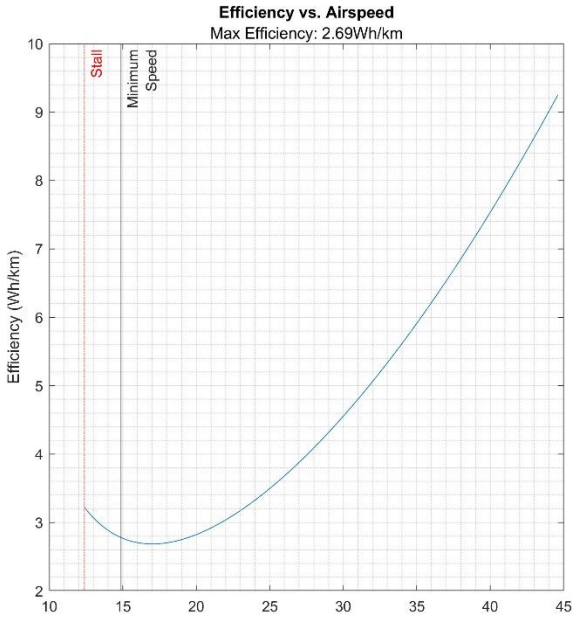
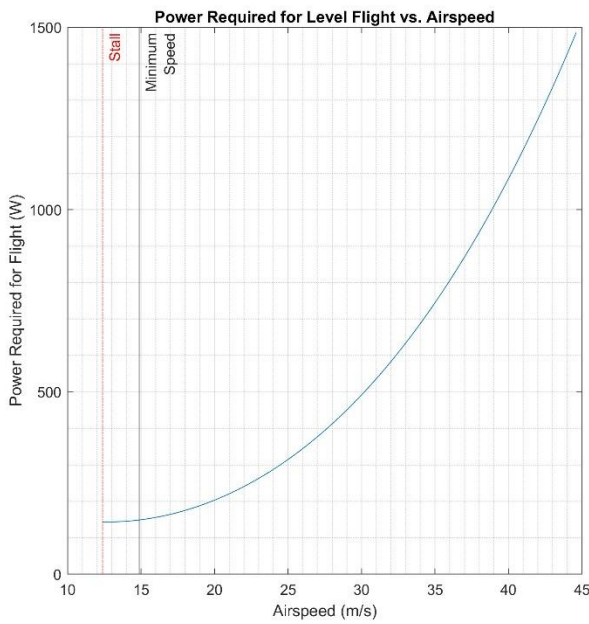
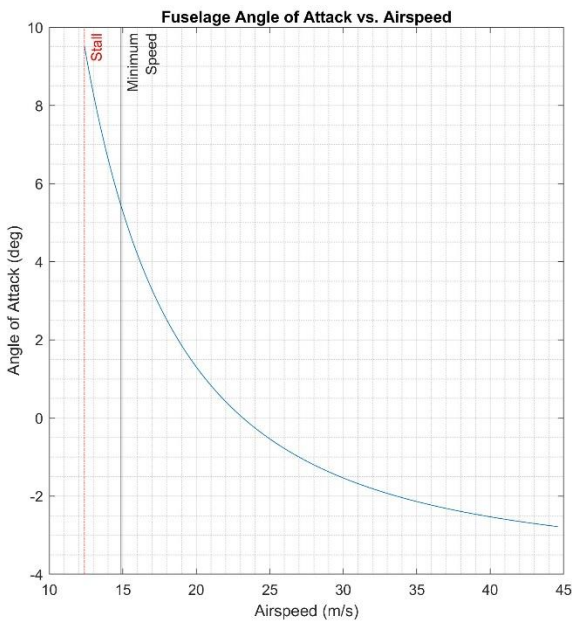


Titan Recon | AUW = 4.5kg





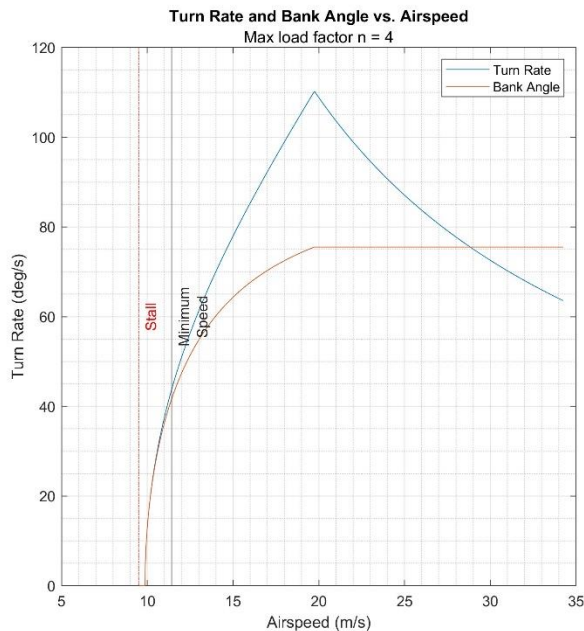
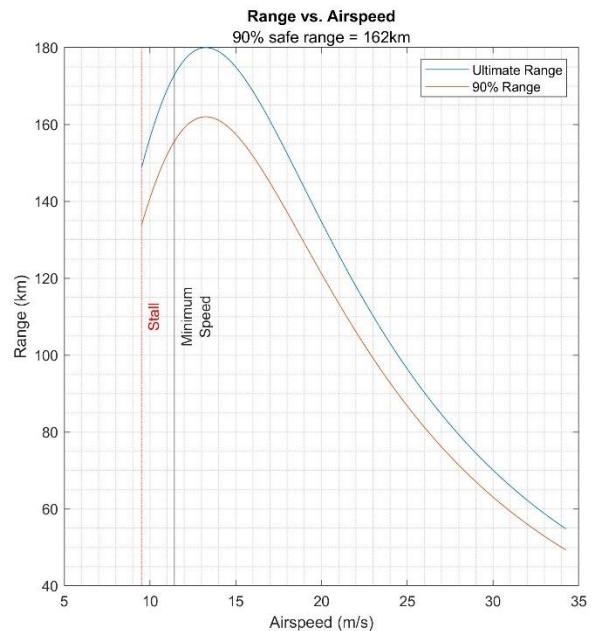
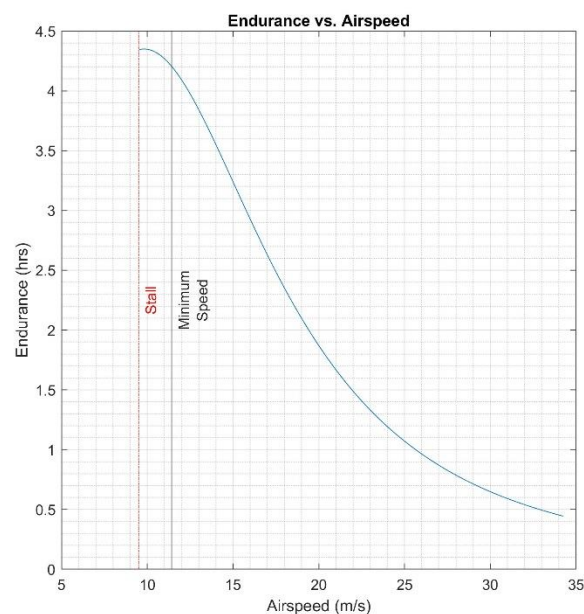
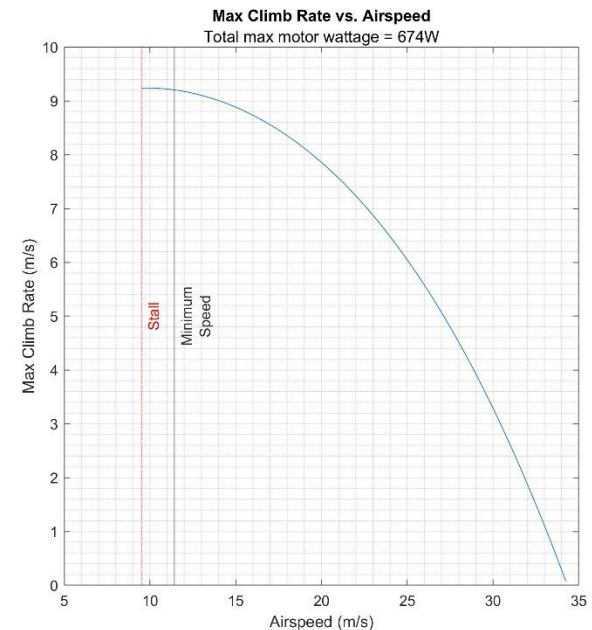
Titan Recon | AUW = 5.5kg





