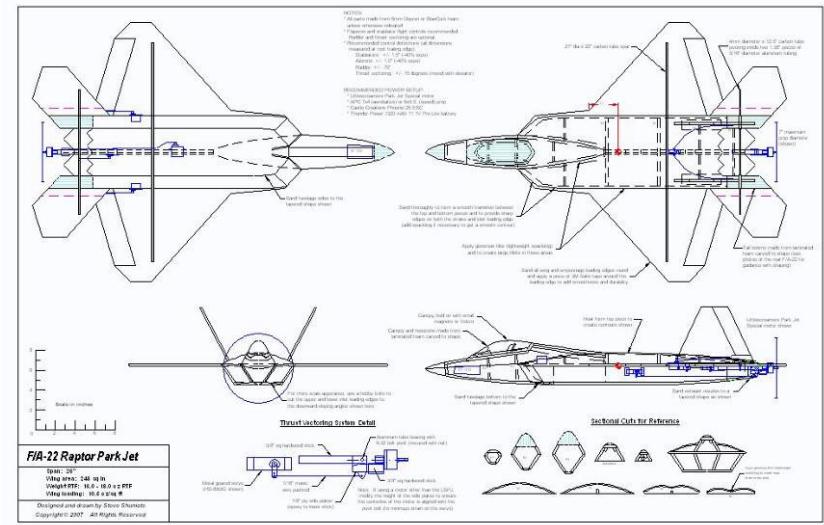


Construction Guide for the F/A-22 Raptor Park Jet

By Steve Shumate





Building Tips

This model can be built using the following types of adhesives:

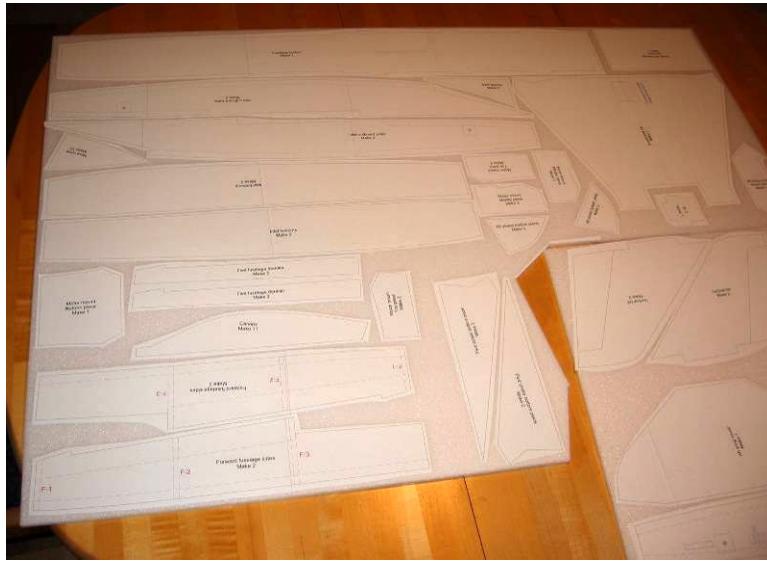
- Epoxy (with or without microballons)
- Odorless cyanoacrylate (CA) with accelerator
- UHU Creativ for Styrofoam (or UHU POR)
- 3M 77 spray adhesive
- Hot glue gun
- ProBond (or Gorilla Glue)

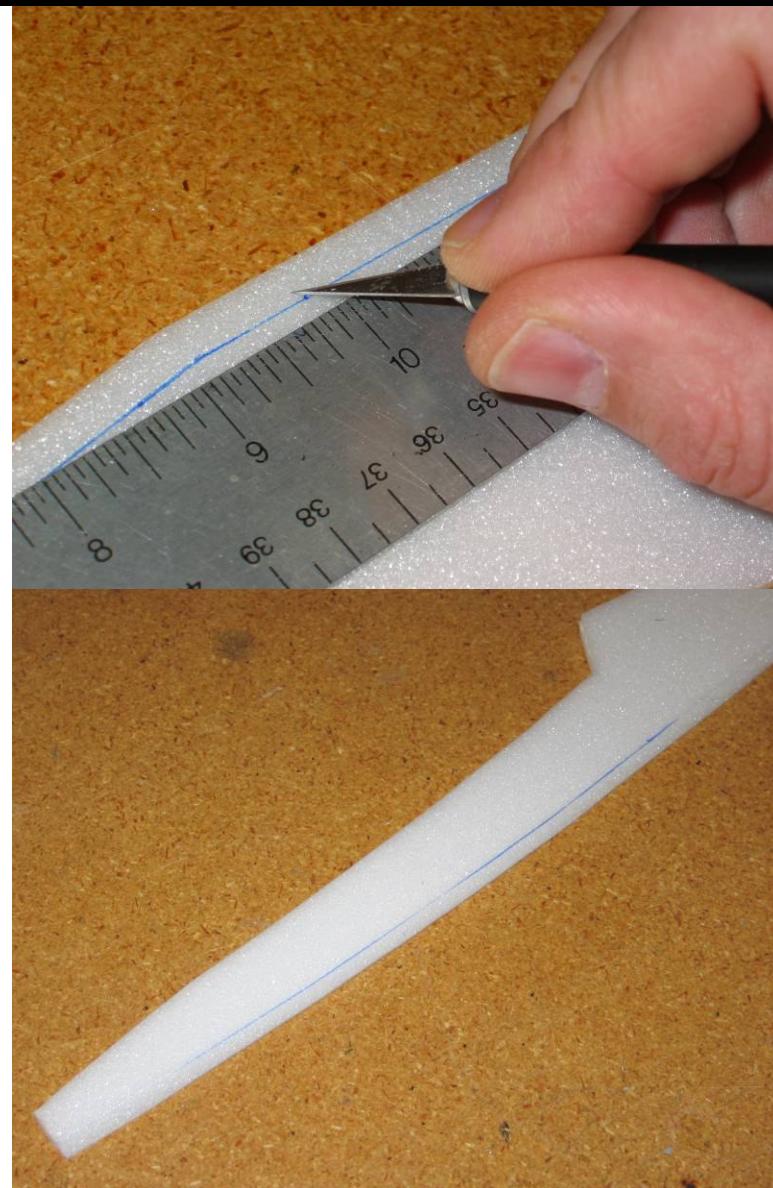
To minimize weight, try to use as little epoxy as possible on this model, saving it for only critical joints such as wing spars and motor mounts. You can also mix microballons into the epoxy to reduce weight considerably and help it fill gaps better. The majority of construction should use a lightweight and quick-drying adhesive such as foam-safe CA, UHU Creativ, or 3M 77. I personally use 3M 77 and UHU Creativ (both pictured at left) for the majority of construction since they are strong and dry very quickly.

3M Satin tape is called out many times in these instructions since it works so well for hinges, leading edge protection, and general strengthening. Make sure to get 3M Satin tape (sometimes called 3M Gift tape), which is sold in the purple container. The common 3M Scotch tape sold in the green container doesn't work nearly as well, nor does common packing tape.

Begin construction by cutting out all of the paper parts templates with scissors, trimming them to within approximately 1/8" of the lines. Then test fit all of the templates onto the foam sheet, trying to minimize wasted foam as much as possible. Once you're satisfied with the arrangement, remove each template individually and spray the back of the template LIGHTLY with 3M 77 spray adhesive. Then replace the template onto the same spot on the foam sheet. Repeat for every template.

After all the templates are tacked onto the foam, cut out all the pieces by cutting on the lines with a SHARP hobby knife. To help keep track of the parts, keep the paper templates on each piece until you're ready to use it.





1. Begin assembly with the forward fuselage. Start by carefully cutting the beveled edges on all of the forward fuselage pieces as shown on the plans. Draw a reference line on each part that's inset from the edge the distance indicated on the plans (note you can trace the lines from an identical part onto the opposite part). Then cut the bevel with a sharp hobby knife. You can use a straightedge for the straight segments, but the curved segments will need to be cut by hand. It's best to practice with some scrap foam first to get the hang of it before cutting the actual parts.

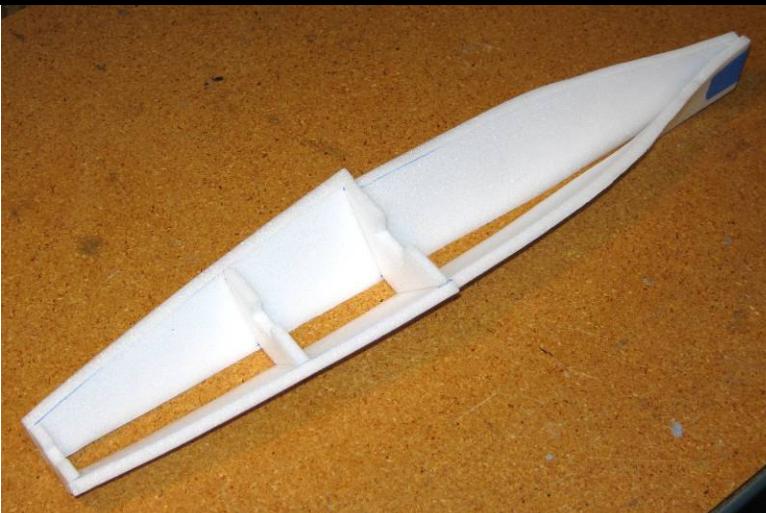
Be sure to make mirror-image left- and right-side pieces!

The beveled parts should look like the photo at lower left when done (upper forward fuselage side shown).

