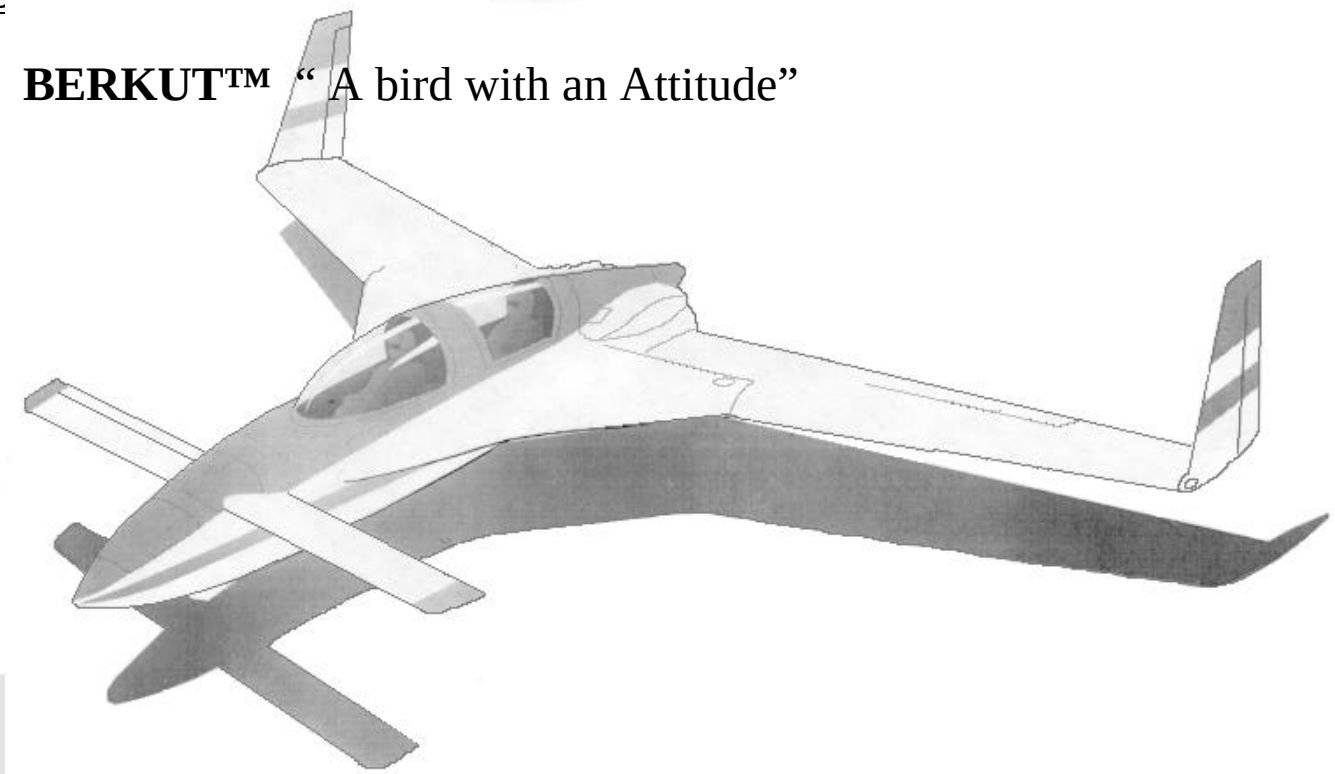
Volume

A

BERKUT ENGINEERING

BERKUT™ " A bird with an Attitude"



BERKUT™ A-Kit Manual

Part 2: Construction: foam wings

BERKUT ENGINEERING

ASSEMBLY MANUAL

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ABOUT THIS MANUAL

This section of the manual is for those building the Wings and canard with a foam core.

This technique is similar to the one designed by Burt Rutan for the original Long-EZ and Vari-EZ. We have made a few improvements to the technique to give you a more consistent, straight wing.

WINGLETS

Chapter 1

THE FIRST SKIN

You're ready. You've read the previous 78 pages with rapt attention. You've poured over the videotapes until your VCR screamed in agony. You've set up your workshop, and you've warned your significant other that you are going to be completely stressed out for the next 72 hours. This is it; your first step toward the glorious day when you will roll your BERKUT™ down the runway and soar into the sky, effortlessly slicing through the clouds with a thrilling roar.

But, seriously.

The first structure that you will build is your winglets. The reason is simple - they are easy, and if you somehow manage to completely destroy one the materials are cheap. You will build 2 winglets, a left and a right. They aren't identical. The winglets are lifting surfaces, and were originally developed by Dr. Whitcomb at NASA. The cambered side - the "up" side of the airfoil - faces inward, toward the fuselage. This creates a low-pressure area over the end of the wing, loading up the end of the wing and letting it work as though it were much longer than it really is. We are going to give you the instructions for a generic winglet - the instructions, and the illustrations apply equally to both the left and the right. It is simple and easy to do both winglets simultaneously, side by side on your table. Just set them a couple of feet apart so you have some elbowroom.

We have included instructions for the installation of a communications antenna in the winglet, under the inboard skin. Some of you may wish to install one of these antennas in each winglet. We don't encourage you to do this, especially seeing as how we've only included enough material for one antenna. But, if you simply must have 2, call RST (listed in the supplier's appendix) and ask for one of their comm. antenna kits. If not, we suggest that you put the antenna in the second winglet. That way you'll have had a little bit more experience, and you'll (slightly) reduce the chances that something will go wrong. You will notice comments that will refer to doing one at a time. If you are doing both, ignore them.
And awaaaay we go.

NOTE

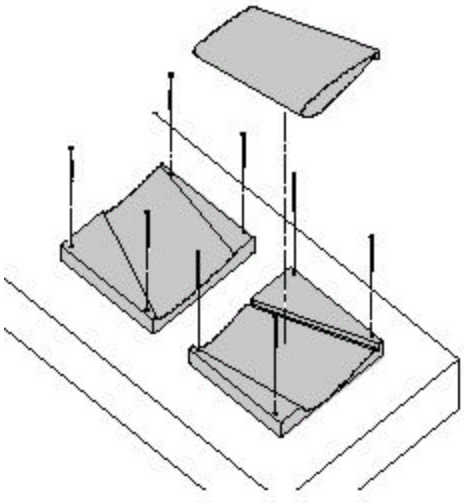
In some of the A kits we have included some hardware that won't be used for a while. 3/8" cold rolled steel rod, hinges and rudder horns are all used in these structures, but not until you cut out rudders and ailerons. If you don't have these things, don't worry; you'll get them in your C kits, when it's appropriate. If you do have them, put them someplace safe, you'll use them by and by.

HAVE YOU REVIEWED THE VIDEOTAPE ON SANDING DOWN FOAM CORES? IF NOT, DO SO NOW.

First, lay out your supplies:

Uni and bid glass
Scissors
Mixing cups and sticks
Gloves
Breathing mask
Bar sander
Phillips head screw driver
2 1/2 inch drywall screws
Winglet templates.
Epoxy pump with 2410 resin and 2183 hardener if NOT vacuum bagging
Epoxy pump with 2410 resin and 2187 hardener if vacuum bagging

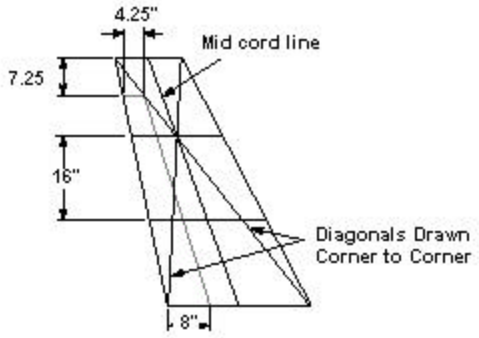
Cut 3 pieces of uni cloth - 63", 53" and 40" in length. Cut one piece of bias bid 20"x30", and set all the cloth aside. Take one of the winglets out of its box; separate the flashings from the core. Take the bottom and top flashing and remove three inches from the leading edge side of each flashing using a bandsaw or a handsaw. This will let you sand around the leading edge of the core without the flashing getting in the way. Take the flashings and nail or drywall screw them to the table. Put the core down in the upper flashing - the trailing edge foam jig should be pointing down.

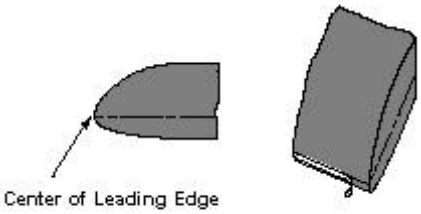


Use drywall screws to attach the aluminum winglet templates to the appropriate ends of the winglets. The holes in the templates should line up with the holes that we made when we earlier attached the hot-wired templates here at the factory. NOTE: You will notice many of the holes were not used during hot wiring. It is important that you have a 2 1/2 to 3 inch drywall screw in every hole. Hot-wiring puts very light pressures on the templates, so we have less concern about it shifting during the process. Bar sanding puts much more pressure on the template, and thus requires more mounting screws Use the sanding bar, with 36-grit sandpaper, to sand the foam down to the templates. If the sandpaper starts to ride on the smaller template before you get down to the larger one, take the end piece of sandpaper off that end, and let the wood or aluminum face of the sanding bar ride on the template until the rest of the sanding bar catches up. While you are sanding, stop occasionally and make sure that the core is coming out straight and to brush the foam dust off the surface - it too can act as an abrasive. Put a straight edge on the foam span wise (from end to end) and check for gaps. When you're done sanding, check the whole surface.

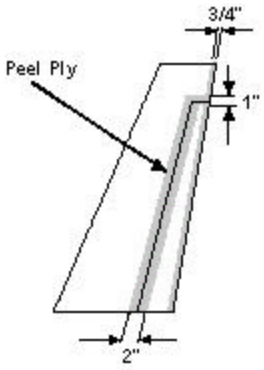
If you aren't going to vacuum bag, you will need to hold the foam securely in the flashing. Since the flashing is screwed or nailed to the flat table, screwing the core to the flashing will make sure that the core remains straight. Before doing so, make sure that the core fits the flashing perfectly - there should be no gaps at the ends or around the perimeter. Then run 2 drywall screws from the big end of the core diagonally into the flashing, tightening them gently, just until the heads of the screws are pulled flush with the core. Repeat the process at the small end of the core. Then run several screws

diagonally up from the flashing into the core along the leading edge, and from the aft face of the foam jig down into the flashing. Next, we'll make some lines on the upper surface of the core to help orient the cloth when we lay it down later, and we'll lay out the rudder. Take a sharpie marker and draw the following lines on the winglet: First, 2 diagonal lines, corner to corner, then 1 horizontal line, paralleling the top and bottom, where the 2 diagonals meet, then a second horizontal line, parallel to the top and bottom, 16" below the first line. From the Trailing Edge (TE), measure 8 inches forward along the bottom of the winglet, and mark. Measure down 7.25" from the top TE, mark, and draw a line parallel to the top of the winglet forward 4.25". Use these marks to outline your rudder cut out as per the drawing.





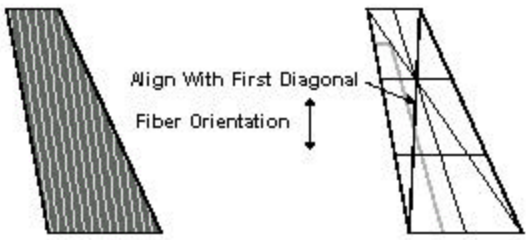
Use a straightedge and a marker to put a line down the centerline of the leading edge. Run a piece of silver duct tape or wide masking tape down the leading edge. The upper edge of the tape should be just below the line you marked. The tape should not adhere across its entire width - only the top 1/4 to 1/2 inch of the tape should be stuck down, the rest should hang clear of the core. This way any extra drips of resin traveling down the leading edge will drip away, onto the table, and won't glue the core to the flashing.



Once the winglet is marked, mix up a batch of Epolite slurry and cover the entire upper surface of the winglet. The marks will show through the slurry. Cut several lengths of peel ply tape and apply as indicated - 3/8" along the trailing edge, 2 inches along the vertical rudder cut out and one inch along the top rudder cut. The 1" and 2" tapes along the rudder cut outs should be centered on the marked lines. Rub the tape down with your finger or a squeegee, but be careful not to get any micro on top of the peel ply tape.

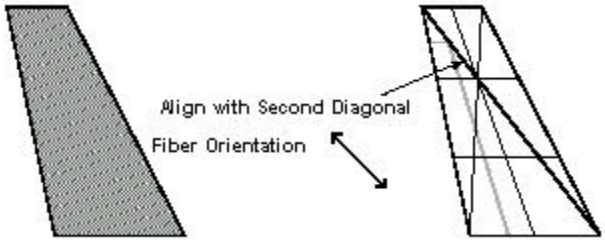
Your next step is to (Ta-Da!) apply glass cloth.

Take the 53" piece of uni glass and apply it along the diagonal from the top leading edge (LE) corner to the bottom trailing edge (TE) corner. Run the grain of the cloth along the diagonal, and let the cloth cover the entire winglet - there should be enough excess that you will have to trim it. Wet it out, squeegee it, and get out all the air. Be sure that the grain of the cloth is straight - that it doesn't wander to the left or right, but follows the diagonal line across the surface of the winglet. Trim the glass to within 1/4" of the foam (closer if possible) along the top, bottom and TE, and let it hang off the leading edge. Be careful not to disturb or disorient the fibers as you cut the cloth. This is the first layer of cloth on your airplane. This layer,

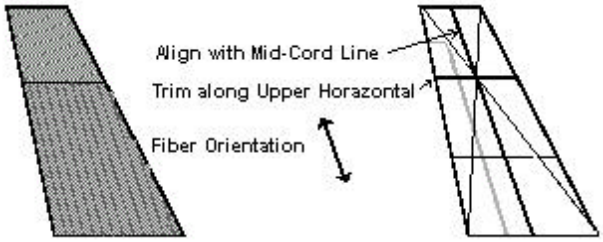


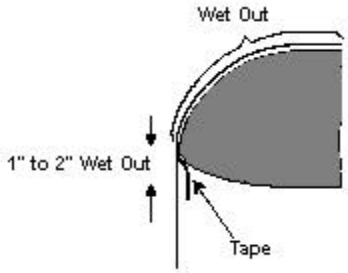
at this stage, can be a little wet, and should have no air in it. Be certain this ply conforms to all inspection criteria. If it does conform, proceed to the next ply.

Take the 63" uni and apply it along the opposite diagonal, from the bottom LE corner to the top TE corner, just like in the illustration. Use a heat gun or hair dryer to carefully warm the resin in the first layer, and squeegee the skin to draw the resin up into the second layer. This is a technique that you will use often - the first layers will go on a little wet, then use heat and a squeegee to move the resin into the subsequent layers.

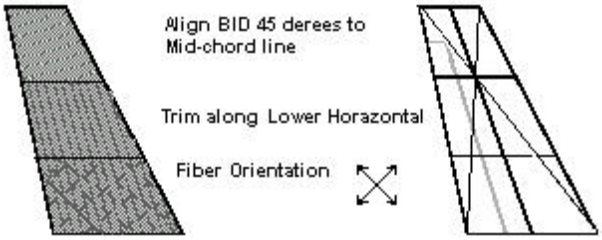


The third ply of uni goes from the base of the winglet to the upper horizontal line, span wise, oriented along the mid-chord line. The last ply, the bid, goes across the bottom, from the base to the lower horizontal line. Wet out each ply carefully, and be sure that you remove all the air.





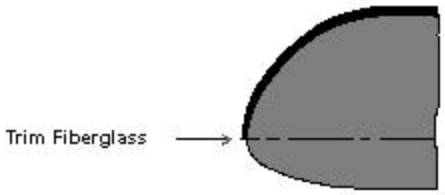
Trim them all back to the same place - even with the top, bottom and trailing edge, and to at least 1/2" below the centerline of the leading edge, where it meets the tape underneath. More fabric here doesn't hurt anything, since you will be trimming it all off when the laminate is semi-cured. In fact, a little excess will make that job easier.

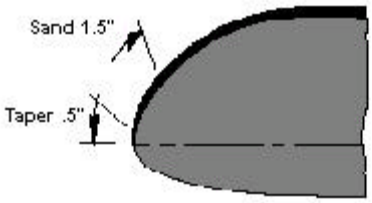


After the 4th and final ply of glass, lay down a layer of peel ply across that ply. When you remove the peel ply several months from now, it will leave a rough, easily sandable surface that will make it easy to attach the winglet to the wing. Caution: Do not heat the peel ply with the heat gun or hair dryer - it will shrink and distort. If you are going to vacuum bag the part, use a layer of Teflon fiberglass instead. Use your squeegee to rub down the peel ply, and use this as a last opportunity to look for resin lean areas. Any section of the glass that doesn't transfer a little resin to the peel ply is probably resin lean. It may be a very little resin, but there should be enough to change the color of the peel ply just a bit. If you are vacuum bagging, go on to the vacuum bag section that appears after Leading Edge (below), if not, let the resin cure out while you have a sandwich.

