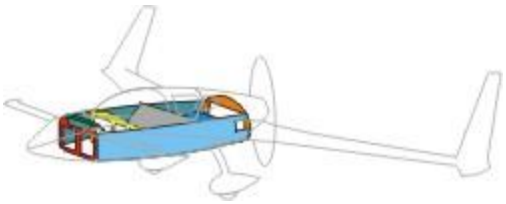


Picture by Bernard Siu

Chapter 7

Misc Techniques/Tools

9.13 - What are the modifications required to implement the electric brake mechanism?

The slot through the fuselage bottom is longer and wider than plans, and additional attachment points get added onto the seat-back brace for the electric mechanism. All modifications are easily accomplished, but it is best to have the mechanism in your possession before starting the landing brake construction (or even before glassing the outside of the fuselage in Chapter 7). Each installation is a custom fit and slot dimensions vary widely. In general, plan on a slot about 3/4" to 1-1/4" wide and about as long as the plans slot. Some builders are widening the *LB-19* plywood insert by about 1/2" on each side.

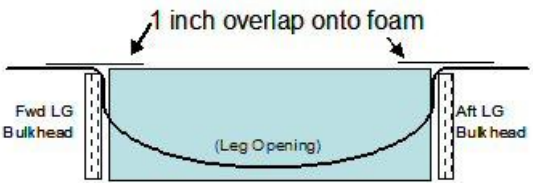
Wayne Hicks LG Cover Option:

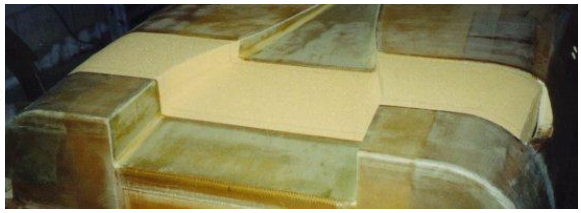
My Process

My cover is built to be between the gear bulkheads. The cover is attached to joggles within the bulkheads and is secured in place with screws and nutplates. It doesn't require any joggles to be carved into the fuselage bottom, and it doesn't require any aluminum slugs. If you strip a screw or nutplate, you simply replace the nutplate. Replacing a nutplate is far simpler than replacing the aluminum slug.

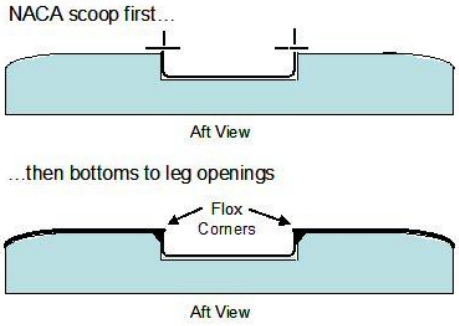
Now, a warning. Warning! The following procedure is far more difficult to explain and illustrate than it actually is to do. The process is fairly easy and straight-forward! It just LOOKS and SOUNDS complicated!

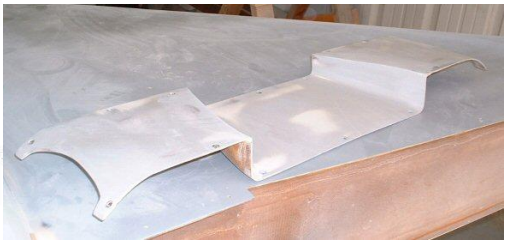
Step 1 -- The process starts with the fuselage upside down. Take a foam block, cut it to the width of the landing gear well, and stuff it in there. It is simpler if you can use one large block, but several smaller pieces will work just as well. Once it is in place, sand the foam block flush with the fuselage exterior surface, NACA scoop walls, and NACA scoop ramp. For the NACA scoop, make sure you leave a radius where the walls and the ramp (floor) intersect. The radius should match the existing radii of the forward and aft sections of the scoop. Vacuum the foam thoroughly, then apply strips of box sealant tape overlapping the foam and fiberglass. The tape should overlap one inch onto the fore and aft edges of the foam. You will later peel up this tape so that you can form a glass to glass edge between the exterior skin and the interior skin.



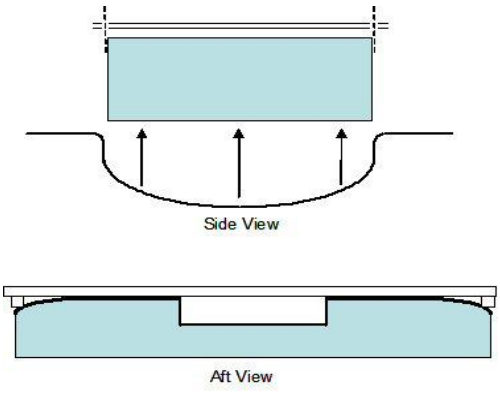


Step 2 -- Glass the external surfaces with 2-BID. Start with the NACA scoop first. Slurry the exposed foam for the NACA scoop sides and ramp. Glass the NACA foam with 2-BID. The BID should overlap just a tad onto the box sealant tape protecting the fuselage so you have material to trim away after cure. Once cured, sand the walls flush with the top of the foam. Make a flox corner on each wall, slurry the remaining foam, then apply 2-BID from the NACA scoop to the leg openings. Let cure.



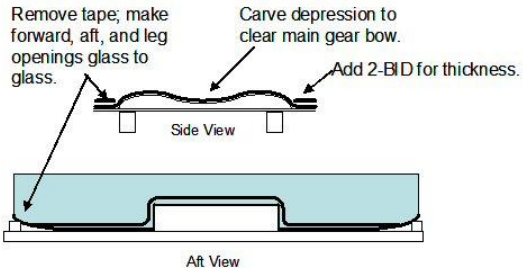


Step 3 -- Once cured, reach under the fuselage and very carefully push the foam block out of the landing gear well. It helps to first run a hacksaw blade between the BID and the release tape to unstick it. Once free, trim the forward and aft edges of the external skin flush with the foam block. Bondo two boards over the cover from left to right. The boards will hold the shape of the cover and will keep it from warping when the interior skin cures.