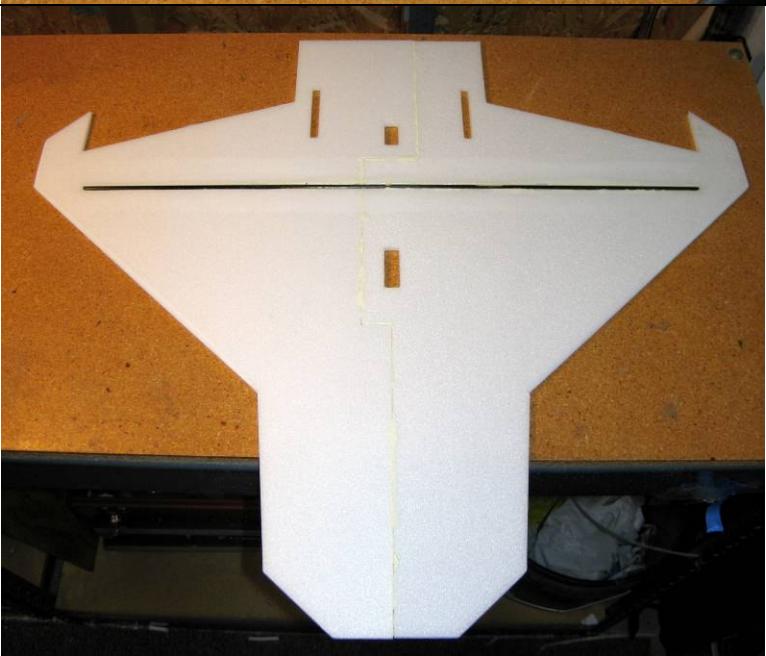


2. Next form the curvatures in the lower forward fuselage sides. Use a heat gun to gently heat and soften the foam and then bend them to the shapes shown. The curves required are a bit complex—there should be one gradual curve over the entire piece to form the taper of the fuselage (as seen from the top), and a quick twist at the aft end to match the angled fuselage sides to the vertical fuselage centerline support. Study these photos and the photos in the following pages to guide you. The curves don't have to be exact since the bulkheads will help form the fuselage as well once it's assembled.

Again be sure to make mirror-image left- and right-side pieces.

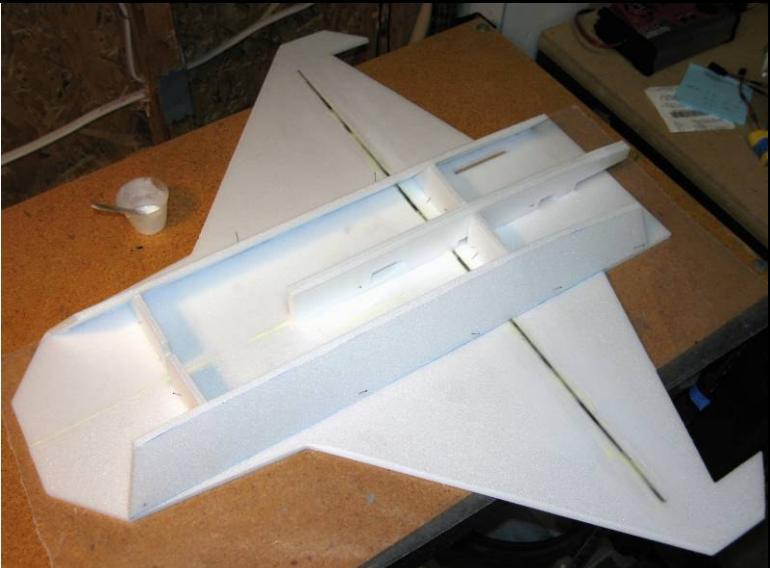
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3. Glue the bottom half of the three fuselage bulkheads (the ones with the notch on top) to one of the lower forward fuselage sides at the locations shown on the plans, making sure they are perpendicular. Then set the fuselage sides upright and flat on the workbench, apply glue to the edges of the bulkheads, and then glue the two fuselage sides together.

After the glue has dried, glue together the aft ends of the fuselage sides as shown, ensuring they are perfectly vertical. You may need to heat-form the foam a bit more to get things to align just right.

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4. Next build the wing. Cut a slot to fit the carbon wing spar and use 30 minute epoxy to spar into place. Mixing some microballons into the epoxy is recommended to reduce weight and help the glue fill gaps better (you can also use ProBond). Place wax paper and some heavy books on top of the wing to hold it perfectly flat as the glue cures.

After the glue has cured, sand the leading edge of the wing to a well-rounded shape, as well as the wing tips. Apply a strip of 3M Satin tape around the leading edge for smoothness and improved durability.

Cut the flaperons free from the wing.

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5. Laminate the two fuselage centerline support pieces together (3M 77 spray adhesive recommended). Then cut bevels on the edges of the aft fuselage sides as indicated on the plans.

Place the wing on a flat surface, and then glue the two aft fuselage sides and centerline piece onto the bottom of the wing as shown. Use the four temporary bulkheads provided to ensure the fuselage sides are glued on at the proper angle. Note pins can be used to hold everything together while the glues dries. I recommend using a gap-filling glue such as epoxy with microballoons or ProBond for this step.

Remove the temporary bulkheads once the glue dries.

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6. Glue the forward fuselage lower assembly in place on the front of the wing. Make sure the aft end of the forward fuselage mates with the forward edge of the centerline support piece. Also make sure the curvature is smooth as the angled forward fuselage sides twist to meet the vertical centerline support. Some trimming and additional heat-forming will likely be required to get a smooth curve here.

Also note that the top of the forward fuselage droops down a few degrees relative to the wing (see bottom photo at left). This is important for achieving a scale look. As long as the top of the forward fuselage assembly mates flat against the bottom of the wing, this droop will be set automatically. Trim the fuselage sides if necessary to achieve this.



7. Next assemble the thrust vectoring motor mount. This step is optional—you may choose to install a straight motor stick if you don't want thrust vectoring.

Begin by drilling a hole in the main motor mount stick to fit the aluminum tube bearing. Then glue the bearing in place with thin CA. Cut a small chamfer in the lower edge as shown. Wrap the aft end of this stick with a layer of packing tape to ensure a smooth and low friction surface.

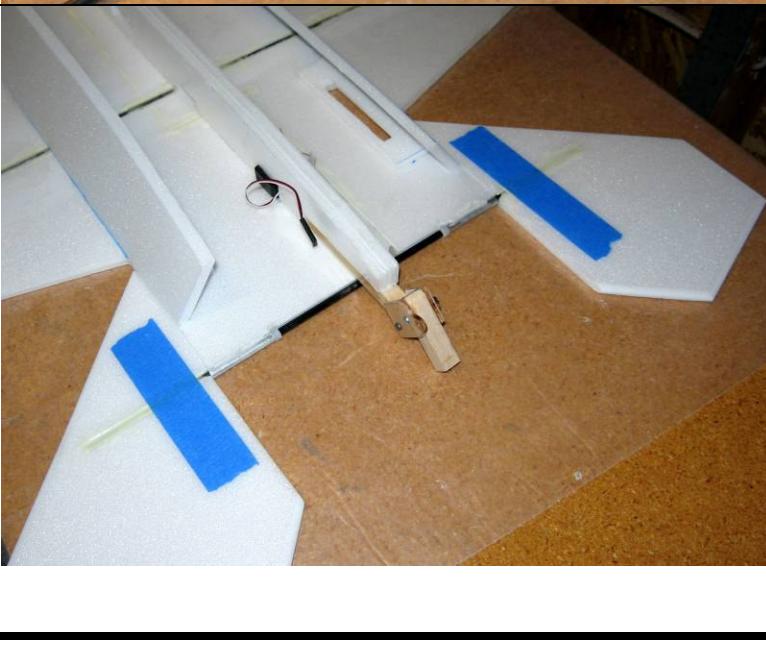
Sand the inside surface of the two 1/8" plywood side plates to make them as smooth as possible. Then glue both side plates to the movable portion of the motor mount stick using epoxy. After the glue is dry, drill the pivot hole through the top of both side plates at the same time, making sure it is exactly perpendicular to the plates (using a drill press is highly recommended).

The assembled thrust vectoring system is shown in the lower left photo. The movable portion pivots around a small bolt, and the system is actuated via a pushrod and clevis on the bottom. Note that you may need to trim the lower edges of the motor mount to clear the pushrod and clevis. Make sure the system pivots smoothly, and sand or trim as required.

IMPORTANT NOTE: It is important that the thrust line of the motor runs directly through the pivot pin. This will minimize strain on the thrust vectoring servo and also prevent pitch trim changes with throttle setting. The parts provided were designed specifically for the Littlescreamers Park Jet Special motor with the stock 3/8" stick mount. If you use a different motor and mount, you may need to make new custom side plates out of 1/8" plywood that raise or lower the movable motor mount stick to realign the thrust line with the pivot pin. If so, this won't be difficult. The design of these plates is very simple (just trim or extend the square upper edge), so it will be easy to make new ones if required.

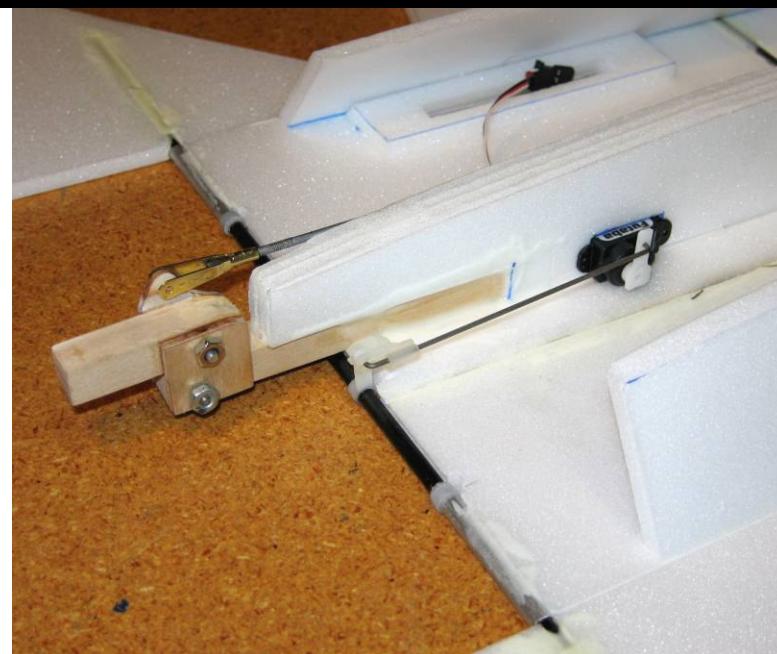
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8. Glue the completed motor mount into the slot in the aft fuselage centerline support, aligning it to a zero-zero thrust line (no left/right or up/down thrust angle). Use 5 minute epoxy.

After the glue has dried, press a circular notch along the length of the aft edge of the wing assembly using the aluminum stabilator tube bearings. Then glue the stabilator bearings into place using 5 minute epoxy. Use small strips of tape to hold them in place and insert the carbon tube stabilator pivot into the bearings as the glue dries to make sure they are perfectly aligned.

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9. Sand the leading edge of the stabilators to a well-rounded shape, and the trailing to a tapered shape. Apply a strip of 3M Satin tape to the leading edge for smoothness and durability.

