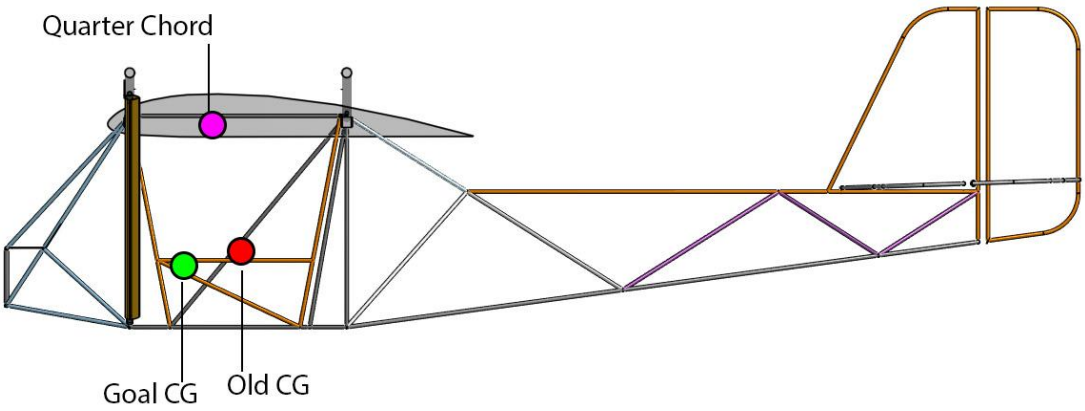
Fuselage Design Update 11/25

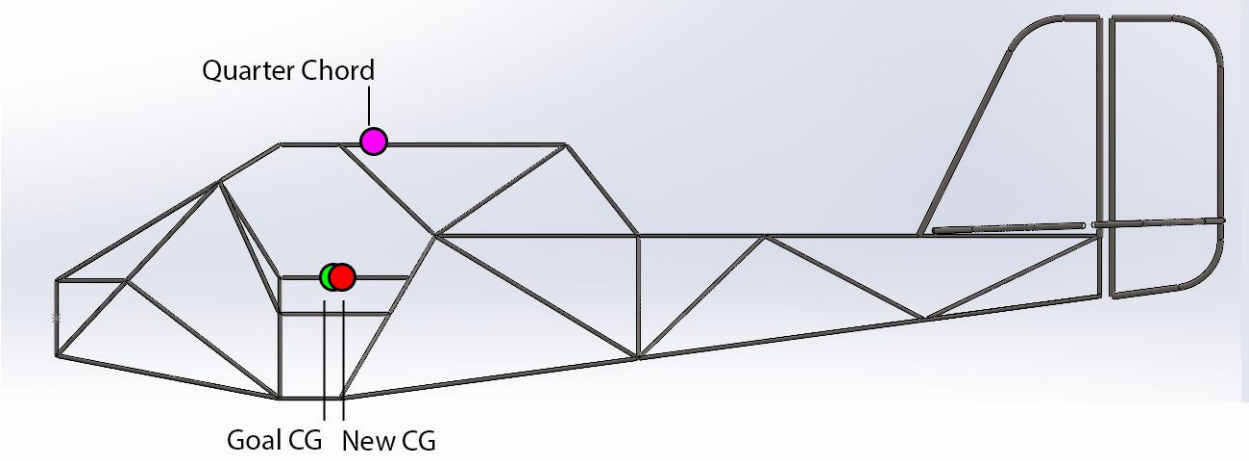
We've been making some rapid progress on our truss design, but not updating the blog as much. The design team hopes this post will cover all the changes we've made in the past 2 months, and will be posting more consistently.