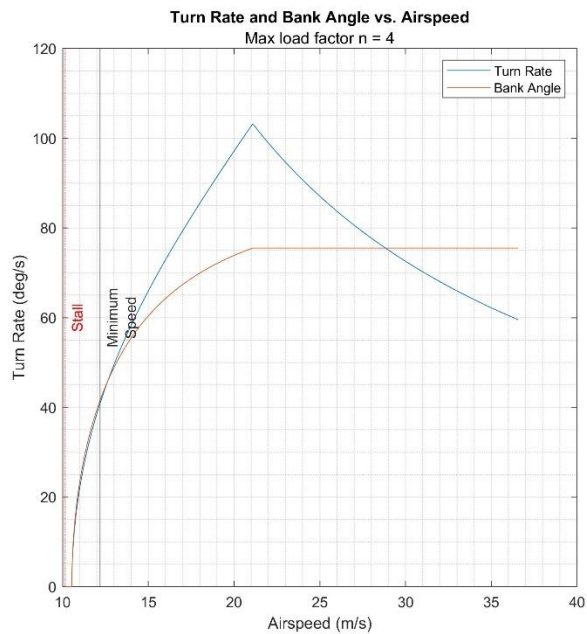
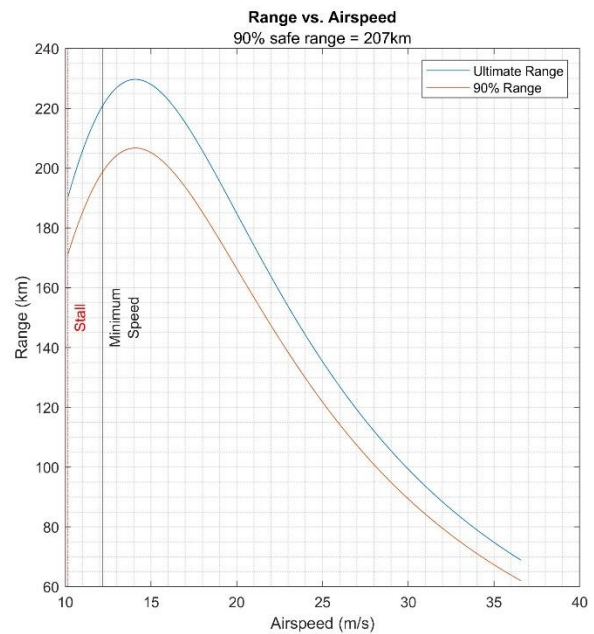
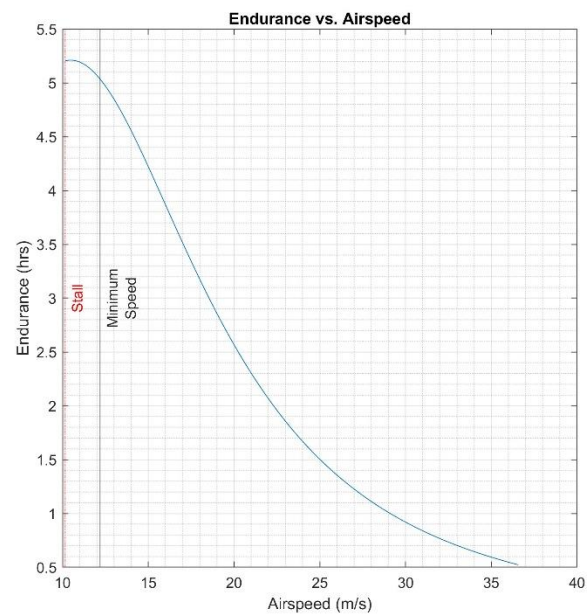
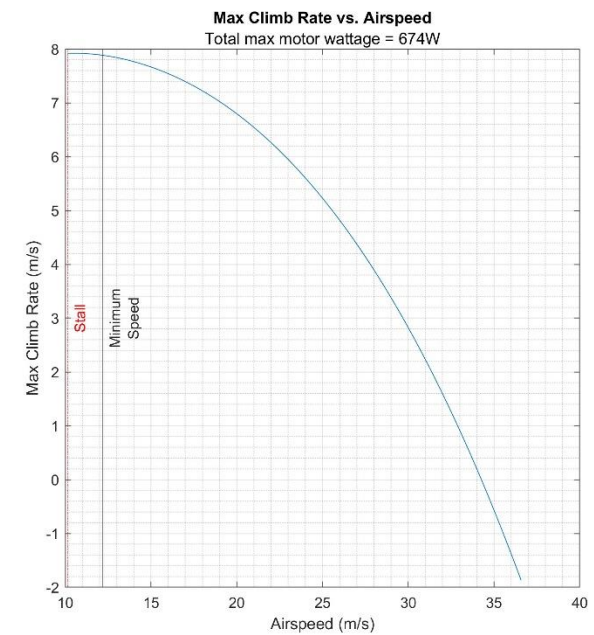
2.2.2: Turn rate, range, endurance, and max climb rate for a variety of different battery configurations:

