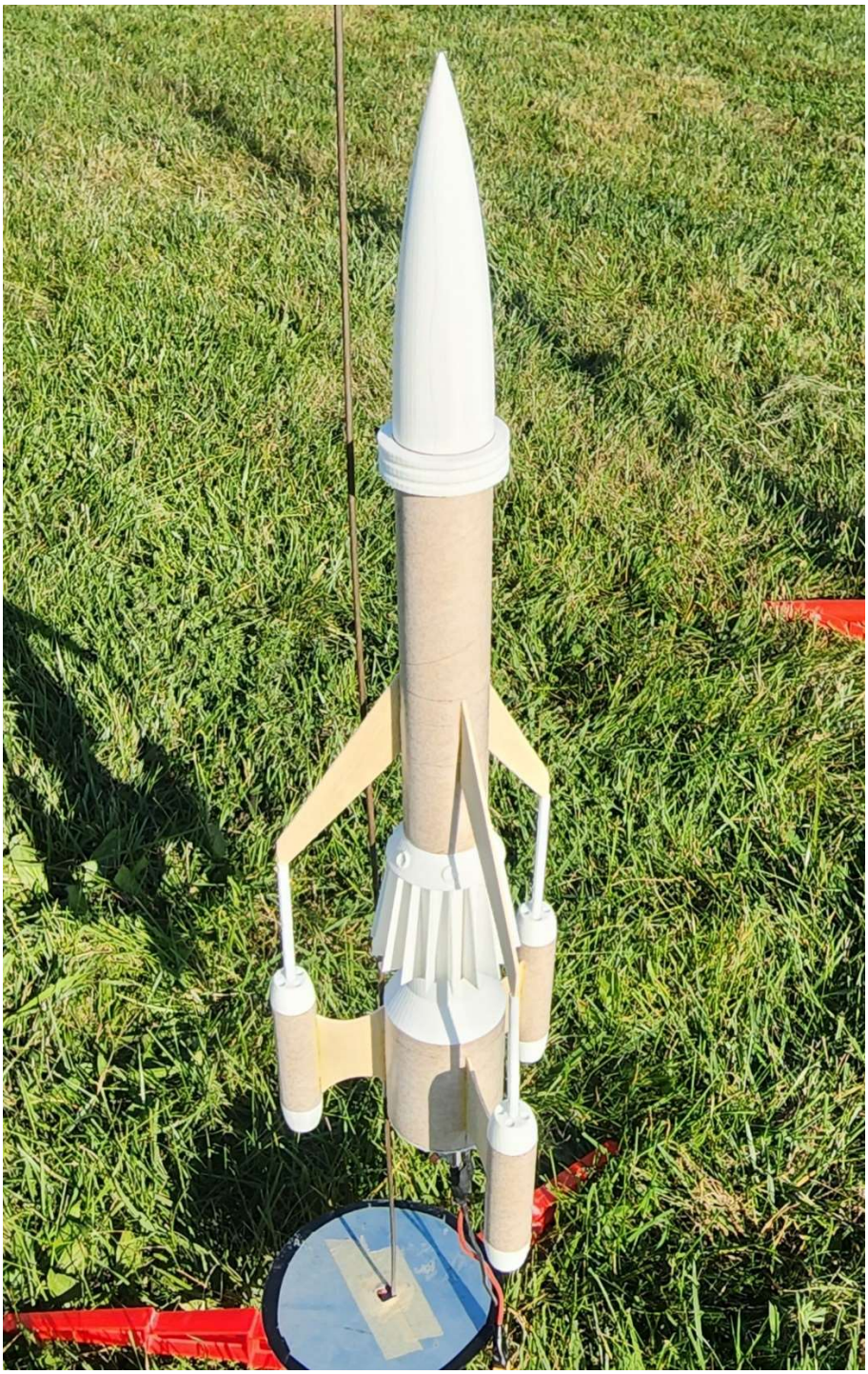
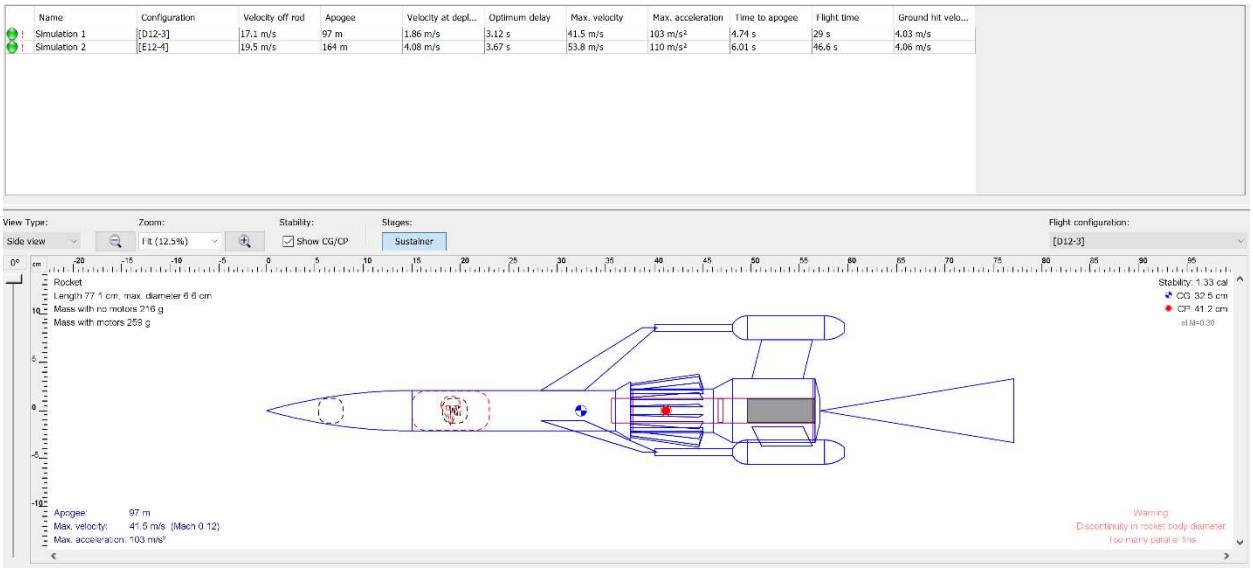
Thunderbird 3 [Inspired] Model Rocket
Build Guide / Advice Document