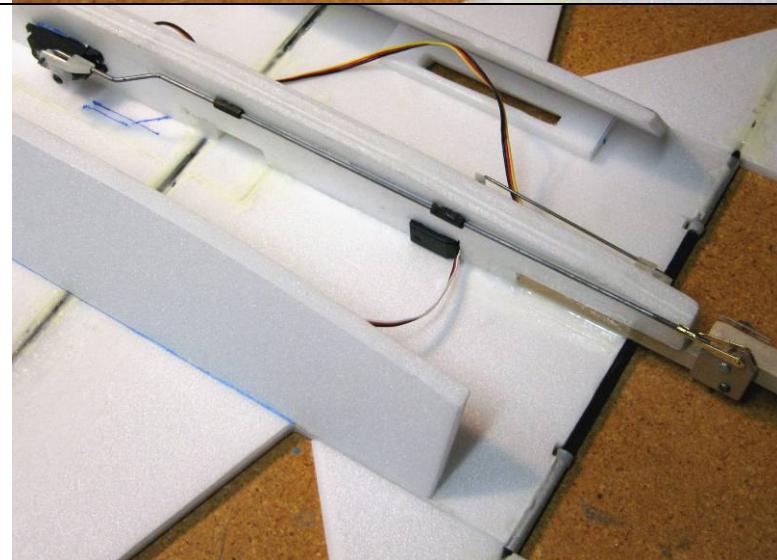
Note the hardware required for the stabilator pivots. The single carbon tube pivots inside two short pieces of aluminum tube. Two end stop bearings butt up against each aluminum tube to keep the pivot from sliding left/right. A control arm is also installed to allow a pushrod connection to the servo. Both the end stops and control arm can be made from spare nylon servo horns, just drilled out in the center to fit the carbon tube.

Lay the wing assembly down on a flat surface as shown. Slide the carbon pivot tube, end stops and control horn through the aluminum bearings. Once everything is in place and aligned, glue the end stops into place with thin CA (but don't glue the control horn yet). Then glue both stabilators to the carbon tube using epoxy (mixing with microballons is recommended).



10. Install the stabilizer servo into the slot in the fuselage centerline support (thick CA can be used to hold the servo in place). Make and install a music wire pushrod to the stab control horn. Once everything is properly aligned, glue the stab control horn into place using thin CA.

For extra strength, I recommend adding small strips of fiberglass chordwise to the roots of the stabilators, both top and bottom (see the plans for size and location). These aren't required for normal park flying, but if you intend to fly really fast or land in tall grass they add extra insurance against structural failure.



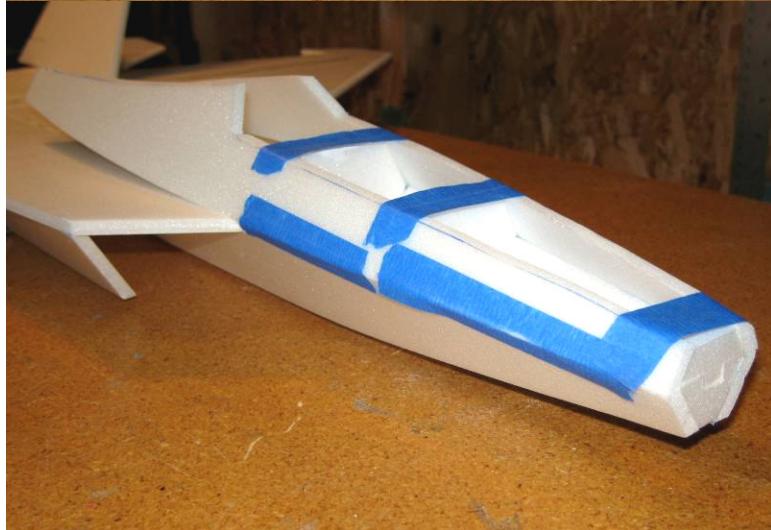
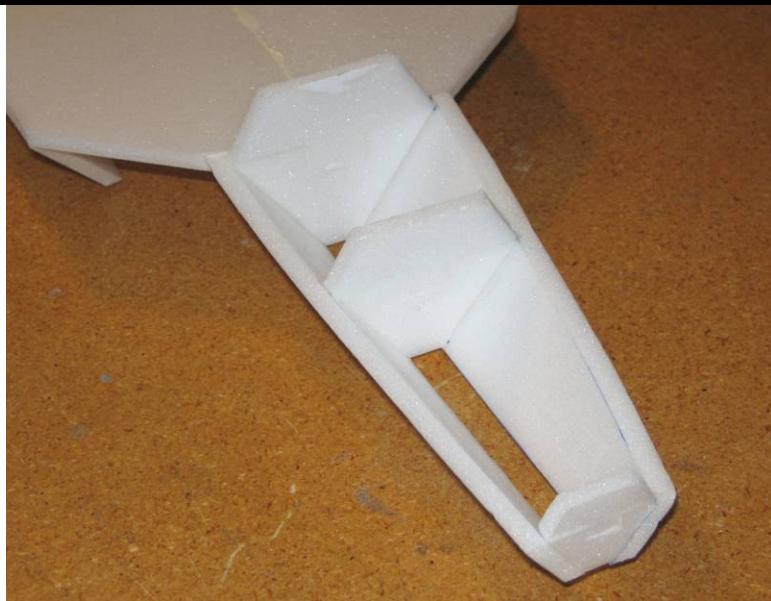
11. Next install the thrust vectoring servo and pushrod. A strong (40+ oz/in torque) metal-geared servo is required since a plastic-geared servo could get stripped if the prop hits the ground during landings. The prototype used a Hitec HS-85MG servo, which worked very well. Install the servo in the slot in the fuselage centerline support, securing it with CA.

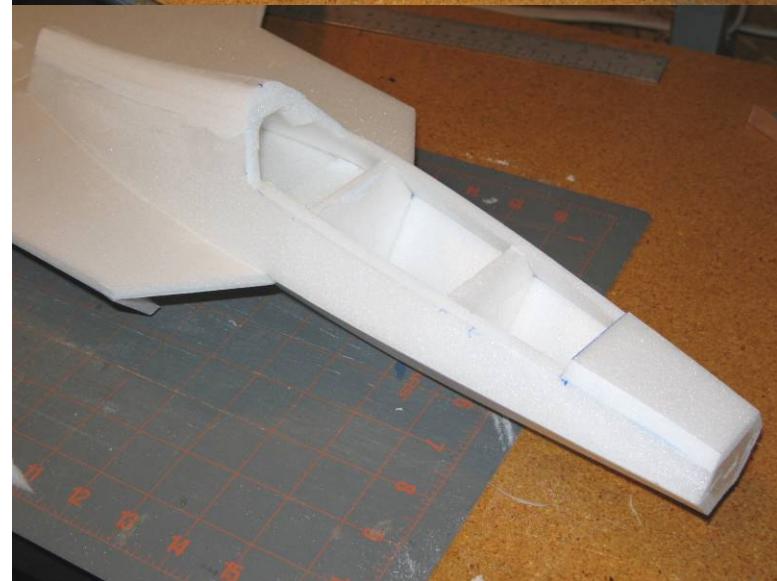
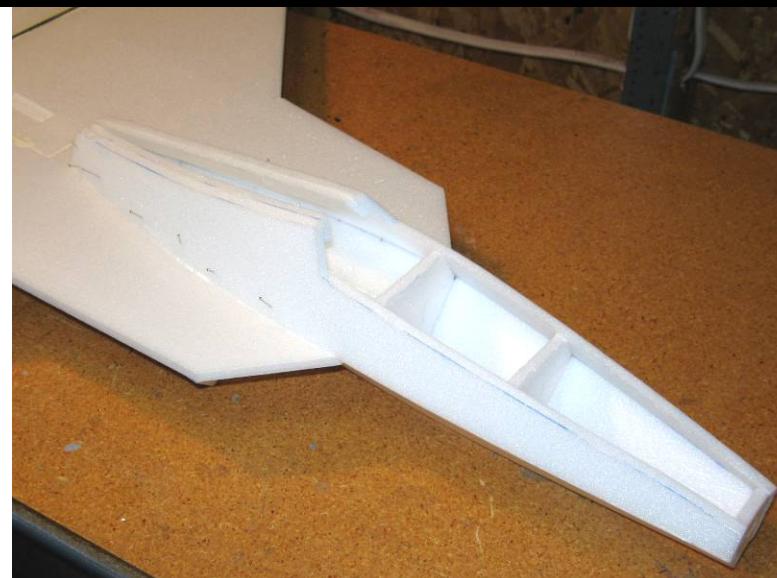
Make the pushrod from 1/16" threaded music wire, with a large Z-bend at the front end to rise up to the servo arm. Install pushrod guides as shown to eliminate flex in the pushrod (I used scrap carbon fiber tubes from the stabilator pivot rod). Make sure the pushrods guides are very securely attached, or a rough landing could break them free. I used small strips of fiberglass cloth with epoxy over the pushrod guides to provide a very strong attachment.

Use a steel threaded clevis to connect the pushrod to the motor mount. Verify that the system moves freely and with minimal slop, and adjust as required.

12. Use a sanding block to lightly sand the top of the lower forward fuselage until it is flat and even. Then glue on the upper half of each of the three forward fuselage bulkheads.

Test fit the upper forward fuselage sides, trimming and sanding as required to get a perfect fit. Note the upper and lower pieces should meet to form a sharp edge to give it that scale Raptor look. Once satisfied with the fit, glue the upper forward fuselage sides onto the bulkheads and lower fuselage sides only (don't glue the aft part to the top of the wing yet). Use tape to hold the sides in place as the glue dries.