Step 4 -- Carve the foam as shown in the "aft view". All you're really doing is carving away 99% of the foam and leaving about 3/8th of an inch to ensure the cover is rigid. At this point, I placed the main gear bow back into the gear well so I could trial fit the cover to the gear before committing to glassing the inside of the cover. I found that I needed to

carve a depression into the foam to clear the gear bow. The M-drawing will give you a good idea of how much clearance is needed initially, but it's always good to check against the real thing. While I was at it, I also trimmed the leg openings to match the main gear legs. Once the foam was shaped, I cut away one inch of foam on the fore and aft edges and peeled up the box sealant tape applied in step 1. I also removed one inch of foam at the gear leg openings. This is done to provide for glass the glass edges. I then rounded off the edges of the foam to make a good transition from the foam onto the fiberglass. I slurried the foam, then glassed the inside of the cover with 2-BID. I applied two additional plies of BID (one inch wide) along the fore and aft edges of the cover to build up some thickness. The thickness is needed later to allow for countersink holes for the screws. Once the cover is cured, trim the edges and recheck the fit of the cover to the fuselage and the main gear bow. Remove the main gear bow and set it off to the side.

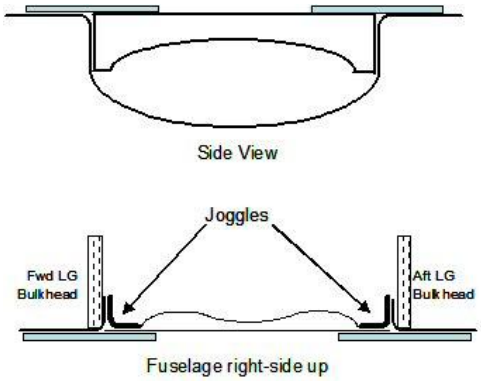


Step 5 -- Prep sand the interior faces of the forward and aft landing gear bulkheads to accept the BID joggles. You'll need to prep-sand a swatch of about 2 inches from the edges. Apply strips of release tape onto the inside fore and aft edges of the landing gear cover. Bondo a few mixing sticks onto the outside of the cover. Place the cover into position over the gear well and bondo the other half of the mixing sticks to the outside of the fuselage. MAKE SURE the cover is FLUSH with the fuselage bottom and the NACA scoop.

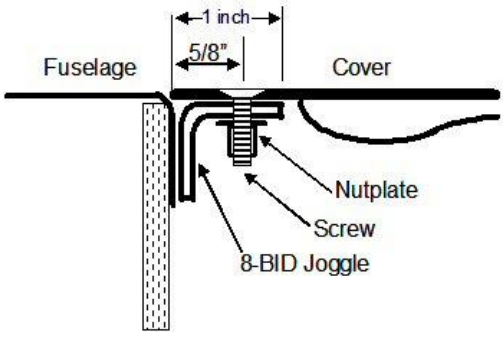
Flip the fuselage right-side up. Make up a batch of 2-BID tapes that are about 2 inches wide. What you'll be doing is applying the 2-BID tapes between the landing gear bulkhead and the gear cover so that 1 inch overlaps onto the inside of the gear cover and the rest overlaps onto the inside face of the bulkheads. This is fairly easy to do when the joggle is straight, like from the leg openings to the start of the NACA scoop. But the BID tapes will not want to wrap 90 degrees AND bend around the four corners of the NACA scoop AT THE SAME TIME!

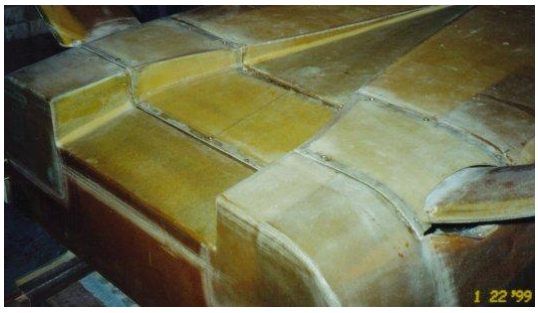
So what you must do is apply the BID tapes in short lengths. Measure from the leg opening to the start of the NACA scoop (the corner where the fuselage bottom and the side of the NACA scoop meet). Add one inch and cut off a segment of BID tape to that length. Fold the tape and apply it to the cover and joggle. I make BID tapes by wetting out the BID on plastic or saran wrap, covering with a top sheet of plastic or saran wrap, then cutting the tapes to width and length. To facilitate handling, I only remove one sheet of plastic. Using a brush, I stipple the BID tape in place, starting at the leg opening and progressing toward the NACA scoop. As the BID tape sticks into place, I then and only then begin removing the second sheet of plastic. When you get to that first corner, the BID tape will distort as it gets pressed into the corner. That is okay for now. Believe me, no one will see it. Now measure the length of the NACA side. Add TWO inches and cut

that length of BID tape. Press the first inch into the corner you just did, overlapping the BID tape you just applied. Press the rest of the BID tape into place, then try your best to form the remaining inch around the second NACA corner, the one formed between the NACA side and the ramp. This is the basic procedure followed along all lengths and all corners. Believe me! This is harder to explain than it is to do. It's quite intuitive once you see what's going on. The truth be told, the overlap is only necessary on the first 2 plies. After that, you can simply butt the tapes together at the corners.
You keep making BID tapes and applying them until the joggles are thick enough for nutplates and rivets. I found three passes (6 plies) to be more than adequate. Four plies would have probably worked just as well.



Step 6 -- Once the joggles are cured, it's time to drill the holes for the attachment screws and nutplates. First, remove the cover and trim the joggles to be one inch wide as measured from the face of the bulkhead. Trial-fit a nutplate under the joggle. Try to fit it such that it is in the middle of the available space between the vertical part of the joggle (6 plies can get pretty thick!) and the end of the joggle. Measure this distance from the bulkhead. For me, that distance was approximately 5/8th of an inch. Replace the cover, space out the location of your holes, and then drill through the cover and through the joggles. Once the holes are drilled, remove the cover and install the nutplates. Go back and countersink the holes in the cover. I've attempted to show these details in this figure.





Step 7 -- There's one last detail to discuss, but it's very important. As it turns out, the joggles make the gear well a little too narrow. Thus you will need to notch out small sections of the joggles for the landing gear tabs to slip through. This is very easily

accommodated. You can hopefully see this in the pictures below. The notches are directly above the tabs.

