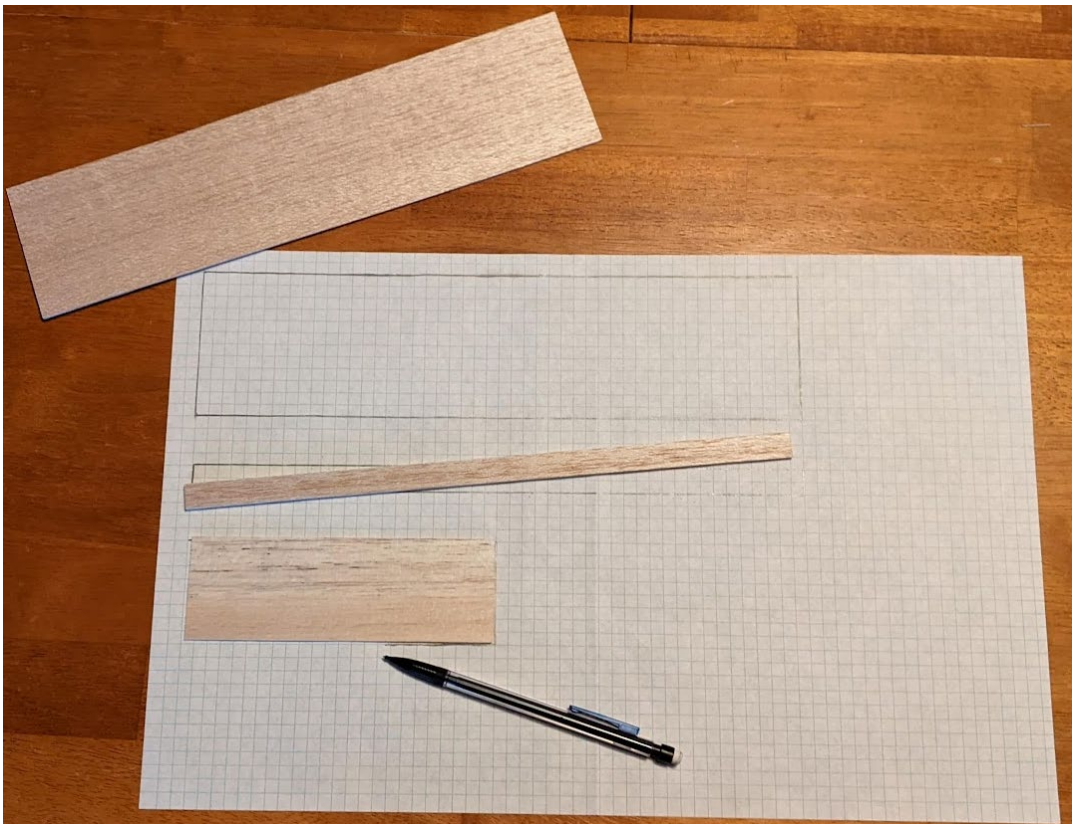
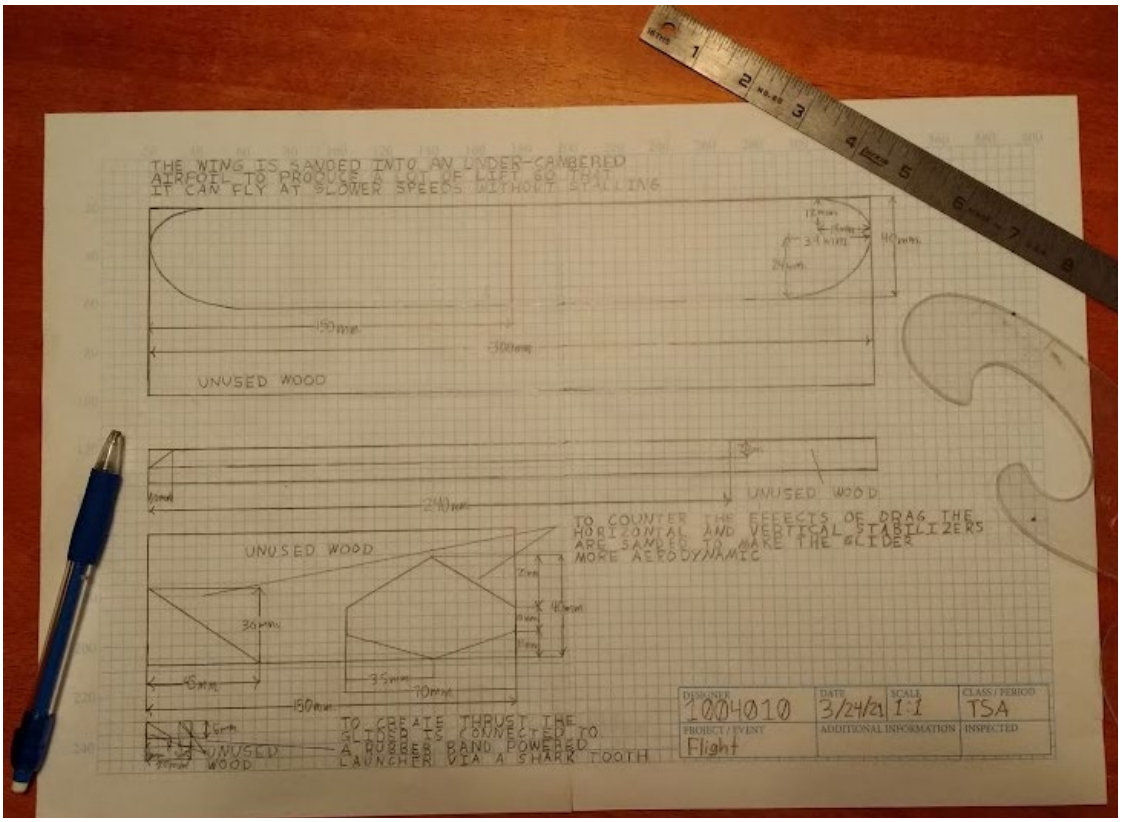
MS Flight Reference Guide - Primarily for Balsa/Bass Wood Gliders