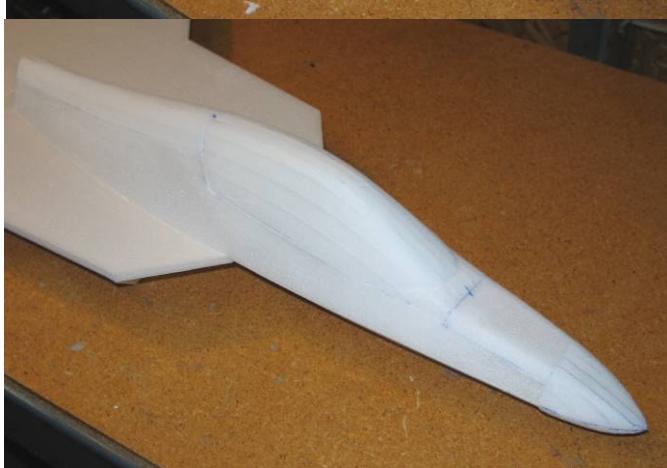
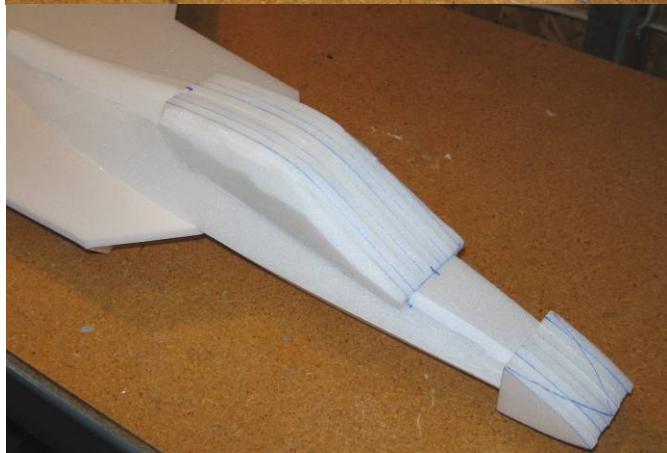
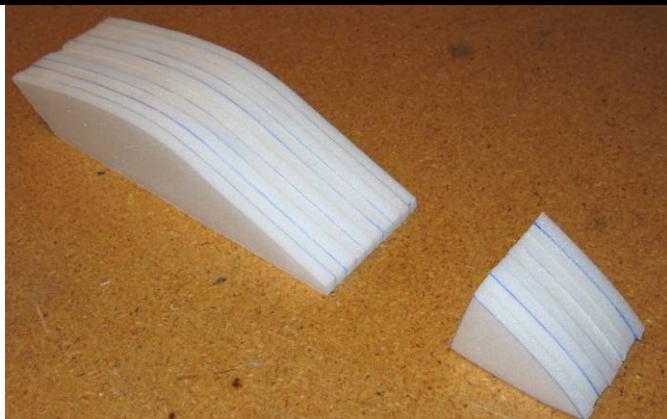




13. Glue bulkheads F4 and F5 to the top of the wing in the locations shown on the plans. Then glue the aft part of the upper forward fuselage sides to the top of the wing and the bulkheads. Note how the fuselage sides curve inward as they run aft—you can heat form the foam slightly to attain this curvature. Pins can be used to hold the foam in place as the glue cures.

Cut the bevel in the two turtledeck support pieces and then glue them in place on the top inside edges of the fuselage sides. Then glue the two turtledeck top pieces in place, one at a time so they can be formed to the proper curvature. Once the glue is dry, carve and sand the turtledeck roughly to shape.

Install the forward fuselage top (bottom photo).



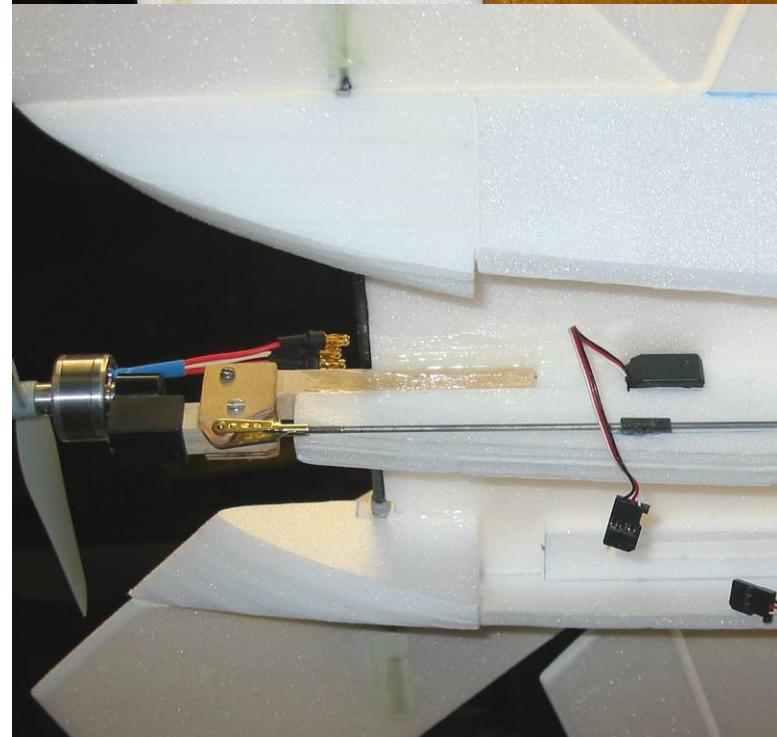
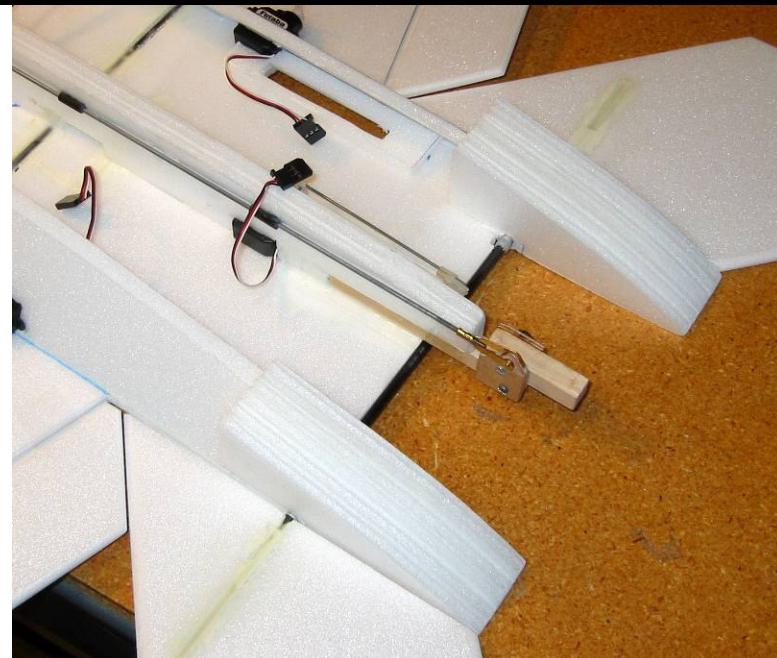
14. Laminate all of the nosecone and canopy pieces together using 3M 77 adhesive. Then glue the nosecone block to the front of the fuselage.

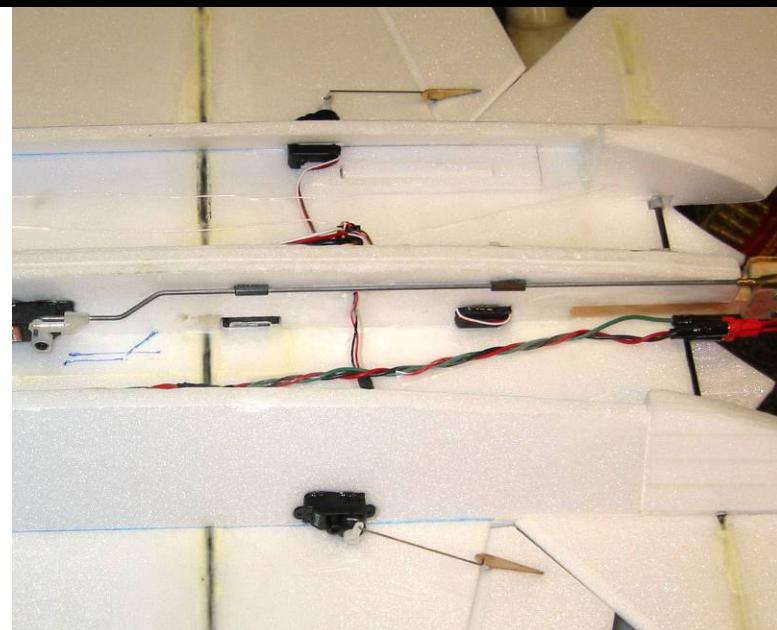
Once the glue has dried, sand the nosecone to shape. Start by tracing the top outline of the nosecone onto the foam (using the provided template) and cut it to shape with a long knife or saw. Begin with coarse sandpaper (100 grit) to rough out the basic shape, then move to a finer sandpaper (220 grit) to do the final shaping. End with 320 grit sandpaper to do the final polish sanding and provide a very smooth surface.

Carve the canopy to shape using a similar procedure.

15. Laminate the tail boom pieces together using 3M 77 adhesive. Then glue the tail boom blocks to the aft fuselage with epoxy. Note that you'll need to carve out a small channel in the top of the tail boom blocks first to clear the aluminum stabilator pivot tubes. Make sure the tail boom blocks fit tight against the stab pivot tubes, since they provide significant extra strength to the stabilator pivots.

Next carve the tail booms to shape. Note the outboard sides are angled to match the aft fuselage sides, the trailing edge is cut at an angle to match the trailing edge angle of the stabilators, and the trailing edge is sanded down to a feathered edge to match the stabilators.





16. Next install the flaperons. Cut a 45 degree bevel in the leading edge of the flaperons using a ruler and a hobby knife, and then sand the trailing edges to a tapered shape. Then hinge the flaperons with strips of 3M Satin tape top and bottom. Trim as necessary to provide a small and parallel gap from the leading edge of the stabilators.

Install the flaperon servos, control horns, and pushrods. Note the pushrods are angled out slightly to allow locating the control horn in a stronger area of the flaperon.