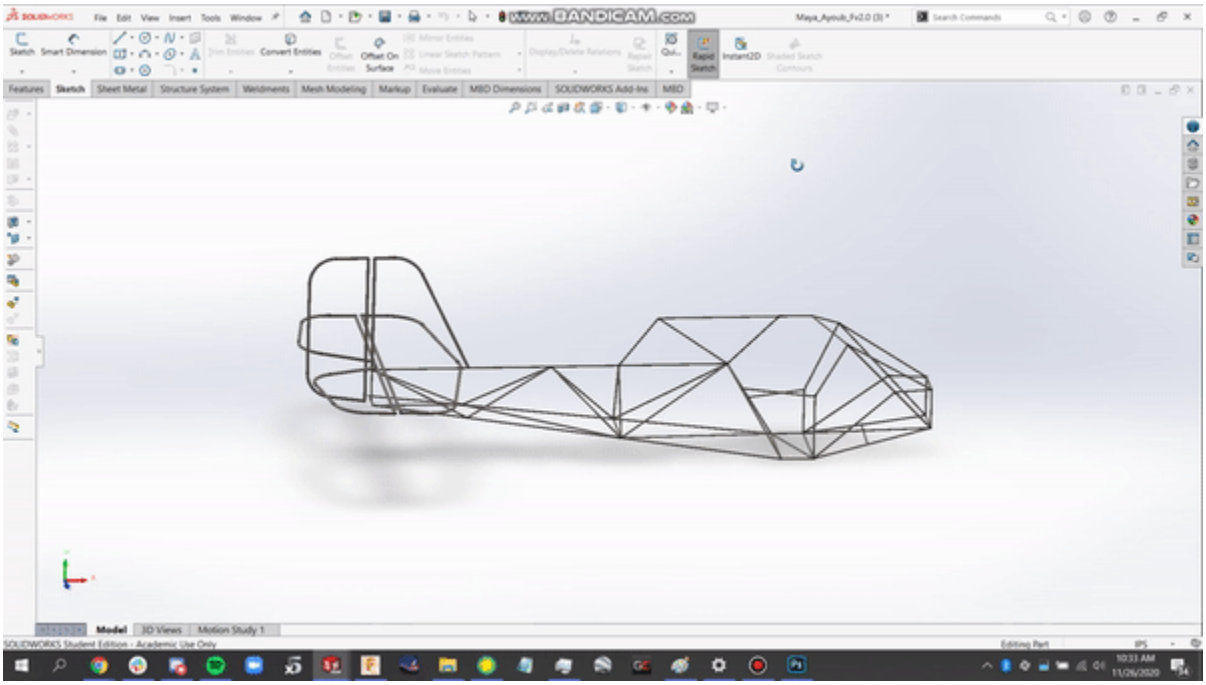
Our Physics team realized through XFLR5, a properties of flight simulation software, that our previous center of gravity (CG) placement would lead us to be statically unstable. To solve this problem, they recommended we move our CG 5.8 inches forward of Quarter Chord (QC). The QC is where our mean aerodynamic center is, or where we can approximate our center of lift to be.



To solve this problem, we initially thought of pushing our batteries farther into the nose, but even shifting 80 pounds 10 inches forward would not solve our CG problem. This problem combined with our recent decision to weld our frame led us to realize that we may as well take this as an opportunity to redesign our entire fuselage.

First Draft





Changes:

⅝” OD, 0.035” wall 4130 chromoly steel tubing: we needed to switch our material since we are now welding, and the Legal Eagle constructs their truss out of this dimensioned steel.

Switched CAD programs: We first switched to Solidworks because of its 3D sketch capabilities but we ultimately moved over to Fusion360 for easier team integration, in part assemblies, its sophisticated pipe feature, and its simulations are more accurate.