Disclaimer / Safety Recommendations:

Please note that I cannot provide any guarantee that your flights will go like mine. I only sell kits for model rockets that I have launched successfully. However, stability and other flight characteristics are very much dependent on the nuances of your specific build, engine and recovery system used, etc... I strongly recommend that you update the Open Rocket simulation provided to match your build details and check stability. Also I recommend that you perform a swing test and/or other tests to determine the stability of your rockets prior to launching. Please follow NAR, local laws, and other safety guidelines and launch “heads up” till you are confident in the stability of rockets you have built.

Please see OpenRocket file included and modify to match your build. I launched with a D12-3, a slightly extended front body tube as compared to scale models (see below), and 1.5oz in the nose. I used the “base-drag hack” in OR since the base of this model seemed to be pretty draggy – rocket flew as if this was a good assumption. The simulation also seems to suggest that this model would be stable with an E12-4 without additional nose weight. It also looks like with a shorter front body tube (12cm) and an E12-4 engine that this would have over 1cal of stability with 2.5oz in nose. However, please validate for your own build and I recommend a swing test if you are changing flight characteristics substantially.



Cleaning and Part Prep

Part fit – too tight, too loose, just right:

Note: When you are test fitting parts be cautious about any parts that fit too tightly. When two tight-fitting 3D printed parts are snapped together the ridges from 3D printing can make them "lock" together somewhat. If parts are too tight, please sand them to take down the ridges and give a bit more space.

I generally try to make shoulder fit quite tightly in body tubes when they will be glued (I hate slop when lining up parts). If you prefer a looser fit or use different body tubes and find the fit is too tight, please sand shoulders to allow the fit you are comfortable with. Also be sure to clean up any brims that are left behind – the Brims, and the 3D printing process in general, can create a little bulge at the base of a shoulder that may even be invisible to your eye that makes parts fit less smoothly.

If by chance a part fits too loosely, you can apply a layer of ABS glue (see below) around the shoulder or other part and this will expand the part some to make for a tighter fit. If a part is not glued, for example the nose cone, you can also use a layer of tape to make a tighter fit.

Cleaning 3D Printed Parts

First, don't throw away the brims, supports, or other 3D printer scraps that you remove from the parts. You can dissolve these with acetone to make ABS juice, glue, slurry, filler, etc… Thickness and best use will depend on how much acetone you mix with the ABS (my slurry in the picture has dried out some so is thicker than you likely want unless you are filling big gaps).

https://www.matterhackers.com/news/how-to-make-abs-juice-glue-and-slurry

This glue/slurry can be used to glue ABS parts together (apply a thin coating to each part and push together, hold for 30 seconds and it will set), to fill in gaps or holes in parts (paint on a thicker coating into gaps, overfill somewhat so that you can sand flat), to strengthen parts (when a layer is painted on parts this helps adhere layers together more strongly or it can also be used to thicken / strengthen thin parts), to tighten the fit of a part (if a part is a bit too small you can paint a thin coating around the part and apply layers till your part fits as tight as you would like, sanding a bit after the slurry dries to get just the fit you want), or even to make things like fillets (I have used for internal fillets to strengthen engine blocks or to more tightly attach fins to slotted body tubes or parts).

Acetone dissolves just about everything so you need to put this in a glass container if you want to safely store it (the gasses will still dissolve the gasket on a mason jar which is why my slurry is a little dried out

– the acetone will keep evaporating so just add more and stir again). Also be cautious about pooling too much of this on / in your parts (e.g., in tip of nose cone) since the acetone can melt/soften/distort the whole part before the acetone evaporates.

Some parts, nose cones and other cylindrical parts in particular, sometimes show a distinctive z-seam or z-seam gap/scar. I usually opt to align this imperfection (it comes about from changing layers or changing parts in a multi-part print) since it is easier for me to patch / sand one long line than many small holes.

Basically, you can just fill this, or an other imperfections, in with ABS slurry or something else (even wood filler should work) and sand the nose cone. I sand many of my parts anyway to make them smoother before priming so it has never been too big of a deal to fill these imperfections in before I sand. The resulting filler will be just as hard as the 3D printed part (maybe even a little harder) – be sure to give time for it to fully dry since it can still be gummy for a while – so try to be as neat as possible or you may wind up with extra sanding.

I have used a couple of different types of paint brushes to apply my ABS glue/slurry and the bristles have not dissolved. That being said, I assume that some types of paint brushes with plastic bristles may dissolve, especially if left in the mixture too long.