Titan Recon | AUW = 3.24kg | 6S4P Panasonic NCR18650GA | Payload: 0kg 7.5W
Empty Mass: 1.922kg | Propulsion Efficiency: 48%



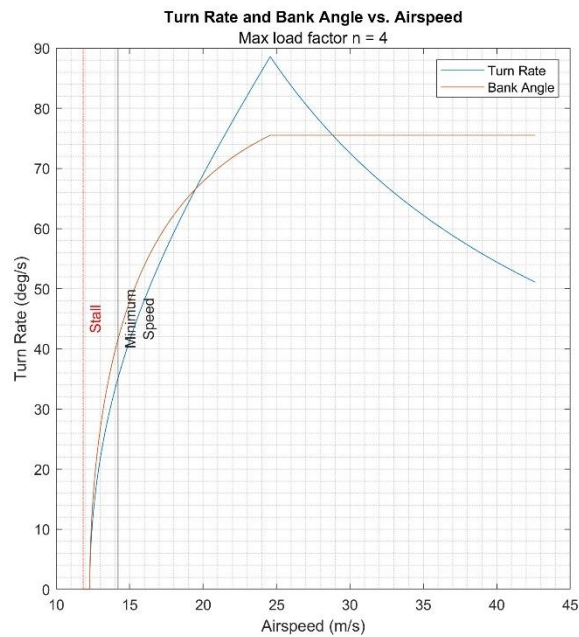
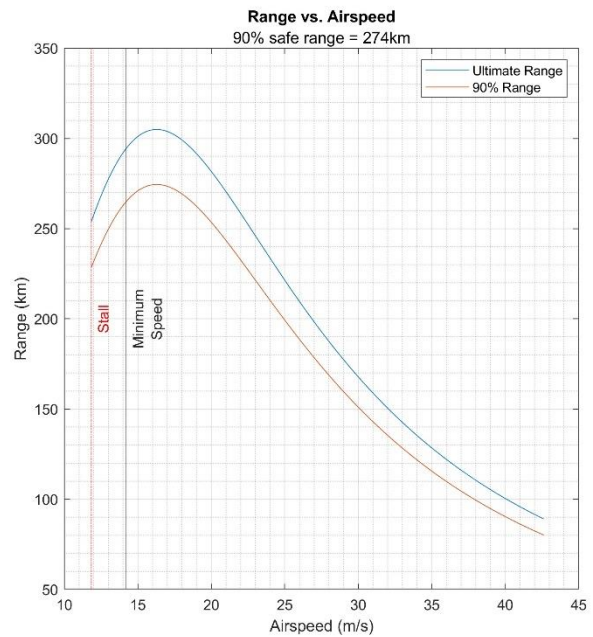
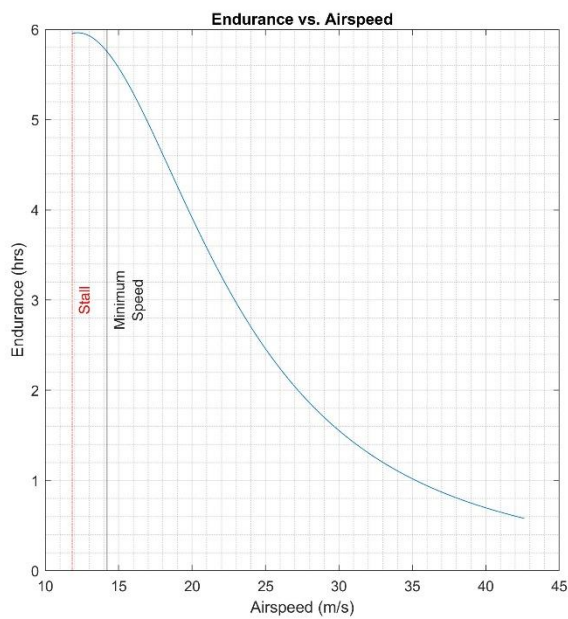
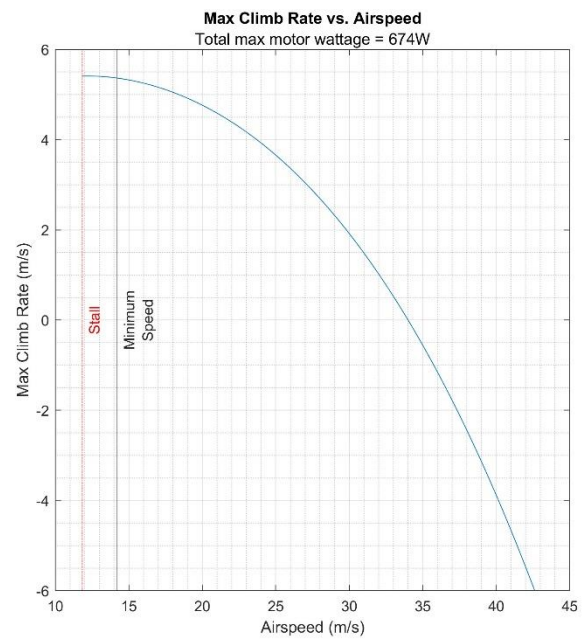


Titan Recon | AUW = 3.7kg | 6S4P Samsung 50E | Payload: 0kg 7.5W
Empty Mass: 1.922kg | Propulsion Efficiency: 48%





Titan Recon | AUW = 5.02kg | 6S7P Samsung 50E | Payload: 0kg 7.5W
Empty Mass: 1.922kg | Propulsion Efficiency: 48%





Section 3: Required Build Materials

Spars needed (solid rod if no OD/ID specified):

- (2) 10 OD x 8 ID x 1000mm - front & rear main wing spar
- (1) 8 OD x 6 ID x 600mm - inner wing spar
- (2) 4x600mm - flap/aileron hinge
- (1) 4x350mm - hstab support
- (1) 3x500mm - elevator hinge
- (1) 4x150mm - vstab support
- (1) 3x200mm - rudder hinge

Recommended motor & prop:

- Twin Motor Configuration:
 - 19-25mm mounting pattern
 - BrotherHobby 2816 620kv and APC 11x8 CW/CCW props (this is only a suggestion, there are hundreds of other motor and prop combos that would work)
- Single Motor Configuration:
 - Gartt 5010 300kv - Aeronaut 20x10
 - Brotherhobby T5 640kv - APC 12x8.5F

Recommended electronics:

- ELRS / Dragonlink / TBS Crossfire
- 5.8ghz / 1.2ghz analog or digital. Supports DJI / Walksnail / SIYI as well
- Matek F405-WTE or similar flight controller running Ardupilot (optional)
- Matek M10Q-5883 GPS/Compass or similar (optional)
- (2) 35A BLHeli ESC or 51a Lumenier Blheli32 ESC with telemetry
- (6) Emax ES08MAII servos
- Li-Ion Battery: 6S3P 21700 15Ah, 6S4P 21700 20Ah, 6S8P 18650 28Ah
- LiPo Battery: 6S 6Ah, 6S 8Ah, 6S 10Ah, 4S 14Ah (many other options...)

Misc:

- Polymaker Polylite prefoamed LWPLA
- PETG or other high-temp filament for the motor mount
- Medium CA glue
- 220x220x240 minimum size print bed
- Control horns and rods
- M3 threaded inserts (max 6mm height)
- M3 bolts of various sizes (countersunk ones as well)
- 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://teachingtechyt.github.io/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 RECON WITH 3.5% CUBIC SUBDIVISION INFILL

Notes:

- 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 over 13G 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, stick to cubic subdivision or cubic. A part printed at 3% gyroid is comparable in 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.

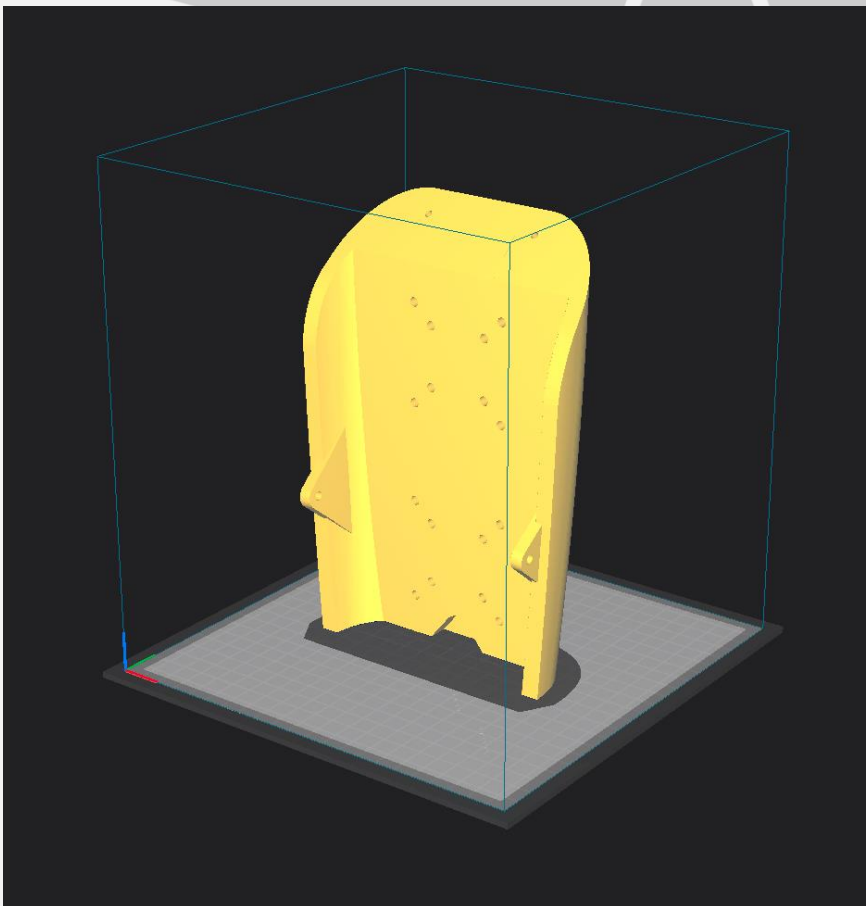
- High temp Polycarbonate or PETG parts should be triple wall and high infill (25%).