LEADING EDGE

Just prior to slurrying your foam you ran a piece of tape down the leading edge. Now we need you to remove the tape and the fiberglass that has gotten onto it, and then use sandpaper to feather the plies of glass from their full thickness to nothing, over a distance of about half an inch.

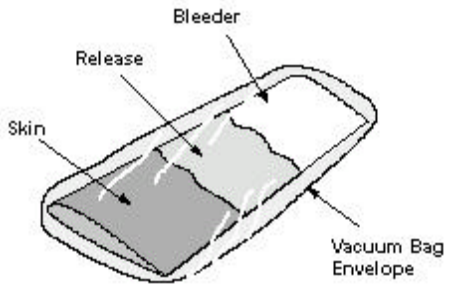




You will also scuff/sand back from the taper another 1 1/2 inches to prepare for bonding the second skin where they overlap. So, a total of two inches back from the LE centerline will be sanded. If you can get back to the laminate while the epoxy is semi-cured you can knife trim the fiberglass right along the centerline of the LE. Then remove the tape. Let the laminate fully cure, and sand it back. If the epoxy is already fully cured trimming is a little harder. A number of methods can be used - Dremel saw (as in the video), hand held hacksaw blade, or use sandpaper to cut through the curved leading edge glass. If you keep your sanding block in a plane tangent to the curve, you'll cut through the glass right along the edge of the tape. This last method also accomplishes tapering mentioned previously.

THIS SECTION IS ONLY FOR VACUUM BAGGERS

At this point, we'd like to take one last chance to discourage you from vacuum bagging your flying surfaces. If you don't vacuum bag them they will be plenty strong, and there won't be nearly as much opportunity for something to go wrong. They will be a little heavier - our guess is that you can save about 10 to 15 pounds off the weight of the entire airplane by bagging. But it carries a risk, and we leave that decision to you.



So, take the 6 mil plastic sheet that came with the vacuum bag kit and cut a piece 6 feet square. Fold it in half and set it next to your flashing. Have an assistant (or 2) help you gently lift the now-glassed- but-uncured winglet from the flashing, and center half the plastic sheet over the flashing. Unfold the top layer back. Make sure that the plastic sheet is tucked down into the trough in the flashing left by the trailing edge foam jig on the winglet. Set the winglet back into place in the flashing. Cover the winglet with bleeder cloth; where you have excess, fold it back onto itself, giving you multiple layers of bleeder. Again, it won't hurt anything. Fold the plastic over the top of the winglet, making sure that the top half of the sheet matches the bottom half.

Take out your roll of Bag Seal Tape (BST) and run it around the edge of the bag. Where you have to bend the BST around a corner stretch the BST just enough to tear the paper backing, then the BST itself will bend quiet nicely. Leave the paper backing on it for the moment. Cut a swatch of bleeder ply about 6" square and wrap it around the end of the vacuum hose that will go into the bag - secure it in place around the hose with masking tape. Lay the end of the hose, now wrapped, on top of the bleeder, on a section where the bleeder is folded over onto itself and is fairly thick - that way the excess resin will get soaked up into the bleeder, and wont end up clogging the end of the tube. Again, use a piece of masking tape to hold the tube in place This procedure is all covered in the videotape, and the video will illustrate this procedure much better than we can on paper. You are going to seal the topside of the bag down to the bottom side, kind of like zipping a garment bag shut. Starting at the fold. Peel the paper backing off the BST and seal the bag. Right in the corner you can fold the BST over onto itself -it's much easier than trying to fold the bag just at the end of the BST. It is likely that you will "run out" of one surface before you run out of the other - it's just as if you had more zipper on one side of your garment bag than on the other. You will end up with a wrinkle and nothing to attach it to. If the wrinkle is in the bottom surface - the one that you put BST on in the first place - it's easy to seal it to itself. If it's in the top surface you will need to fill it with a strip of BST that you cut to the right length. We call these strips "worms." Pull the upper surface back off the BST by a half-inch or so. Butt the very end of the worm against the surface of the existing BST; rub the top plastic down against the exposed surface of the worm. Remove the paper backing, and seal the other side. We know, it's hard to understand the "worm" concept from this, so trust us and watch the video. Wrap a layer of BST around the hose where it lays against the BST, close out the bag, and turn on your vacuum pump. Set the pump so that it only goes up to 13 to 15 inches of vacuum. That's enough to get out all the excess resin, but not enough to damage the foam. As the bag sucks down be sure that you don't get any spanners (defined earlier) on the underside of the winglet, especially where the trailing edge foam jig kicks up from the surface of the foam.

When the vacuum pump turns off listen carefully for leaks. You will hear them as faint hissing sounds, and you can locate them by putting your ear down next to the BST and moving slowly around the entire perimeter of the bag. You can often see the leak point as well, as a small wrinkle in the plastic that has pulled away from the BST and formed a passage for air. You can seal these just by rubbing them with your thumb and finger. Occasionally there are tiny cuts or pinholes in the plastic. You can find these by listening closely as you move you hand over the plastic - if you hear a change in the sound with your hand over one particular spot, your hand is over the leak. Seal such leaks with a small tab of BST.

HINT - if you live in a damp climate, take the BST out of the refrigerator a few hours before you intend to use it. We have you keep it cold so that it doesn't soften and slowly flow off the roll, but when you take it out of the refrigerator water will condense on it. The water will make it harder to stick to the plastic, so leave it out long enough that the water will evaporate.

For best results at this point, you should gently heat the part, using a tent, and bring the temperature to 90 to 100 degrees. This will thin the resin and let it flow, so more will be removed, and accelerate the cure.

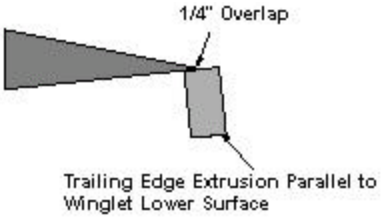
SECOND SKIN PREPARATION

The second skin is more involved and difficult than the first. The laminate sequence is actually the same - three plies of uni and one of bid.

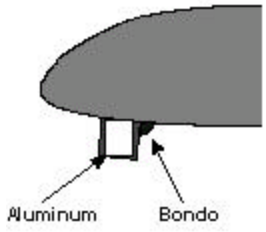
The changes are
1: You will remove the trailing edge foam jig and do a glass-to-glass transition.
2: You will bond aluminum extrusions near the leading edge and to the trailing edge. This keeps the structure straight while the epoxy sets.
3: At least on the second winglet, you will install a comm. antenna under the skin.

ALUMINUM EXTRUSIONS

The reason that we have to use aluminum extrusion is that, without the second skin in place, the winglet doesn't have a lot of structural integrity. It's floppy. And since you sanded and glassed the bottom side, it doesn't sit in it's flashing accurately anymore. We want to hold the winglet in a totally straight, untwisted condition while the second skin sets. We can do that by bonding a pair of straight structures to it, and setting the structures on a straight surface - in this case, your jig table. So the first thing we'll do is re-attach the sand-down templates to the root and tip ends of the cores. Look for the waterlines that are scribed on the templates. Measure 4 inches aft from the LE along the large, root end template. Mark that point. Place a square along the water line, and mark a point on the first skin straight down from there. Go to the tip template, measure aft 2 inches from the LE, and repeat. Leave the templates on the winglet.



Next, bond a piece of aluminum extrusion, 1"x2"x48", along the length of the trailing edge. Mix up some Bondo and use a pop sickle stick to smear a small blob every few inches along the underside of the trailing edge. Set the extrusion on the table, and gently place the TE on the edge of the extrusion. There should only be about 1/4" overlap between the trailing edge and the extrusion - the smaller the overlap, the smaller the bonding area and the easier it will be to de-bond the extrusion later.



Use a straight edge and a sharpie marker to draw a line across the first skin between the marks you made previously. Prepare a second extrusion to bond to that line - it should be about 52 inches long. Place a blob of Bondo on the first 2 inches of each end, and place the extrusion down firmly along the line. Puts weights on the extrusion to hold it down firmly against the surface and let it set for a few minutes. If you are vacuum bagging, you're done, but if not, leave the weights on and put a very small blob of Bondo once every couple of inches along the extrusion's aft intersection. They should be as small as possible - the filet left by the rounded end of a tongue depressor is plenty. These will keep the extrusion in place and still be relatively easy to remove.

WATCH THE VIDEOTAPE FOR THIS SECTION.

You will find that the two extrusions don't quite want to sit evenly on the table. That's OK. The tip end of the LE extrusion wants to sit about 1/16" off the table. Use a pop sickle stick to shim it up and keep the winglet straight. The final determination is the templates - the waterline scribed on each template should be perfectly parallel to each other. You can check my cutting a wedge shaped piece of pasteboard that spans between the table surface and one waterline. The angle should be the same for the second waterline.

Once the extrusions are in place and the core is set straight on the table, take out your long sanding bar and sand down the second side of the core. The technique is EXACTLY the same as on the first side.

TRAILING EDGE

You can rough out the removal of the trailing edge foam jig with a handsaw or a butcher knife. Cut the foam a little higher than the surface of the rest of the core, and then sand away the remainder with a sanding block, 36-grit followed by 80. You can use a short straightedge to make sure that you are shaping the foam correctly. Lay about 6 inches of the straight-edge chord wise from the TE forward - you shouldn't see any gaps or bumps, especially at the point where the trailing edge foam jig began. At the trailing edge the foam should taper to nothing right at the end of the skin from the first lay up.
Then use a straight edge and mark a line parallel to the TE, 3/8" forward of the TE. Use a wood rasp to carefully remove the foam on the TE aft of that line. Remove the foam until you are down to the micro slurry that you applied before the first skin. From one end of the winglet or the other, using a matte knife, carefully get under the peel ply and peel it off the trailing edge.

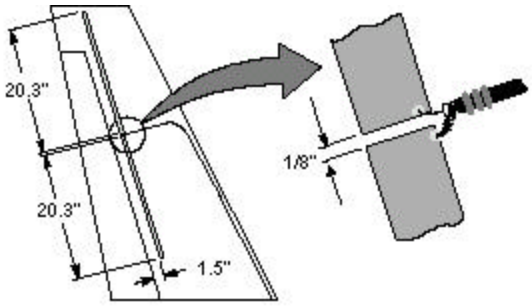
Use a sanding block with 80 grit sandpaper to bevel back the foam that now sits at the trailing edge - it should bevel up at about a 45 degree angle. At the same time, you can lightly sand the now-exposed surface of the TE glass, preparing it for a bond.

Then use a permanent marker to mark the foam the same way that you did for the first lay up - 2 diagonals, 2 horizontals, a vertical, and the rudder cut out.

COMM ANTENNA

OK, just to repeat, if you are installing one comm. antenna, don't do this to the first winglet, wait for the second. If you are installing two, we can do it now.

Use a felt tip marker to gently lay out the antenna on your foam following the drawing provided. The antenna strips themselves will be parallel to the rudder cut out and 1.5" forward of the cut line. A channel for the coaxial cable runs from the center of the antenna, 90 degrees to it, forward to the leading edge. It turns, with a radius of about



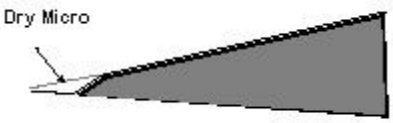
1.5", and runs downward just aft of the LE. When you have all the markings laid out, use your router or Dremel tool and rout a 1/8" channel for the co-ax cable. If you use a Dremel tool, use it at slow speed. If the bit is turning too fast it can melt the foam instead of cutting it. The result will be a growing ball of melted and solidified plastic on the end of your bit and a slowly widening channel.

Find the roll of RG58-AU coaxial cable we've provided. Strip 1 1/2" of the external insulator. Take the three torroid beads we've provided and slip them on to the cable - go ahead and let them slip a couple of feet down right now, we'll place them later. Gently shove back the braided shield wire, and then use a nail or a pencil to poke a hole through the braided strands. Slip the inner core - the white plastic insulation and the copper center wire – through the braided shield wire. Strip the last inch of the center insulation. Set the first bead 1/8" back from the end of the outer insulation; tack it in place with super glue. Leave a 1/8" gap, then place and tack the second bead, leave another 1/8" gap and tack the third. Look at the relationship between the end of the cable and the beads, and enlarge the appropriate area of the channel so the torroid beads will sit below the surface of the foam.
Unroll and cut 2 strips of copper foil tape off the roll provided – each should be exactly 20.3 inches long. That length will optimize the antenna for the middle of the com frequency range, a little longer or shorter will optimize the antenna for a lower or higher part of that range. Pull the backing, place the tape on the foam and rub it down in place. Press the torroid beads and the first few inches of cable into place. Solder the wire core to the upper tape and the braided shield to the lower one. A little foam will burn away from the soldering, that's all right, just press the tape and the wire down against the burned part - that will keep the wire under the surface as well. Finish pressing all the cable into the channel, starting at the antenna end and working toward the root LE.

THE SECOND SKIN

Cut UNI and BID cloth to the same dimensions as the first side. Mix up slurry and dry micro. Pack the dry micro in around the RG58 cable, especially in the well around the torroid beads. Slurry the winglet upper surface. Apply peel ply tape. NOT ALONG THE TRAILING EDGE, only around the rudder cut out. The laminate sequence is the same as on the first side - 2 full 30 degree plies, one short span wise ply, one ply of bid. Wrap all 4 plies over the leading edge. The first should lap over 2 full inches, the subsequent plies should step back 1/4 inch each, so the second only laps 1 3/4' inches, etc. Cover the whole structure with peel ply and let it cure.

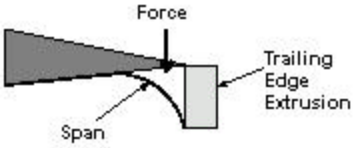
When the skin is cured and solid, but still chemically active, mix up some dry WEST micro and fill the depression in the glass-to-glass transition that you have formed along the TE.



VACUUM BAGGING

The technique for vacuum bagging for this side is very similar to the first, so we will only cover the differences here. You will have to seal the open ends of the aluminum extrusions with silver tape. If you don't, the vacuum will try to pull the plastic bag down into the extrusion, and it may rupture the bag.

Before you seal the bag, you must wrap a piece of caul plate material around the bleeder ply that laps over the leading edge. This material can be thin gauge aluminum or .010 Mylar - something stiff enough that it won't wrinkle, but flexible enough that it will wrap around the simple curve of the leading edge. This will prevent any wrinkles that might form in the bag from sucking up the skin, leaving a permanent ridge in the laminate.



Finally, you will have to be careful of spanners forming around the aluminum extrusions.

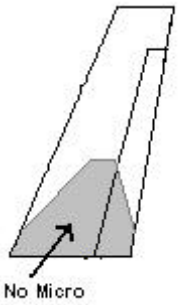
As the bag sucks down, carefully press the bag into the corners. The most crucial corner is the one just forward of the trailing edge on the bottom skin - if a spanner forms there it will try to pull the TE extrusion forward, and it will put a kink in the trailing edge.

REMOVING EXTRUSIONS

When the glass is thoroughly cured, take a knife or a spatula and work it under the extrusion at one end. Use a light hammer to gently drive the edge along the TE seam, separating the winglet from the extrusion. You can use the same technique at the ends of the LE extrusion, and then you can use a hammer to knock the extrusion off the bottom skin. Knock the extrusion AFT, to prevent denting the foam. If you want to do this the ultra-trick, too-cool way, set the root of the wing on something to put it a couple of inches higher than the tip end. Seal the tip end of the extrusion with duct tape and pour in a couple of cups of liquid nitrogen. That's right, liquid nitrogen. You may be able to find it at a welding supply store. If you choose to remove the extrusions this way, the liquid nitrogen will chill down the aluminum to -150 F or so, and the aluminum will shrink much more than the Bondo. Let it chill; give it a good whack with a hammer and it will pop off all at once. Not necessary, (in fact, probably a waste of time and money, and you need to be very VERY VERY careful in handling the liquid nitrogen, since it can burn your skin like acid if you spill it) but it's fun and we thought we'd let you know about it.