Draw out your design on 11”x17” paper

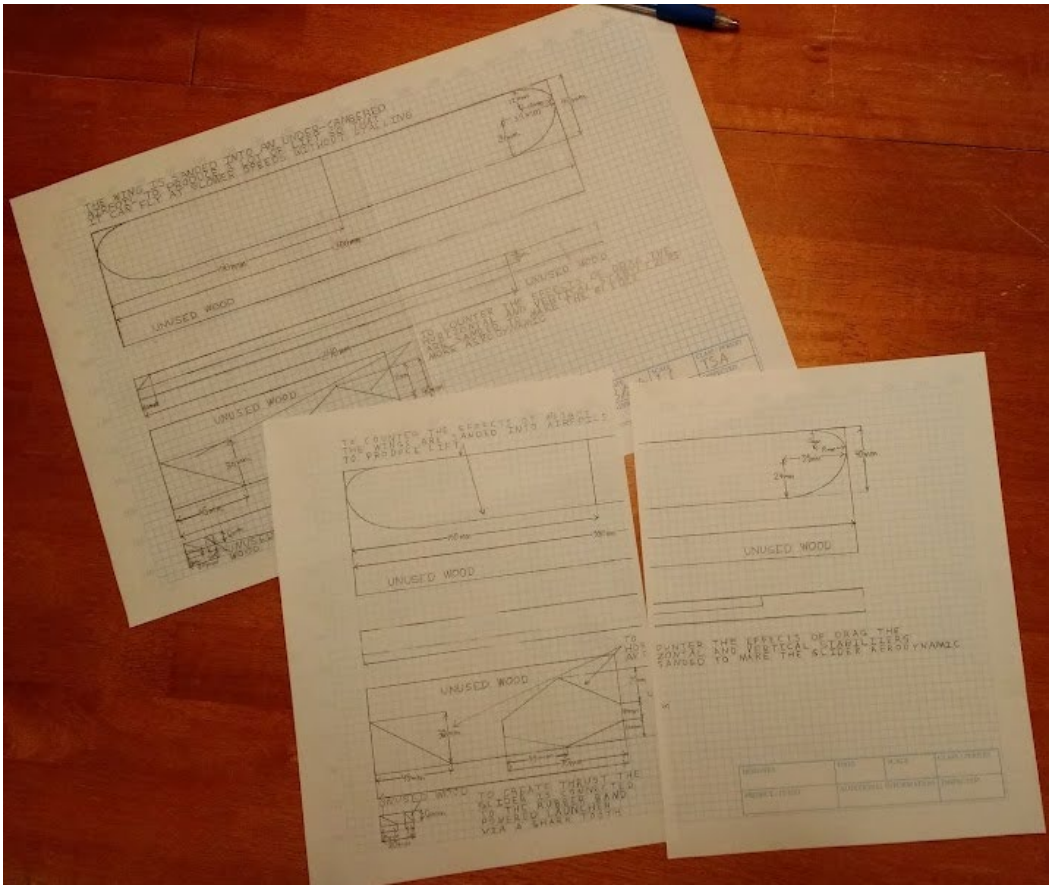
To start, trace all of your pieces of wood out onto your paper. Once you’ve done that, draw your design onto them. If you have an idea, go ahead and do it, even if you think it is not going to work, that is what it takes. You have to experiment to figure out the best way of doing things. I had a box full of failed gliders that I tried, and some of them were weird designs. If you don’t have any ideas, I would go for something like you see in the packet you have, with a fuselage, a dihedral wing, a vertical stabilizer, and a horizontal stabilizer. I want to go over the different parts of a glider briefly. These are your basic ones. The long stick is your fuselage, and it connects your different parts and holds them together. The smaller flat pieces are your horizontal and vertical stabilizers, they keep your plane stable during flight. The largest piece is your wing which provides lift, so your plane can fly. This drawing should be very accurate, with all of your dimensions, for better instructions refer to https://fractory.com/engineering-drawing-basics/, which is a good guide to engineering drawing.