Sanding ABS

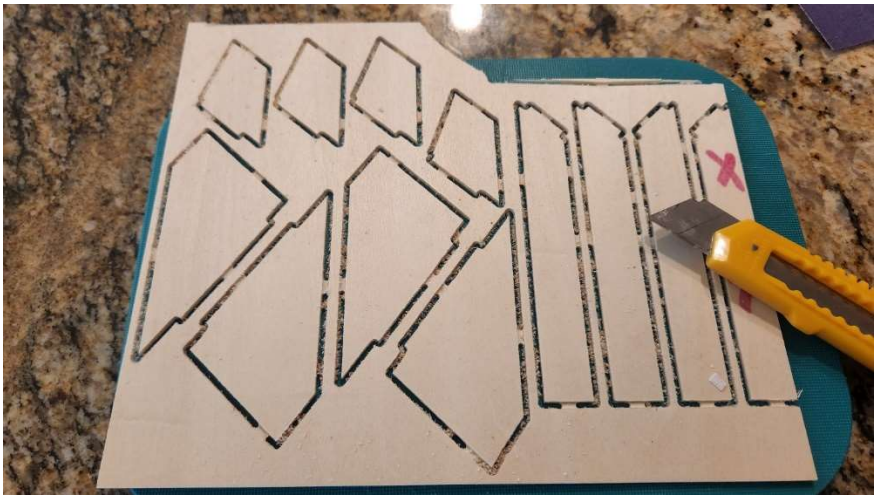
Parts are printed in ABS which is great for heat resistance – engine ignition, ejection charges, and sun in the field. It also is relatively easy to sand or finish in other ways. I typically sand most parts somewhat and often sand my nose cone till it is smooth – if you sand against the print grain (top to bottom) it will make a distinct scratching noise when the layers are distinct (sounds like a DJ scratching vinyl). As you sand the nose cone the noise will decrease and eventually, when it is smooth, it will stop making noise.

I have moved to smoother / higher-resolution nose cones to reduce sanding needed. However, sometimes a part gets some ringing due to the order in which things are printed or the speed of the 3D printer. This can be easily sanded off when finishing parts. Below is an example of this on the left and on the right after literally 30 seconds of sanding with 100 grit sandpaper. I would usually continue to sand like this across the whole nosecone surface but just wanted to show the result of a quick sanding.

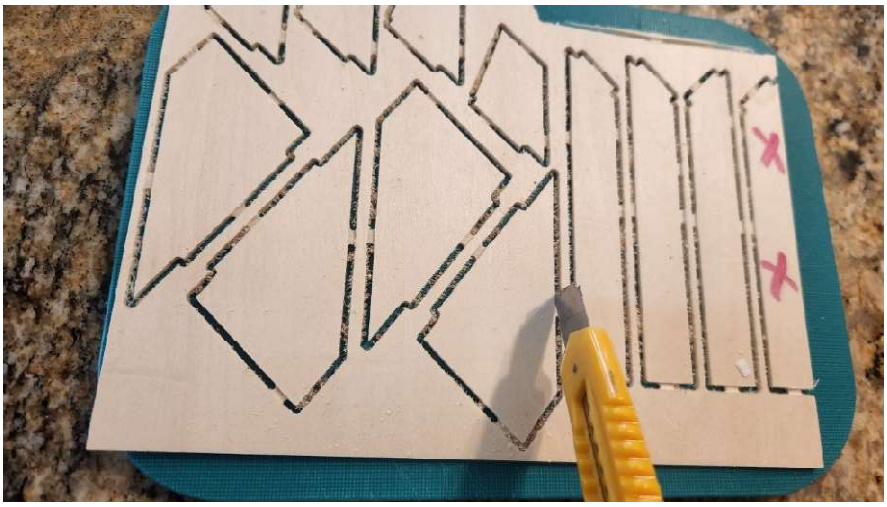
Note: Some people do not like the smell of ABS (some people get headaches from ABS when it is being 3D printed and evidence suggests it releases styrene when it is heated up to 3D printed temperatures – not too much different than the VOCs released when you get a new carpet but I am mentioning it anyway). It is up to you, but you may want to wear a mask when sanding ABS (I don't bother).

CNC'd Fins

I know that sometimes the CNC'd fins can look somewhat "hairy" and have annoying tabs. However, they are actually easy to clean up.



First, cut through all the tabs for each part on a cutting board.

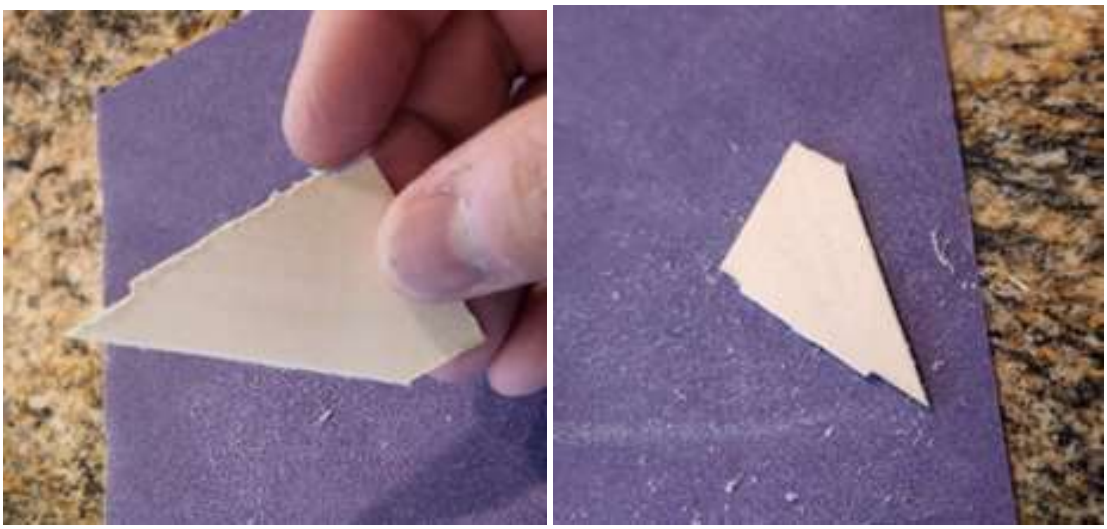


You can also cut through any areas where the CNC did not fully cut through the materials (hopefully there should only be a paper-thin layer left if there is anything) – thickness of plywood varies although I try my best to use similar thicknesses for the same rocket production. I also recommend removing any remaining tab material with a sharp knife, by spot sanding, or even with a flush cutter (this is an often-overlooked way to cut small pieces of plywood – be careful since cut-off tabs will shoot off at Mach 1).