Again, I found it more difficult to explain and illustrate this process than actually doing it. For me, it seemed straight-forward and much easier than the plans method. And it doesn't have all the pratfalls associated with the plans method. I once asked Nat why he didn't do it this way. He said that he figured it would be too hard for the average builder to do. Plus, he couldn't figure out the clearance issues with the landing gear tabs.

Step 1 – Building the NACA Scoop

7.1.1 – Trace NACA Scoop template, cut foam, and micro to bottom. (1st paragraph – Step 1)

The NACA template does not match the bulkhead cutouts. Which is correct?

There is a some "slop" allowed in the width of the scoop, the critical part is that the slope of the ramp be smooth, have a 7 deg. slope, and have sharp edges where the curved sidewalls meet the fuselage bottom. Most people appear to trust the template over the bulkheads; and, for example, cut off an extra 0.1" from each side of a bulkhead if needed to match the template. The cutout in the aft LG bulkhead seems to be the one most often enlarged.

(SIU) I also noted a few comments from other builders that the foam dimensions per plan were not quite long enough to provide a continuous flat surface to the bottom of the fuselage. If you put a straight edge from the landing brake to the forward LG bulkhead, you will find a dip as much as 3/4". Some builders decided to fill it with micro while others added additional foam. I chose the latter approach.
I took my line laser and projected a flat line along the surface of the fuselage bottom. It helped me to locate the starting point of the fuselage curvature. It turned out to be a couple inches from the landing brake. I ended up extending an additional 7" of foam to the fuselage bottom. After all the sanding was done, you can see there is no gap underneath the straight edge. I like it much better this way.

7.1.2 – Cut out plywood pieces and flox them to LG bulkheads. (2nd paragraph, and 1st sentence 3rd paragraph – Step 1)

(SIU) Instead of using nails to hold the wood parts in place during cure, I taped a couple stir sticks to the fuselage walls as support. This worked well and I do not have to fill the nail holes later. If you look close, you can see I had a piece of duct tape on the face of the stir stick - to keep it from sticking to the flox. I also lined up parts A, B & C flush with the fiberglass surface and *not* the edge of the longeron.

7.1.3 – Micro foam to outside of plywood. (3rd paragraph, 2nd sentence – Step 1)

What shape should the 1" urethane foam on the outside of the triangular plywood pieces be?

You could use two oversize triangular pieces, or one big rectangular piece, it does not matter. One big rectangular piece errs on the safe side. Most of this foam is sanded off anyway.

7.1.4 – Cut plywood to fit between aft LG and FW, and flox in place. (4th paragraph, "Now study…through…hold them in place." – Step 1)

My plywood parts *C* and *D* do not match the plans template well. What did I do wrong?

Do not sweat it -- these are basically just support for the foam filler pieces around the gear legs, as well as tie-ins for the bulkheads to the sides, everyone's will be a little different. Just sand them to fit reasonably well, and fill any voids in the joint with flox. The plans are trying to tell you that your parts will be different when it says to make a foam version to trial-fit first.

7.1.5 – Cut foam for between LG and FW, and flox in place. (4th paragraph "Cut a block…through…blocks in place." – Step 1)

7.1.6 – Cut and flox in place foam to finish NACA scoop. (5th paragraph – Step 1)

7.1.7 – Contour the NACA foam. (7th paragraph – Step 1)

How far do the joggles extend down the sides for the landing gear cover?

There appears to be no "right answer", but a general consensus seems to be the middle of the gear strut, or roughly the top of the triangular plywood gussets. See the photo of Marc Z's landing gear cover at http://www.cozybuilders.org/chapters/chap09_3.html and notice that you do not need a joggle on the foam covering the plywood triangles, just the area along the LG bulkheads. Note also that the cover rounds the curve of the bulkhead only a short distance.

7.1.8 – Insert aluminum for LG cover. ***SKIPPING DUE TO HICKS METHOD.*** *(8th paragraph – Step 1)*

7.1.9 – Glass inside of NACA Scoop (9th paragraph – Step 1)

Step 2 – Contouring the Bottom

7.2.1 – Taper sides from ~25 forward of firewall back to the firewall. (1st paragraph – Step 2)

When shaping the rear of the fuselage, the plans describe the horizontal dimensions of the area to be removed, but what about the vertical extent?

Visualize a hot-wire cutter, one side fastened on a pivot 25" forward of the firewall, right on the edge of the foam at the "top" corner ("top" because the fuse is upside down). Now visualize how the foam will be cut if you take your imaginary hot-wire cutter and slide it along the firewall from the bottom to the small triangle of the lower firewall with the other end merely pivoting at the front. You will have cut out roughly a triangle of varying depth, deeper at the firewall and shallower toward the front (with no foam cut out in front of the wing spar cutout). Stop shaping if you get down as far as the electrical channel (which most people seem to). As the plans point out, it is not very important how it looks ahead of the spar cutout as this area is hidden under the strake.

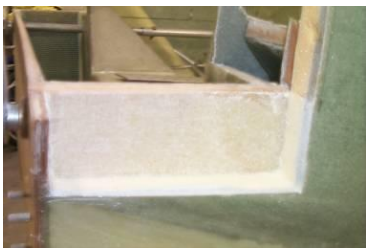
(SIU) There were conflicting interpretations plus there were new clarifications from Nat per news letter #78 which dictates that all foam be removed outboard of the top longerons and LWYs to provide for glass-to-wood bonds in the spar box area.
First I addressed Nat's clarifications - removing the foam from the top longerons and LWY was easy. I pre-marked the foam locations, removed them with a chisel, then sanded a 1.5" slope to the edges all around the opening.
The next step is to sand the fuselage back sides. I was a bit confused by the instructions and looked through the archives. There's a slight conflict in interpretation between Cozy Builder site Q&A for Chapter 7 and one of the e-mail clarifications from Nat. Per Nat's e-mail, the tapering should be as follows: "Imagine a line approx. 25" forward from the firewall perpendicular to the upper longeron, gradually taper the sides from this line back to the firewall".

Per Cozy Builder site Q&A Chapter 7, "Visualize a hot wire cutter, one side fastened on *a pivot* 25" forward of the firewall...."