MICRO

If you decide you can't wait and have to apply micro now, read the section about applying micro to the wings. There are a couple of places you should avoid micro as you will bee applying BID to the winglet to attach it to the wing.



WINGS

"SO, YOU 'VE FINISHED YOUR WINGLETS AND YOU THINK YOU 'VE SURVIVED PRETTY WELL, EH? HA! YOU 'VE ONLY BEGUN TO BUILD. LOOK ON THIS AND QUAKE WITH FEAR, FOR NOW YOU MUST BUILD YOUR WINGS!!
HAHAHAHAHAHAHAHA !!!!!"

Chapter

2

WING

Right.

Everybody approaches building his or her wings with a little trepidation. Wings symbolize flight. When we get a pilot's license we don't talk about receiving our propellers or getting our canopies, we say we've earned our wings. But wings are really very simple structures, and there's no reason to be any more afraid of them than of, say, the landing gear or baggage door. We've developed some new methods for building foam core wings that should insure that your wings will come out straight, light and strong. We've given you videotape of the entire procedure and described the process here in great detail, but if there is anything you are not sure of, call us. We'll explain it to you and see if we need to amend these manuals so the question won't come up in the future. The steps in this section are similar to the ones you took in building your winglets, but there are some additions. You'll start by sanding down the cores - both sides this time. You'll make wooden jigs that will hold the wing in place while you work on it. You'll cut off the leading edge of the foam core sections, bond the sections together, and lay up the sheer web for the spar. You'll then bond the leading edges back on, lay up the spar caps and lay up the skins.

As with all the sections, you must read the entire section of the manuals and watch all the pertinent videotape before you start. We want you to be gear extended. Familiar with all the processes, and be free of any confusion, before you actually start working.

SAND DOWN

There are 4 sand down templates for the wing cores, labeled with their But line positions. The inboard template, B.L. 23, is only the aft portion of an airfoil. It goes on the inboard end of Foam Core 1 (FC1).

The B.L. 55.5 template is used for the outboard end of FC1 and the inboard end of FC2/FC3 B.L. 106.25 goes between FC2/FC4 and FC3/FC5, and B.L. 157 is the outboard end of FC3/FC5. Attach the appropriate templates to the right wing FC3. Assess the core. It's possible that it may be slightly bowed. If it isn't, proceed as usual: sand out the bottom side, flip the core over and put it in the other flashing, and sand out the top. If it is warped, set it in the flashing that it is warped AWAY from. That is, the middle of the core will be touching the flashing, and the two ends with their templates will be lifted up into the air slightly. Very gently sand the surface without pushing down too hard - you don't want to bend the foam as you are sanding it. When you are done with the first side, flip it over and put it in the second flashing. The second side will have a bulge in the center, but the core should sit closely against the flashing and be supported along its entire length. Sand out the second side. Then lift the core up and re-assess the first side again. It may have taken on another warp when you sanded away some of the foam and relieved the stress. If so, sand it down again. You will likely end up with

cores that are perfectly straight, but there is a small chance that you will get one side straight and one side minutely undercut.

Repeat the procedure on all the middle and inboard right wing cores.

Don't sand out your second wing cores until you are completely done with your first wing. It will probably take you at least a couple of weeks to get done with the first wing, and in that time your pristine left cores would be sitting around getting bumped and dented. Leave them in their flashings, protected, until you are ready to deal with them.

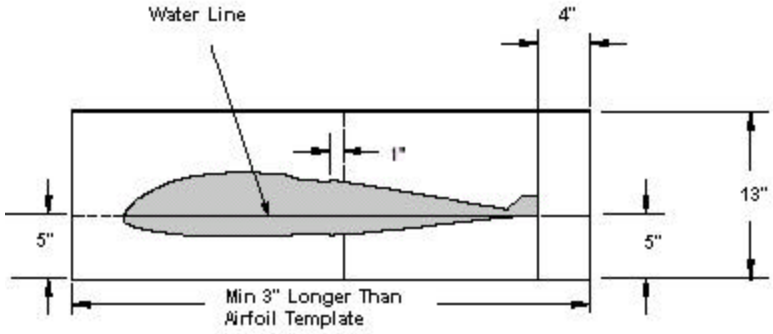
One more thing - don't dispose of your first wing flashings, either. You wont be working with all the cores at once, and putting them back in your flashings will keep them safe too.

WING JIGS

Before you start, make sure that you have assembled your components:

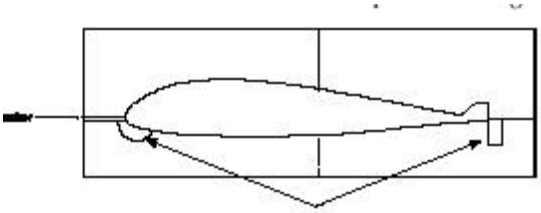
4 pieces of 1/2" A/C interior grade plywood
Make sure that all 4 pieces are true and square
13"x23" (B.L. 23 template)
13"x48" (B.L. 55.5)
13"x38" (B.L. 106.25)
13"x28" (B.L. 157)
32 1/4x20 1.5" bolts (hex head)
32 1/4x20 nuts and washers
32 pieces of 1/4" plywood, 2"x10"
4 pieces of 1/2" plywood, 10"x10"
8 pieces of aluminum angle stock, (brackets) 1/16"x3/4"x8"
Buy at any hardware store
50 1/2" self tapping screws or small wood screws
Super glue, aliphatic resin or epoxy
24 duplex (double headed) nails, smallest you can find, about 8p
6 2"x4" stamped sheet metal shelf braces (hardware store)

You will build three jigs (the BL 55.5, 106.25 and 157 jigs) exactly the same way - the B.L. 23 jig doesn't have a leading edge, so you will only be doing the aft portion of that one, and instructions for that will come at the end of this section. Refer to the drawing on the next page. Draw a horizontal level line, parallel to the bottom of the each sheet, 5" from the bottom. Draw a vertical line 90 degrees to the bottom 4" in from trailing edge. Set the appropriate template on each piece of wood, with the scribed waterline on the template aligned with the horizontal line on the wood, and the TE just on the vertical line. Trace around the template with a sharp pencil.



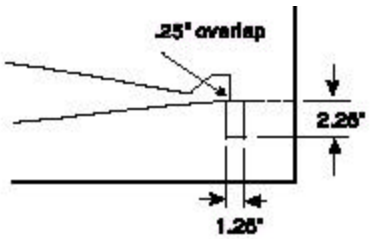
Then take a flexible ruler and place it along the top line. Bend it so it spans the spar cap trough, and have an assistant mark that line with a pencil.

Repeat on the bottom trough.



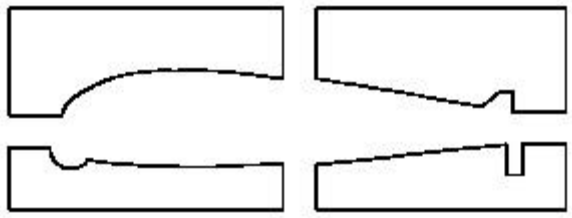
Mark a vertical line perpendicular to the waterline 1 inch aft of the spar cap troughs. Starting at the centerline leading edge, draw a line parallel to the bottom of the wood forward to the edge of the jig. This line will be close to the waterline, but won't quite match it. Add a round cut out at the leading edge there and trace around it.

as per the drawing - you can just set a cup
This will give you enough room to lap the edge without the jigs getting in the way.
square cut out below the trailing edge, overlapping the TE by .25".



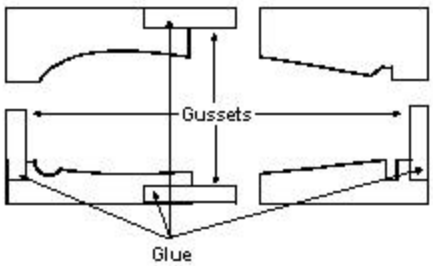
skins around the leading
You also need to add a 1.25"x2.25",

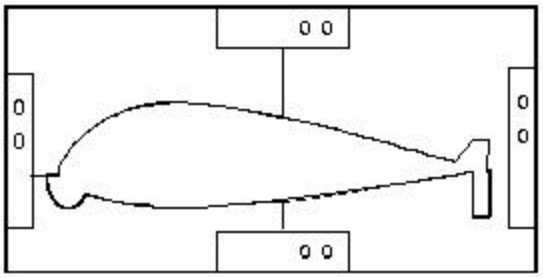
Then start up your bandsaw or saber saw and make the cuts shown.



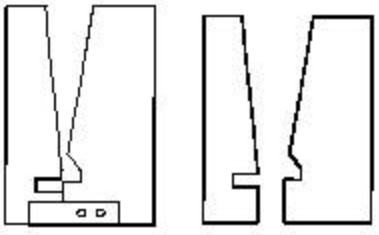
Cut in along the leading edge line, along the top line all the way to the trailing edge. When you get near the trailing edge scroll down toward the middle and exit straight along the waterline you drew to the trailing edge. With the plywood now split in half, cut out the airfoil of the template and the extra cut outs at the LE and TE. When you are done, cut along the vertical lines to separate the jig into 4 pieces.

Place the 4 pieces back in their original orientation on your table. Use a straight edge to align them. Place 4 .25" plywood attach gussets in the positions shown and apply glue between them in the appropriate places. Use the double headed nails to nail down both the gussets and the jig to the table. Then drill a pair of 1/4-inch holes, three inches apart, through each gusset at the unglued end and through the jig below. When the glue sets, remove the nails, turn the entire assembly over and glue and nail the second side.





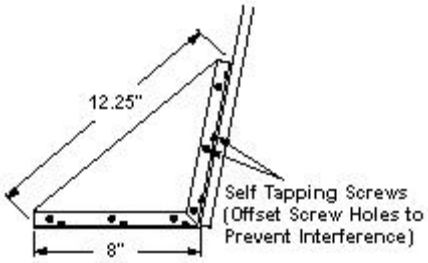
Once the glue is set, turn them back over re-assemble the 4 parts in their original orientation, and back drill the second gussets. Insert 1/4 20 bolts, slip on washers and thread on nuts. Your template is done. Repeat this process with the other 2 full airfoil templates.

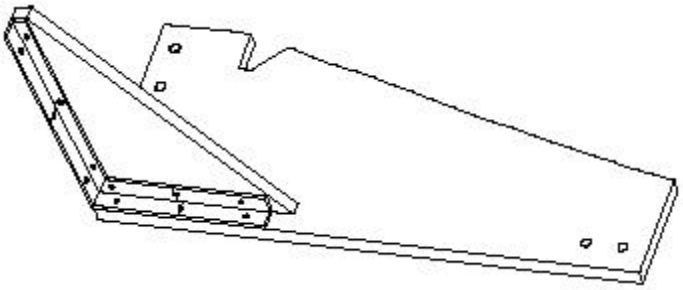


The B.L. 23 template is a little different. Because it doesn't have a leading edge, you can't just use a straight edge to make sure it's square. So, when you re-assemble the 2 halves measure the two ends to insure that they are parallel.

ANGLE BRACKETS

101.36 degrees. That's an important number. It's the angle at which your trailing edge meets the centerline of your airplane. And, right now, it's the angle at which your jigs will meet your table. They won't hold that angle by themselves, so you need to build 4 triangular braces that will hold them at just that angle.

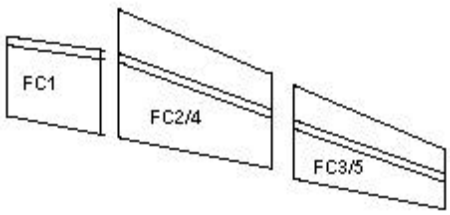




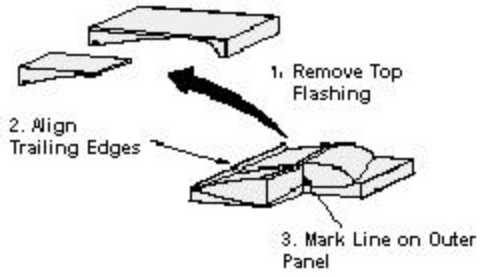
Fortunately, you don't need to generate that angle with a protractor; you already have a guide that will do that for you. It's your flashings. Set one flashing down on top of a piece of 10x10 (appox.) 1/2" plywood and mark the angle. Then cut out a triangle using that angle - the short legs should be about 8", the long leg about 12.25". Then take 2 pieces of your 3/4"x1/16 aluminum extrusion and drill three 1/8" holes in each side. Offset the holes at least 3/8" or so, then use the small self tapping screws to attach them to the plywood angle bracket. Use more screws to attach the brackets to the jigs, as shown.
Each brace will attach to the aft upper quadrant of the jig.

CUTTING OFF THE LEADING EDGES

Once you have the jigs ready, you need to cut off the leading edges of your middle and outboard foam cores. This will separate FC3/5 into FC3 and FC5 - the same will hold for FC2/4. There are 2 small aluminum triangles included with your A kit - these are templates that you will use to guide your hot wire as you cut off the LE's.

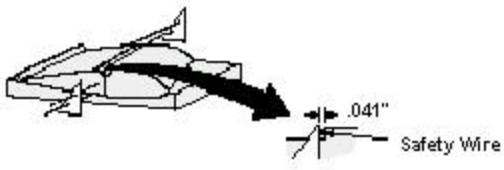


The procedure is simple - mark the foam, screw the template to the foam, position your hot-wire on top of the foam, turn on the current to the wire and cut down along the template. One thing that you may notice as you look at the cores in their flashings is that the waterline isn't level. That's on purpose. We slope the waterline so that the trailing edges come out in the middle of the foam block.

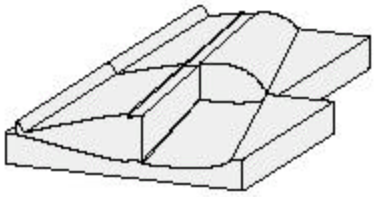


It gives you a straighter core but it means that the cut that you make won't be quite vertical. So don't be tempted to just use a carpenter's square - follow these directions. First, place the middle and inner cores - both still in their lower flashings, with the TE foam jig pointing UP, on the table. Set the inner core against the middle core so that the trailing edges match perfectly. Take a fine point felt tip marker and run a line down the inboard end of FC2/4 just along the forward face of FC1. This line should be just at the forward end of the spar cap trough of FC2/4. Place one of the aluminum templates against the inboard end of FC2/4just aft of the line - one short leg of the triangle flat against the table, and the other should just touch, but not cover the line you just drew.

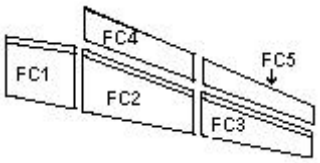
Screw it in place with drywall screws, making sure that the screws point away from where the wire will pass through the foam. Go to the outboard end of FC 2/4 and place the second aluminum template in the same orientation - just aft of the forward end of the spar cap trough. There should be just enough room between the template and the forward trough lip that the hot wire can slip between them. Screw it in place. Get an assistant if you can (this goes much easier if there are two people working) place the hot wire against the templates, turn on the power and slice through the foam.



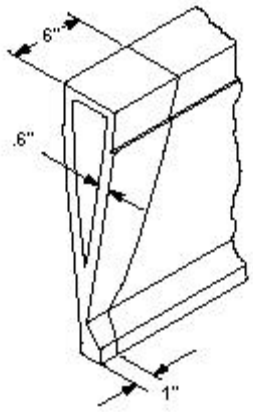
Once you've cut the middle section you need to do the same thing to the outboard core, but there is one small problem. If you look at the outboard core you'll see that there is a bond line that crosses the spar cap trough. Your hot-wire cut must pass though that bond line. Only, a hot-wire wont cut the mixture of epoxy and micro balloons that are used to bond the foam. So set the core on its end, big end down, and stand over it. Take your keyhole saw and poke through the core from bottom to top just barely forward of the spar cap trough, just outboard of where the bond line crosses the front of the spar cap trough. Since you are standing over the end of the core you'll be able to look down it's length and see exactly where you are cutting on both sides. Saw through the bond line so that the hot-wire will pass through easily as you cut the foam. If you have to error forward or aft, stay on the forward side.



Once you've cut the bond line, prep the core for the hot-wire cut. Use the aft portion of the middle core - now FC2, separated from FC4 - to mark the inboard end of FC3/5, place your templates, and cut.



You'll end up with 5 core segments, as in the illustration.



