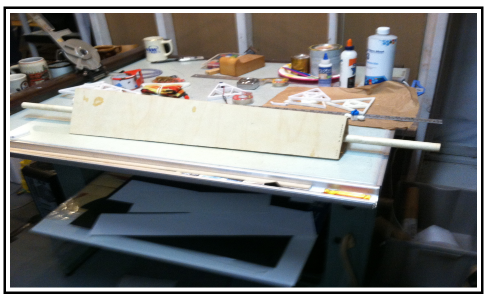
Executive Summary

This month I made a wooden mold to hand layup the carbon fabric for the Mk I Viper. I hand laid up the carbon fabric in two layers. The carbon fabric fuselage has a mass of ~ 290 gm. I designed and printed a forward and aft strut for the fuselage. The forward strut supports the fuselage and nose cone. The aft strut supports the fuselage and the fins. Next I'll design and print the forward cockpit strut, the aft cockpit strut, and the cockpit. The estimated mass (including propellants) for the Mk I Viper is ~1.3 kg. With a thrust of ~15 N, the thrust to weight ratio is ~1.2.

Technical Stuff

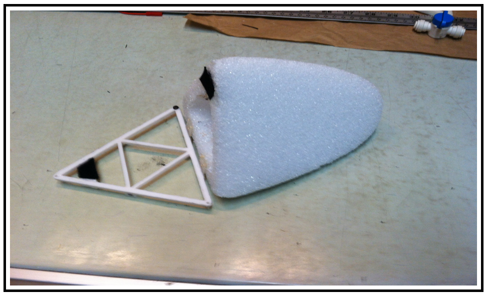
I began this month by making a wooden template to hand layup the carbon fabric for the Mk I Viper. I found that by laying Saran Wrap on the wooden template it was easier to remove the carbon fabric panel from the template. Originally, I made one panel at a time, trimmed the panel, assembled them together with tape, mounted the panels on two PLA brackets for support, and then used a single piece of fabric for a second layer. This became time consuming as I had to let each panel set and dry before beginning the next panel. So, I cut two more wooden panels, made some PLA mold brackets to hold everything together, and inserted some supports and a 1" CPVC pipe (shown below). I wrapped some Saran Wrap around the mold and hand laid up the carbon fabric in two layers. The carbon fabric fuselage, shown below, has a mass of ~ 290 gm.

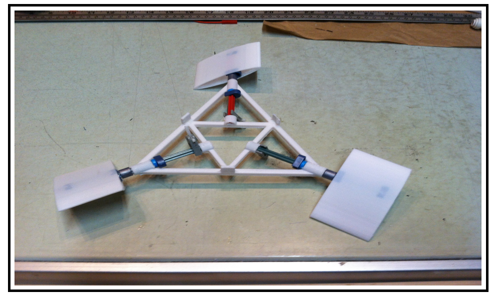


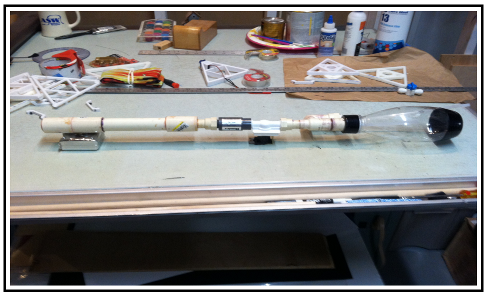
Next, I worked on the nose cone and forward strut. Originally, I tried to make the nose cone out of PLA. But, it look terrible and the mass was greater than 50 gm. I decided to go with a styrofoam nose cone. I cut a styrofoam block into a rough shape of a nose cone and then sanded down the edges until I reached a tapered shape resembling a nose cone. I glued some hinges on it and attached it to the forward strut. The forward strut is made of PLA and is secured to the fuselage by three small screws. When inserted into the fuselage, the propellant tank rest against the forward strut, pushing on the forward strut during take off. The mass of the nose cone and forward strut, shown below, is ~ 42 gm.

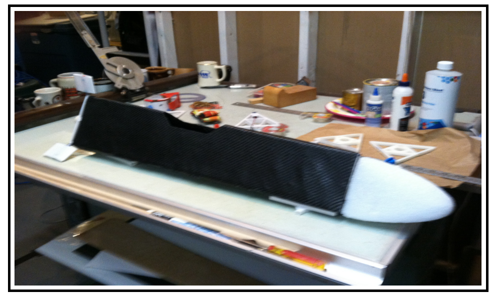
Finally, after Christmas, I worked on the aft strut. The aft strut centers the rocket engine and supports the fin assembly. I made three fins using the thinnest wall setting on the 3D printer. I glued some K'Nex pieces to the fins to hold everything together. The aft strut and fin assemble, shown below, have a mass of ~ 70 gm.

I made some plumbing modifications to the propellant tank, solenoid valve, check valve, injector, and rocket engine assembly. Before the modifications, the subsystem mass was ~ 930 gm. After the mods, the subsystem mass, shown below, is now ~ 575 gm, a savings of 355 gm. So far, the total mass is ~ 980 gm, this includes the fuel but not the HTPE.









The forward and aft cockpit struts are next. The forward cockpit strut supports the fuselage as well as a micro servo motor to open the cover and deploy the paraglider (an estimated 40 gm including the motor). The aft cockpit strut also supports the fuselage and three micro servo motors for the fins (an estimated 70 gm including the motors). The cockpit itself which houses the battery, receiver, and paraglider has an estimated mass of 130 gm. Finally, the HTPE mass is an estimated 75 gm. The total flight system mass is an estimated 1,292 gm, well below the 1.5 kg class I requirement. The mass allotment is summarized in the table below.

Subsytem	Mass (gm)
Prop Tank, valves, rocket engine with fuel	575
Forward strut and nose cone	42
Cockpit forward strut (includes servo motor)	40 (est.)
Cockpit (includes batt, receiver, & paraglider)	130 (est.)
Cockpit aft strut (includes three servo motors)	70 (est.)
Aft strut and fins	70
HTPE Oxidizer	75
Carbon Fabric Fuselage	290
Total System	1,292 (est.)

I expect the thrust to be greater than 15 N. As such, the thrust to weight ratio will be ~ 1.2. This may not be enough to get it off the launch rail with enough velocity for aerodynamic control. I haven't done the calculations yet. There are several ways to get more thrust, a larger throat diameter or increasing the propellant tank pressure to 140 psig. A larger throat diameter will mean a shorter thrust duration. Increasing the tank pressure may result in the opening valve failing. In short, I'm not there yet. More work is to be done.