I went ahead and started sanding between the 2 guidelines and hoped for the best. I used a straight sanding block and tried to connect the 25" position to the firewall. Here's what I got...

However, too much of a straight line sanding will expose the electrical channel underneath. Fortunately, this will be covered up later on.

(Maddy:) It turns out I misread the plans a bit (along with many other people) with regard to contouring the foam around the spar cutout. Nat published a clarification in newsletter #78. The problem here is that the foam should be removed along the outside of the upper longeron above the spar cutout and from LWX under the spar cutout. The whole idea is that when the spar is mounted and taped into place, the tapes should be on the longeron and LWX, not the foam.
Here is the upper longeron after the initial removal of the foam. Here is LWX after the initial removal of the foam.


The last step is to make everything taper and transition well for future glassing. All of the exposed foam will be covered later when the spar is installed.

7.2.2 – Contour corners – 1st cut at 45 degrees. (2nd paragraph – Step 2)

(WOLFE) That being done I moved on to a bit of contouring on the bottom. For this i used the plans described method of making a 45 degree cut down the side to about 25" forward of the firewall. I used a jig saw to do this but they don't seem to make 12" long jig saw blades so I bought a sawzall blade and took the grinder to it at the top where it attaches to the jig saw until it was the right size and shape to fit perfectly (ok - it fit if not perfectly) into my jig saw. I made the first big cut and then went back and sanded this down till I was 1/4" into the lower longeron as described in the plans. The plans then has you make 2 more cuts, one above the previous cut and the other below. This gets you 80% of the rough shape of the side contour. I didn't make the cuts I just uses a sander and sanded the cuts in. Takes a bit longer but I didn't feel that I had the right tool (don't like the hacksaw blade idea) to maintain the right level of control. I didn't want to take too much off.


Now... There is a tool designed by Tim Lumpp made expressly for this next bit. It has been passed around from builder to builder and I am now in possession of this tool. I love this sort of thing. The deal with it is that the builder who has it pays the freight to send it to the next person. So I will pay to send it on the next builder in need of it just as was done for me. It's pretty cool. Each builder that has used it has added to the note that was in with the tool. Some have added supplies. I'll do the same :-) cause I'm cheesy like that.

Anyway.... this tool is made for final contouring of the bottom. Below is one picture of what it did in just a couple of passes. I didn't finish because I had been at it for 8 hours today already and it was dinner time. I hate to miss dinner so tomorrow I'll move on.



(HICKS) Carving the fuselage bottom and sides was fun, but tough and challenging! The challenge comes in trying to get good curves in the transitions between the PVC foam and the clark foam spacers. The clark foam is sooooo soft compared to the PVC foam. After roughing in the corners with the belt sander, I used a sanding plank (4-foot long poplar board with sand paper glued to it) to finish up. I highly suggest this. The length gives you excellent control. I always focused on shaping the PVC foam first. For final shaping of the clark foam, I used a belt sander belt (suggested by one of our brilliant builders). I bought a 3x24 inch, 100 grit belt sanding belt, cut it crosswise, then used a gentle buffing motion until I got the curved shape I wanted in the clark foam. Buffing straight up and down (90 degrees to longerons) would cut deep; buffing at shallow angles resulted in good, rounded curves. I gave up trying to carve the sides exactly like Nat's curvature templates. I ended up with a "pleasing shape", not too far removed from the templates, and that's good enough for me. I've learned that Nat's plans can specify dimensions, but your mileage will vary. This is not a knock against the plans, it's just to say that in moldless construction, no two planes are ever identical. It took me about 5 hours to carve the first side and about 2 hours to carve the second side.

(SIU) Before trimming or sanding along the edges of the fuselage, I needed some form of marking to guide my sanding path. I used a piece of 1/2" scrap board and cut a 90^{o} angle on it. I used this thicker board because it 'hugs' the fuselage sides better and gives you a more consistent distance between the fuselage sides and the line mark. Then I clamped a felt tip pen onto it at the desired position and traced the path along the fuselage. Surprisingly, the clamp held the pen in place well.

I followed the instructions to the letter for my first cut - cut slowly and checked every 1" along the way. In addition, I added a 'cut line' along the fuselage as a guide. From the drawing, I calculated the distance of the 'cut line' to the foam edge is 1.3". In other words, if I take a 45^{o} cut with my jig saw and cut along the 'cut line', I should get a .25" of width on the lower longeron.

I found a jig saw blade at Home Depot (Bosch) which is long enough for the angle cut. Therefore, no need to make a custom saw blade. The result looked pretty good. After the cut, I followed with a belt sander to make sure I got a nice .25" of the lower longer exposed - from the front (F22) to the mid/end of the landing brake.

- Be sure not to cut into the longeron past the midpoint of the landing brake, or you will cut away too much foam and will not be able to match the round part of the LG bulkheads without extra work.

(KHU:) The NACA scoop was first formed per plans. Then it was on to cutting the 45° angles. Check out Oreste Muccilli's method to establish the cut lines. The Bosche saber saw came with a blade long enough for the cuts. Unfortunately I got too cocky with the saber saw and cut a segment too deep. I will need to patch that with epoxy. The Tim Lumpp "contouring tool" was a tremendous help for shaping from F22 to midpoint of landing brake cut out. The tool will be passed on to the next builder.

After completing the fore contouring, I then worked on the aft section. It was quite easy to remove the foam from the upper longerons and LWX stringers with a chisel and hammer. The contouring tool is of no help at this point. My primary tool for gross shaping is the cheese grater (AKA Shurform plane). It made short work of the foam. The long and short permagrit sand blocks took care of the fine work. A small block of urethane foam will nicely smooth out the urethane areas.