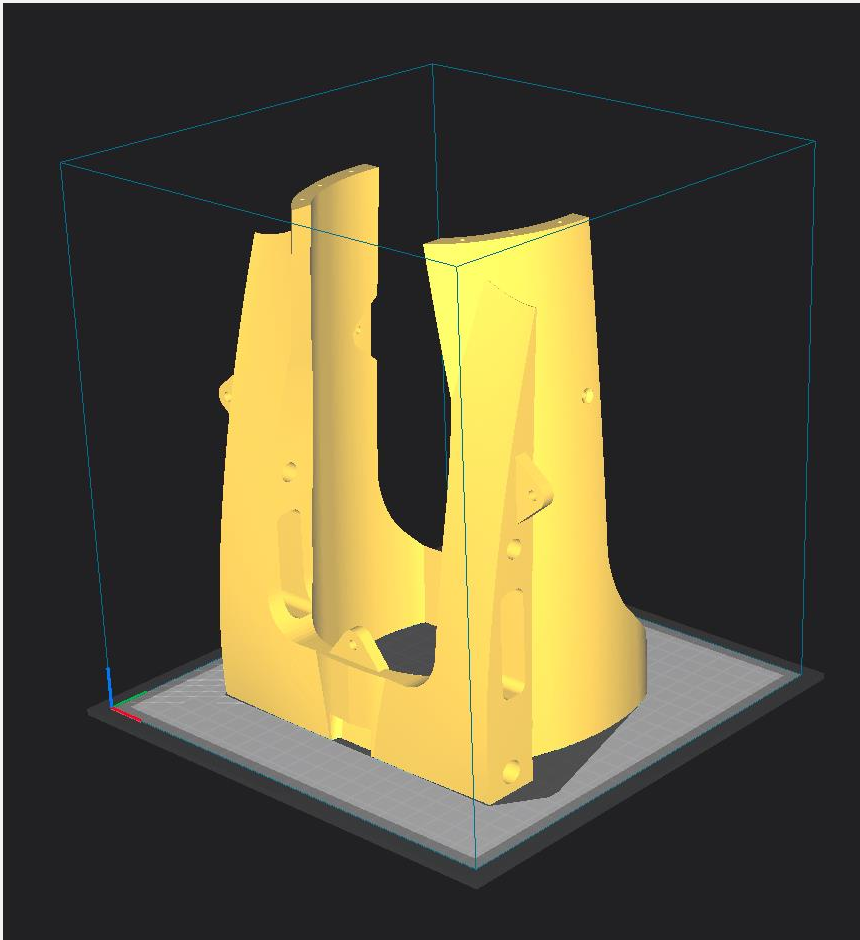
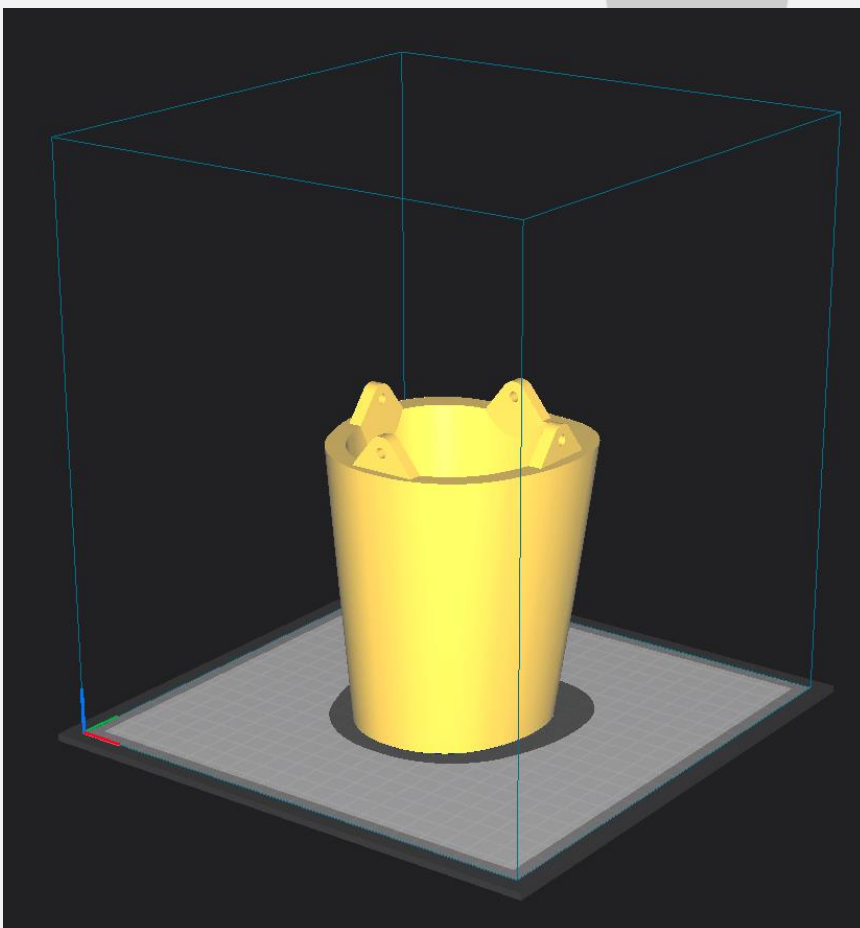
We recommend using [version 5.2.2 of Ultimaker Cura](#). You can find many instructions and a suitable LW-PLA profile at [this link](#).

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 to avoid using supports:







4.3: Tuning “hole horizontal expansion”

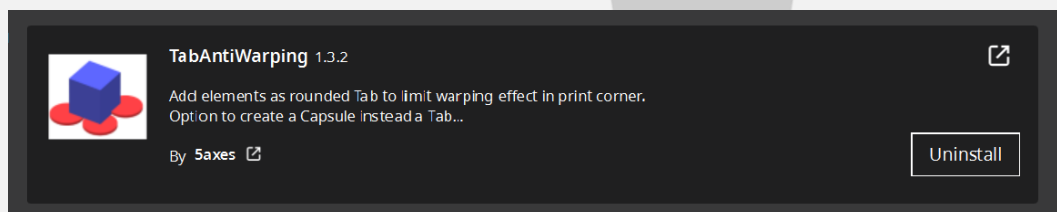
It is very important to check the fitment of the carbon rods in their holes on the first parts you print. Because everyone may be using different printers, materials and slicer settings, it is not possible to provide the models with a slicing profile and hole size that will work for everyone.

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.

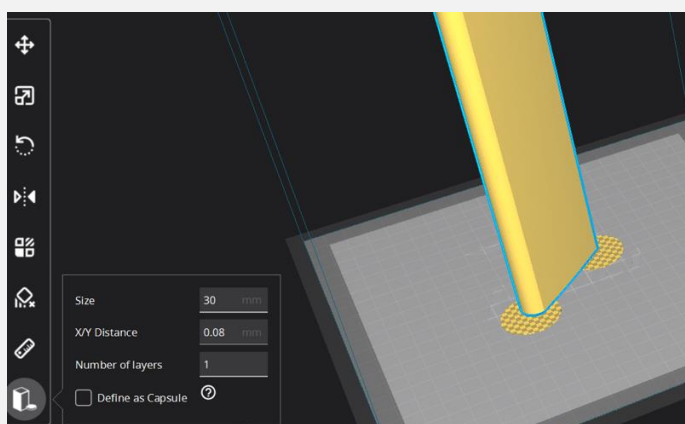
4.4: Bed Adhesion and warping

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.