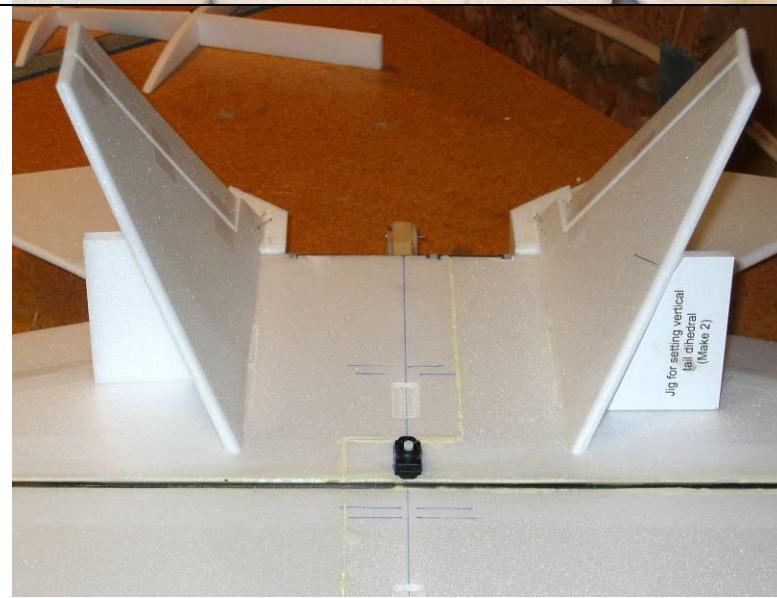
Glue the vertical tail support pieces under the wing centered over the vertical tail mounting slots, trimming them if required to clear the flaperon servos.

17. Sand the leading edge of the vertical tails to a well-rounded shape, and sand the trailing edges to a tapered shape. Apply a strip of 3M Satin tape to the leading edge.

If installing rudders, cut them free from the vertical tails. Bevel the leading edges and hinge with strips of 3M Satin tape.

Cut the vertical tail mounting slots in the aft wing, making the cut at the proper dihedral angle (use the foam jigs provided as a guide). Cut all the way through the support pieces mounted underneath the wing.

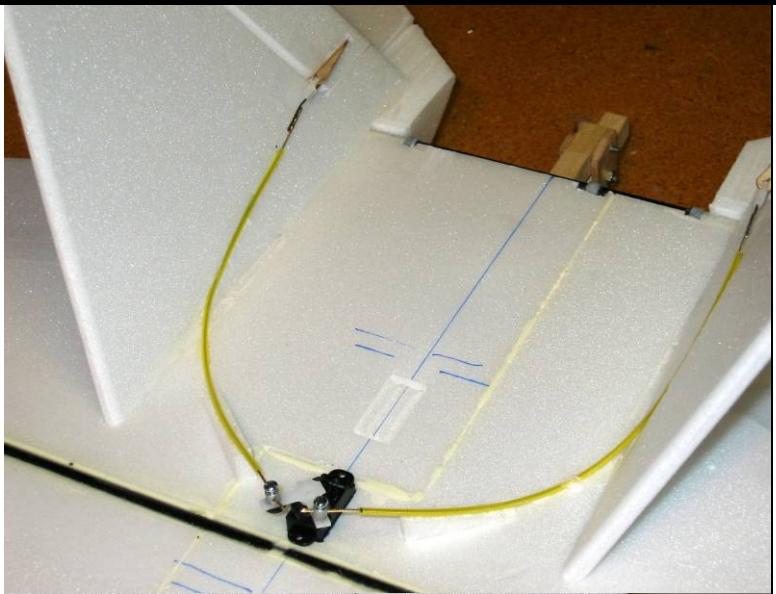
Glue the vertical tails in place with epoxy (adding microballons is recommended), using the foam jig pieces to ensure the proper dihedral angle. Pins can be used to hold the pieces in place as the glue cures.



18. If incorporating rudders, install the control hardware now. Rudders are not required, but are helpful for improved control at high alpha and for better aerobatics.

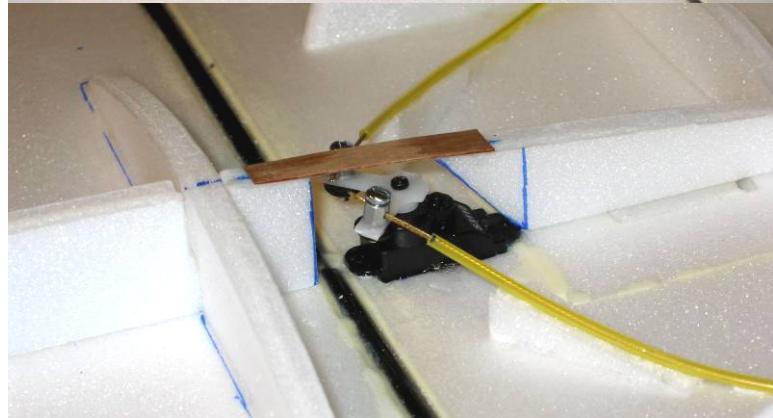
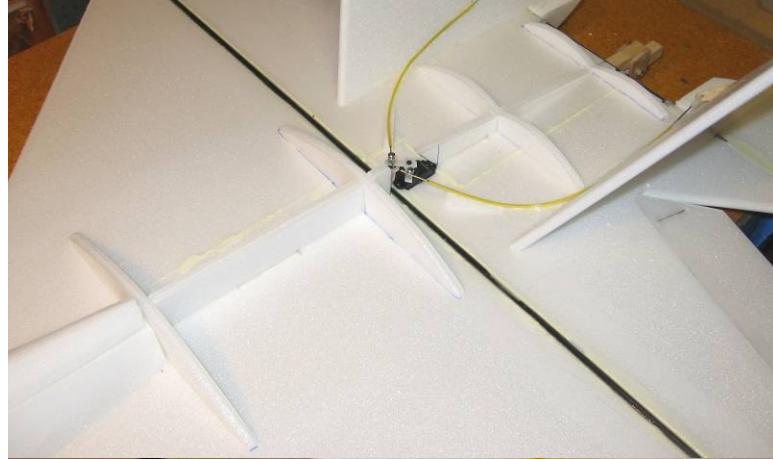
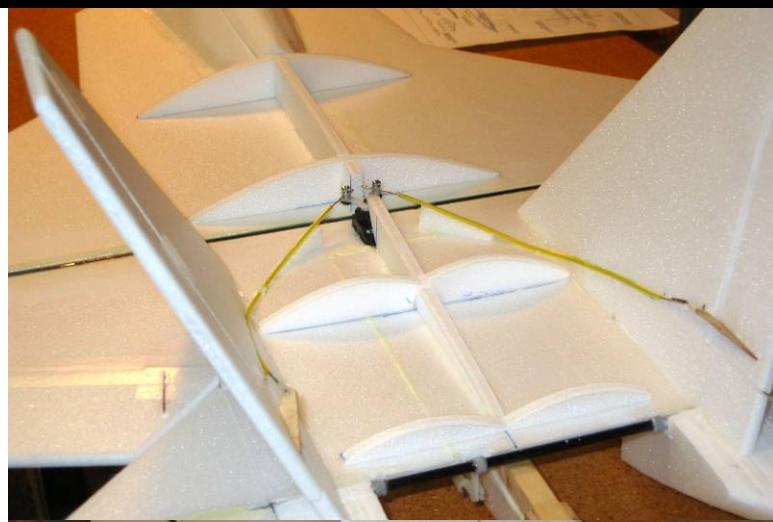
Mount the servo in a slot on the centerline just aft of the wing spar. Use Sullivan micro flexible cable pushrods, with small pieces of 1/32" music wire soldered onto the rudder end. Use small scraps of foam to support the pushrods near the servo as shown, and embed the aft end of the pushrods into a slot the foam in the vertical tail (add epoxy over the slot later to re-strengthen this area).

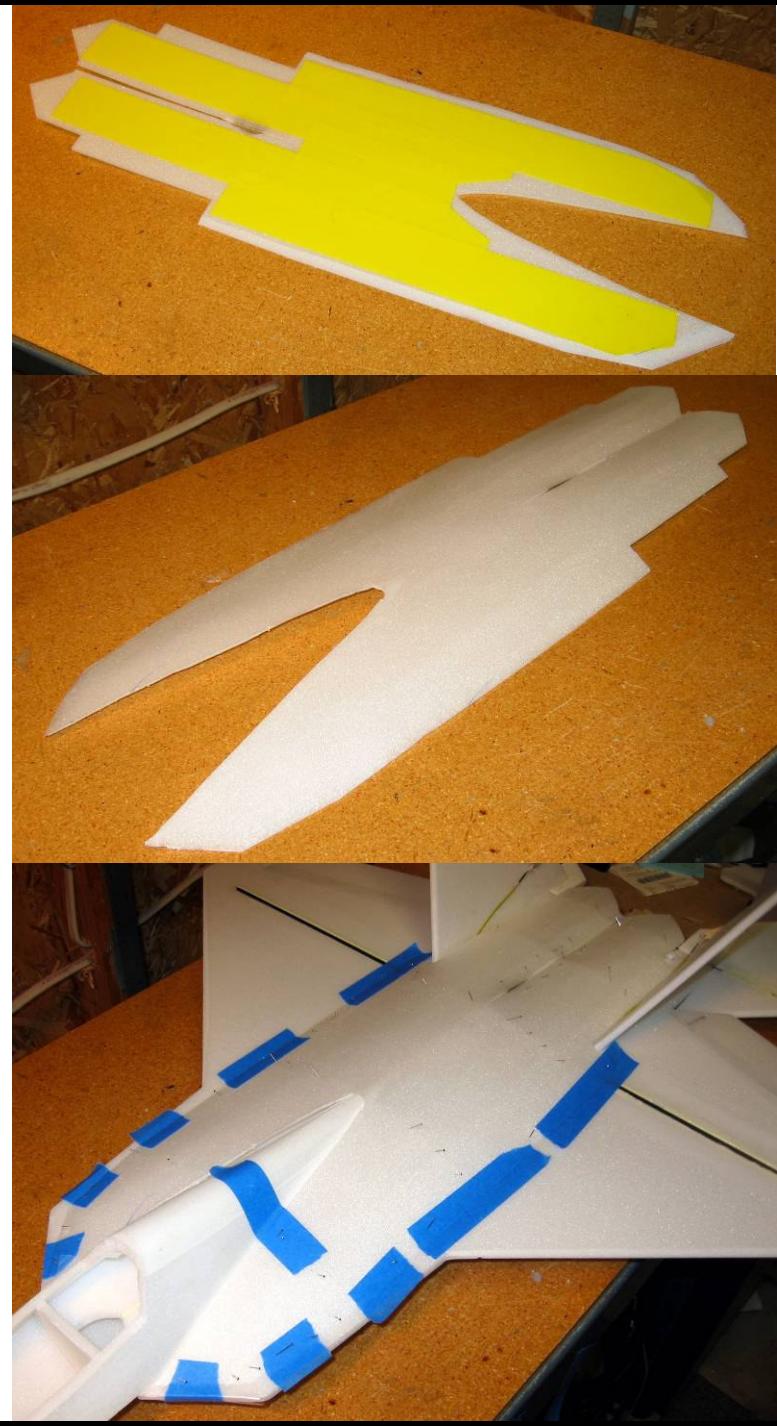
I used Dubro micro pushrod keepers on the rudder horn and Dubro micro EZ connectors on the servo end. Use a 90 degree servo arm and make sure the pushrods connect to the servo arm at a 90 degree angle at neutral (to ensure the rudders deflect equally).