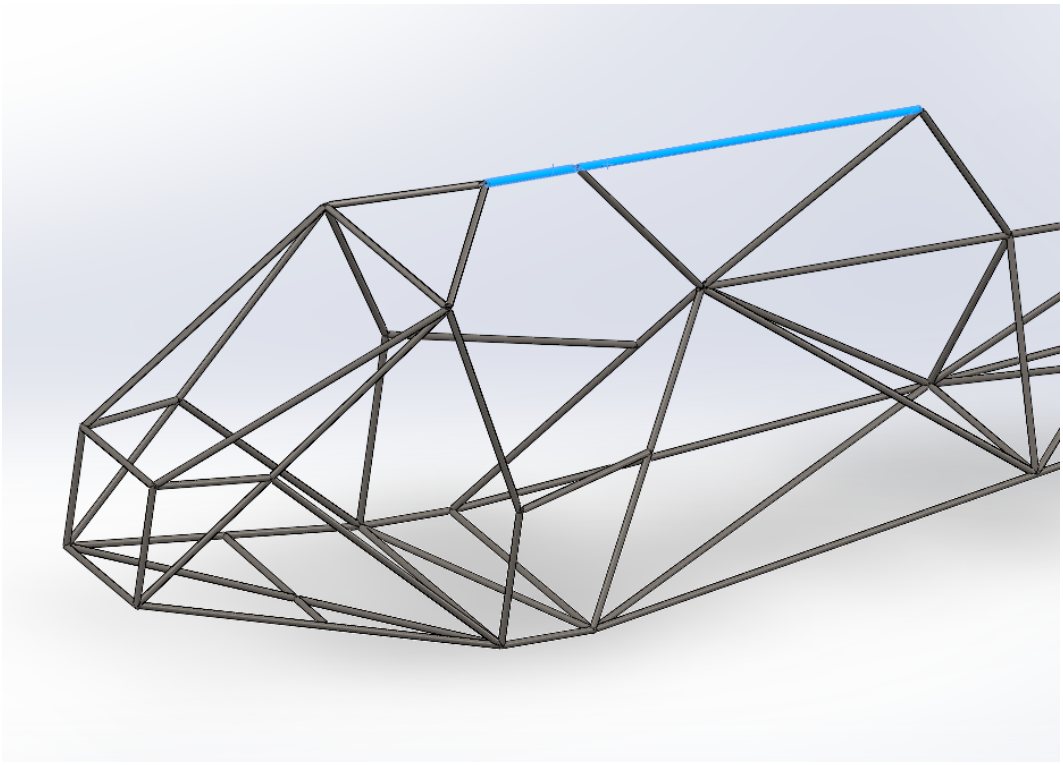
Nose Extension: This enables us to place the batteries farther forward, thus moving our CG forward as well.

Single beam cabin roof with "dorsal fin": since we are able to redo most of our fuselage, we took inspiration from many other ultralights such as the Legal Eagle and Affordaplane to implement a single beamed roof.

Legal Eagle

Affordaplane

The top cabin beam (blue) would also be the only fuselage- root wing connection beam, so we're worried it may collapse under the force. However, the force could be mitigated enough by the struts, since they're going to be holding the wing to the fuselage as well.



We will be cross-comparing several truss simulations in Solidworks, Fusion, and Grape FEA to ensure the structural viability of the new fuselage