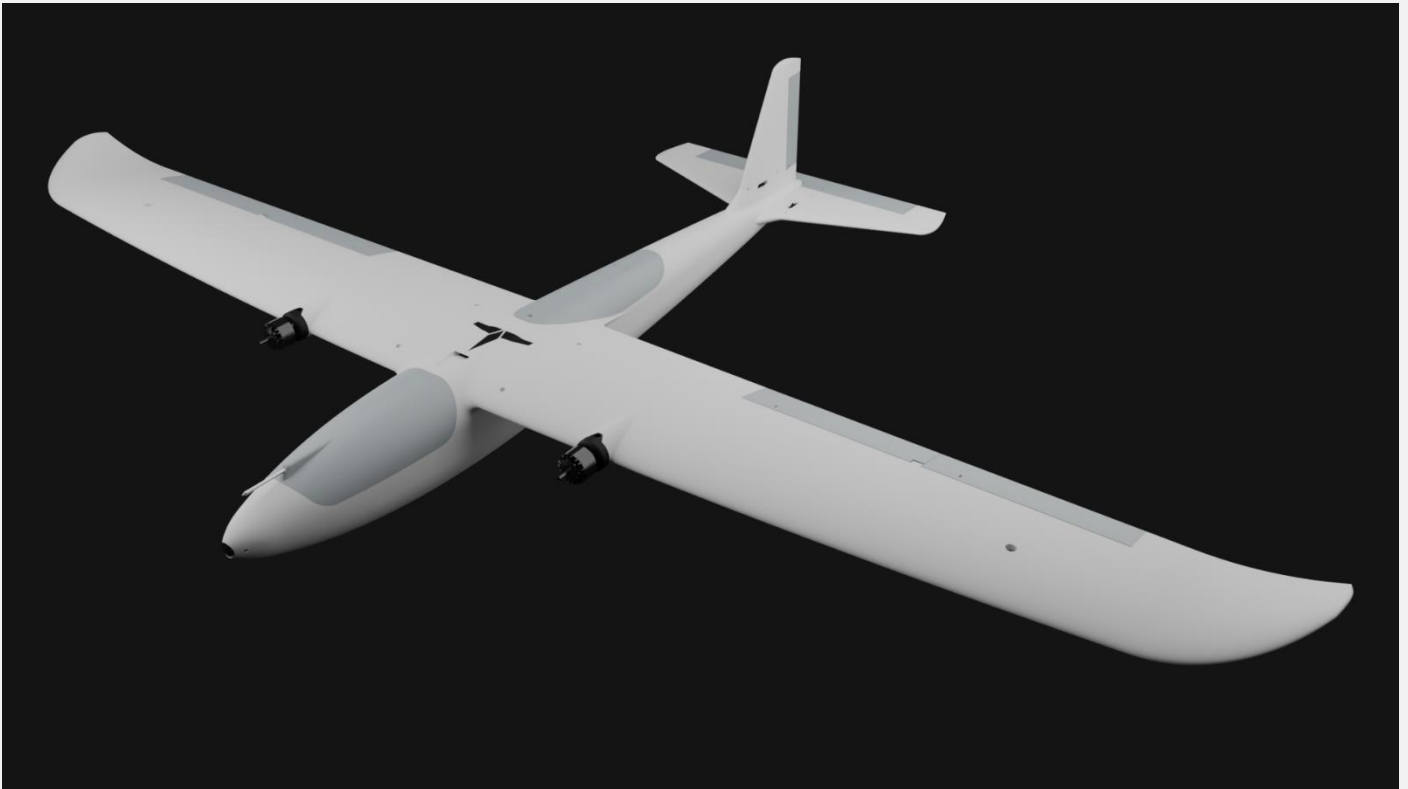
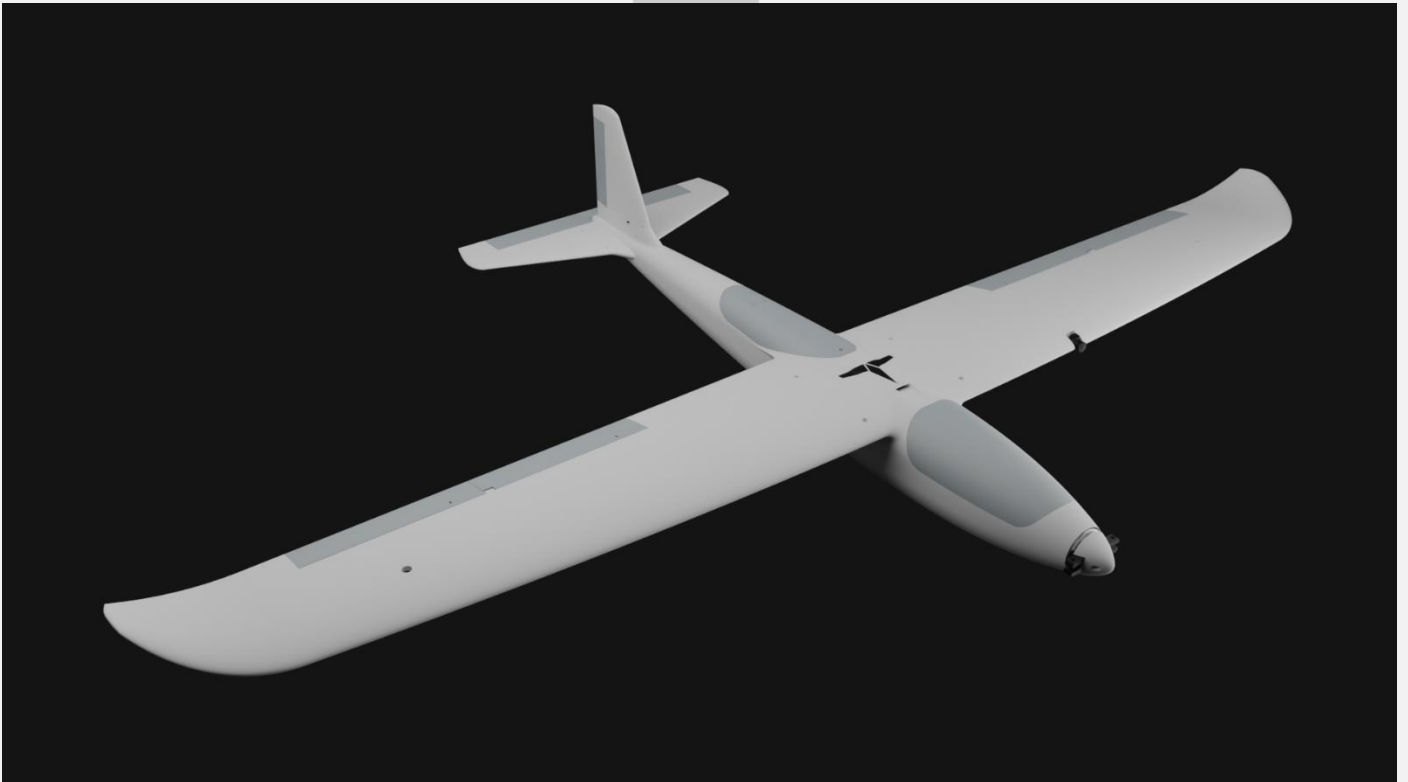
When installed, use the new icon at the bottom of the left menu to choose tab diameter and thickness, then click on the model to add a tab at each point you think is at risk of warping or poor adhesion (typically parts with low surface area in contact with the print surface in relation to their height).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