Take FC1 and cut off the inboard end, as shown in the illustration. Then cut out the interior of the inboard foam segment, leaving a shell of .6" all the way around. The easiest way to do this is with a band saw, but if you don't have one you can use your hot wire. You can start the cut by passing your saw or wire through the cut we made for the aileron torque tube. The .6" dimension is critical underneath the upper spar cap. The rest of the shell can vary by as much as .25". Save the plug, you'll need it.

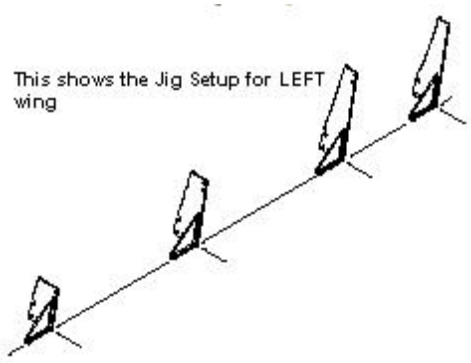
Set the main portion of FC1 back into it's flashing, mix Epolite 2183 micro and bond the shell back onto the rest of FC1 in its original orientation. Use drywall screws to hold it in place for a couple of hours (depending on temperature) while the micro cures.

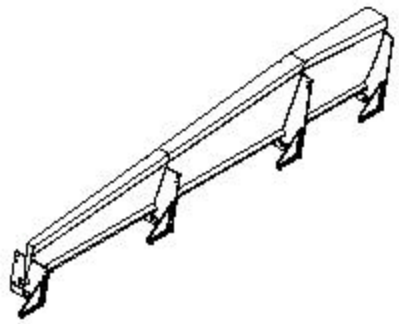
BONDING THE AFT SECTIONS.

Take your table off its sawhorses and set it on the floor. If your floor is uneven there will be gaps under the table, use tongue depressors to shim up those points and relieve any stress that might try to twist the table's surface

Draw a straight line down the length of your table right down the center. Separate all the jigs into their 4 sections, and set aside the forward quadrants of each - the B.L. 23 jig only has an aft section, so you won't have to worry about that one. Set the three aft foam core sections FC1 FC2 and FC3 along that line, each butted up against the next. Mark the table at the end of each foam block - 4 marks total. These marks will place your 4 jigs along the table.

So, place the upper aft quadrant of jig B.L. 23 as shown. The jig itself is perpendicular to the line on the table, and is just inside the line you made marking the inboard end of FC1. The edge of the jig - and thus the waterline that lines up the trailing edge - is right along the line on the table. Use self-tapping screws or wood screws to attach the angle brace to the table. Place the upper aft quadrants of the B.L. 55.5 and the B.L. 106.25 jigs the same way, except that the .5" thickness of the jig material should split the line on the table. The B.L. 157 jig goes just inside of its mark as well.



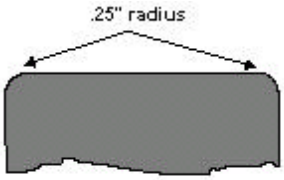


Gently place the FC1, 2 and 3 blocks in the upper aft jigs, as a trial fit. If you placed the jigs correctly on the table, you will see that the end jigs completely support the ends of FC1 and 3, and the middle two jigs both support the very ends of all three core sections. Bolt on the aft lower quadrants of the jigs. Examine the fit. If there is any gap between FC2 and 3 remove a little foam from the two faces to make them match. If there is a gap between FC1 and 2, remove foam from FC2 ONLY. The dimensions of the sheer web face of FC1 are critical, and you must not change them while making your foam cores fit.

This is another area where a picture is worth a thousand words, and the videotapes will help you immensely. Up to 1/16" gap between the foam blocks is acceptable, but you should try to make the gap as small as you possibly can. .

Once the blocks have been sanded to match one another, remove the aft lower portions of the jig, set FC2&3 on the table on their sheer web faces, trailing edges sticking up, and bond the two of them together. Refer to the chapter on bonding foam cores in the education section of the manuals, and review the videotape section if you have any questions about the basic method. We'll give you a quick checklist here - mix up Epolite and micro, smear a thin layer on both parts, run a generous bead down one face, squish the two sections together while you work them back and forth, then hold the assembly together with coarse drywall screws while the epoxy sets. In this case, you need to check and recheck that the cores are remaining straight. It's possible for the force exerted by the micro to bend the assembly. So check it several times with a straightedge along the sheer web face and along the TE. When it seems to be stable, and when micro has stopped oozing out of the joint, back off all the drywall screws by a half a turn or so. Keep an eye on the joints, if the assembly bends, tighten the screws on the outside of the bend to force the core back into shape.

Once FC2 and 3 are together, and held solidly with drywall screws, place them back on the table, sheer web face down. Set them on the table so that the inboard face of FC2 - the one where FC1 will attach - is at the end of the table. You may even want it to protrude a couple of inches. Get an assistant to hold FC2&3 down to the table so that they don't move. Prime the inboard end of FC2 and the outboard end of FC3, bond them together and run in drywall screws loosely. There should still be just a tiny bit of play in-between the cores. Gently lift the entire assembly and place it back in the jigs. Carefully check the fit of the cores in the upper aft sections of the jigs. This is your last chance to make sure that everything is straight. Check the TE for straightness with a long aluminum extrusion. Sight down the sheer web face, and look for any deviations. Once you are satisfied, bolt the lower aft sections of the jigs in place.



Let everything cure completely, then radius the edges of the sheer web .25" along the entire length.

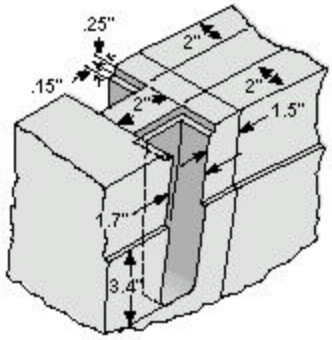
PREPARE WING MOUNT HARDWARE

There are 6 aluminum plates that you have to have ready for each wing. They are designated LWA (Large Wing Attach) points. These are cut out of the aluminum bar stock that's included with your A kit. The first 3, the 2 LWA 4's and the LWA 6, are made from 1/4-inch

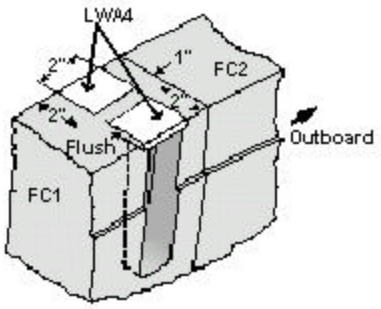
material. The LWA4's are 2"x2", the 6 is 2"x2.5" The second 3 are made of 1/8" stock. The LWA 2 is 2"x2.5", the LWA 3 is 2"x6.5" and the LWA 7 is 2"x1.75".

All are made from 2024 T3 aluminum, and all burrs and sharp corners should be removed. You need to radius the edges where fabric will be wrapping around the aluminum. Radius one of the 2" edges of the LWA4's, the LWA2, and the LWA6. Radius both 2" edges of the LWA3. Radius one of the 2" edges of LWA7. The radius should be the same as the thickness of the material - 1/4" radius for the thicker material, 1/8" for the thinner. Clean them with lacquer thinner to remove dirt and oils, and put them where they won't become contaminated.

PREPARE WING MOUNTING POINTS

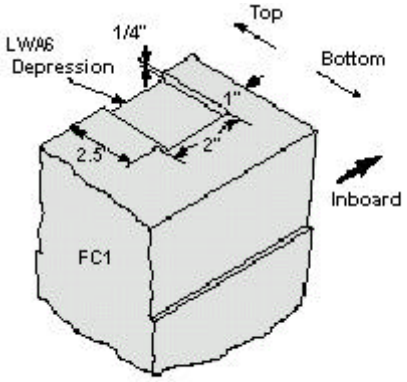


After the micro-joints have hardened, lay out the bolt access depressions with a fine point felt tip marker. There are two ports just inboard of the B.L. 55.5 joint. The illustration will give you the dimensions for their placement. Lay them out with felt tip pen, and then use a rotary file in a Dremel or drill to carve out the majority of the foam. There are 2x2" depressions, 1/4" deep, exactly 1" inboard from the B.L. 55.5 joint. The "floor" of the trough section is perpendicular to the sheer-web face for both the top and bottom access ports, but the slope is much steeper on the topside of the wing than on the bottom. So, at the aft end of the depression, the trough on the top skin will be about 1.3" deep, and the trough on the bottom will be 1.75" deep. Use 80-grit sandpaper to smooth out the foam when you are done with the major carving.



Then carefully fit the LWA4 aluminum plates in their depressions. The outside edge of each plate should be rounded to a 1/4" radius.

Then go to the inboard end of FC1 and carve in the depression for the
LWA6 plate. It's 1" outboard of B.L. 23, 2" wide and 2.5" tall. Again, carve it out, fit the .25" thick aluminum LWA6 plate, and radius the outside edge.



From the center of the LWA6 to the center of the upper LWA4 plate it should measure 28.84 inches.

Once you're done with the hard points there are two final pieces of aluminum you will have to fabricate - the W18 plates. These are made out of .016" 2024T3 aluminum. You don't have to dig the foam away so that these fit flush. Instead, they are simply pressed into the foam for a plush fit.

So, you have one LWA6, two LWA4's and two W18's. The LWA's have all had one of their 2" edges rounded with a radius of 1/4 inch. Put on a pair of latex gloves and sand the LWA's thoroughly with 80-grit sandpaper. Try to get off every bit of surface oxide that you can. When you are done they should be bright and silvery on both surfaces. Be careful as you do that you keep wearing gloves. If you touch the aluminum after you sand it you will contaminate it with body oil, weakening the epoxy bond that will attach the aluminum to the fiberglass that follows. Bond all three of them in position with 5-minute epoxy. Cut 2 pieces of bias bid, mix up a little WEST slurry, and slurry the inside of the well. Fit the first piece inside the well so that the front edge just buts up against the inside of the LWA4. Poke the rest of the bid down into the well and work it until it conforms to the inside of the well. Wet it out with WEST. Trim it so that it sticks up above the surface of the foam by 1/4 inch or so. Repeat with the second patch of bid, and on the second LWA4. Let the WEST set until it's semi-cured, then trim the glass back just below the surface of the foam. You have to be sure that the glass ends 1/16" below the surface in the area of the spar cap trough, because you will press the W18's into the foam that much for a flush fit.

Press the two W18's in place, bond them there with 5-minute epoxy. Then take your LWA3, the long and skinny 1/8" piece. Place it over the LWA4's, so that the radiused edges stick out over the spar cap trough. You'll note that, because the wing tapers, the edges don't quite parallel the foam. Use a file to dress down the edges to match the taper. It should extend .4" beyond the foam on the top and .3" on the bottom. You are only doing this to make sure that the LWA3 is the right size and shape - you won't really be installing it until much later.

OPTIONAL JIGGING

When you are done with the aluminum, examine the wing core. If you have placed the trailing edge jig cuts on a straight line, the trailing edge should be straight. That should make the sheer web and spar caps straight as well, but there is a possibility that there may still be some warp in the foam. Look down the face of the sheer web, and examine it for deviations. There may be a slight deviation where you sawed through the bond line in the outer foam core - if so, correct it now. If it's a bump, sand it down carefully, so as not to dish out the foam on either side of the bond line. If it's a depression, fill it with dry micro just prior to glassing the sheer web.

If there is any deviation of the foam cores to the left or right between the jigs, you can place extrusions along the tops of the jigs to straighten the foam while the sheer web cures. (This is why you cut your jigs off 1" behind the spar cap troughs - now you have room to place the extrusions.) You can use 1x2" aluminum extrusion or Doug fir. The aluminum is probably cheaper and easier to find. and you'll need a piece to hold the trailing edge straight for the top skin lay-up anyway. Place the

extrusions on both sides of the core, setting on top of the outboard three jigs. Mark the positions of the jigs on the bottom of the aluminum, drill the aluminum and drywall-screw it to the tops of the jigs. You should probably drill pilot holes in the wood as well, to make sure that the wood doesn't split when you screw into it. If the aluminum is pressed in tightly against the foam when you screw it to the wood it will hold the foam straight while you lay up the sheer web.

Once the sheer web cures, the web itself will hold the wing straight while you apply the spar cap and the skins.

LEADING EDGE PREP (OPTIONAL)

If you are using the optional hard points (tie down points) you need to relieve the aft face of the LE cores to accommodate the tie down plate. Set the plate on the sheer web face so that it straddles the B.L. 106.25 jig, with the tapped holes pointed toward the bottom skin and sitting flush with where the skin will be. Set FC 3 and 5 in their places, and use a felt tip marker to mark on the outboard end of 3 and the inboard end of 5 where the tie down impinges. Remove that foam with a rotary file. Try not to remove too much -you just want to get rid of enough that the foam will clear the tie down.

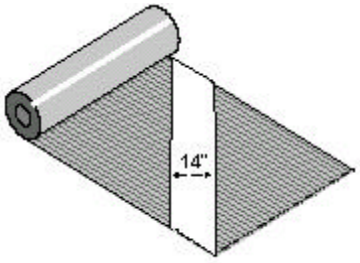
Chapter 3

SHEAR WEB LAY-UP

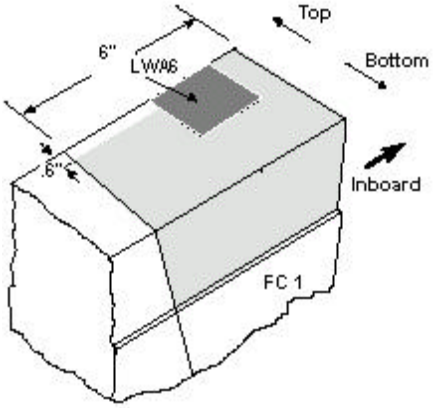
Before we start, be aware that this lay-up is big. Really, earth shatteringly enormous. Australia is nothing compared to this lay up. The mortal mind boggles and gasps at how truly amazingly large this lay up is. If the entire planet were a pea, this lay-up would still be really, really big.

Actually it's not that bad.

But count on it taking the better part of a day to do. Make all the necessary preparations, lay in food in the 'fridge, get your workspace warmed up, and make a pit stop. This is one that you cannot stop in the middle of.



Roll out your roll of UNI cloth and cut 16 strips of cloth, 14" wide, on a 45-degree angle, roll them up and set them aside. Take a tape measure and measure the length of the spar cap trough. Use a red sharpie marker to divide the length into quarters, 35" to each section. Then use an adjustable square to draw lines at 45 degrees across the sheer web face at each division mark. 8 diagonals total, one each slanting left and right at each 35" division mark. If you're confused, check out the videotape again. If there are any drywall screws in the core left over from your bonding of the TE's, remove them now. Make sure that your pump is still filled with the 2187 hardener that you used for your winglets. This is the slow hardener, with a pot life of 3 hours or so. It will give you plenty of time to work with the glass before it starts to set. Even so, don't let any 2187 mix sit for more than a half hour or so before you use it. If it's more than 30 minutes old, toss it out. Mix up a fairly large batch of Epolite slurry and slurry the sheer web face and the bottom of the spar cap troughs down the entire length of the aft section of the wing, from inboard end to outboard end.



Go to the inboard end, where you re-attached the .6" thick shell. Cover the sheer web face of that shell with peel ply, except for the LW6A aluminum plate and a .6-inch strip from the LWA6 to the outboard end of the shell, along the topside of the sheer web face. Also cover the entire first 6 inches of the bottom spar cap trough and the first inboard inch of the upper spar cap trough with peel ply.

This section differs from the videotapes.

Paul Lampasso (NY) has found a better, faster, easier way to complete the shear web face lay-up on his main wing. He tells me this method was described to him by professional aircraft composite builder Ken Miller.

The method involves laying out the 16 pieces of UNI fiberglass on an aluminum foil template then inverting the whole affair onto the shear web face of the main wing.

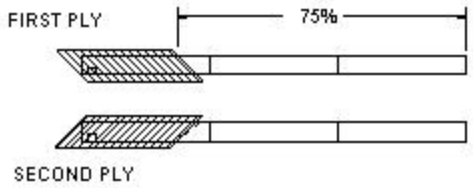
It may sound bass awkward, but according to Paul it works great.