Next, removing the fuzz. This is really easy if you simply drag the part perpendicular to the edge along a piece of sandpaper on a flat surface (or drag a curled up piece of sandpaper along the edge perpendicular to a curved edge).

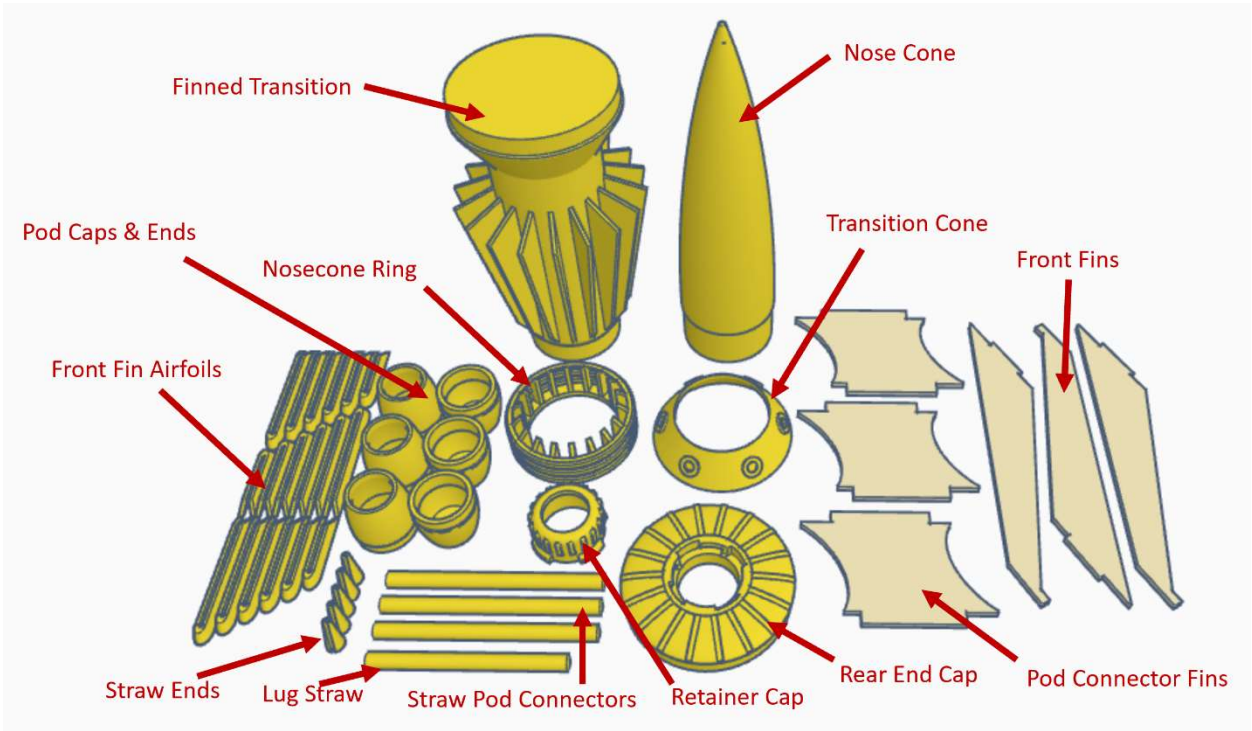

Only takes one or two passes to get rid of the fuzzies.



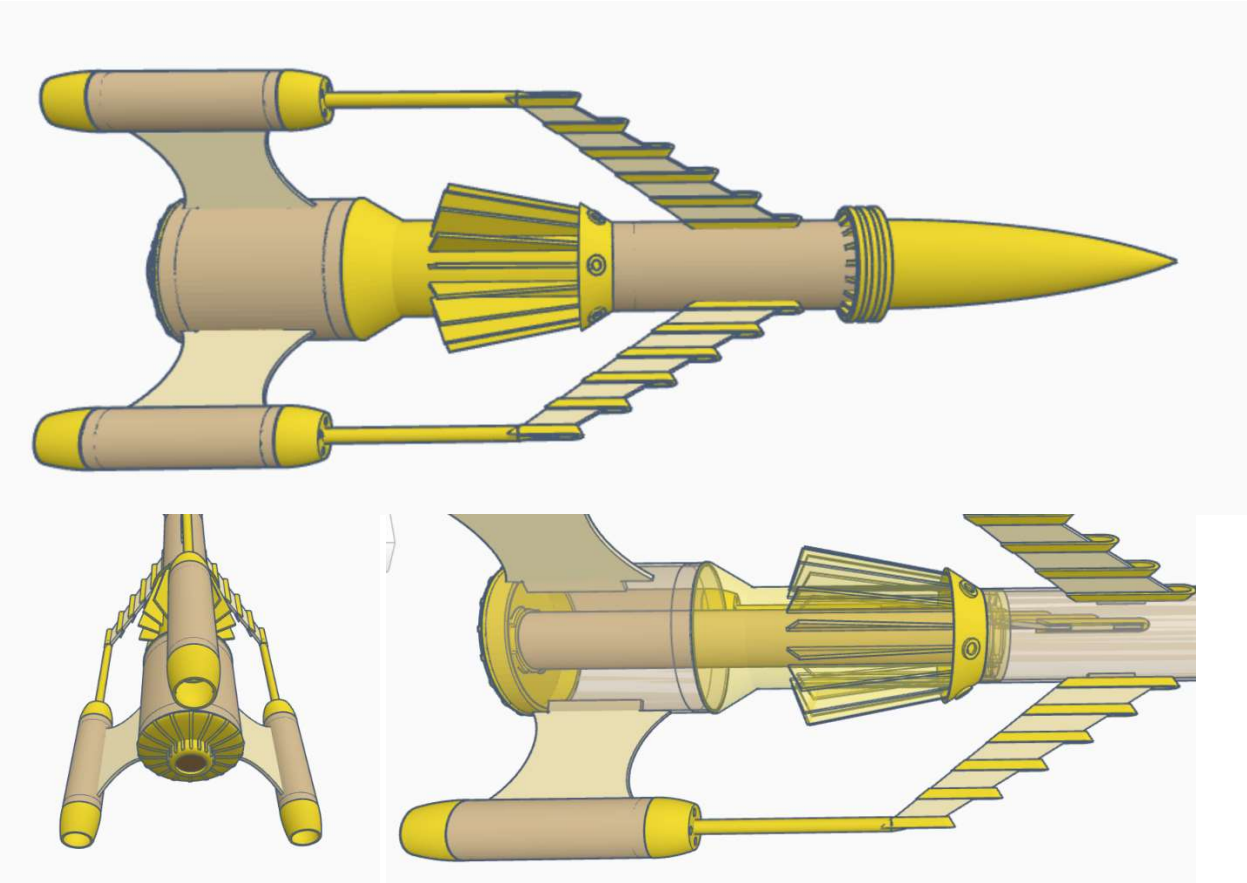
Sanding edges – One of the great things about this plywood is that it's very durable. However, this means it takes more sanding than balsa to put an airfoil or curve in the fins. I normally use 120 grit sandpaper to sand my plywood fin edges. I count the number of passes and use 20-40 passes on a 30-45 degree angle on front of fins and 10-20 on side and rear edges. It looks really finished once you round the edges.