7.2.3 – Contour corners – Finishing cuts and shaping. (3rd paragraph – Step 2)

(SIU) I did not make the secondary cut per plan because I was concerned about making too deep of a cut. Instead, I took a belt sander and ran along the full length of the fuselage (lightly) using the exposed width of the longeron as a guide. I have the 1/4" exposed longeron at F22 and eventually tapered to just the edge of the longeron at the end of the landing brake. You can see the various sanding tools I used

To smooth out the fuselage bottom, I cut across a 3" sanding belt for the purpose. Instead of running the sanding belt side to side (as polishing your shoes), I held the belt tight and slid it along the full length of the fuselage bottom edge. It shapes the fuselage bottom edges nicely. Be careful with the stiff edge of the belt, I got a couple of good gouges on the side of the fuselage to show. I later found that a soft cloth type 3" sanding belt worked much better than the stiff ones. Between the 5" sanding block, belt sander, and hand sander, I managed to get a reasonable rounded edge along the fuselage bottom. It fits the template reasonably well, but not perfectly.

7.2.4 – Sand depressions around Landing Brake and F22, and tape build-up around LB – reference step 9.6.1 before beginning. (4th and 5th paragraph – Step 2)

(SIU:) A 1/16" depression is required around the landing brake. Instead of sanding in the depression by hand, I used the Dremel with the small grinding wheel set at a 1/16" protrusion and routed out the depression. I rounded the corners and hope it will work out fine.

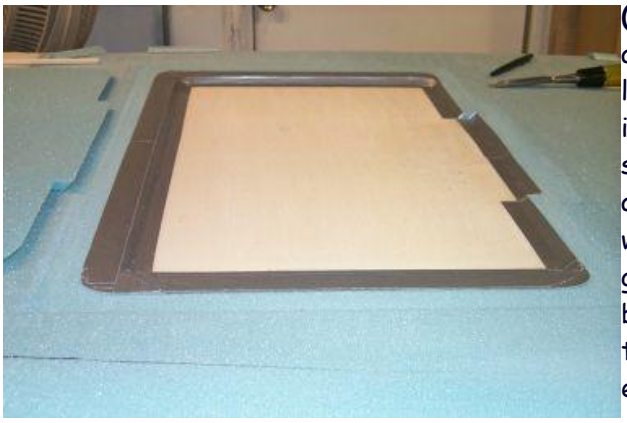
The next step is to put a 1" wide duct tape around the landing brake. During my visit with Wayne Hicks, he demonstrated a quick and easy technique to rip out an 1" wide duct tape for this application. I tried it at home and just didn't like the rough edges and the occasional bumps on the surface of the multi-layered duct tape. I decided to go back to the double sided tapes. I hope I won't regret this!

I used 2 types of double sided foam tapes (as shown in the picture). The white one is thinner than the green/white one and is about 1/32" thick. Between the two layers of foam tape, they are flush with the landing brake. In addition, the corners are easier to trim with a razor blade. Note that the outside edge of the tape will define the outline of your landing brake.

(Wolfe:) Well the first thing I managed to get back to was this area around the landing brake which needed to be sanded down 1/16th of an inch so that some overlapping layups that occur later don't cause unnecessary bumps. I started doing this by getting out the router and setting up a bunch of complicated ways of making this happen and then I realized I had the perfect tool. The Fein Sanding tool. (Yes that is spelled correctly). I whipped this out in no time and because the sanding tool attachment for the Fein tool is small and triangular it got right into those corners with no difficulty (something I was still trying to work out with the router. (Picture Below Left)

That worked so well I did the required sanding on the forward portion of the fuselage including F-22 so that the nose layups don't cause bumps later as well. (Below Middle)

After you get all of that worked out to depth perfectly the plans call for you to 5-Min epoxy that landing break back in place. I did it with a hot glue gun. It doesn't smell as bad as 5Min Epoxy and works just as well for something like this. (Below Right)



(Maddy:) Here I have applied the 1" of duct tape around the landing brake. The sides required 5 layers and the aft edge required 6 layers to make it flush. The difference seems to be due to sanding the depression. You can also see that I applied duct tape around the lip of the cutout as well. Some people have had trouble with epoxy getting under the landing brake while glassing the bottom. The result is the landing brake is glued to the bottom and this obviously creates of bunch of extra work.

7.2.5 – External step reinforcement. (6th paragraph – Step 2)

Should I recess the step and outer reinforcement piece?

If you want your step to be flush with the fuselage outer surface, then you will need to recess the wood reinforcement piece into the foam and make the step curvature match the outside of the tub. You should have instinctively known to do this in Chapter 7 before the bottom and sides were glassed. ;-(

(HICKS:) From the drawing in the plans, I was expecting the wood reinforcement piece for the step to be fairly thick. After carving out the foam, I realized that the piece for my plane would be rather thin (less than 1/4th-inch thick). It almost wasn't worth the effort and might have been easier just to fill the space with flox. Again, the thickness will vary from plane to plane.

(SIU:) The next task is to add a hard point on the left side of the fuselage for bolting a foot step. Looking at the process, I didn't care for the mounting arrangements called out by the plans. First, it is bolted onto the surface of the fuselage, disturbing the streamline cosmetics of the fuselage. Second, the curvature of this pre-fab part does not always match the contour of the fuselage (since every builder's contour is slightly different), therefore gaps can be seen in between - not eye pleasing in my opinion. Third, carving a block of wood to fit the inside contour of the fuselage will be time consuming. Personally, I much prefer the foot step to be flush with the fuselage contour.

There were a few discussions on this subject in the Cozy forum and I found a couple of elaborate schemes for improvement - a bit rich for my taste. I got a chance to discuss this with Wayne Hicks and received a few good pointers which allowed me to proceed with a different approach.

Instead of carving a wood block for the hard point, I filled it with flox and embedded the step flush with the fuselage. It is important to note that the foot step is not mounted onto the embedded wood block directly (refer to Chapter 8 Fig.11). It will be bolted through the lower longeron instead. Therefore, if I want to embed the step flush to the fuselage, I need to move the cavity accordingly (i.e. higher along the sides of the fuselage).

Unfortunately, I already carved out the chunk of foam from the nicely contoured side before I realized this. However, the entire hard point may still be necessary.

Regardless, here's what I did:
1) To do this, I needed the step NOW and not till chapter 8. I drove down to Ken Brock Mfg. and picked one up (Its good to live close to approved suppliers). With the step on hand, I marked the new cavity area to accommodate the intended step position. Note the bolt positions (indicated by the dark line) on the step. Refer to Chapter 8 Fig.11.