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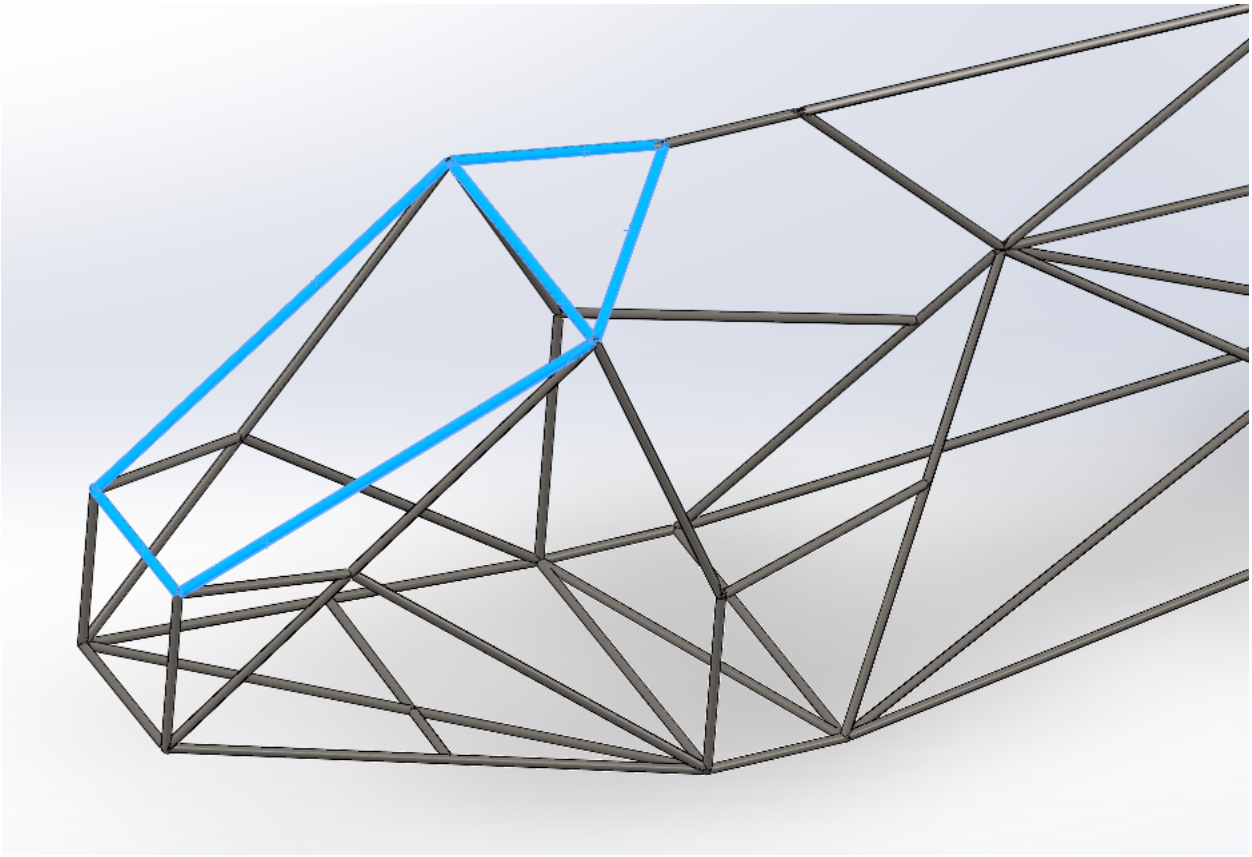
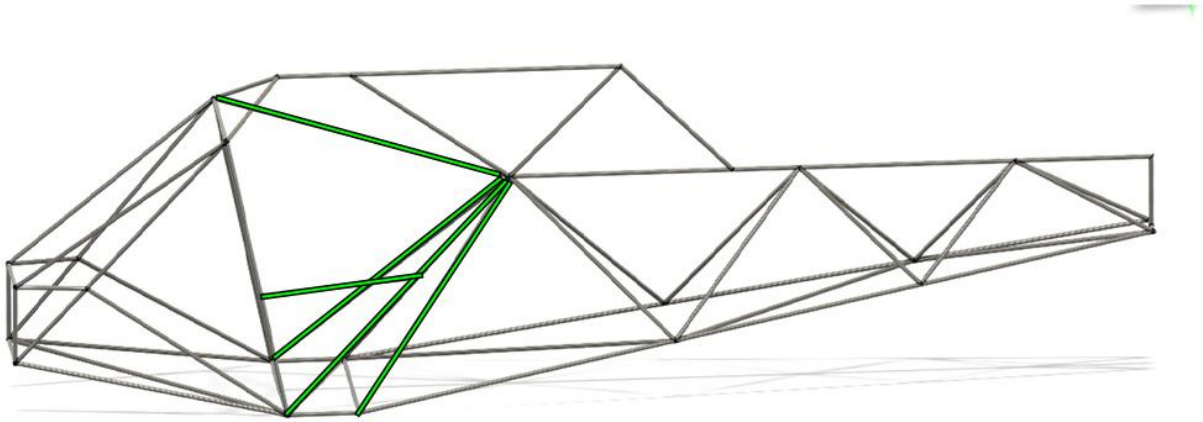
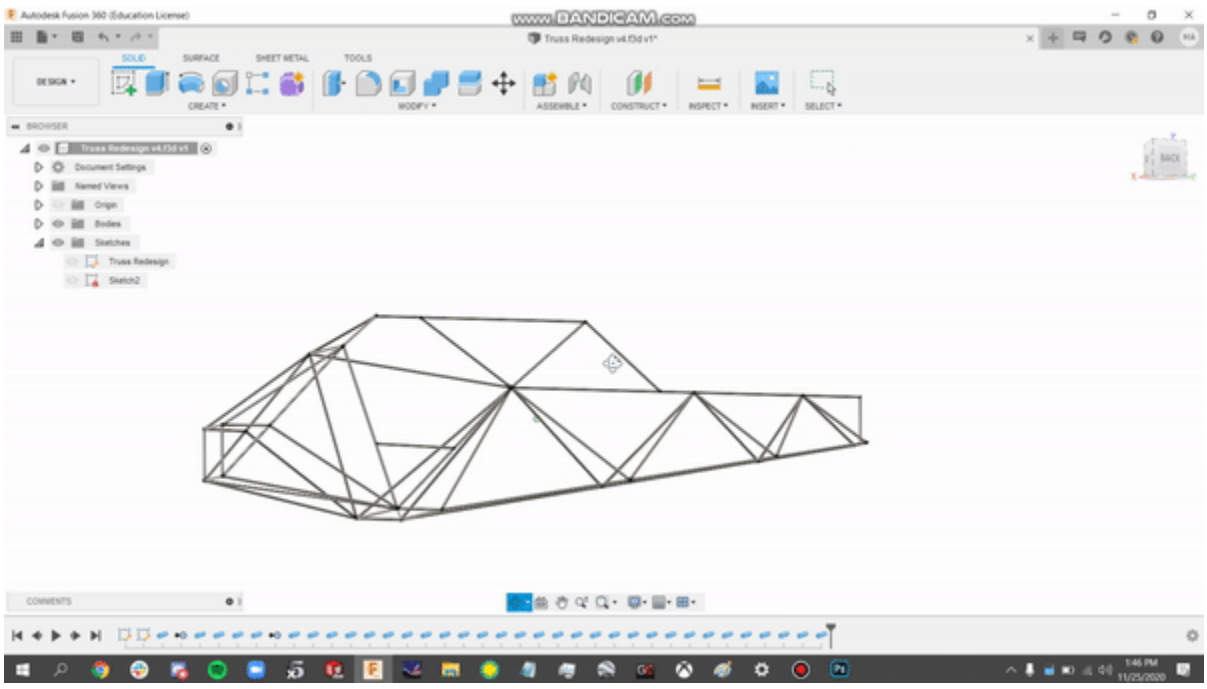