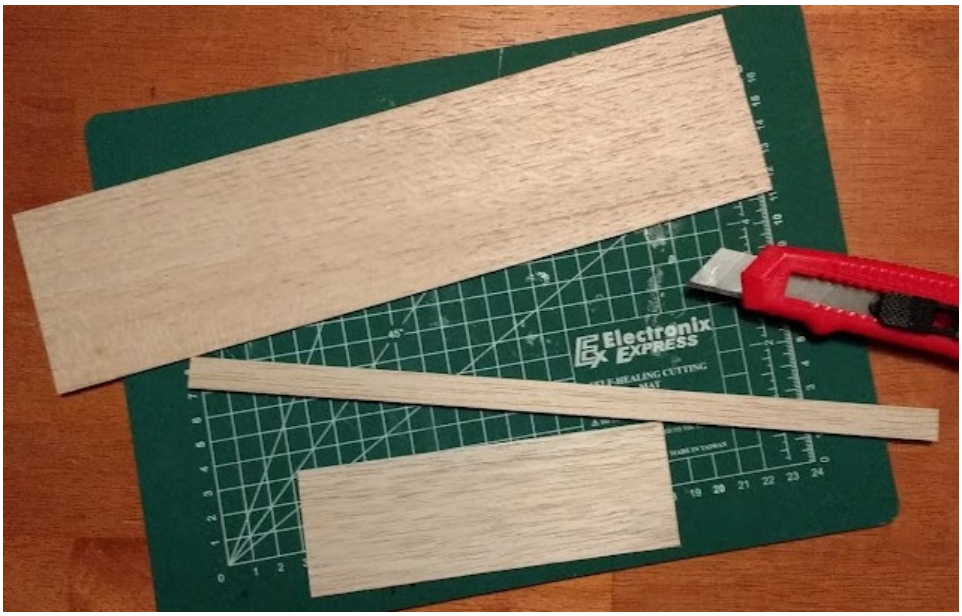


Scan and make a copy of your drawing

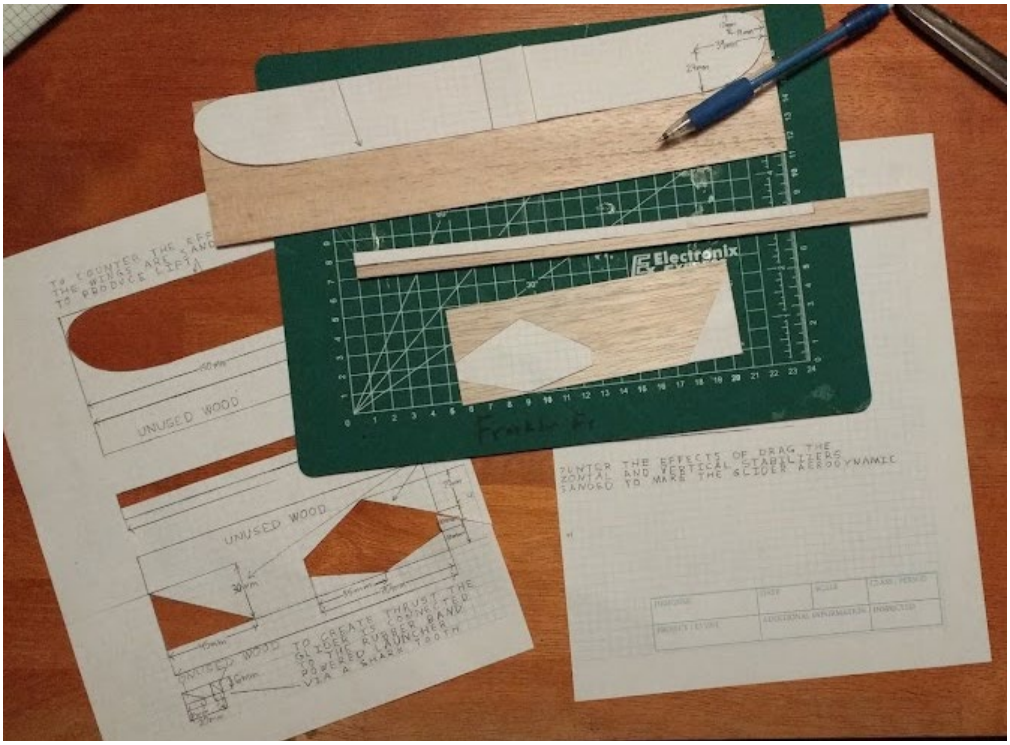
You will probably need to make two scans unless you have access to a printer that can scan the full sheet. Then, you can print out a copy of your drawings. Hold on to your original, you will want that for your portfolio.



Cut the designs out of your copy and then trace them onto your blanks



To have a very accurate design, you will want to cut your drawings out (of the copy, do not ever cut your original drawing), and then use them to trace onto your wood blanks (uncut pieces of wood). You can buy wood blanks here: https://www.whiteboxlearning.com/products/item/WFL-K1. Whitebox Learning also has a really good program for designing and testing gliders virtually, which is great to use: https://www.whiteboxlearning.com/applications/gliders. It helps you understand how gliders work and allows you to experiment without expending wood (although nothing beats experimenting with wood).