TB-3 Assembly

Parts



Overall Assembly

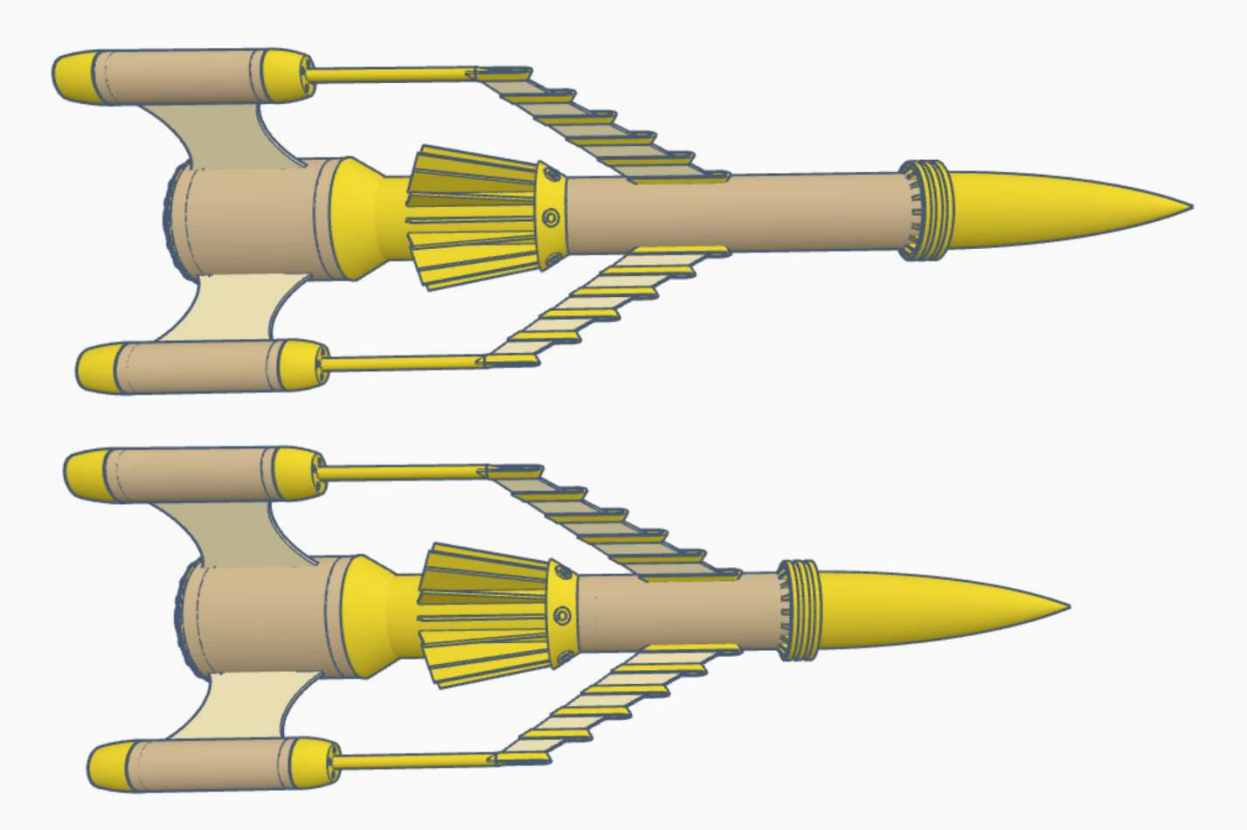


3D Printed parts are yellow; Body tubes are tan, plywood parts / fins / wings are lighter tan.