Our front section is now a 3D kite shape to accommodate the single beam and to give the pilot the largest field of view possible. We were initially concerned about the rectangular shape of it, but we then realized almost all ultralights have a similar opening and it would not be carrying much of the load other than the thrust from the motor. This can be seen above as well on the Legal Eagle and Affordaplane.

Second Draft



Changed section in Green



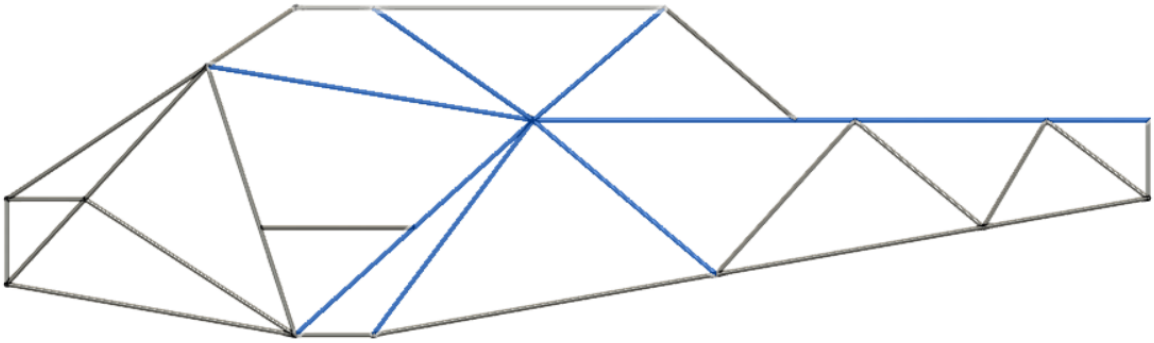
Changes:

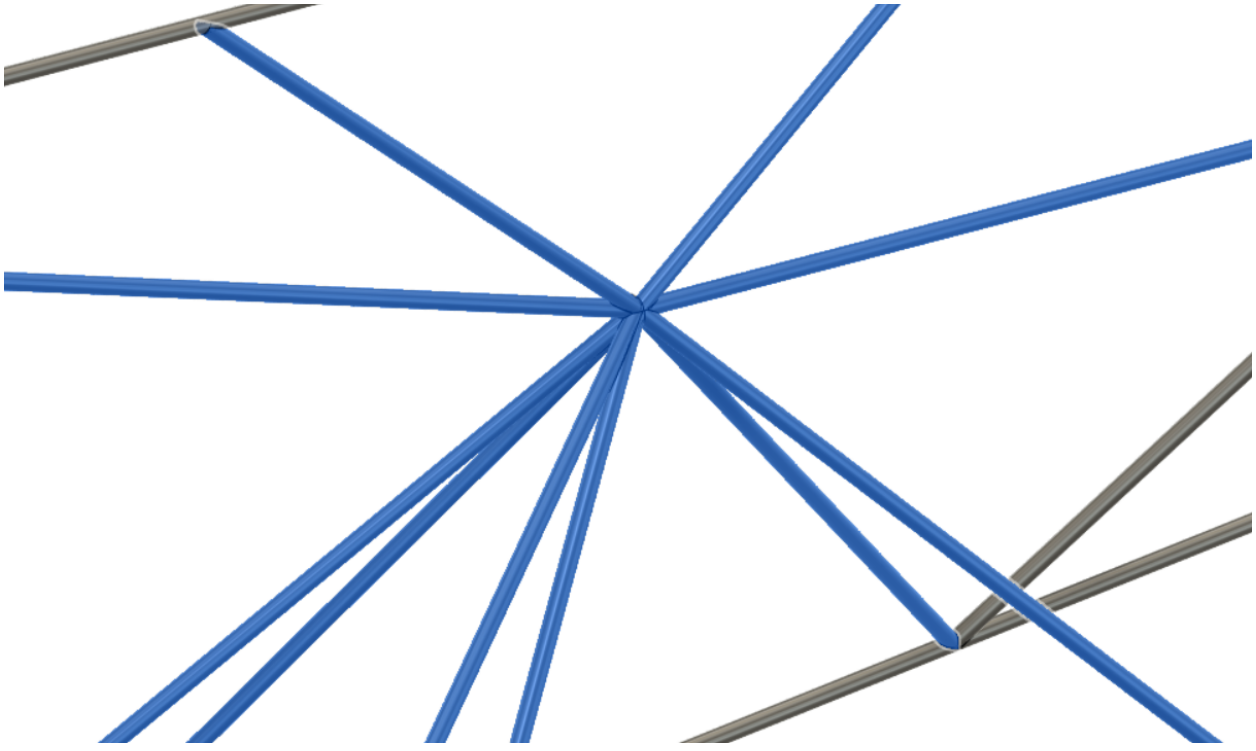
This new iteration was created to simplify the cabin section as the previous version had an abundance of unsupported beams. This also created more problems since now all the beams connect to one point, which we will elaborate further on in the next section.

Additionally, this was the first fuselage we designed in Fusion!