2) I expanded the cavity (marked by blue rectangle above) to accommodate the eventual step bolting position. Note the alignment of the bolt line relative to the longeron line (left).
3) I built a vertical support along the side of the fuselage (yellow square) to ensure the horizontal position for the step. This will also be used to secure the step during the flox curing stage.

4) I hot glued two mixing sticks onto the outside surface of the step. This will help me to determine the depth position of the step on top of the flox.

5) I covered the inside of the step with clear packing tape for mold release. I also replaced the duct tape with clear packing tape because they are thinner - creating an un-noticeable step between the foam and flox. The clamp on the square functions as a stop - to keep the step from sliding off.

6) I wet out a strip of peel ply onto the inside (curved part) of the step. The peel ply is to prepare the flox surface for subsequent glassing of the fuselage bottom. The peel ply will not stick to the packing tape on the step.

7) I filled the entire cavity with flox and pressed the step onto it until the mixing sticks hit the foam. I also shaped the remaining flox (areas) as the neighboring foam contour. Peel ply was added.

8) I was going to weigh down the step lightly. However, the suction of the flox held the step in place nicely - I decided to leave it alone for cure.

Once the flox was cured, I removed the mixing sticks, and the packing tape. The step is now flush with the foam and the drill holes line up to the lower longerons. The step will be set aside while the bottom is being glassed. The depression formed by this deviation, should provide a flush step in Chapter 8.

7.2.6 – Nav Antennas. (7th paragraph – Step 2)

Jim Weir of RST says to put the Marker Beacon antenna on the bottom, while the plans say put a Nav antenna there. What should I do?

Each has its own set of issues regarding routing. (See following answers to Questions 7.7 and 7.8.) Nat prefers the Nav while Jim Weir <jim@rst-engr.com> of RST (http://www.rst-

engr.com/) prefers the Marker Beacon since its ideal length is so long (78") and it should be oriented horizontally, fore-aft. Recall that you have got enough room on the wings for just about as many Nav, Glide Slope, and FM antennas as you could possibly want.

(HICKS:) I bought the antenna kit from Jim Wier and installed the VOR antenna per plans. The copper tape has adhesive on one side, which gets stuck to the foam. I routed out a groove for the solder joints, torroids, and cable. Like Zeitlin, the cable enters to cabin just in front of the instrument panel. If marker beacons are still around in 4 years, I'll just put one along the lower longeron (on top of skin and under final micro fill), or put it on the strake or in the wing. Note also where I've routed out the overlapped area for the landing brake. The yellow paper says, "Don't forget to do the duct tape buildups before glassing the bottom!" *Addendum: Years and years later, after the exterior skins were glassed, I decided to add another NAV antenna about 18 inches forward of the existing one that was installed in the plans location. I simply soldered up another antenna, cut a hole and a channel into the bottom skin for the baluns and the cable, filled the channel with dry micro, and glassed a strip of BID over each of the foils. It will be covered up and hidden completely with the contouring process in Chapter 25.*

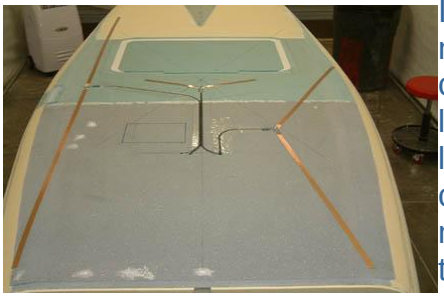
(SIU:) I decided to mount three (3) antennas on the fuselage bottom - the NAV#1, Glide Slope and Marker Beacon. I also plan on adding NAV#2 (and whatever else) on the bottom of the canard. Of course, I will mount the 2 COM antenna on the winglets per plan. I set a few criteria prior to laying out the antenna:

1) Make sure to make room for the landing light;
2) Keep the antenna tip from going through large metal structures (engine) or warm bodies for line of sight communication;
3) Orientation of the 2 NAV antennas will be 90^{o} from each other for best coverage.
4) The cable entry point will be behind the instrument panel.

As shown above, I first drew out the landing light position per plan (the rectangular box under the pilot seat), even though I was considering nose lights instead (just in case I change my mind later). Then I translated the instrument panel position onto the bottom of the fuselage. The cables will come up right against the forward wall of the instrument panel and up the insides of the cable braces. Once drawn, the layout was quite easy. The turning radius for the cables are 3" or greater. I routed out the trough for the RG58A/U coax cables with a 3/16" rounded tip Dremel bit for best fit. They turned out a bit tight, but the 1/4" were too loose for my comfort. Note my NAV#1 antenna is on the passenger side to avoid the metal foot step (on the pilot side) and is pointed at 90^{o} to the canard (where NAV#2 is going to go).

I prepared the coax cables for soldering onto the copper foils and shrink sleeved the ferrite triodes per instructions in the archives. I confirmed with a couple RF engineers that spacing between the triodes are not necessary - therefore, I just stack them together. Note that toroids are 3/8" in diameter - happens to be the same thickness as the underlying (blue) foam. Adding the thickness of the shrink sleeving, the donuts were protruding 0.050" above surface. I have to bring in the heavy duty router and carefully take the bottom out - pretty close to bare glass - but I got them to fit without feeling a

bump! I then sloped the foam smooth to support the foil transitioning from the solder joint (to be floxed in under surface) to the surface of the fuselage.



I did a few trial runs on soldering onto the copper foil to make sure I got it right - it was not too tough. I taped copper foils onto the fuselage per my layout, cut them to length per RST's recommendations and soldered the coax leads in place. I also did a continuity test on each of the connections to make sure they are not broken or shorted. I mixed some wet micro and 'pot' the connections in place. I then sanded them to foam level after cure.

If I decide to go with the Nav antenna on the bottom, are there any special things to watch out for?

a. Be sure to layout the cut-out for the nose wheel and route the cable to avoid this (refer to Chapter 13). Otherwise you may have to reroute your antenna when you reach Chapter 13.
b. Avoid the area where the landing light will be (refer to Chapter 17).

If I decide to go with the Marker Beacon antenna on the bottom, where do I put it?