- BT-60 Front Body : 12 to 21cm (two options – see below)
- BT-80 Rear Body : 8.2cm
- BT-50 Pod Tubes : 8cm
- BT-50 Motor Mount / Stuffer Tube : Approx. 20cm (seen in 3rd picture above)

<u>Two Lengths – slightly different looks</u>

Scale measurements from the TV show suggest that the BT-60 body tube should be around 12cm. I changed the way I had planned to build my model midway through (originally BT-60 tube was going to go through to small transition section and have 1.5mm plywood cooling fins mounted on it in the middle). This means I had cut my BT-60 tube around 9cm longer than needed. However, when I was mocking up the model with the tube I had already cut and the new integrated transition, I liked the slightly larger / longer look, so I left my tube longer.

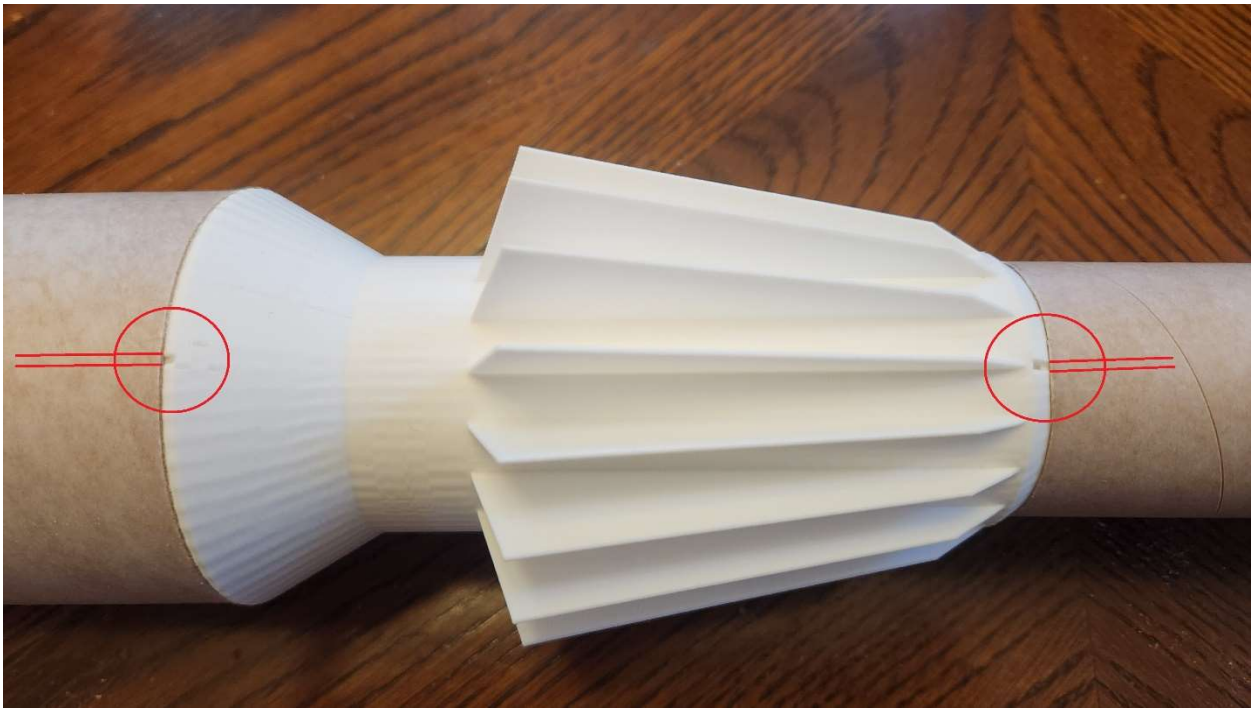


Marking & Slotting Tubes

The BT-80 to BT-60 transition has tick marks on both ends to help you mark and align the fins in front and rear portions of body. I recommend you mark the tube using the tick marks and then use the "doorframe method" or another approach to extend those marks vertically along length of tube. I mark both sides of the tick mark to give me approximately a 2mm slot (and to avoid mistakes).

You should probably mark your tubes before attaching to transition (transition is slightly larger than body tubes so this may create some issues with making straight lines on tubes after everything is glued together. However, you can cut the slots in your body tubes either before or after mounting them to the transition (FWIW - tick marks remain visible even after tubes are attached to help align tubes and transition).

- BT-60 tube has 3x slots about 5.6cm from bottom of tube that are 2cm long x 2mm wide.
- BT-80 tube has 3x slots that about 2cm from bottom of tube that are 4cm long x 2mm wide.
- BT-50 pod tubes need a single slots 2cm from bottom of tube that are 4cm long x 2mm wide.



I usually also wrap pieces of paper around my body tubes so I can mark them with lines perpendicular to tube. I use these marks to make sure that all my slots are the same distance along tube and that my fins are mounted evenly.

Don’t glue your BT-80 and BT-60 tubes to the transition till after you attach your Kevlar shock chord to the transition (see below).

Kevlar Line

As you can see in the picture on the right below, the finned transition has a pair of holes at the front BT-60 side which are intended for mounting a Kevlar Shock chord. You need to drill these holes out to 2mm or larger in diameter to allow you to snake your Kevlar through the holes and knot it. Be sure to attach your Kevlar line or shock chord to the transition before gluing transition into BT-80 or BT-60 tube. It is a bit tedious to get the Kevlar threaded back out of the 2nd hole but totally feasible when you just have the transition to work through. Once the transition is attached to body tubes it will be much more difficult.

Stuffer / Motor Tube

This build requires a stuffer tube that goes from halfway through rear cap on BT-80 to the front of the transition piece where it inserts into the BT-60 tube. On the rear cap, just be sure that your stuffer tube does not extend into the area where the retainer cap needs to screw in (unless you are using composites or something and do not want to use the retainer cap). If by chance your stuffer tube interferes with the retainer cap you should be able to cut it back with a hobby knife.

Stuffer tube may vary slightly in length depending on how long your BT-80 tube is or due to other subtleties of your construction – it should reach to be flush with front of finned transition part.