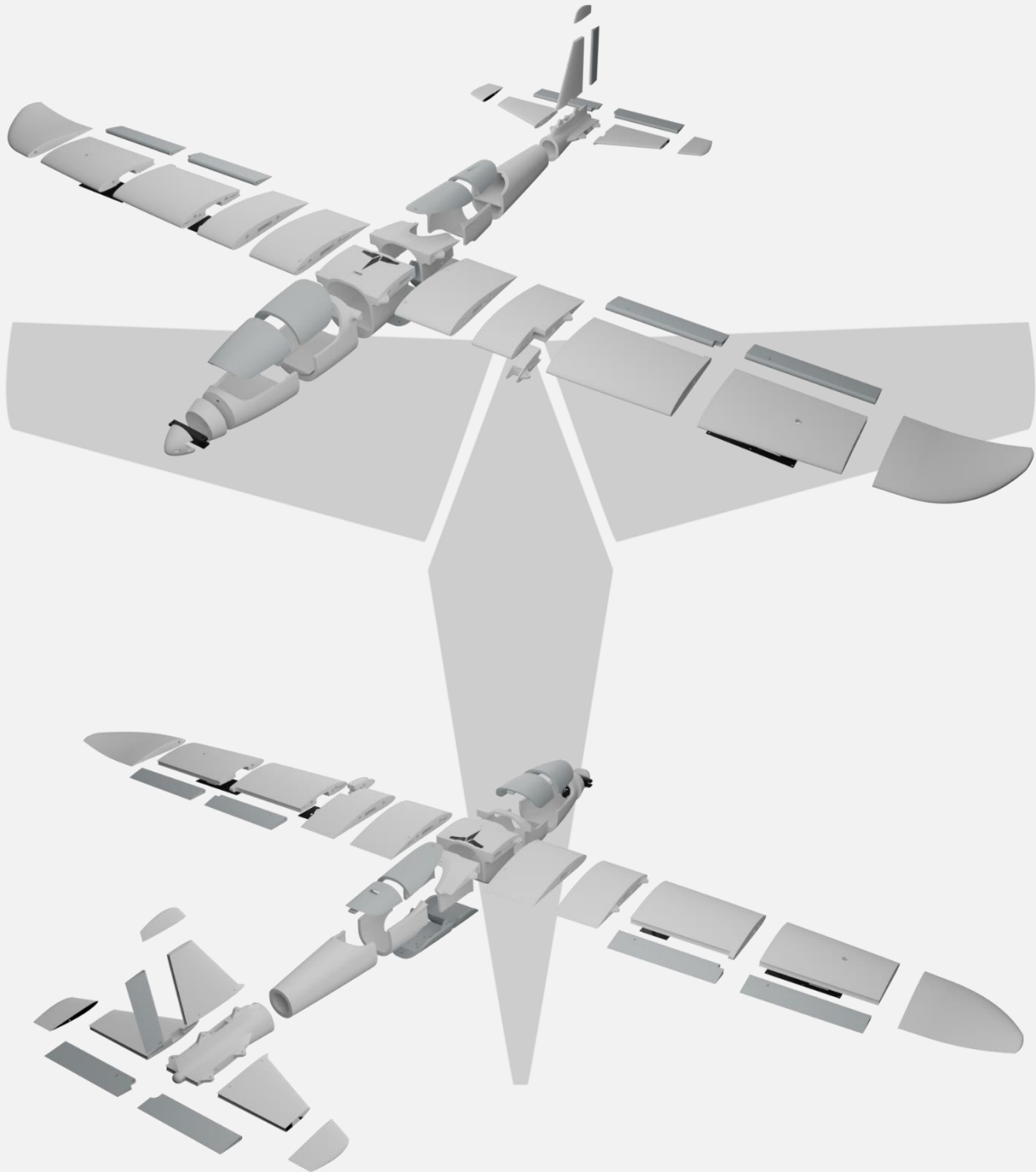
Section 5: Assembly of 3D Printed Parts

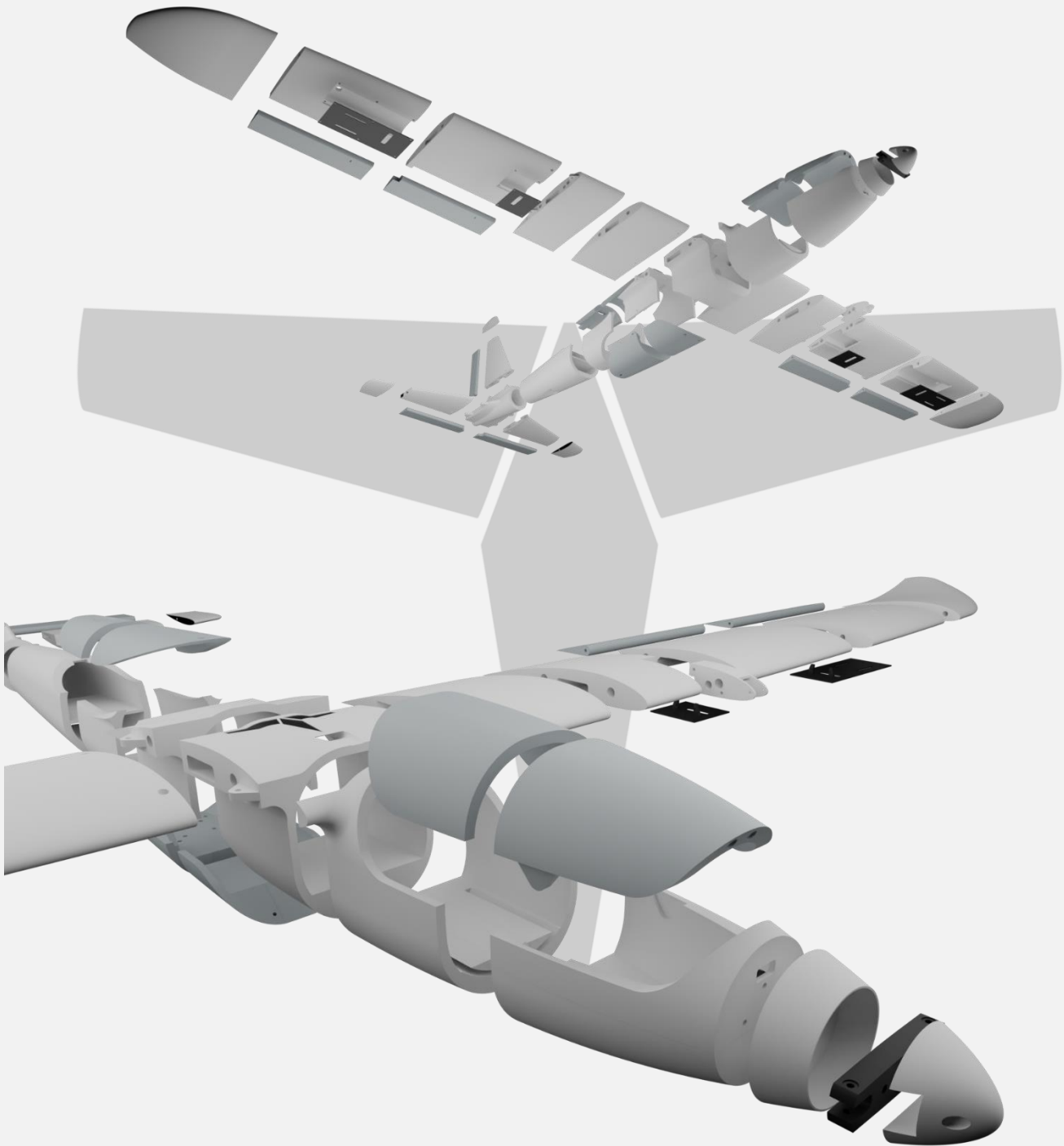
Recon has two options for the configuration of its propulsion system. The first being a single motor puller, with the FPV camera mounted on the wing, and the second being a twin motor aircraft, with FPV camera in the nose. The nose and wing nacelles are swappable to accommodate these differences, and the choice of configuration is left up to builder's preference. Below are a few renders depicting each configuration.