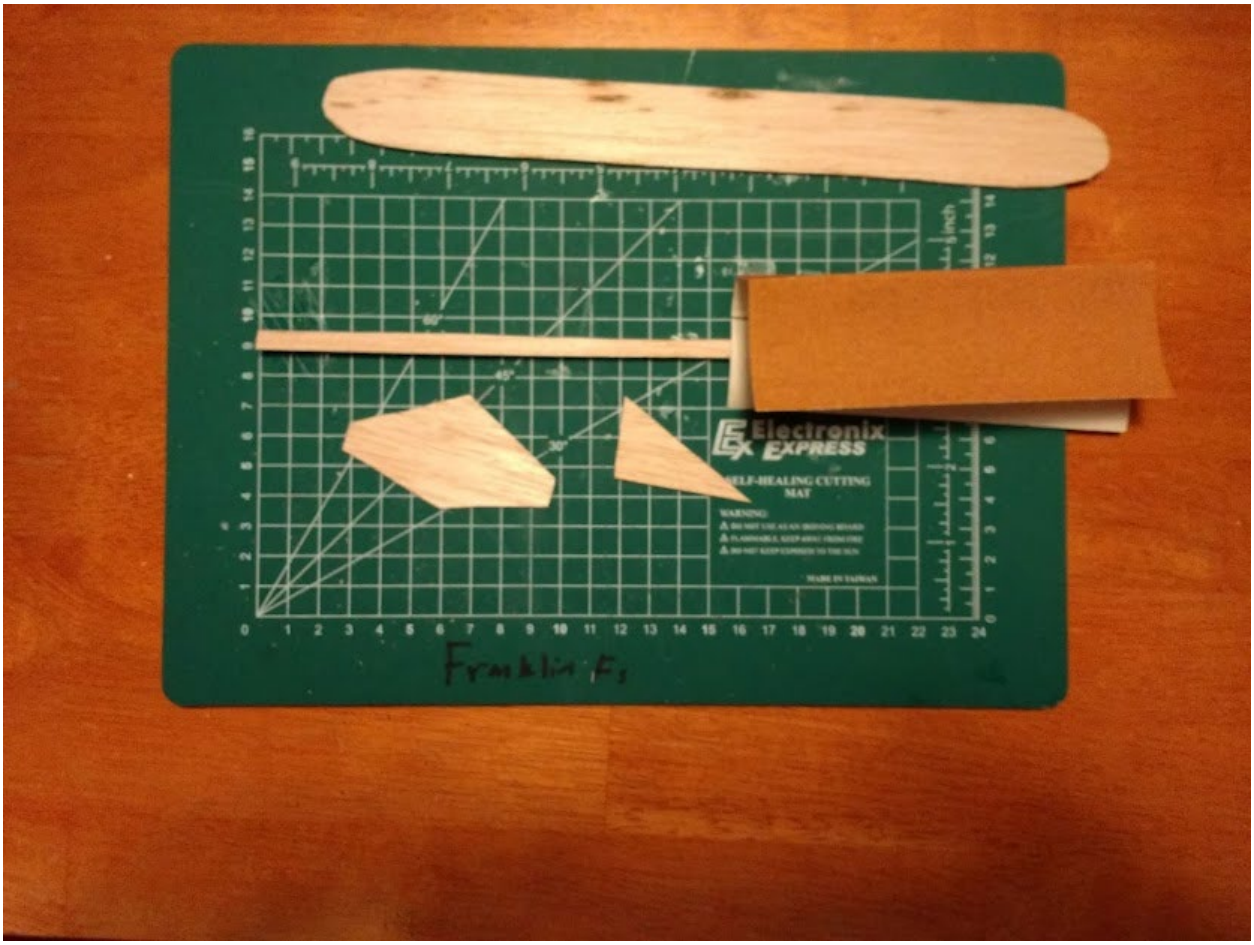


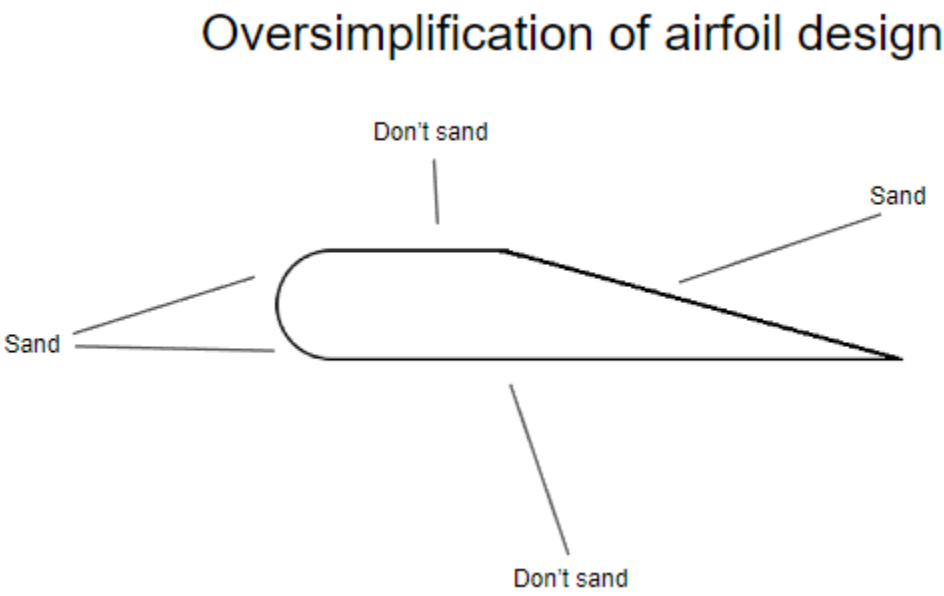
Cut your parts out

Using a razor blade, cut your parts out, using the traced lines you made previously. Be careful when cutting across the grain of the wood, as it is easy to tear the wood. Make sure you use a proper cutting surface, such as a cutting mat or piece of plywood, so you do not damage your work surface. If you are going to do a dihedral wing design, which is basically where the wing is cut in half and set at an angle from the fuselage (would recommend), wait to cut it until after you have sanded, that way you have the same airfoil on both sides.

Sand your cut parts

This is my least favorite, but the most important part of the process, where you get to sand all of your parts. The horizontal/vertical stabilizers are pretty straightforward, you just want to round their edges to make them a little more aerodynamic, and the fuselage does not need to be sanded much, only to clean up imperfections. Your wings are the fun part. So, the biggest feature of wings is their airfoils. They are what create lift, the force that makes planes go up. You have four main forces affecting planes when they fly. Thrust, which makes a plane go forward, drag, which makes a plane go backward, gravity, which makes a plane go down, and lift, which makes a plane go up. A wing is shaped like an airfoil, and as it moves forward through the air, it compresses the air below it and thins out the air above it. So, it creates a higher pressure below, because it presses air molecules closer together, and lower pressure above because it thins it out. So, the tightly packed air molecules below push the wing up, causing the plane to go up. These are some very good references for airfoils: Principles of Flight: Foam Wing (Grades K-12). Look specifically at pages 3, 4, 11, 12, and 16-22. This is a very good kind of airfoil: http://www.discuskid.net/uploads/7/6/2/7/76278509/stanfoil_2016.pdf. Use 150-220 grit sandpaper. I would recommend writing lightly on your wing which side is down so you don't get mixed up!