I recommend gluing BT-80 tube onto transition (aligning your marks on tube with tick marks on transition). Then install stuffer tube into transition from inside. Finally, install end cap into BT-80 tube and over stuffer tube (if you extended your lines on BT-80 tube all the way to rear you can align tube marks with the detail lines on rear cap so fins align with those details.

Please be sure to securely glue stuffer tube into the two parts it makes contact with. This is critical resistance that keeps the engine and stuffer / motor tube where it belongs during launch. You may want to put a little bit of wood glue around front end of stuffer tube before inserting into front of transition (this will create a strong ridge that keeps stuffer from moving forward). I would then also wick some CA glue into seam between BT-60 transition and stuffer tube or apply thick CA glue in front of wood glue for a solid connection.

When I need to glue two pieces at once (e.g., stuffer tube into end cap and end cap into BT-80 tube), I usually use some type of thick / slow drying CA glue and/or wick thin CA glue into seems after parts are assembled. Before you start, make sure that end cap is not too tight a fit inside BT-80 tube and that stuffer tube is not too tight a fit inside end cap or this will all be very difficult to glue together (sand parts to give you some play).

Motor Block

There is a small BT-50 motor block that needs to be glued inside stuffer tube / motor tube. This part is tapered on one side and I do not think it matters which way it is installed for this rocket (this part is also used when you need to use 18 to 24mm adapters to allow A-C and D engines in the same motor mount).

To get motor block installed at the correct depth inside stuffer / motor tube you should load either a D or E 24mm engine inside the retainer cap, put wood glue around inside of stuffer tube around 2.5-3" inside tube, and insert motor into stuffer tube till retainer cap is fully inserted and can lock in place. Then unscrew and remove retainer cap and motor so that motor block stays inside stuffer tube at correct depth. If you ever want to use E engines then use an E engine to set motor block (you can use an adapter to launch on a D engine when you want). Wood glue will not necessarily make a strong bond to the plastic motor block but it will make a ridge above motor block. You can also drip a bit of thin CA glue onto edge of motor block inside motor tube after wood glue dries.

Assembling Pods

Front part for pod is closed (with hole in middle) and rear part is open. Opening in rear pod parts were sized to take 18mm engines but I have not provided an internal centering tube / motor block since this is considered to be "non-standard use". That being said, I would love to see pictures / video if you launch with plugged engines in pods.

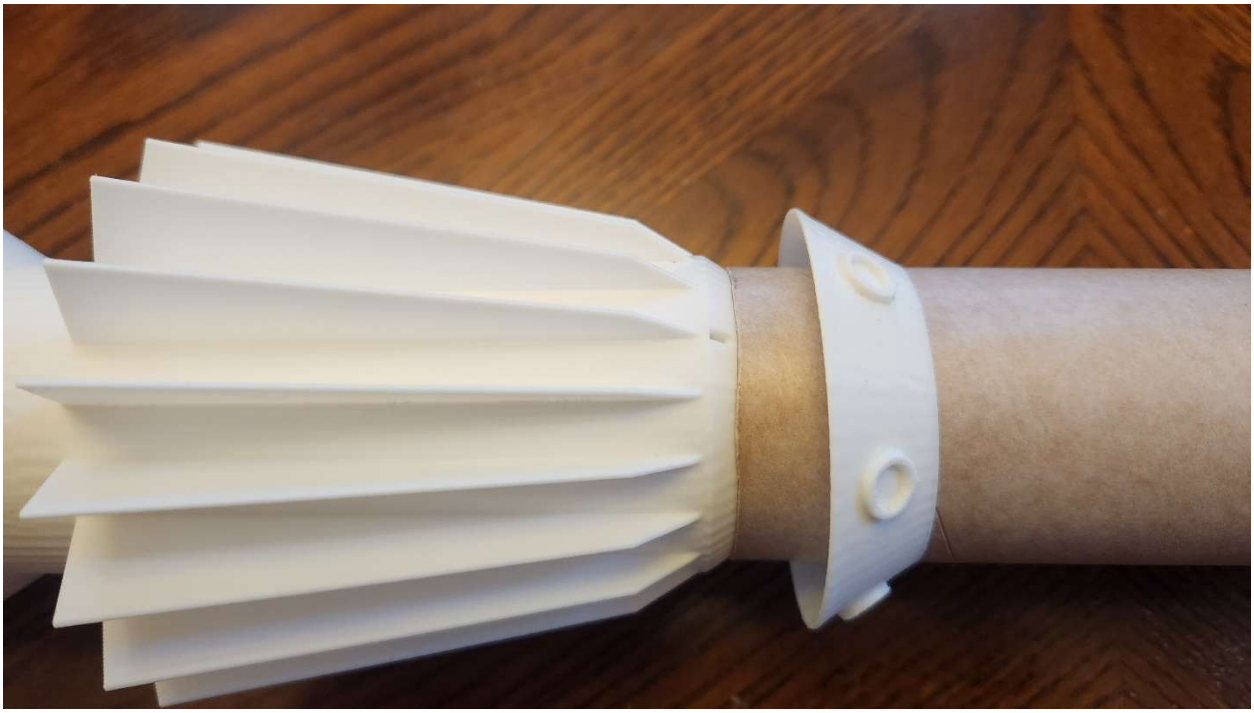
I installed rear fins in BT-80 body tube (using jigs) and then installed pods afterwards. However, you may want to install pods on fins first and then install fin w/ pod attached to BT-80 tube.

The curved rear fins that connect to pods are not perfectly symmetrical but are close enough to be confusing. I recommend that you stack them up to be sure they are all in the same orientation and mark them so that you are sure to install all three in the same way.

Pay attention to orientation of indentations and align in same way across 3 pods (purely for aesthetics). I recommend you install straw that connects front fins to pods as a final step since they can slide in as far as you need them to into the hole in the pods (i.e., you have some slop in their fit).