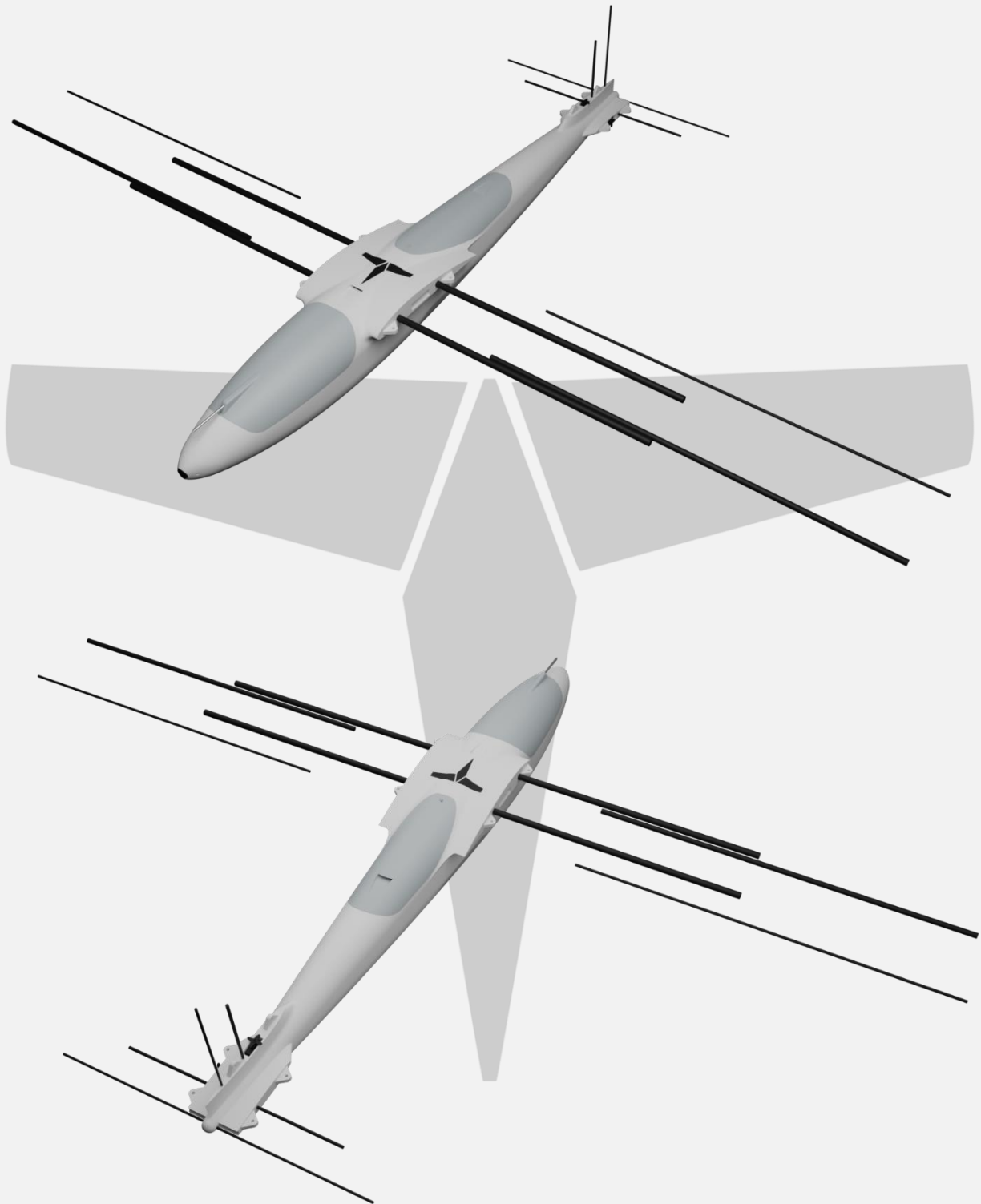
Below are a few exploded views of the Recon to help with assembly.







The spar layout for Recon is as depicted below:





- Medium CA glue should be used to assemble all glued 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.
- 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 should be adhered to within ± 10 mm.
- Add duct tape or other abrasion resistant material to bottom of the fuselage to increase durability if landing on rough surfaces.
- Use the included ESC mounting plates for tidiest wiring.
- If your goal is long range, aim for maximum antenna separation by using the wing bays to mount your VTX and RX.
- Install your propellers such that the left is rotating CCW (looking forward as the pilot) and right is rotating CW. This gives a small performance boost over the other rotation.
- Set AUTOTUNE_LEVEL to 8 prior to doing an autotune on Ardupilot for ideal flight characteristics. PIDs will vary from setup to setup, especially with increased weight. A good starting point for both roll and pitch PIDs are: P: 0.25, I: 0.125, D: 0.002, FF: 0.125
- You can comfortably budget 3-4kg of total battery + payload weight, given your power system can produce nearly a 1:1 power to weight ratio or more.

An ideal Recon setup for maximum range and endurance:

- [Arducustom](#) running on H743 or better FC
- Dragonlink for RC + Telemetry (> 100km capable)
- 1.2ghz 1500mw Partom VTX (> 100km capable)
- Lumenier 51a ESCs with telemetry (for RPM/Temp display on the OSD)
- Samsung 50E 6S7P 21700 35Ah LI-Ion
- Brotherhobby T5 640kv + 12x8E/EP APC props | Brotherhobby 2816 620kv + 11x8E/EP APC props
- Airspeed sensor for best speed measurements and TECS behavior