Future Plans:

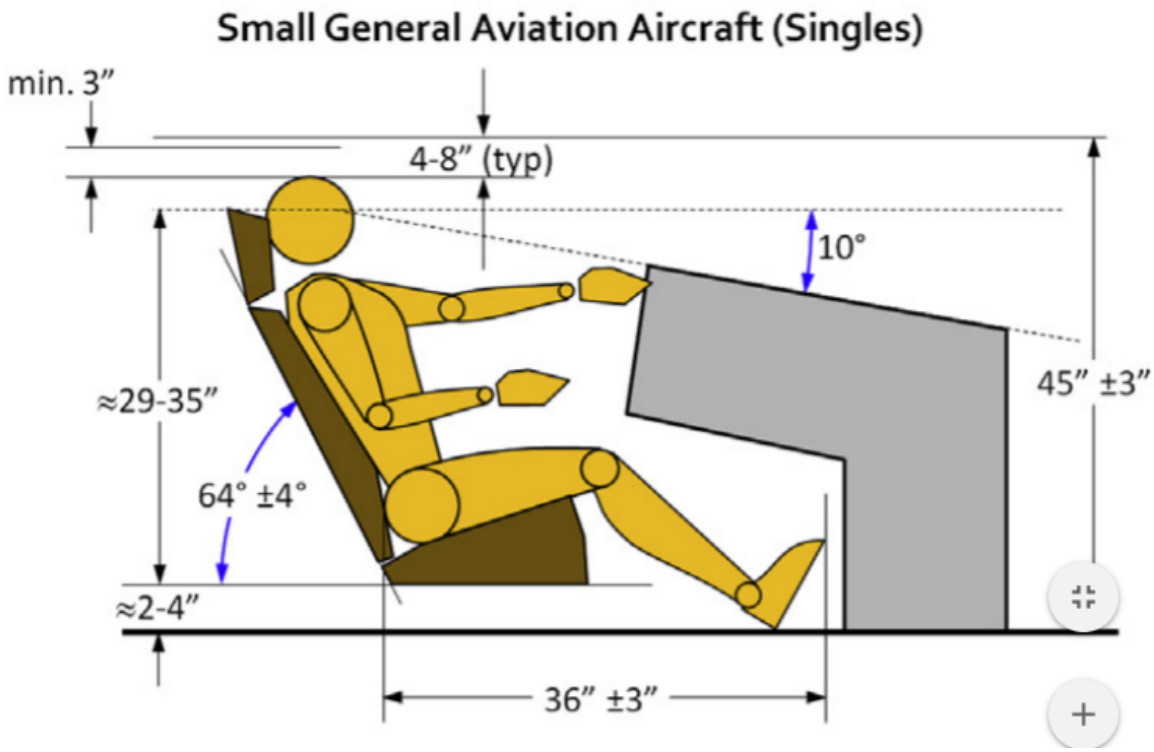
Cluster Problem:





This complex cluster wouldn't be easily weldable, so we are going to separate it into multiple connections by spacing out the intersections and potentially using reinforcing gussets.

Pilot space



Pilot Room - General Aviation Aircraft Design

Our current design does not leave this much room, so will embiggen our cabin section and increase our height.

Decision on Landing Gear

With this redesign, we have the option to switch to a trike configuration, however, many components need to be taken into account with this decision.

Trike:

Advantages	Drawbacks
- Naturally dynamically stable - Easier to maneuver on the ground - Easier to land → favored by pilots - Better forward visibility during cruise	- Higher speed required for takeoff - Weighs & costs move - Higher chance of dipping the propeller on uneven surface - Requires a higher strength braking system

Taildragger:

Advantages	Drawbacks
- Cheaper and lighter - Protects the propeller during uneven runways - Simple steering mechanism - Most ultralights utilize this arrangement - Easier to rotate at low speeds - Structurally simpler to attach to the fuselage	- Much harder to maneuver on the ground, take off, and landing - Poor mitigation of crosswinds - Poor forward visibility - If break hard → prop strike - Slower initial acceleration → need a longer runway

As seen, the taildragger would be the obvious choice if we were only concerned with manufacturability, weight, and cost. However, because we are all students with no pilot's license, logistically we may need to move to a trike, as it is more advantageous in convincing other pilots to fly our plane.