Installing Transition Cone

Make sure to install the cone portion of the transition before installing front fins or ring near nose cone. Cone should slide over BT-60 body tube and fit snuggly around transition fins. You probably do not even need to glue this but a little ring of CA glue at end of body tube that you slide cone over will hold this in place. Pay attention to alignment of the circle details (purely for aesthetics).



Installing Front Fins

Nothing too special about mounting these – I made fin tabs less deep on these so that they would not hang up parachutes. However, you may want to smooth the ends of the tabs to reduce chances they catch a shroud line. Be sure to install transition cone before installing these. Also check your alignment with rear fins. Assuming your tick marks are aligned with transition on both BT-60 and BT-80 tubes, fins should line up.

Installing Nose Cone Ring

The nose cone ring is mounted on front of body tube. Added bonus: this should stop any tube zippering.

Installing Straw Pod Connectors

I put a bit of thick CA glue around outside of one end of straw and some more on inside of other end of straw. I then inserted straw (glue on outside end) into pod front hole, slid it inside till I could get straw

around the tab on tip of front fins, and slide back around the front fin till it was tight against front fin. You may need to sand fin tip tabs some to make this fit without deforming the straw too much.

Installing Launch Lugs

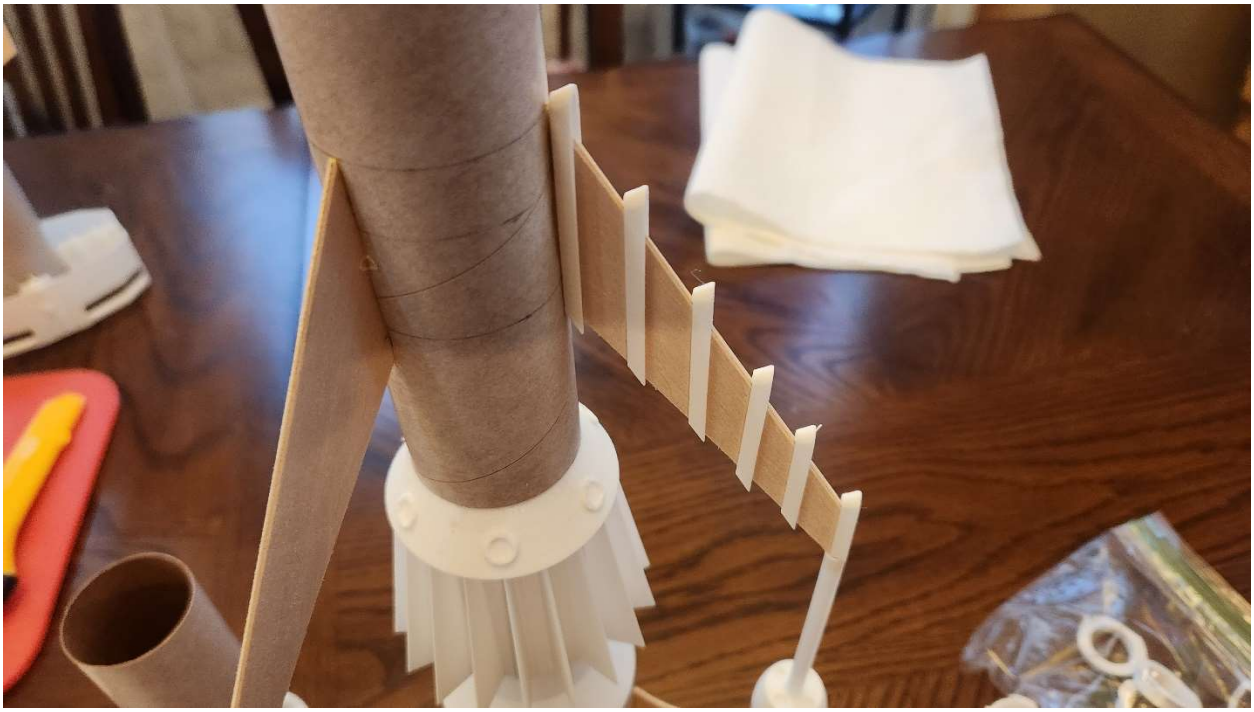
I used straw launch lugs (and included them in your kits) with one mounted in the corner of one fin on BT-80 tube and other aligned on the front fin between 1 and 1.5cm out on fin. One of the 4 straws included in your kit is shorter than the others and it should be long enough to be cut into these two pieces. Please confirm that fins on transition do not interfere with the rod going through the two lugs.

This is actually a bit heavy for rod-based launches (it worked fin but the rod was swaying like crazy). If you would like to use a rail-based lugs, just make sure they are long enough away from body to clear the transition fins (if you needed to trim one transition fin or even mount a lug on a transition fin I think they would be viable options.

Installing Front Fin Airfoils

I assume that these will not move CP forward too much but, word of warning, I did not have these front fin airfoils on my model when I launched it. These should be sized to reach from front to rear of fin at the point they should be mounted. The largest airfoil should mount right against the body tube, the last one could be mounted flush with end of the fin (you will not need the straw to fin finishing cone) – you

will need to trim the last airfoil so that it fits in front of the straw. There should be around .8cm between each airfoil. I recommend you use a square edge to draw lines on your fins parallel to the body tube since it is easy to get out of alignment when working close to all those angles.



Straw-to-fin Finishing Cone

These are provided as an alternative to the airfoils and can work to smoother the transition from the straw to the front fin. I do not know is these will work with the airfoils (at least not with the last one). You need to sand the slot some to make this fit better (it basically needs almost no thickness on the outside edge but it would be too difficult to work with two tiny separate pieces).