Materials

Heavy-duty aluminum foil (like the type used for barbecue grills)

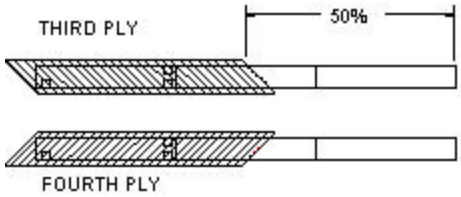
Method

1. Lay out a 12-foot length of aluminum foil on your jig table (fig. 2).
2. Draw two parallel line 14 inches apart down the center of the aluminum foil using a Sharpie ink marker.
3. Make 45 degree cross marks between marked parallel lines on the aluminum foil 35 inches apart. These are the same cross hatch markings made on the shear web face described in the videotape.
4. Slurry the shear web face of your wing with epoxy before proceeding with the fiberglass lay-up on the aluminum foil.
5. Proceed to lay down your individual pieces of UNI fiberglass cloth on the aluminum foil and wet with epoxy just as you would have done to the shear web face by the process described in the video, but working backward.



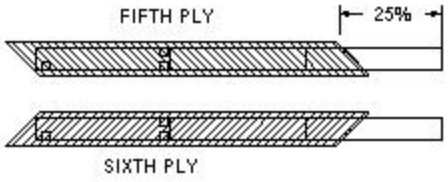
Take one of your 14" wide pieces and lay it down on one end of the aluminum foil. It should parallel the diagonal you drew. Wet it out thoroughly with Epolite. When you've finished with the first piece of the first ply apply your second. The inboard, diagonal edge of the first piece should butt up to the outboard, diagonal edge of the second, they shouldn't overlap. The 1st and second plies end 35 inches from the inboard end.

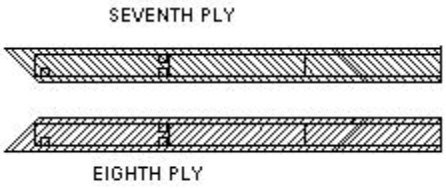
The first ply is the hardest one to do - subsequent plies will be easier to move around after you have laid them down. . The second ply starts at the same point as the first - overlapping the outboard end. But it slants the opposite direction. Again, butt the ends, don't overlap them. You will be able to use a little less resin on the second ply, because you can draw up some from the first ply with stippling and the careful use of a heat gun or blow dryer. Don't overheat the part, just warm it gently. If it feels at all hot to the touch, you've heated it too much, don't use heat on that spot again.



The 3rd and 4th plies end 70" in from the end, exactly in the middle of the wing.

The 5th and 6th plies end 35" in from the outboard end. Use the diagonal marks you made earlier to place and orient the cloth strips.





The 7th and 8th plies cover the entire length of the foil. By this time, you should be sparing in your use of resin, drawing up as much as you can from the previous layers.

6. Take care to squeegee out air bubbles between the layers of UNI cloth.
7.**WARNING: The only way you can seriously screw up this technique is to place the wrong side of the fiberglass down on the shear web face. The full-length layer should be against the foam.**
8. Line up the middle and end marks on the aluminum foil/ UNI cloth sandwich with the shear web face and place the fiberglass lay-up on top starting at the middle of the shear web.
9. Firmly but gently push down the fiberglass lay up onto the shear web face and work out air bubbles toward each end. Gently tease back the aluminum foil from the shear web taking care not to disrupt the orientation or position of the fiberglass cloth. Very gently use the heat gun to remove any air bubbles.
10. The UNI fiberglass should maintain the desired 45-degree orientation along the sides of the shear web as you squeegee the fiberglass cloth in place.
11. While the resin is still wet, cover the spar cap areas with peel ply. This will make it easier to sand the glass in preparation for the spar cap lay-up, coming up soon.

Congratulations! Your shear web lay up is now complete and in much less time than the original method.

On the second wing, I got adventurous (cocky) and figured that this vacuum bagging was a cinch. Since I pre-make the vacuum bag and slip it on over the part like a sock, I decided to vacuum bag the shear web. I used some cord stretched across the jig table as a clothesline to hang the bag. Once I had the fiberglass and the epoxy on the shear web, I separated the end wing jig support and slipped the pre-formed bag over the end of the wing. To make sure that the plastic bag was pulling up snug to the bottom of the wing, I held the bag up using clothes line spring pins attached together with rubber bands. Once I had the bag fully pulled over the end section of the wing, the end jig went back in place and the next jig was disassembled. That allowed the bag to be pulled over the next section. Finally, with the bag totally covering the wing, I sealed it and started the vacuum. After comparing weights of wings, it looks like the vacuum bagging of the shear web saved about three pounds on the wing. You judge whether the effort was worth it.

Bill Haas

FURTHER WING ATTACH HARD POINT INSTALLATION

You did the first hard point installation before you did the sheer web, but this second installation will trap the sheer web between hard aluminum plates, and distribute the wing loading evenly into the composite structure. Sand the surfaces of the LWA3 thoroughly, removing all surface oxides. Cut 3 patches of bid 4" by 6.5", 3 patches 4"x4". Lay up the larger ones over the LWA 4's. Trim the first 2 plies just to the edge of the sheer web face; let the third one stick out 1/4" over the spar cap troughs. Take two finishing nails and press them through the glass and into the foam, 1" in from the spar cap troughs, just along the inboard edge of the LWA4's. Brush epoxy over the inside face of the LWA3, and run a small bead of flox down the center. Set the LWA3 in place, letting the radiused edges hang out over the spar cap trough area - .4" over the upper trough, and .3" over the lower one. The finishing nails will keep the LWA3 from sliding down the slope of the sheer web face toward the inboard end. Use a brush to stick the bid down to the inside face of the aluminum. The bid will keep the carbon spar cap tape from making contact with the aluminum, and prevent the galvanic corrosion that can occur where such contact takes place. Then place the smaller patches of bid over the LWA 6. Again, trim the first 2 patches flush with the corner, and let the third ply extend into space. Set the LWA 2 in place on top of the pad of bid, it's radiused edge extending about .1" out over the spar cap trough. Again, push 2 finishing nails in along the inboard edge of LWA6, through the sheer web face.

Once the two plates are placed accurately put a 10 lb. weight on the center of LWA2 and a 5 lb. weight on the center of LWA3, to compress the laminate beneath them and make sure that there is no air trapped under the aluminum plate. When the lay up is semi-cured, knife trim the third plies of bid back to the edges of the LWA 2 and 3 where they hang off the foam over the spar cap trough.

OPTIONAL HARD POINTS (TIE DOWN POINTS)

If you purchased the optional hard point set up, you received in your kit two metal pieces. Each one consists of two steel bushings, tapped to 1/4"-28, welded to a steel plate 3.5" x 3", cad plated. There will be a number of holes drilled in the steel plate - these aren't there to remove weight, but rather to form the "flox rivets" that will attach the plate firmly to the sheer web. The sheer web lay-up was long and difficult, but if you can it's much easier to do both this operation and the reinstallation of the LE's with a chemical bond. Since you used 2187 for the sheer web (you did, didn't you?) the surface will certainly be chemically active the next morning, unless it's been curing at more than 100 degrees F. So, sand the back, flat side of the steel plate. The sanding will also provide some tooth for the epoxy to hang on to. Place the plate in the same place it was earlier, straddling the B.L. 106.25 jig, threaded openings toward and even with the bottom skin. Place the LE's - FC3 & 5 - in place. Readjust the hard point so that the threaded face is just flush with the foam surface. Mark the perimeter of the hard point with a felt tip. Remove it and the LE's. Stuff the hole with tissue paper or a pencil eraser so it won't fill with epoxy, and can be cleaned out later.

Cut 2 patches of bid, about 5x5. Mix up some Epolite, '83, or and mix some of it into flox. (If you are trying to hurry things along, you can do this entire operation with WEST.) Paint the area with fresh epoxy, and then smear it with flox. Set the hard point in place, using your felt-tip mark to align its depth. Pack more flox in the area between the two bushings, into the holes, to form "rivets" of flox to hold the whole thing in place. Then apply the 2 plies of bid over the entire hard point, wet them out, and stipple them down. After you are done with skinning the wing you will be able to find the hard points with a magnet or by tapping, and you can use a small drill and a countersink to clear them out.

RE-ATTACHING THE LEADING EDGE.

If you are rolling right along with this, you can re-attach the leading edges immediately after you are done with the hard-points. If you let the sheer web completely cure, on the other hand, you should lightly sand the face of the sheer web to get a good bond. The technique is the same one you used to bond the aft sections of foam together - mix up Epolite 2183 micro, prime the surfaces to be bonded - in this case, the sheer web and the aft faces of the foam leading edges. Trowel on a wedge of micro, place the parts, work them together and hold them in place with drywall screws. Just note a couple of things:

1: Remove the peel ply on the spar cap troughs, and sand them. Use 36-grit sandpaper, and be sure that you remove all the gloss of the fiberglass on the bottom of the spar cap trough. You need to get a good bond between the spar cap carbon and the fiberglass that forms the sheer web, and the only way to do that is to sand the glass. Since you peel plied the troughs the sanding should go quickly. It's much easier to sand the troughs before you reattach the LE's than after.

2: Sand the sheer web face of FC1. You will be bonding several things to the sheer web face of FC1, and lapping the wing skins over the face in this area. So remove the peel ply, sand it out and remove the gloss.

3: Don't sand the rest of the sheer web face if you can still do a chemical bond. If the sheer web has fully cured, sand it lightly. The bond that you get, even to cured and unsanded glass, is better than you would ever get to the foam.

4: You'll use drywall screws to hold the LE cores together, just like you did to bond the TE sections together. But to bond them to the TE you will run screws through the top and bottom surfaces of the LE cores back through the glass face of the sheer web.

5: After you place the LE's, re-attach the forward section of the outboard three jigs. Of course, you'll have to remove the aluminum extrusions first. But adding the front part of the jigs will make sure that the LE's are held in exactly the right place while the micro joints cure.

As always, fit the foam together before you start to bond it to be sure that the bond lines are as thin as possible, no more than 1/8 of an inch. There may be some damage to the outboard core where you had to cut through the previous bond line with the saw blade, if so, repair it before you proceed. Also, since you have some micro handy, run a piece of masking tape on either side of the cut along the bottom skin of FC5, the LE of the outer section. This cut is where the hot wire went into the core

when we cut out the conduit tube. Then run a little smear of micro down the cut and remove the excess by pulling off the tape leaving a little inside the cut to harden. This will keep the core from squeezing the cut shut during vacuum bagging. This is different from the videotape.

Once the epoxy has cured you can remove the drywall screws. The ones that go through the glass sheer web may be a little tough, be careful removing them. If you end up damaging the foam as you remove them, it's OK; you can repair it with micro just prior to skinning the wing.

RE-JIGGING THE WING FOR THE BOTTOM SURFACE

Chapter 4

Now you have a finished wing core, ready for the spar caps and skins.
This is a major milestone. Now you will re-jig the core horizontally, getting ready to lay up the lower spar cap and skin. Unscrew the angle brackets from your table. Set the wing core, in its jigs, flat on the table with its bottom side facing up. Center it on the table, so that it's easy to get to from both sides. The upper aft quad will still have the angle brace attached, and of course on the B.L. 23 jig there is no forward quad. The angle brace should keep them from falling over. Just as with the first jigging operation, the inboard and outboard jigs should be flush with their respective ends, and the mid-span jigs should run just along the bond lines in-between the major core sections. Once the jigs are positioned properly, use more short, self-tapping screws to attach the 2 shelf braces to each of the outboard jigs, and use long drywall screws to screw straight down through the angle braces into the table. If you want to you can use another shelf brace on each of the inboard jigs. This should give your wing core a totally secure bed, one that will hold the wing in exactly the proper twist while the spar cap and skin is laid up, as well as provide a secure cradle in which you can sand and surface your wings.

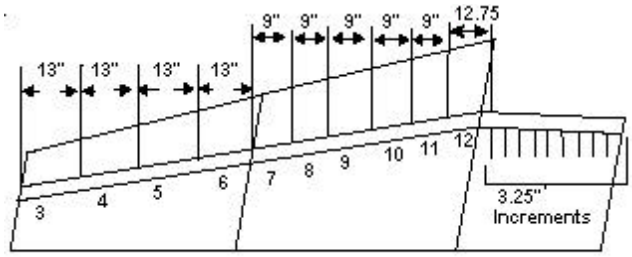
BOTTOM SPAR CAP PREPARATION

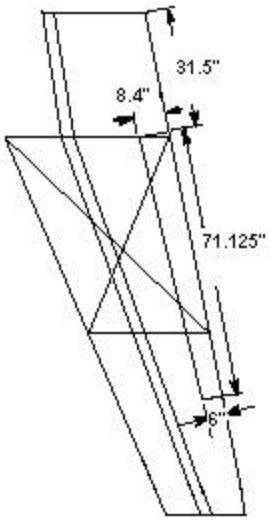
In a box in your A kit you will find 200 yards of 3" wide carbon fiber spar cap tape. This stuff is very strong, much stronger than the fiberglass that it replaces, and like all carbon fiber it is very expensive. One more time, don't handle your roll of carbon fiber with epoxy on your hands. In order to avoid such an eventuality, we are going to give you a table for cutting the spar cap tape to pre-determined lengths before you start laying up the laminate. We didn't do it that way on the videotape, we know, but remember, follow the written manuals. They are much easier than the tape for us to revise, so the latest and best information is always found here. Measure the total length of your lower spar cap trough. It should be 140", to within 1", if it's off, adjust the measurements below. If it's off by more than 1", check everything, because something may be wrong. If you can't figure it out, call us. If you just missed a measurement somewhere, cut the second wing to match when you build it.
Cut 12 lengths of carbon tape. In order of application, they are

1: 140" 7: 75"
2: 140" 8: 62.75"
3: 140" 9: 50.5"
4: 123.75" 10: 38.25"
5: 107".5 11: 26"
6: 91.25" 12: 13.75"

These measurements aren't critical; if you're off .5" it doesn't matter. The real reason you are cutting them to length is so that you don't run out of tape before you're done. Label the tapes you cut in a non-contaminating manner - that means no Post It notes, no masking tape, and no writing directly on the carbon. The best way is to write on a slip of scrap paper and pin the paper to the carbon

Then go to the inboard end of the core and use a marker to mark 3.25 increments just to the side of the spar cap trough, starting at the outboard end of the core. There should be 9 marks total, and the distance from the 9th mark to the B.L. 55.5 should be 3.75". Go to the outboard end and mark as illustrated - four 13" segments, then five 9" segments.

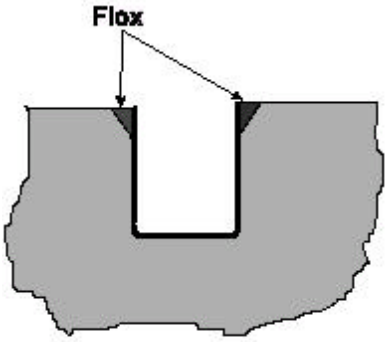




Once the spar cap increments are marked, lay out the ailerons per the drawing. NOTE: both the spar cap sequence and the aileron dimensions are different for the top and bottom skin. We will give you the top dimensions when you do the top skin; these dimensions are for the bottoms. The sides of the ailerons are at 90 degrees to the trailing edge, so use a carpenter's square to help draw them. The most critical dimension is the forward inboard corner. It must be exactly on the B.L. 55.5 joint, even if that means fudging the 31.5" measurement inboard of the aileron by 1/8" or so. Also mark a pair of diagonal lines across FC2/3, from the TE of B.L. 55.5 to the LE of B.L. 106.25 and vice-versa. These diagonals will help you visualize the proper grain- orientation when you lay down your carbon wing skins.

Find a piece of pasteboard or cardboard scrap, at least 12x110". If you can't find a single piece that long, it's OK to splice a couple of pieces with tape or glue. Lay it along the trailing edge, up to the inboard aft corner, and mark it where your aileron cuts start. Cut forward at those points 8.4" and 6" respectively, and then across. Lay it back down on the TE, and you should have a perfect template for your aileron cutouts.

Mark the template so it doesn't get accidentally discarded, and store it away safely. Later on we will use it to re-mark the aileron - you won't be able to see the old marks through the carbon fiber. When you lay out the second wing core you can flip the template over to mark the aileron. Run a piece of masking tape down the centerline of the leading edge, just like on the winglet.



Finally, take your Dremel, with a small, fine nib, and rout a small, triangular channel out around the bolt access wells. This is going to form a flox corner, so if you don't remember the concept, check the education section.

SPAR CAP AND SKIN LAY-UP

The next lay-up is big, though not as big as the sheer web lay-up. In fact, it's all-downhill from here; the sheer web is the hardest lay-up you will have to do on the airplane. But, like the sheer web, you must not stop in the middle of the lay up. This is doubly important if you are vacuum bagging the structure, and being generous with resin. So be prepared for it. Reserve an entire day. Put lunch, and maybe even dinner, in the refrigerator. Make sure that you have enough supplies for the entire lay-up, like brushes and squeegees (as you may have learned by now, you can never have too many brushes and squeegees.) Recruit a couple of volunteers to help hold the wing skin uni carbon while you lay it down and cut it. And get an early start - it's much easier to work at 11 in the morning than 11 at night.