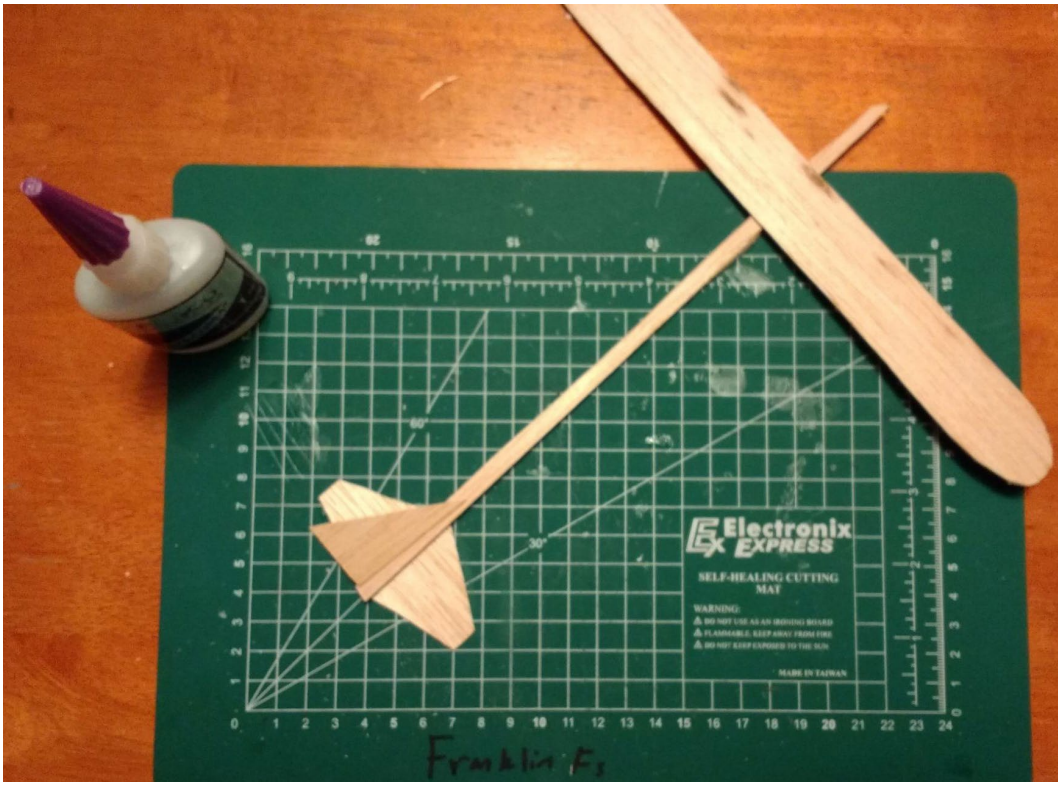




This is an oversimplification of how airfoils are shaped, but it helps to demonstrate where the wing should actually be sanded.

Glue sanded parts together

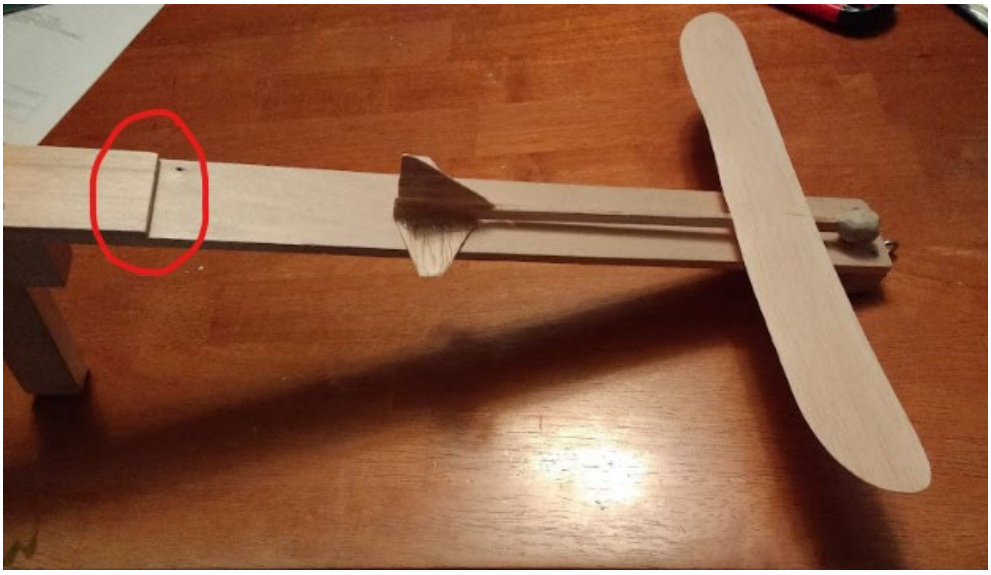
For this process, you are going to want to use cyanoacrylate glue (CA super glue). Try to use as little glue as possible, to keep the glider's weight down, while keeping in mind that you want to have a sturdy glider. Make sure when gluing that you use something to protect your work surface, so you do not get glue on it. When gluing, it is best to glue conservatively at first, and then add more if you need it. You do want to err on the side of less because you can always add more. First of all, though, we need to get a surface to glue on. The glue by itself glues fast, but with the accelerant, it dries instantly, so be careful with it. If you have a dihedral, I would recommend gluing the wings first on the wax paper and then attaching them to the fuselage.