19. Glue the turtledeck top spine into place on the wing centerline. Then glue the five turtledeck bulkheads (T1 through T5) into place in the locations shown on the plans.

If you decided to install rudders, note you'll need to cut a clearance hole in the top spine to clear the rudder servo. After cutting this hole, glue a small scrap of 1/64" plywood over the gap as shown in the bottom picture. The plywood will allow the fuselage top piece to sit flat along the entire length of the spine.



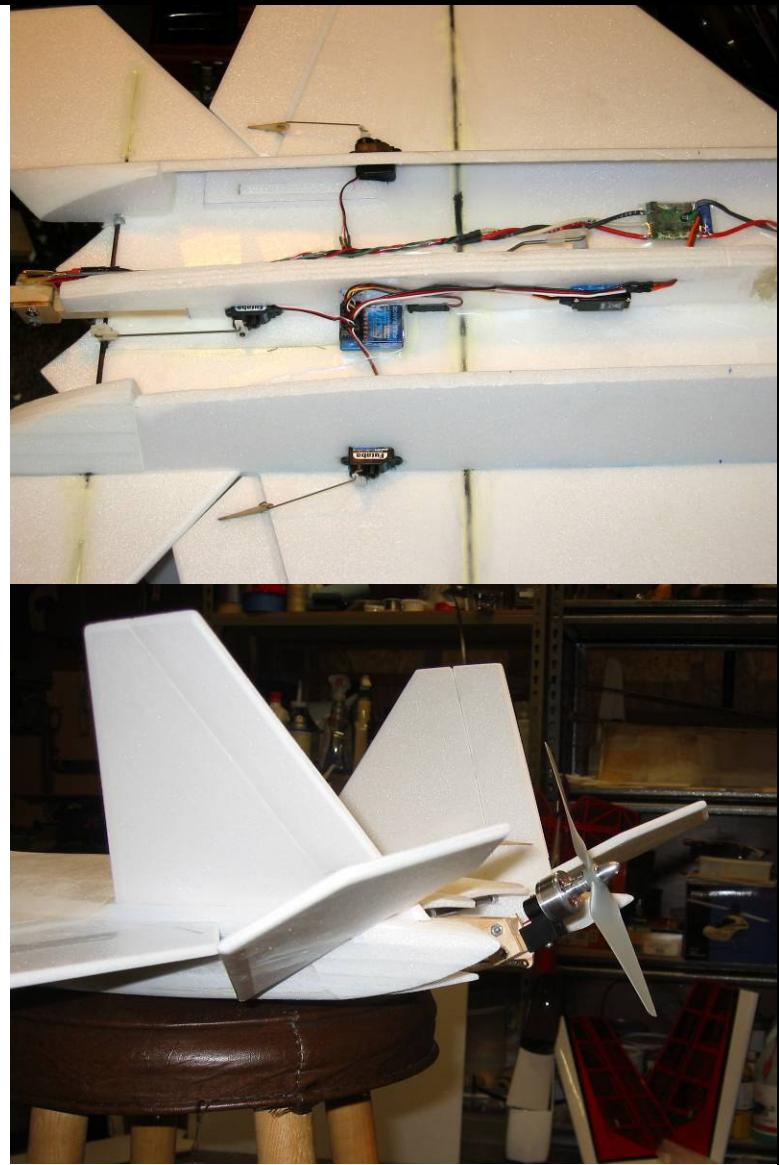


20. Next shape and install the aft fuselage top piece. This is perhaps the most challenging aspect of building this model, so take your time. There are many ways to form the curvature required, but I'll describe the particular method I used.

Begin by cutting all the beveled edges in the aft fuselage top piece as shown on the plans. Next cover most of the bottom of the part with packing tape (I used yellow packing tape in the top picture at left). The tape will help keep the piece from wrinkling as you heat form it, and will be removed when done. Use a heat gun to gently form all the curves as shown in the middle picture. Test fit the piece onto the model as you go to determine the exact curves required—use the installed turtledeck bulkheads to guide how much and where. There are many ways to heat form the piece, but the method I used was to put the heat gun in a bench vice (to leave both of my hands free), place a large diameter wood dowel on my chest, and then stand in front of the heat gun and roll the fuselage top piece back and forth across the dowel to form nice gentle curves. I highly recommend that you practice this method on some scrap foam before attempting it on the actual piece! It takes some practice to learn to bend the foam gently without wrinkling it. When done heat forming, remove the packing tape from the bottom of the part.

Test fit the piece on the model and trim as required to get a good fit. The fit should be close but doesn't have to be perfect, since you can easily use spackling compound later to fill any gaps. When satisfied with the fit, glue the top piece in place. Use a lightweight, sandable, and gap-filling glue such as epoxy with microballoons, ProBond, or aliphatic resin. Use lots of pins and tape to hold the piece in place as the glue dries (bottom photo at left).

After the glue dries, use lightweight spackling compound (available at any home improvement store) to fill any gaps and to create large fillets at the junction with the fuselage turtledeck and at the junction with the wings. After the spackling dries, sand the fillets to shape. Note a thin foam sanding pad works very well for sanding rounded fillets.

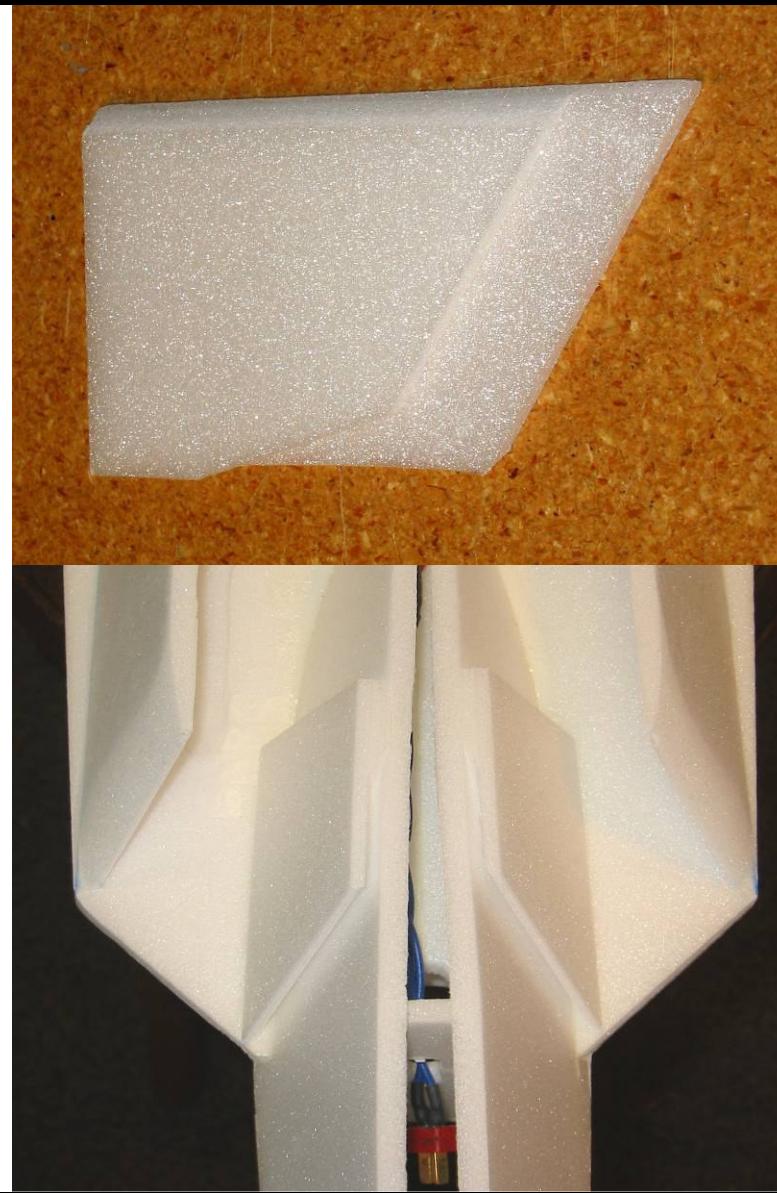


21. Now install the receiver and speed control. There are many ways you can do this, but I chose to install the receiver aft and the speed control near the middle of the plane with short wire extensions to both the motor and to the battery in the nose. I used a Berg 7P receiver and a Castle Creations Phoenix 25 ESC, and highly recommend both. Try to locate everything as far forward as possible since this model tends to be tail-heavy. Twist all the ESC wires together to help reduce electromagnetic interference, and tape all wiring down flat against the foam to keep them from flopping around in flight.

NOTE: It's very important to install the speed control where it will get LOTS of cooling airflow. Mounting it inside the inlets as shown is ideal. I even cut away some of the plastic shrink wrap to promote even better cooling. Cooling is important not just because of the heat generated by the motor controller, but even more so for the integrated BEC circuitry since this model requires 5 servos (and most speed controls are only rated for 3 or 4 servos). Providing ample cooling to the BEC will allow it operate more servos safely and help prevent premature shutdowns due to overheating. Note you could use a separate and more powerful BEC component instead, but that would add weight and cost.

It's also recommended to cut cooling holes in the forward fuselage to provide airflow to the battery (not shown here). Choose a location that works best with the particular battery size and shape you use.

After everything is installed, test all the controls thoroughly to make sure everything works properly and that you aren't getting any major interference between components. Once the fuselage bottom is glued on, it will be much more difficult to access all the electronics (you'll have to cut access holes in the foam). I don't recommend installing any access hatches at this point—just cut hatches in the foam later as needed if you find you need to access something.