Try to pick a warm day - you will need to maintain at least 67 degrees, and preferably about 74 degrees, throughout the lay-up. At the same time, you should try to work in a well-ventilated area. If it's 32 degrees outside, these two goals will be mutually exclusive. Fill your epoxy pump (with 2187 hardener) and put it in its enclosure the night before to get it nice and warm.

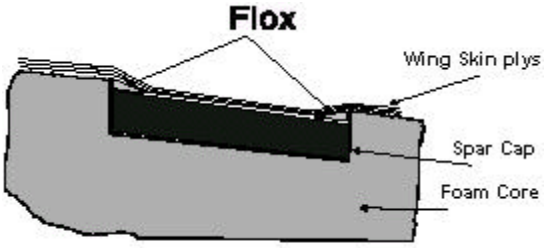
Mix a large batch - 15 to 20 shots - of '87 EZ-Poxy. Brush it on the thoroughly sanded fiberglass in the bottom of the lower spar cap trough. Fill the groove between the radiused corner of the sheer web and the leading edge with flox. Grab your first pre-cut piece of carbon tape, one of the 140" pieces. Take one end while your volunteer takes the other. Pull the tape taut several times to make sure that all the fibers are straight. Don't be afraid to really pull on the tape - you won't break it. If you do, something is terribly wrong with the laws of nature and it's better that we find out here. Start at the outboard end and gently place it into the spar cap trough. Work the fibers to get the tape to remain flat as it bends around the B.L. 55.5 point. Pour some resin down the length of the tape, and work the resin with a squeegee until the entire tape is wetted. It's very difficult to see if carbon fiber is wet, the only thing that you can look for is a change in how shiny the fabric is. But if the surface looks wet, and you can squeegee resin across it without any more being absorbed, it's wet. You can also listen to it as you squeegee - bubbles of trapped air will make a little sound as you pass over them, like a bowl of Rice Crispies in low fat milk.

Apply and wet out the second and third 140" tapes. Then take the #4 tape, the one that's 123.75 inches. Start it at the first outboard mark, 13" in from the end of the wing, and lay it up. It should stop at the first inboard mark, 3.25" in from the inboard end. Continue with the process. Each subsequent ply moves in one mark at the outboard end, and should just come to the matching mark on the inboard end. If your ply misses the inboard mark by an inch, it doesn't matter; the important thing is that they keep tapering shorter and shorter with every layer.

It is ***very important*** that you don't overfill the spar cap trough!!

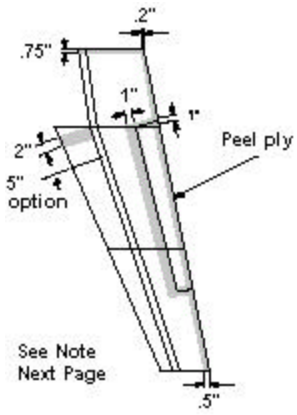
With the lengths that we give you should end up under filling it slightly, but there are variables in the foam that may result in a shallower than normal trough. If it looks like you are overfilling the trough

cut the tapes shorter, so they just reach the surface of the foam. If you have to leave **out a couple of layers of tape that's OK**



As the laminate gets thicker, you will find that you are able to draw resin up from the layers underneath, especially if you gently warm the area. Go ahead and do so, but be careful - the last thing you want to do at this point is burn your foam with the heat gun.
After the final, 13.75" ply goes into place, mix up some flox. It's likely that some areas (perhaps even most areas, depending on how vigorously you squeegeed) will end up below the level of the surface foam. Use your gloved finger to smear a fillet of flox in those areas. This will allow the carbon skins to make a gentle transition from the level of the foam to the level of the spar cap, maintaining maximum strength as they do.
You will also need to pack the groove around the bolt access well for the flox corner. Use a tongue depressor, and pack the flox in firmly, so there is no air trapped underneath it. Run a flox fillet around the LWA 3 and on the two long sides of LWA2, to make a transition. Then paint the aluminum with epoxy and lay up one ply of bid over each that entirely covers the aluminum.

WING SKIN



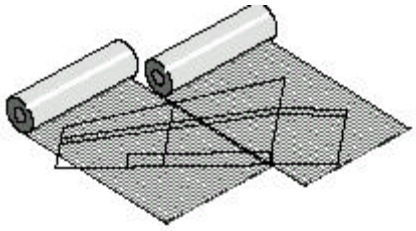
Mix up a fairly large batch of EZ-Poxy/micro slurry and slurry the entire wing skin. Don't get any slurry on your spar cap. Then apply peel ply in the areas indicated. It's .5" wide along the TE from tip to B.L. 55.5, and then tapers to .2". The aileron side cut lines are covered with 1" tape at each end, centered on the line; the forward cut line gets a 1" tape forward of the line. The inboard end gets a .75" tape, but it doesn't overlap the TE tape that's .2" at the TE inboard corner.

The 5" peel ply option along the leading edge is for a landing light. Your fuselage will come with a depression molded in, allowing you to place a landing light below the pilot's thigh support. That's where landing lights are on hundreds of Long-EZ's. If you must have more light you can put one or two in the wings. WE DO NOT RECOMMEND IT. If you chose to do so anyway, peel ply a 5" wide area of the leading edge instead of the standard two-inch. In either case,

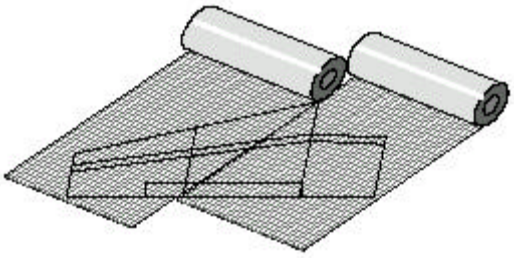
The outer edge of the peel ply will be 90 degrees from forward face of the inboard sheer web from the point where the spar cap crosses B.L. 55.5. (A lot of builders have interpreted the preceding drawing wrong. The peel ply is 90 degrees to the inboard spar cap, not the outboard length. Look at the drawing at the end of the section, where this section is cut away, if you are confused)

(This will be the only suggestion we make toward this landing light configuration. We will fully support the belly light, but for this one you're on your own.) Once all the peel ply is in place, call out your carbon sherpas to hold the roll while you lay the fabric out and cut it off What are we careful of? That's right.

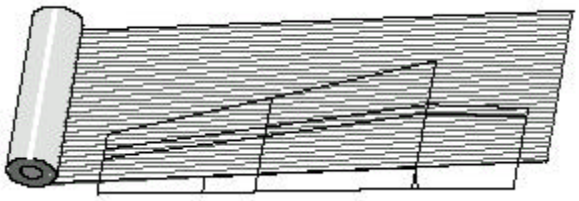
Don't contaminate the roll of carbon fiber with epoxy!!



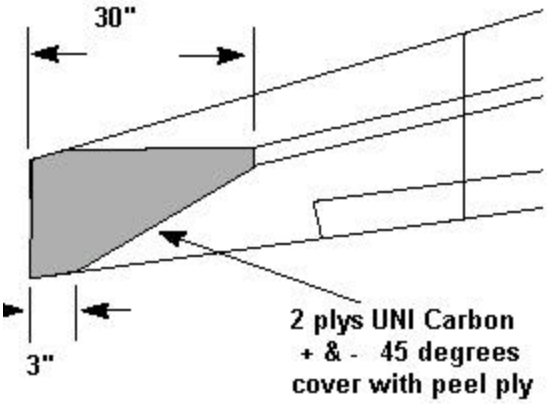
The first ply of carbon goes at a 30-degree angle to the centerline of the wing, along the diagonal you drew across FC2/3. The drawing is based on 50-inch wide fabric - the fabric you receive as part of your kit may be narrower. If it is, don't worry. We try to keep our price as low as possible, and finding the best price on carbon fiber fabric sometimes means that we purchase rolls in different widths. The important thin is the orientation - right along that diagonal line. Trim it 1 to 2" below the masking tape on the LE and to within .25 of the LE, root and tip. Let the skin lap 4" down the LE face of FC1. Wet out the ply carefully - it's better to be a little wet than a little dry, especially in the first ply down. You'll see the same condition with the skin that you saw in the spar cap - the carbon is very easy to wet out, much easier than the glass you used for your winglets.



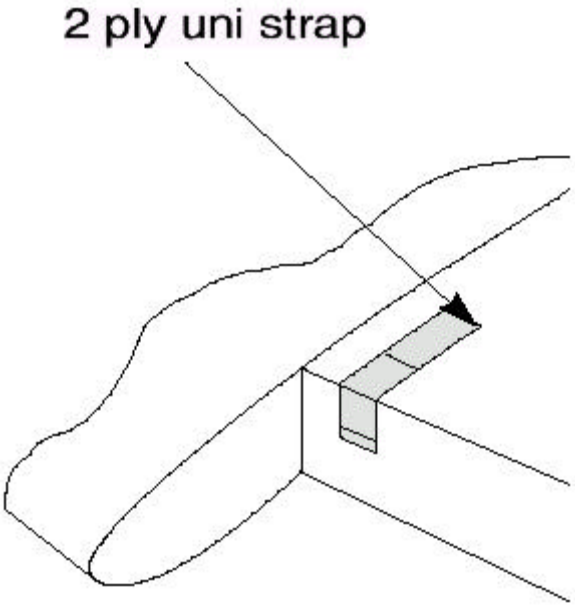
The second ply goes on just like the first, in the opposite bias. You won't be able to see the diagonal line you drew - it's underneath the first ply. But you can easily see the TE of B.L. 106.25 and the LE of B.L. 55.5, just by looking at the LE and TE below where you trimmed the first ply. Again, wet it out and trim it.



The third ply is run span wise, 1 5/8" aft of the aileron cut line and parallel to that line. You should be able to see the aileron cut because the thickness of the peel ply tape will show through the wet carbon. Just get the light reflecting off the wet carbon surface and you'll see the distortion. Trust us, it'll work. Measure aft from there 1 and 5/8" aft, along the ends of the ailerons. Press straight pins or tacks through the first two plies and into the foam at those points. Apply the third ply of carbon as shown, using the pins as your reference points. You want to keep the third ply off the aileron aft of those reference points - any carbon aft of there is aft of the hinge point, and will make the aileron harder to balance. Wet out the ply and trim.



Then, add 2 plies of uni carbon in the area shown. There should be enough scrap from the earlier plies for this operation. They go down at a plus and minus 45-degree orientation. Again, wet out the plies.
If you are putting a landing light in the wing, add a patch of glass bid over the area that received the 5" piece of peel ply - one ply extending 1" beyond the peel ply in all directions, and a second ply stepped back .5" from the first. If you aren't going to be vacuum bagging, apply peel ply to the outboard end of the wing, over the last 2 plies of uni carbon.



Finally, add a 2-ply strap of the uni wing skin material over the LWA4 and W18 plates. Cut the strap out of the scrap of the skinning operation - it's 5" wide, and runs from the centerline of the sheer web face of FC1 across the spar and past the bolt access hole. It re-enforces the hole and transfers some of the tort ional loads from the LWA4 into the spar cap. The second ply is shorter - it should only run aft 3" from the sheer web, to the aft edge of the spar cap and step back .25" at the sheer web centerline end.

That's it, you're done. Pour out your last batch of epoxy, but keep the cup next to the wing, so it is the same temperature as the wing skin and will cure at the same rate - that way you can check the condition of the cure.

On the first wing skinning with carbon fiber, I followed the approach in the video. Unfortunately I worked by myself and did not have the benefit of the sherpas. Ten hours later and very exhausted, I had the bottom side of the first wing. Looking at the pile of scrap carbon fiber and considering the cost of the scraps, I decided to look at some other approaches. I decided to lay over the wing a sheet of brown paper and cut out the outline of the wing. I set up a temporary table in the second bay of the two-car garage (while my wife was out) and used it to lay out the carbon fabric and the brown paper patterns. The paper was diagonally cut to the orientation of the fabric; it was simple to align the template to the edge of the carbon fiber. I found that I could save quite a bit on excess fabric by flopping the fabric over and under to best fit to the paper templates. The second approach used in the covering of the wing was to actually attach the carbon fabric to the brown paper templates. I found that the double-sided carpet tape (indoor variety) could be used to edge the sides of the paper templates. By sticking the tape to the paper and leaving the other side covered with the protective covering, I could lay the paper template over the carbon fiber on the cutting table and get every pattern to perfectly fit. Then by reaching under the side of the paper template I could peel off the remaining strip of paper from the carpet tape and press it down onto the carbon fiber. Once the paper pattern was firmly stuck to the carbon fiber, the fabric could be cut. Those little fabric pizza cutters fabric shears found in fabric stores work great on the carbon fiber and make the cutting job a cinch.
The second portion of the fabric covering of the wing is probably the most controversial of my methods. If you have worked with the carbon fiber for any length of time, you have noticed that it will unravel with little effort. Sticky tape attached to the edges of the fabric when pulled off makes for a world-class disaster. This is the situation I have just made with the patterns attached to the fiber. How to get the tape to release with out pulling the fabric all out of shape? Well the epoxy does the job. When laying the fabric/pattern on top of a wing, I over apply the epoxy along the lines where the edges and taped paper will lay. What happens is that the epoxy saturates the fiber from the bottom up and when it saturates the fabric stuck to the tape, the tape peels right off. It sort of like what happens when scotch tape gets wet, it looses its stick. I have not seen any residue on the fabric. It certainly makes for a fast covering process. The second wing was covered and in the bag in five hours working alone.
One other approach used on the wing patterns is to pre-cut blow out panels from the brown paper templates. This is simply the center section of the paper template being cut out and reattached to the paper edges with masking tape. Do this work before laying the pattern on the fabric to avoid cutting the fabric in the process. The blow out panel provides the resilience to hold the pattern in shape until in is properly oriented on the wing. Once in position, the masking tape and center of the template is removed and the edges of the fabric can be pulled taut to smooth out wrinkles.
This also allows the center of the panels to be covered with epoxy while the edges are soaking up the epoxy from underneath. In about ten minutes, the heavy application of epoxy under the tape has absorbed up to the paper and the strips of remaining paper can be peeled off. You will certainly notice the difference between saturated and unsaturated fiber under the tape.

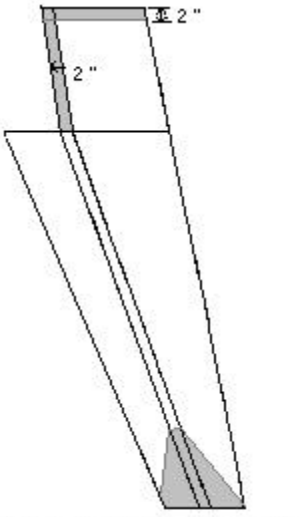
Bill Haas

VACUUM BAGGING YOUR WING.

The process of bagging your wings is just like bagging your winglets, with a few exceptions. The biggest, and most important, is the use of caul plates over areas of foam that might be damaged in the vacuum process. You will need to make 4 caul plates: 1 each to cover the two LWA wells and 2 to place on each side of the aileron torque tube hole in FC1. Make the torque tube plates about 36" long, they should go from the root at B.L. 23 past the micro joint at B.L. 55.5. Make them out of .063 aluminum, and be sure that you sand or polish all the edges to get rid of any sharp points. You also need to replace the plug that you cut out of the shell on the inboard end of the wing - press the plug firmly toward the aft end of the cavity, to support the foam in that area. Cover the entire skin with Teflon coated fiberglass as a release ply.
We can't stress enough that every square inch must be covered, otherwise you'll bond bleeder cloth to your wing. Remove the jig at 106.25. Find 2 pieces of blue foam left over from the flashings, and cut them to form opposing wedges. Slide them in under the wing where the 106 jig was. Take your long aluminum extrusion and set it on the wing span wise, down the spar cap, to see how much the wing has bowed under it's own weight. Adjust the wedges to support the wing and remove any tension. Cover the wing with bleeder. If you haven't received it from us, note that anything absorbent will do. We use a material that's intended as a lining for slippers, but we've used terry cloth, batting for quilts, even paper towels. Just be sure that you get enough bleeder down that the vacuum will travel through it, and enough to absorb all the resin that will be pulled from the lay-up. Once the bleeder is in place, place the caul places and hold them in place with masking tape. Get a couple of assistants to gently lift the entire wing out of the jigs, place you 6 mil plastic under the wing, and replace the wing. From there, it's vacuum as usual - Bag seal tape and turn on the pump.