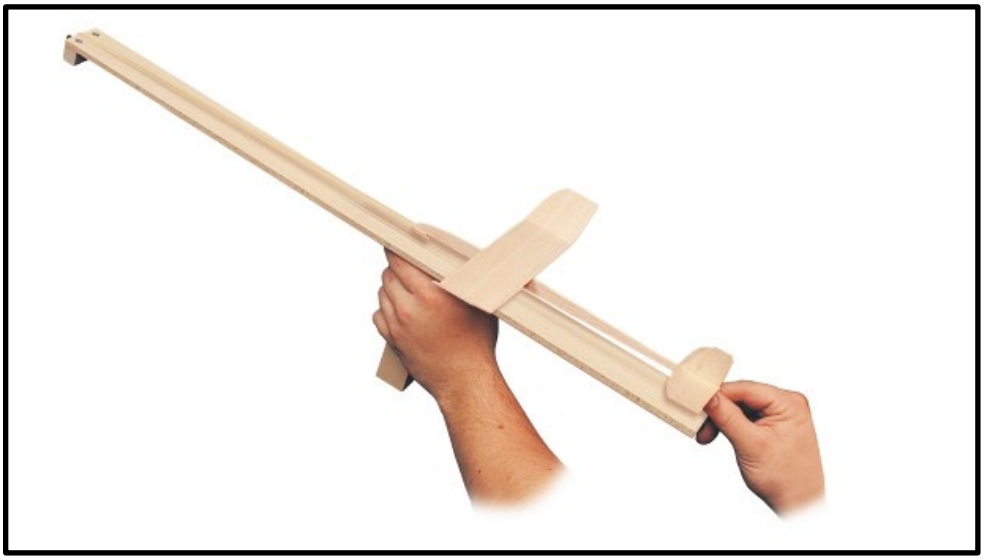
Testing and trimming gliders

You will need the glider rubber band launcher that you can find the designs for in the MS Flight Event Guide, so you can build it. You can also buy it here: https://www.pitsco.com/Tech-Glider-Catapult-Kit (due to supply chain issues items may be out of stock), however, the Pitsco catapult is not quite the same and needs to be modified. As you can see in the image below, that back plate is part of the catapult, and not included in the Pitsco one. Testing is all about figuring out what works, and what doesn't. The two main ways that you can do that are by changing how you angle the catapult when you release it and how much ballast (clay) you have on your glider. In general, you want your glider to balance on the wings, that is where the balancing point should be. The other component to this is testing different airplane designs. Using the flight log in the event guide as an example, you can use that to be more scientific in your approach to experimenting.

Homemade:



Pitsco:



Repeat

Build new gliders, test them, and see what works. Flight is all about learning about the engineering design process, and the different principles of flight. Thus repeating will help with learning.

Finish the portfolio

Refer to the event guide and use it to finish your portfolio. Your portfolio is just as important as your glider, seeing as they are both worth the same points. Follow the events guide very carefully.

Digital form of this guide:

https://docs.google.com/document/d/14MuGAigfqZbdNM-bEEtFpLVW_bdI9aCUb2X9kweJM_E/edit?usp=sharing

Extra resources:

- https://interestingengineering.com/ YouTube: https://www.youtube.com/c/Interestingengineeringofficial/videos
  Interesting Engineering is a great resource for flight and TSA concepts in general
- 1st and 2nd place portfolios from 2 years ago:
  1st place: Flight Example 1
  2nd place: Flight Example 2
- Seth Tandon's previous portfolios
  TSA Nationals 5th Place 2019:
  Tech Drawing*
  Portfolio*
  TSA State 2019 2nd Place*
  TSA State 2018 5th Place*
  *These are outdated portfolios, they just serve as examples for quality of work, and some basic pointers
- Email Peter with any questions at pwhitney@washingtontsa.org
- Email Seth with any questions at sethtandon1@gmail.com