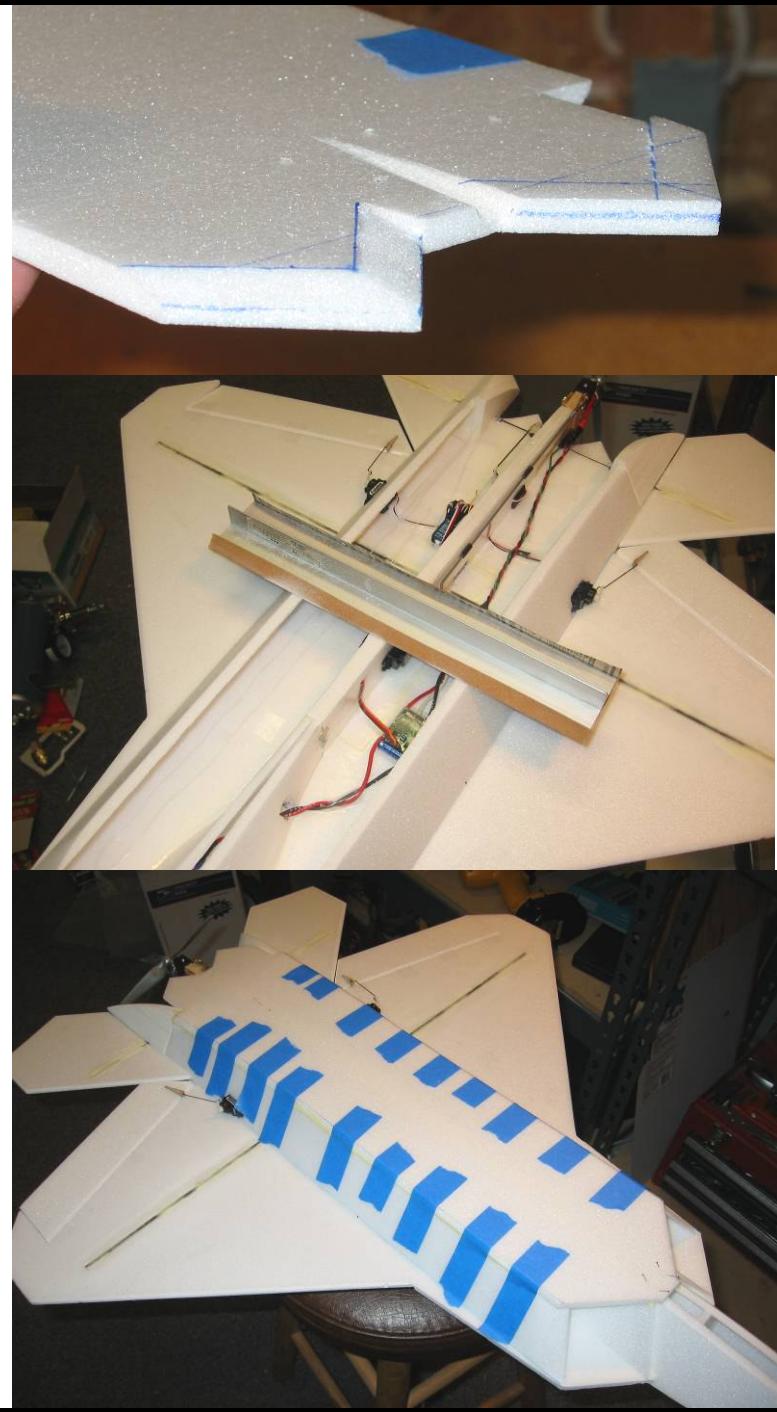


22. Laminate the inlet diverter piece and inlet side piece together as shown in the top photo at left, using 3M 77 adhesive. Make two assemblies. Then glue the assemblies at the front of the inlets as shown in the bottom photo.

23. Next make and install the aft fuselage bottom piece. Begin by cutting the bevels in the sides as shown on the plans. Also cut bevels in the exhaust nozzles as shown in the top photo at left. You'll also need to carve a small notch in the center between the exhaust nozzles to provide clearance for the thrust vectoring pushrod and clevis (test fit the part to determine how much clearance is required).

Next use a long sanding bar to sand across the bottom edges of the fuselage to make it perfectly flat and straight (middle picture). Test fit the bottom piece and trim as required for a good fit. When satisfied with the fit, glue on the bottom piece. Use a lightweight, sandable, and gap-filling glue such as epoxy with microballons or ProBond. Use tape to hold the piece in place as the glue dries (bottom photo).

Lastly, glue on the forward fuselage bottom piece (not shown in the photos).

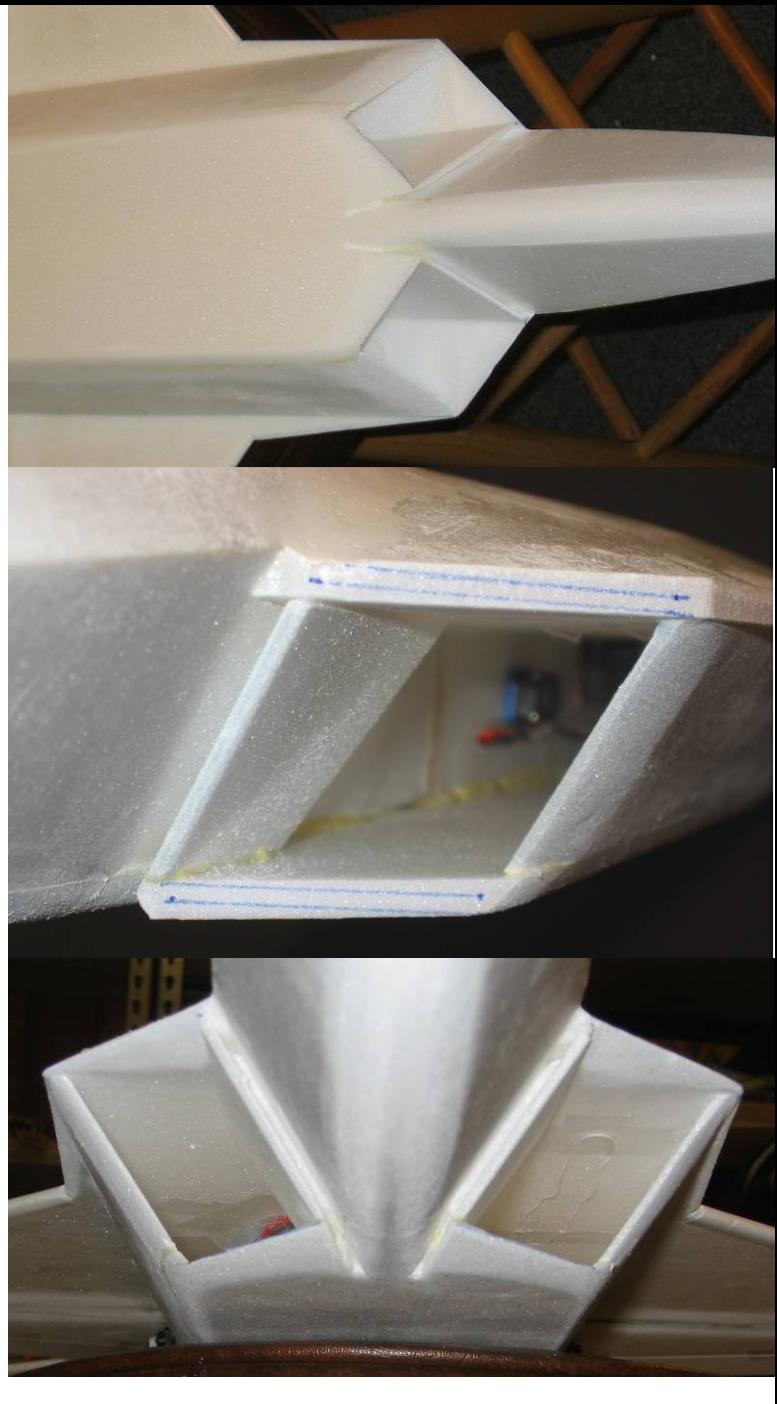


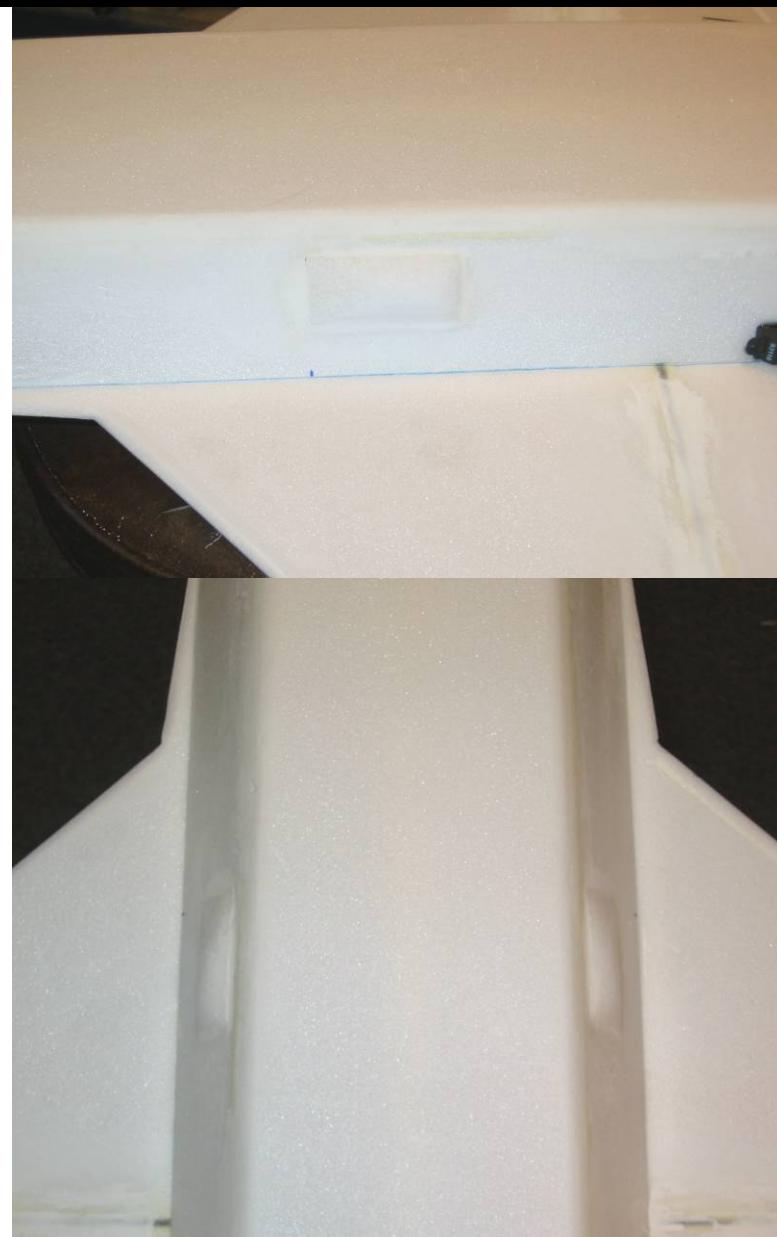
24. Now shape the inlets and aft fuselage. Begin by cutting slots in the aft fuselage bottom piece to provide exits for the inlet diverters (see top photo at left). Use a hobby knife inserted between the diverter pieces to cut the slot, and then trim with sandpaper.