MICRO FILL AND SAND OUT

This step is the same whether you are vacuum bagging or not. On the old Long EZ you didn't do this step right away, not until you started to fill and sand the entire airplane. We have you fill and do the initial sand out now because it takes a lot less work this way. If you apply the WEST micro while the wing skin is still chemically active you don't have to sand the carbon fiber. So, you don't have the work of sanding, you don't weaken the wing skin by sanding away fibers, and you don't fill the air with tiny carbon particles that will make you itch like Jean-Paul Marat. You need to be careful when you do this operation - once the resin has cured to the point where it's hard, but still chemically active (check the last batch of epoxy that you mixed). If you can no longer dent it, but it's still less than 36 hours since the lay-up, it's perfect. Start mixing WEST micro, as shown on the videotape. The faster you mix, the more you can mix at a time, but we wouldn't recommend more than about 10 shots at a time. This is the first real chance you'll have to see some serious exotherm activity, if you aren't careful. So don't leave the micro in the cup. Mix it, and get it on the wing. A quick pass, thin, just enough to wet the skin, then a heavier pass for fill. Don't micro the triangular area at the wing tip or the area at the inboard area of the wing or inboard spar cap. Leave those areas clean,



whether or not you vacuum bagged. Those areas will have layers of BID applied later when doing wing to spar and wing to cowl match ups and when attaching winglets to the wing.

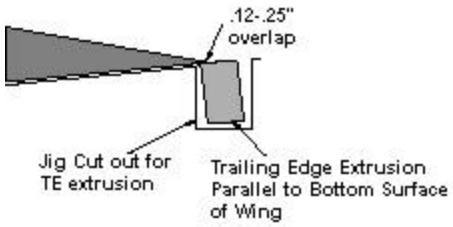
Once the wing has been thoroughly covered with micro, so that you can no longer see the fabric anywhere, let the micro set. Again, we are going to save you some effort here by asking you to do some work now rather than later. Keep checking the micro, about once every half hour. After 4 or 5 hours, depending on the temperature, it should be hard enough to sand without gumming up the sandpaper. Take out your long bar sander, covered with 36 grit paper, and sand out the wing. Keep the bar roughly parallel to the spar, and move it back and forth in a diagonal direction. Again, look at the video. If you sand out the wing at this point, instead of waiting a day or two for the WEST to fully cure the wing will be much easier to sand. Keep sanding until you can just see the carbon fiber fabric through most of the wing. Then look for the areas that haven't been sanded. Circle them with a pencil, mix up some more WEST micro, and fill those areas. Again let it cure for a couple of hours, and sand it out. In a perfect world all the micro would be thin enough that it's translucent, and you'd be able to see wing skin through it all. In practice, about 50% of the micro actually gets that thin. The basic idea is to sand it as smooth and thin as you can, while getting the entire surface even and not sanding into the skin anywhere.

Chapter 5

RE-JIGGING FOR THE TOP SPAR CAP AND SKIN

Once the bottom spar cap and skin is done, and you've done the sanding that you need to do, re-assemble all the jigs, putting their bottom halves on and bolting them in place. Detach the shelf brackets, and lift the entire wing and jig assembly and turn it over. Re-attach the shelf brackets to hold the bottom halves of the jigs straight, and unbolt and remove the top halves. Next, bond a 1"x2" aluminum extrusion to the TE to keep it straight.

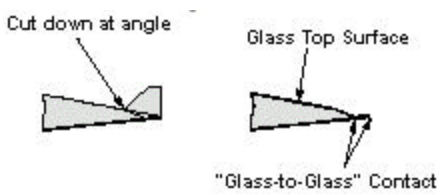
This is the same operation you did on your winglets, only longer. You'll notice that the cut outs in the jigs below the TE are large enough that the extrusion will move freely inside. It's also large enough that the extrusion can be slanted slightly, so it matches the angle of the lower skin TE. Sand the external side of the lower skin TE just slightly - a couple of passes with 80-grit is enough. Do the same with the extrusion. Sanding the surfaces will give them enough tooth to bond to, but don't sand them like you did the spar cap troughs. You want to be able to remove the extrusion, after all. You can either use Bondo or Super Glue to bond it on.



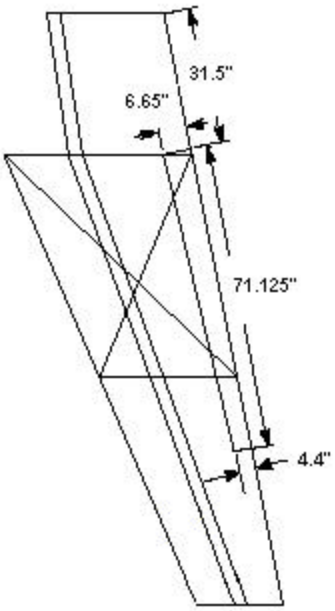
If you use Bondo, use a tongue depressor to smear little blobs of the stuff along the TE, then use spring clamps to hold the extrusion firmly against the TE while the Bondo sets. Be careful that you squeeze as much of the Bondo out from in-between as you possibly can, especially if you are going to vacuum bag the wing. If there is any appreciable mass to the Bondo blobs, the vacuum bag will suck the rest of the TE down against the extrusion while the top skin cures, and your TE will end up looking like a serrated knife-edge. If you aren't vacuum bagging, it's not nearly so crucial. The other alternative is to use a super glue, like Zap a Gap. Use the spring clamps to hold the extrusion on first, and then put a little drop at the intersection of TE and extrusion every few inches. Capillary action will spread it out under the TE and give you a good bond. In either case, what you want is a bond that's not perfect. You will have to remove the extrusion later, keep the overlap to a minimum, and don't use too much material to make the bond.

PREPARING THE CORE FOR THE TOP SKIN

First, remove the TE foam jig. This operation is just like you did for your winglets, cut off the jig, remove the surface foam and pull off the peel ply. Then carefully sand out the now upward facing inside of the bottom skin TE, and bevel back the

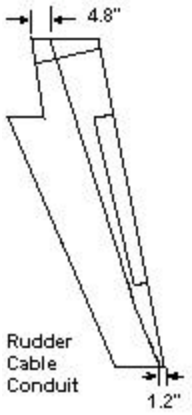


foam. Remove the tape from the centerline LE (CL LE), as per the winglets, and feather back the LE skin, sanding the first two inches of the skin for the top skin to lap and attach to.



Mark out the aileron cuts, as shown in the diagram, along with the diagonals shown.

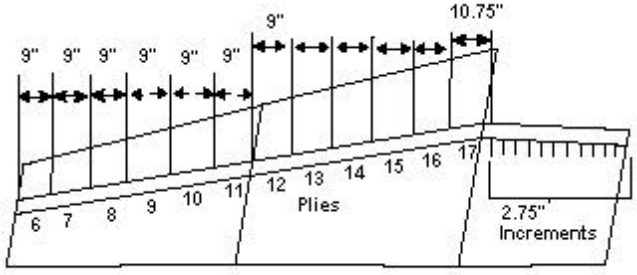
Next you'll need to rout a 1/8" to 3/16" channel in the top of the wing for the Nylaflow rudder cable conduit. This is just like routing the channel in the winglets for the RG 58au cable - use a low speed, or you'll melt the foam instead of cutting it. Use the technique outlined in the videotape to drill through the surface into the area of the shell on the inboard end of the wing. The inboard endpoint of the channel will be at 4.8" aft of the sheer web, and the outboard end is 1.2" forward of the TE. Bend the line so that it misses the corner of the aileron by 1.5"



Feed 8 inches or so of the Nylaflow tubing through the hole, then press more tubing down the channel. The tubing will have a tendency to spring out of the groove, so use some small, broken off pieces of tooth pick, speared into the foam above the tube, to hold it in place. We've recently found that three hacksaw blades held together, will cut a channel just wide enough that Nylaflow will press into it and not spring out.

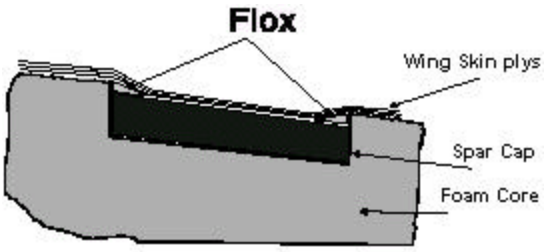
Mark the spar cap trough for the step-backs in the carbon fiber tape. This will be a little easier than for the bottom skin -eleven9" increments from the outboard end, and eleven 2.75" increments from the inboard end. Cut spar cap tape in this sequence:

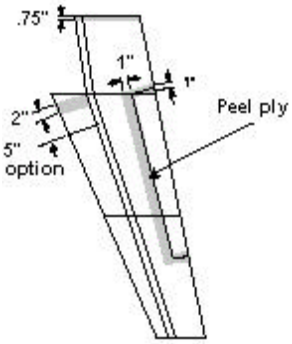
1: 140" 10: 93"
2: 140" 11: 81.25"
3: 140" 12: 69.5"
4: 140" 13: 57.75"
5: 140" 14: 46"
6: 140" 15: 34.25"
7: 128.25" 16: 22.5"
8: 116.5" 17: 10.75"
9: 104.75"



TOP SPAR CAP AND SKIN

Lay up the top spar cap the same way you did the bottom one. Paint EZ-Poxy on the thoroughly sanded spar cap trough fiberglass. Place a small patch of glass bid against the exposed inside of LWA2, to insulate it from the carbon. Stretch the carbon fiber tapes, lay them in the trough one at a time. Work them around the bend, and wet them out. This time you'll have 6 full span plies, and then step back for a total of 17 plies.





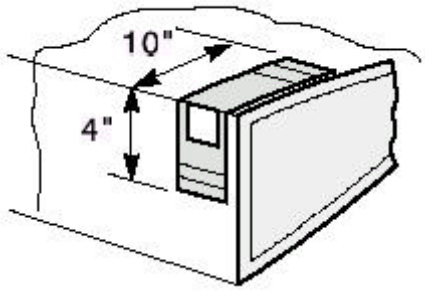
You will peel ply the foam under the top skin too, using the same dimensions that you did for the bottom skin. The only difference is that this time you won't peel ply the TE - you'll be doing a glass-to-glass transition there.

Once the spar cap is done, flox-fillet the exposed edges of LWA2. The skin is the same as the bottom, too. Two plies of uni, oriented to the corners of the middle foam block. The third, span wise block goes just along the aileron cut this time, you won't measure to place it aft of the cut. Again, if the spar cap ends up below the surface of the adjoining foam, you'll mix up some flox put a fillet in the corner to let the skin make a smooth transition. As you do the skins, wrap them 2" past the LE CL, onto the area you tapered and sanded. You'll find that the semi-circular cutouts you did in the jigs allow you to do just that.

So, go ahead and do the spar and the skin. Don't overfill the spar cap trough. You know how, now, you'll do fine. We'll wait here for you.

ADDITIONAL PLIES FOR THE TOP SKIN

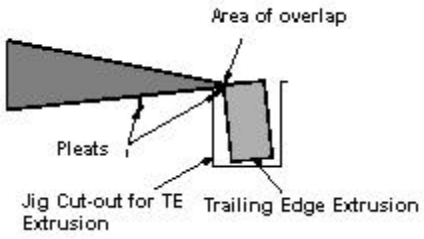
Just like the bottom skin, there are a couple of additional plies that you need to add after the third, span wise skin. The two 45 degree, triangular plies on the end of the wing that you did for the bottom skin are repeated here, and, again, are covered with peel ply. Add another 5" wide 2 ply strap over the LWA4 from the centerline of the sheer web face back across the bolt access hole. Step the second ply back .25" from the first at the sheer web end, and run it aft 3" to the aft edge of the spar cap. If you are doing a landing light in the wing, add two plies of bid on the LE over your 5" peel ply, just like the bottom skin. There is one more strap to add, one that you didn't do on the bottom skin. Cut three pieces of uni, 3" wide, and 14, 10 and 6 inches long. Cut them out of scrap skin material, there should be plenty - and be sure that the grain orientation is down the



length of each piece. These are placed over the LWA3 point - the inboard wing attach point. The first, long piece runs 4" down the face of the sheer web and 10" chord wise from the sheer web face aft on the top skin. The second ply steps back - 3" on the face, 7" on the skin, the third 2" on the face and 4" on the skin. That's it. Either let it cure, or vacuum bag it, then repeat the micro-fill and sand out section

VACUUM BAGGING THE TOP SKIN

There are a couple of differences between bagging the top and the bottom skins, but for the most part everything you did before holds. The first difference if the presence of the extrusion (1"x2"x.063 or .125 wall, 11.5 ft long) along the TE. Make sure that the bag tucks down into the corner, just like on the second skin of the winglet.



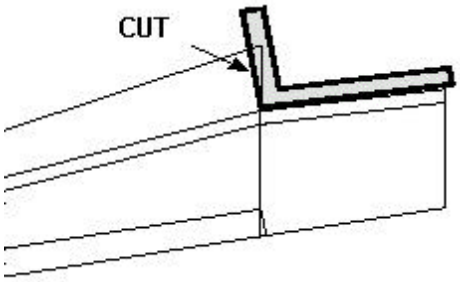
The second is that you need to use a caul plate along the leading edge to avoid wrinkles in the LE skin. This is just like we did with the LE of the winglet second skin. The plate can be made of thin aluminum or Mylar -something stiff enough not to wrinkle, and flexible enough that it will wrap around the LE nicely. Cut it to the proper length, and about 8 inches wide, and wrap it around the LE after applying the bleeder blanket. You can hold it in place with pieces of masking tape holding it to bleeder. That's it. Happy evacuation.

UNBAGGING, ETC.

Once you pull the wing out of the bag you need to repeat the micro fill and sand out process that you did on the bottom skin. It's the same as before; just fill the skin-to-skin transition area at the TE just like on your winglets.

FINAL SHAPING AND LAY UP OPERATIONS

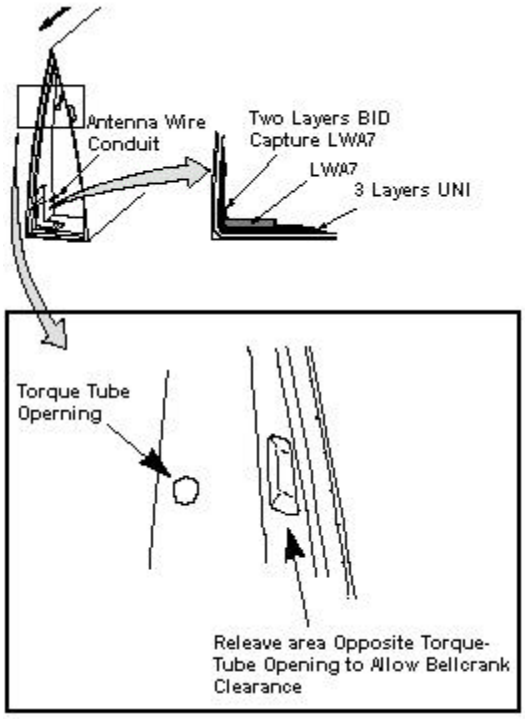
The major structures of your wing are finished, but there are a few more things to do. The first is to cut off the excess LE at B.L. 55.5. Use a large carpenters square as shown to mark the LE at a 90-degree angle from the end of the exposed sheer web face. Use a saber saw or air driven reciprocating saw to cut through the skin, then use a larger saw to cut through the foam core. Dig out the foam core underneath to expose the peel ply you laid in earlier - 2" deep, or 5" deep for a landing light. Remove the peel ply, sand smooth the exposed blue foam. Sand the inside of the LE skin. Lay in three plies of bid, over the entire exposed interior - the inside of the skin, the blue foam, and the sheer web face.



Run the BID onto the shear web face far enough to cover the LWA 4 plates with one ply and apply a 4" square of one ply UNI over the LWA 3 to protect from galvanic corrosion later.

Then go to the wing root. Remove the plug, discard it. The rudder tube should be sticking out and accessible inside the "shell" area. Dig out the foam that covers peel ply - the sheer web face, the three inches covering the bottom spar cap, and .75 inches all around the very root of the wing. Get hold of the peel ply, remove it, and sand the now exposed carbon and glass surfaces. Use sandpaper to taper back all the exposed foam edges at a 45-degree angle, in preparation to closing out the whole thing with glass-to-glass transitions. Draw a line straight down from the aileron torque tube hole; sand a groove in the foam for the bell horn that will eventually ride there.