To avoid the landing brake, you need to run it between the landing brake and a fuselage side, instead of right down the middle. You can put the coax joint just ahead of the landing brake, near the bottom of the front seat back. Run the cable perpendicular to the tape to at least the middle of the fuselage (or even to the other side), then forward to just behind the instrument panel, being sure to miss where the front landing gear cutout will be positioned (refer to Chapter 13) and the landing light cutout (refer to Chapter 17).

- The antenna toroids are just about the same thickness as the 3/8" foam, be careful when routing out the foam for the toroids and coax to avoid cutting into the glass on the opposing side.
- Some coax info from Jim Weir <jim@rst-engr.com> of RST (http://www.rst-engr.com/): for our purposes, there is no difference between RG-58, RG-58/U and RG-58A/U. Plenum or PVC covered is fine, PVC is cheaper, plenum is usually lighter and narrower. Make sure your BNC connectors and crimper are appropriate for the type you select. Jim prefers the soldered, screw-on connectors, but says crimped connectors are fine too.

(Furnweger:) There has been a lot of discussion on the optimal place to put the various antennas on the plane. No matter where you put the antennas, there will be trade offs which need to be made. For me, I have chosen the following antennas and locations:

Antenna	Antenna length (each arm) (in inches)	Number of antennas	Copper tape needed	Location
Marker beacon	34.3"	1	64.6"	Fuselage

Glide slope	7.5"	1	15"	Fuselage bottom
VOR (navigation)	22.8"	2	91.2"	Wings
VHF communication	20.3"	2	81.2"	Rudders
2M amateur radio	17.7"	2	70.8"	Canard
		Total	**322.8 inches (Which is 26.9 feet of copper tape)**	

There are two amateur radio 2M antennas. One will be used for the APRS packet radio tracking system. The other is for 2M voice communications. The tracking system will be connected to a GPS receiver. The radio will then send out position reports at regular intervals. These reports can be viewed by anyone on the Internet by going to the appropriate tracking service, such as FindU.com.

It seems no matter where you put the various antennas, there are trade offs to be made. The ones I made were to put the marker beacon on the pilot side of the plane. This has the trade-off of having the antenna very close to the metal step and just a few inches below the pilot and a couple of inches below the wiring channel. For the glide slope, the trade off is being near the marker beacon and just a few inches below the passenger seat. Neither of these locations is ideal. I'm fairly certain the antennas will function just fine as both of these antennas will be used when they are close to the transmitter at an airport. The navigation, communication and ham antennas will be used with stations much further away, so it is important they be in a more optimal location.

All of my antennas are homebrew. I purchased some 8-inch wide copper flashing from Home Depot. I cut it down to 1/2 inch strips using a bandsaw. Actually, this did not work out all that great as the width varies by about an 1/8 inch, but I don't think that will be a problem. I might have been able to be a bit more accurate using a hacksaw.

The coax is RG-58/U and was purchased from a local surplus shop, HSC Electronics (formerly Halted Specialties Company). I bought 200-feet to have enough for all of the antennas. I estimated it as follows:

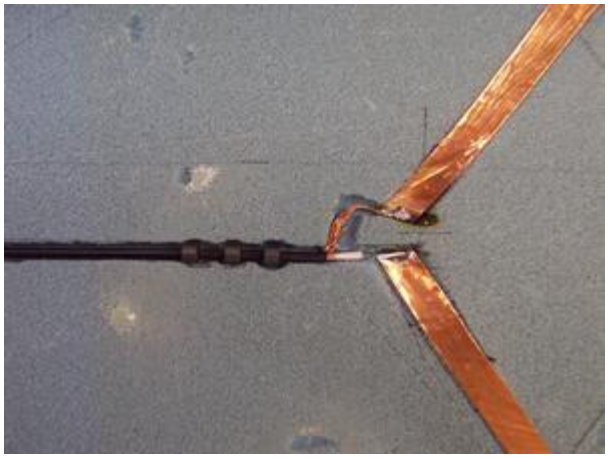
Antenna	Location	Length of COAX needed (in feet)	Number of antennas	Total COAX needed (in feet)
Marker Beacon	Fuselage bottom	9	1	9
Glide slope	Fuselage bottom	2	1	2
VOR navigation	Wings	20	2	40

VHF communications	Rudders	37	2	74
2M Ham	Canard	6.5	2	13
Excess behind IP		6	8	48
		Total	**8**	**186 feet**

The actual construction of the antennas is shown in the following pictures. A dipole antenna, typically has both arms in a straight line. However, this will cause a null in the reception of signals perpendicular to the straight line. To reduce this null area, the arms are offset from a straight line by 10 to 30 degrees, thus forming a "V" shape. The only exceptions to this are the marker beacon and the VHF communications antennas.

The transmission line for a dipole antenna should be a balanced line for optimal performance. However, balanced lines are difficult work with. Instead, the antenna is fed with an unbalanced line, such as COAX. The disadvantage is the shield of the COAX will carry undesired current. To reduce this unbalanced current, three ferrite toroids are placed on the line near the connection to the antenna. However, not all ferrite toroids are designed to work at these frequencies. The toroids I am using is Amidon part number FB-43-2401.

Location of the antennas.



Detail of the connections to the glide slope antenna

(Springer:) Here's a close up of the RG-58 joined to the copper foil. I soldered this up on the workbench then installed it after that. The blue and yellow foam is scraps from previous steps keeping the ferrite donuts separated the right amount without too much fuss.

7.2.7 – Loran Antenna. ***SKIPPING – No Loran to be installed.*** *(8th paragraph – Step 2)*

Step 3 – Glassing the Bottom

7.3.1 – Prep and flox vertical corner of NACA scoop. (1st paragraph – Step 3)

7.3.2 – Trim bottom longerons flush with Firewall, prep bottom for layup. (1st paragraph – Step 3)

7.3.3 – 2 ply UND on bottom, 30 degree orientation. (1st paragraph – Step 3)

When glassing the bottom fuselage, what does, "[t]he overlap of the bottom layup with the side layup should be at the corners, and the edges of the plies should be staggered one inch and the overlap of each ply should be one inch" mean?