The leading edges of the inlets can be sanded to a downward sloping angle if desired to improve scale appearance. Just mark lines similar to those shown in the middle photo at left and then sand down to those lines. Use a sharp hobby knife to trim the inside edges of the inlets to these lines. The final inlets should look something like the bottom photo.

Now sand the rest of the aft fuselage to shape. Sand the sides of the inlets down to a sharp edge as shown in the photos, and sand a slight radius on the bottom edges of aft fuselage bottom piece.

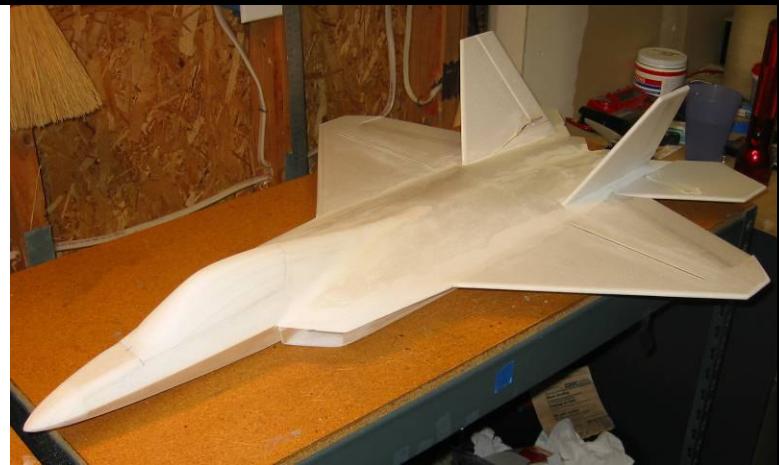
Final sand the entire model to shape.





25. OPTIONAL STEP: Because this model has a wide fuselage with angled sides, it can be difficult to get a firm grip for hand launching. To solve that problem, I added small fairings on the side of my model. These fairings highly resemble the landing gear blisters on the real F/A-22 in size and shape, but are a little lower on the fuselage so that your fingers can rest just behind them. They easily blend into the model and are hardly noticeable, but provide a much improved grip for hand launching.

To install these fairings, simply sand them to shape first (sand all sides to a highly feathered shape) and glue in place as shown. Note the front edge of these fairings are roughly aligned with the indicated CG location (the light tick mark seen in the photos at left).



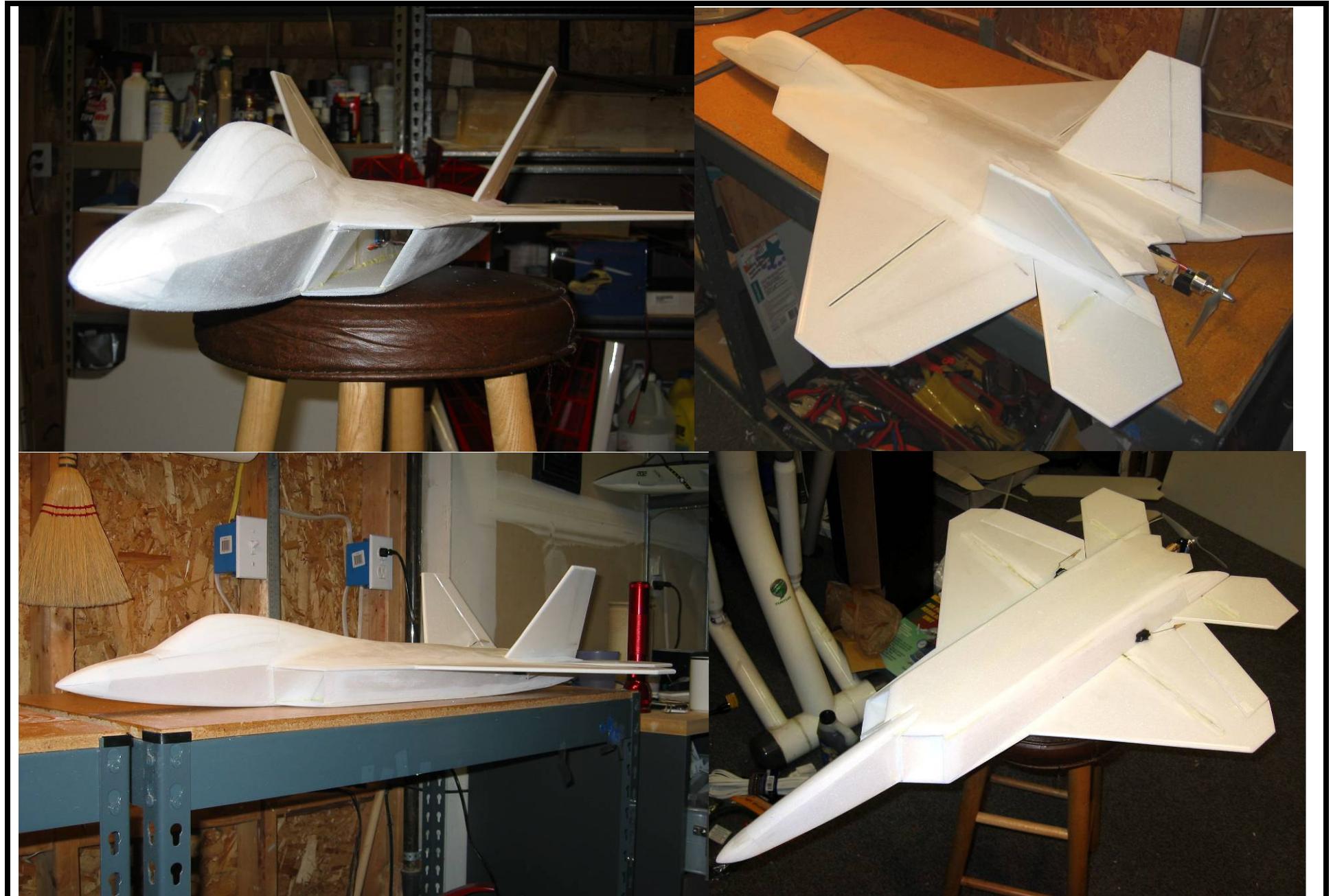
26. CONGRATULATIONS! Your model is now complete.

The model can be flown as is or can be painted using standard acrylic craft paint (available at most craft stores) applied with either a brush or airbrush. Here are a few painting tips:

- Wipe the entire model with rubbing alcohol before painting to remove all grease and dirt.
- Rough areas such as the canopy and nosecone should be filled with lightweight wall spackling compound thinned with water, which fills the holes and can be sanded to a very smooth finish with minimal weight gain.
- Primer isn't required over Depron, but applying a coat of water-based polyurethane (WBPU) will help seal the foam and provide a smoother finish. Mixing some microballons in with the WBPU will help fill holes even better and improve the finish further.
- When thinning acrylic paint for use in an airbrush, thin roughly 50/50 with windshield wiper fluid. The wiper fluid will allow the paint to dry faster (relative to thinning with water), which reduces the chance of runs. It will not affect the finish.

Good luck, and I hope you enjoy this model as much as I have!

Additional Photos For Reference



Flight Setup

1. Adjust the flight controls to provide the following recommended deflections (all measured at the root trailing edge):

Stabilators: +/- 1.5" (-40% expo)

Ailerons: +/- 1.0" (-40% expo)

Rudder: +/- 0.5" (-20% expo)

Thrust vectoring: +/- 15 degrees (mixed with elevator)

2. For best results, the thrust vectoring servo should be set up to use a simple linear mix with the elevator control. Done properly, full aft stick should produce 1.5" stabilator deflection and 15 deg up thrust vectoring (TV). This required a 50% mixing rate on my particular transmitter and model setup. Ideally this mix should be programmed to a switch on your transmitter so that the TV can be turned on and off at will, but it's OK for the TV to be left on full time as well. I recommend starting with 15 degrees of thrust vectoring since it provides amazing maneuverability without making the model seem pitchy. However, you can go all the way up to 30 deg TV for even more maneuverability--though you'll definitely want to be able to turn TV off with a switch since that much deflection will make the model very pitchy at high speeds.
3. Start with the CG at 3.0" behind the wing root leading edge (see the plans). Depending on the motor and battery you've selected, the model may require some ballast in the nose to achieve this. This is a relatively conservative forward CG location, great for making first flights. You can move the CG aft for more maneuverability later if desired.
4. To hand launch this model, grip the airplane near the CG, apply about 75% throttle, and throw it moderately hard straight ahead and slightly nose up. Make sure to keep your hand away from the prop as you throw it! Slowly bring the throttle up as soon as the model has gained some speed and altitude. It's important to not launch at full throttle since the torque from the propeller can cause the airplane to roll uncontrollably before it has enough airspeed to counter it.
5. You'll find this model is surprisingly docile and predictable in the air and has no bad habits. But with the TV on it is capable of amazing aerobatics!
6. Belly landings are easy to do with this model, but remember to **ALWAYS** release the elevator control right before touchdown to prevent the forward stabilator tips from digging into to the grass or ground—which can significantly damage the model and/or stabilator servo! Also remember to pull the throttle back to zero just before touchdown so that the propeller and/or motor mount is not damaged on landing.

Specifications

Wing area: 248 sq in

Span: 26.0"

Length: 36.3"

Weight RTF: 16 to 18 oz

Wing loading: 10.5 oz/ft²

Flight controls: Stabilator, flaperons, rudder (optional), thrust vectoring (optional)

Recommended equipment:

Motor: Littlescreamers Park Jet Special

Battery: Thunder Power 1320 mAh 11.1V Pro-lite

Prop: APC 7x4 (for aerobatics) or 6x5.5 (for speed)

Speed control: Castle Creations Phoenix 25

Receiver: Berg 7P

Servos: Futaba S3110 on all flight controls, Hitec HS-85MG on thrust vectoring