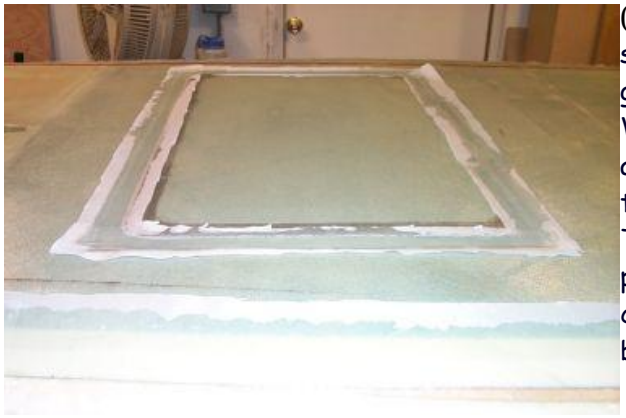
Each pair of plies (one from the side and one from the bottom) must be overlapped 1". Each 1" overlap area made by these pairs of plies should be offset from the 1" overlap area of the plies below it, to avoid a bulge in the side area. So, for example, the overlap area of two full sets of plies would span 2" total, 1" per layer times two layers.

How do I get the glass to lay down in the joggles for the LG cover?

This appears to be a nasty problem, judging from the archives. Several methods have been attempted and documented in the archives. You are not really going for strength in the glass here, so the sharp turns are not really a problem, you just need to get a good flat surface for your LG cover to sit on. In general, there are two kinds of methods mentioned in the archives:

a. The most popular method: put flat, weighted objects over the glass in the joggles, like weighted blocks of wood (see Marc Z's Chapter 7 photos at http://www.cozybuilders.org/chapters/chap07.html) or strips of flat steel from your local hardware store. Some weighting may be required to keep everything in place, and make sure you put plastic wrap or tape on the objects for release.
b. Instead of making a pair of 90 degree angle corners, radius the corners so that it is easier to make the glass stay put. One problem mentioned is that this method requires more filler, and using micro might be prone to chipping, flaking, etc. Instead you might consider a combination of micro and flox or just flox as the filler. However, you will probably still need some weighted flat objects just like in the method above.

(HICKS:) It has been suggested to sand a depression (joggle) along the length of each side to incorporate the glass overlaps without bumps. I didn't do this. Since my clark foam sanded low anyway, I just made my overlaps over the clark foam to build that area up a little.
True confession-- I can't scissor trim in a straight line worth a damn! So prior to glassing the bottom and sides, I ran a length of duct tape down the sides, wet out the cloth to the middle of the tape, then using the tape as a guide, I scissor trimmed to the edge of the tape. Then I peeled the tape away. Wetted cloth scissor trims easier than trimming dry. The tape also kept epoxy drips off the raw foam and/or completed glass work.



(Maddy:) Here is the depression around the speed brake all peel plied. I ran into a problem getting the glass to stay down in the depression. What I ended up doing was cutting the glass with a sharp X-Acto blade. I cut at the edge of the tape where it would have been cut in chapter 9. This allowed the glass to sit in the depression properly and as a bonus, I think it will make chapter 9 easier when it comes to cutting the brake loose.

7.3.4 – Install engine mount reinforcement layups – Two 3-ply UND (6 plies total) both sides. (2nd & 3rd paragraph – Step 3)

Step 4 – Contouring the Sides

7.4.1 – Remove portions of sides forward of F28. (1st paragraph –Step 4)
(Furnweger:) The plan says to cut out the portion from F28 to F22. Since I had moved F28 from the plans 5.9 inches aft of F22 to the general consensus position of 6.25 inches, I thought I would leave the extra 0.35 inches forward of F28 uncut. I can trim it later when I fit the canard in chapter 12.

7.4.2 – Make templates for contours. (2nd paragraph – Step 4)
7.4.3 – Contour corners. (2nd paragraph – Step 4)
7.4.4 – Clean outside area for fuel sight gauge. (3rd paragraph – Step 4)
7.4.5 – Sand depressions at F22. (4th paragraph – Step 4)

Step 5 – Glassing the Sides

*7.5.1 – Build A-Frame "**rotisserary**". (1st paragraph – Step 5)*

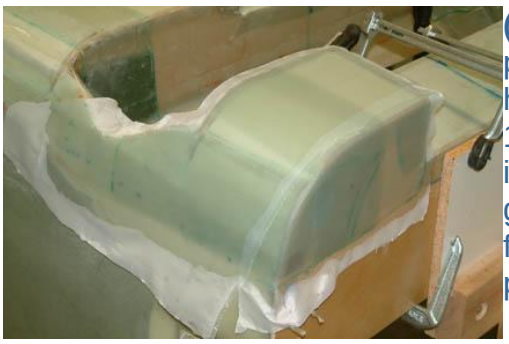
(SIU:) The next task was to build a rotisserie such that I can rotate the fuselage on its axis for the next few operations. Instead of building a whole new support structure, I made some modifications/additions to the existing saw horses and got my rotisserie reasonably quick and inexpensive. Here's the picture of the front end rotisserie.

Here's the picture of the back end of the rotisserie. Note the slot on the top of the rotisserie - that's the wrench access for the locking bolt.

(MADDY:) I made a pair of braces to allow the fuselage to be rotated along its longitudinal axis. This makes glassing the sides and the chapter 8 work easier. Both braces are the same except for how they attach. Each is made from three legs of 2"x4"s. A 1/2" bolt goes through the mount and through the top of the legs.

7.5.2 – UND layups on first side, plus reinforcement layup at Upper Longeron. (2nd & 3rd paragraph – Step 5)

7.5.3 – Engine mount reinforcement layup on first side. (4th paragraph – Step 5)



(SIU:) The last item in this chapter was to add 3 plies UND reinforcement to the engine mount and hard point. The length of the glass was to be 8,10 & 12" beyond the firewall edges. However, the picture in Fig. 24 showed the plies go way past the landing gear openings. I was a bit confused but decided to follow the instructional dimensions instead of the picture.

(HULL:) When lapping onto the firewall (I think it says 5") - make sure you tape your screws that you installed in Chap. 4!

7.5.4 – UND layups on second side, plus reinforcement layup at UL. (5th paragraph – Step 5)

7.5.5 – Engine mount reinforcement layup on second side. (5th paragraph – Step 5)

(HULL:) Hinges should be installed in Chap 7 as well - that way you don't have to cut the shoulder support later to get to that nut.