The groove will be about 6 inches long, .75" wide, and go all the way through the foam to the inside of the lower wing skin at it's deepest point - right below the hole. There should be a small ridge of foam between the groove and the inboard, root end of the lower wing skin. Retrieve your LWA7 plate. You remember that piece; it's 1.75x2, 1/8" 2024 T3 aluminum, with one of the 2" edges radiused. Clean it with lacquer thinner and sand it, set it aside. Then run a flox fillet all around the now exposed edges of the LWA6. Cut three pieces of bias (always bias) bid 20"x30". Lay them up on the inside of the shell, covering the entire cavity, as demonstrated on the videotape. Cut three pieces of spar cap tape - 10, 11, and 12", and lay them in over the LWA6. Cover them with one piece of bid.



Put a dab of flox on the front side of the LWA7, press it in place.
The radius should go into the corner and allow the pieces of spar cap tape to make a nice transition. Again, flox fillets all the way around the LWA7, and cover it with a piece of bid.

Congratulations. You're done. Call us and let us know. This is an important milestone in your construction. Wait. On second thought, before you call us, do it all again, for the second wing. We'll wait here for you.

CANARD

Chapter 6

(Wanna buy a duck?)
CA . NARD (ke nard'; Fr. kan ar'), n. 1. a false story, report, or rumor; a hoax. 2. Aeron. a very early kind of airplane, having a pusher engine, with the rudder and elevator assembly in front of the wings. [t. F: lit., duck] vendre un canard a' moitie', to half sell a duck, to swindle.

The story goes that one of the Wright brothers was demonstrating the Flyer in Paris, and the onlookers thought that, with the large wings in back, the loud engine, and the long, slender framework sticking out in front, the airplane looked like a duck. Canard is French for duck, and the name stuck.
Or maybe the story itself is a canard.

In either case, we've now come to accept the term canard to refer to the forward wing of a tandem wing airplane. And since BERKUT™ is a canard-configured airplane, and you've already built the wings and vertical stabilizers, it's time to build your canard and elevators.

The processes you will use are very similar to what you have done on your wings and winglets. There are a couple of differences. The first is that you won't have to sand down the foam cores. Since there isn't any taper in the canard, it isn't necessary - we can hot-wire them accurately. The second: you won't be vacuum bagging your canard. There are just too many things that can go wrong. The canard that we are flying with on the prototype was laid up wet and not vacuum bagged, and the one that you will see us build on the videotape isn't bagged either.

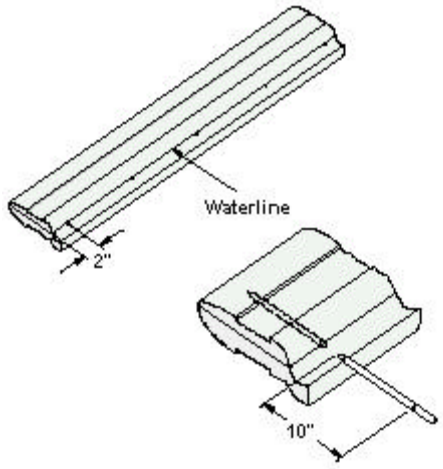
Don't do it, OK?

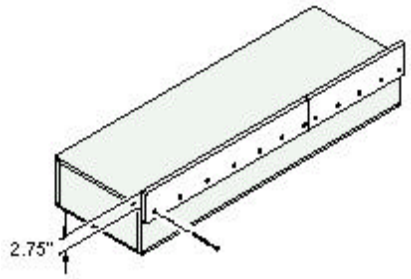
In comparison to the wings, the canard has a pretty simply geometry -it's constant chord, with no twist and no sweep. The only hard part about the whole process will be positioning the elevators exactly right. We will lead you through that process carefully, and use a series of templates and jigs to get everything in the right place.
Allez!!

PREPARING THE CENTER CORES

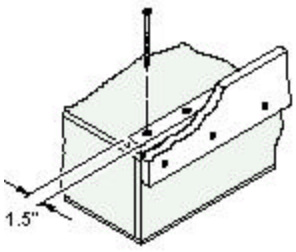
When you open up your canard foam boxes you should find 6 separate pieces. There is one large block with the 2 elevators and the 2 long center sections of canard foam, then a separate box

with 2 shorter canard tips. Remove the center sections. Get 8 feet of 1/4-inch wooden dowel. Cut one piece about 13" long and sharpen one end to a point - about a 30-degree angle. Chuck this dowel in a hand drill and use it to drill 5 holes in each center core piece. The holes are from the back of the core toward the front, and have to be parallel to the waterline that's marked on the end of the core. They must also be parallel to the ends of the core and to each other. Each hole should be 10" deep the dowel with a felt tip pen so you don't go any deeper, since you don't want to come out through the leading edge of the core. See the video for a demonstration of this technique. Start off drilling one hole about two inches in from each end of a core section, then one in the middle of the block, and then fill in the gaps for the last two. Once the holes are drilled, place the cores back in their flashing and weight them down. Use drywall screws to hold a piece of straight edge in place on each end, and cut off the leading edge, just like you did with the main wing cores.

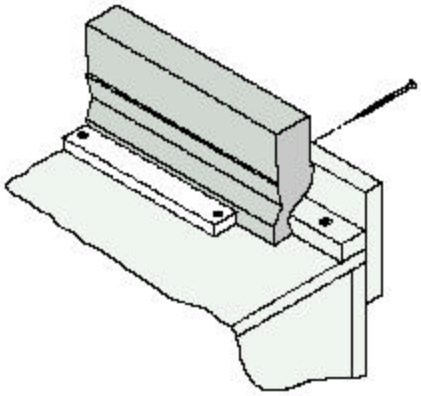




Use more drywall screws to attach a 6"x12' piece of clear Douglas fir or 3/4" plywood to the side of your table. About 3.25" will lap the side of the table, and exactly 2.75" will stick up above the table's surface. It's all right if the 6"x12" piece is made up of 2 or more shorter pieces (i.e., one 8' and one 4' strip off a sheet of 3/4" plywood.)



Then cut another strip of wood (or several shorter strips of wood,) 1"x1.5"x12'. It's important that the 1.5" dimension is consistent all the way along the length of this piece - have it joined and surfaced if you can. If not, cutting off some plywood on a table saw with a gate will be good enough. The 1" thick dimension isn't critical - it can easily be 1-by stock that's really 3/4", but it must be consistent down it's length. Screw these down to the top of the table just along the 3-inch fence. This will space the TE out from the jig-fence so that the aft section of the canard will sit vertically. Take the aft section of the canard center cores and micro-slurry the inboard ends - the ends with the deeper cut troughs for the spar caps.

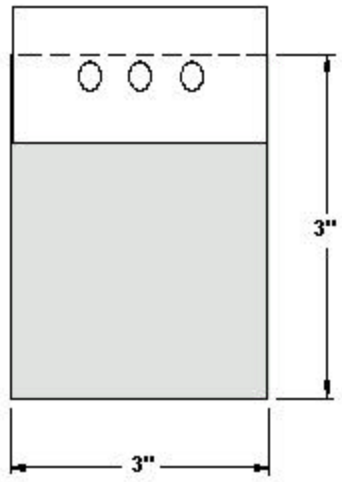


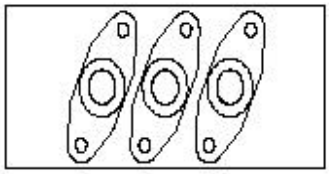
Trowel a wedge of micro down one, work them together, and set them against the "fence" jig, as demonstrated in the video - TE down, bottom toward the plywood. Take several more strips of 1-by stock and set them on the table pressed firmly against the top of the TE, then screw them in place. Run drywall screws through the fence and into the foam cores about once every 8 inches to hold the foam straight and against the jig. Let the bond cure.

PREPARING THE MOUNTING POINTS

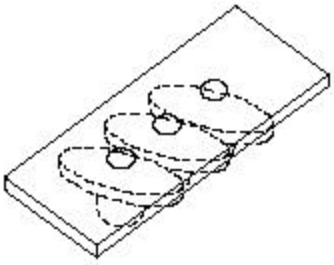
In your canard kit you will find two .012" thick aluminum tabs labeled "CLI". These are Canard Lift Inserts, and they are part of what holds the canard onto your airplane. You have to (1) prepare a pair of jigs for later, (2) prepare the CLI's them to be inserted into the foam under the sheer web and (3) prepare the foam to accept them. The jigs that you have to build for the CLI's are simple - 2 pieces of plywood; 2 3"x3" pieces of scrap aluminum sheet, (anywhere from .062 to .125 thick); 2 pieces of aluminum "L" extrusion from the hardware store (1/16 or1/8 wall, 1 to 1.5" per leg and about 3" long, and a couple of blobs of bondo.

Set the CLI's on top of the aluminum, with the holes in the CLI's lined up just in from the edge of the aluminum. Use a transfer punch to mark the center points of the 3 CLI holes. Drill the three points 1/4". Use a drill press to drill these. If you don't have a drill press, (and you should have one by now) be careful that the holed are perfectly vertical and perpendicular to the surface. Repeat with the second CLI. In theory the 2 CLI's are identical, but you should drill the 2 jigs off the 2 CLIs just in case they are off by a fraction, and mark both the jigs and the CLI's "A" and "B" to keep them with their mates.

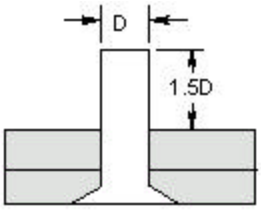




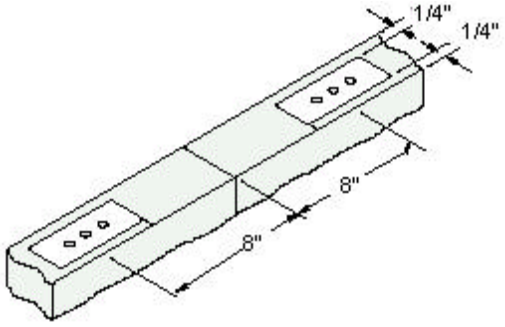
You have to mount 1/4-28 nut plates over each hole in the CLI's. The procedure is fairly simple - position a nut plate over each hole. Make sure that they all fit over their holes without interfering with each other. Thread a 1/4-28 bolt through the CLI and into each nut plate to hold them in place. Use a #40 drill, drill through one of the rivet holes on one of the end nut plates. Drop a number 40 flush head rivet in the hole, to hold the nut plate in place. Repeat with the second hole, and then move on to the next nut plate. Repeat on each nut plate.

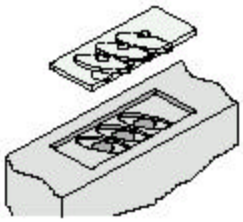


Then remove the bolts, nut plates and rivets. Use a 100-countersink bit to countersink the holes in the aluminum for the flush head rivets. Measure and cut the rivets - basic rule of thumb here, as with all rivets, is that the rivet should protrude 1.5 diameters above the surface. Obviously, the larger the hole and the rivet, the more should protrude. Once all the rivets are in place and the right length, squeeze them down

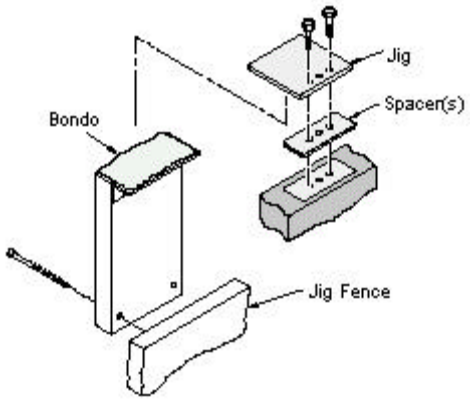


You'll then need to relieve the foam on the sheer web face to accept the CLI's. This is similar to what you did to the sheer web face of the main wings to put in the LWA plates. First, use a felt tip pen to mark BL 8, right and left, on the sheer web face. This is easy - the bond line between the 2 center cores is by definition BL0, so just measure out 8 inches in both directions. You want to relieve the foam so that the CLI sits just flush with the face of the sheer web, centered vertically in the sheer web face. So place the CLI's so that the BL8 lines bisects the center nut plate holes, with 1/4" above and below them, and use a felt pen to mark around them. Dig the foam away to a depth of 1/8". Then press the CLI's into the foam - nut plates down - and the nut plates will mark where you need to relieve the foam more. Repeat until the CLI's fit flush with the foam.





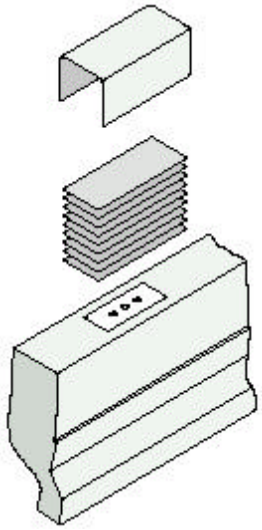
Sand the CLI's thoroughly with 80-grit. If you happen to have a bead blast cabinet, you can blast them, if you have lacquer thinner or MEK on hand you can degrease them. When they are clean, bond them into place with 5-minute epoxy. Once the 5-minute has set you need to make a jig so that you can locate exactly where those holes in the CLI's are. Remember the 3x3 pieces of aluminum? This is what you made them for! First, you need to make 2 spacers, .2 thick, with 1/4" holes in them. These spacers can be 3 layers of .063 aluminum, stacked and drilled, or several 1/4" washers, or anything else you can think of. Take 2 of the 1/4 28 (AN4-10A) bolts that you will use to hold the CLT's in (they are in the canard hardware kit) and use them to bolt the 3x3 aluminum to the CLI's, with the spacers in-between. The aluminum should extend well out over the fence-jig that's supporting the bottom of the canard. Cut a couple of pieces of wood, 3x6x3/4 or so. Use a blob of bondo to attach the wood to the bottom side of the 3x3 aluminum, put a piece of "L" extrusion in the intersection to help support the 3x3 aluminum plate, and then use drywall screws to attach the wood to the fence-jig. Once the bondo has hardened you can remove the jig. It's all demonstrated in the videotape.



SHEER WEB LAYUP

The sheer web for the canard isn't much different from the sheer web that you laid up for the main wings, so (since you are now experienced in such things) we are going to go through the process a little more quickly.) Cut 6 pieces of uni, on a 45-degree, 10 inches wide. Cut 2 pieces of bid, on the bias, again 10 inches wide. Take one of those pieces of bid and cut it in half, so it's 2 pieces 10x20. Then cut up one of those two - you need 18 pieces of bid 1.5"x4". You also need 2 pieces 4"x8", so cut those out of your roll of bid as well. Use a small carpenter's combination square or an angle gauge to mark 45-degree lines on the sheer web face and on the spar cap surfaces. Slurry the foam. Then mark the following BL distances

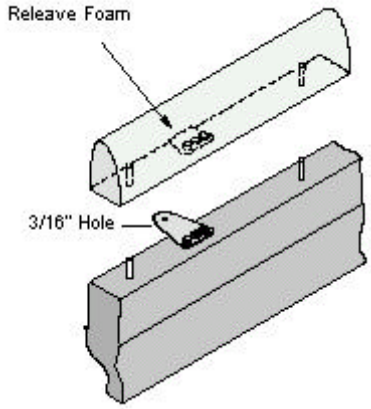
on the aft section of the foam, just aft of the spar cap trough, where it will be easy to see - BL 30 left and right, BL 20 left and right, and BL 10 left and right. Take several fresh, new pencils and cut off their erasers. Press an eraser into one of the holes in the CLI's, stuff it in as far as it will go under normal thumb pressure, then cut it off flush with the surface of the CLI using a razor blade. Repeat this to fill up all 6 CLI holes.
Slurry the foam, fill up any voids in the foam with dry micro. Lay down 2 crossing plies of uni, (that means that their 45 degree slant is in opposite directions) the full, 108 length of the canard. Then lay down 2 more crossing plies of uni from (you guessed it) BL 30 L to BL 30 R. Then one ply of bias bid (45 degrees) from BL 20 L to BL 20 R, then one last ply of bias bid from BL 10 L to BL 10 R.



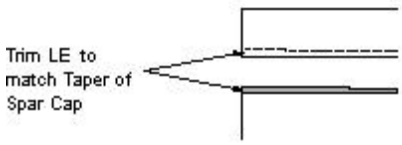
Then take all those pieces of 1.5" x 4" bid and start laying them up directly over the CLT's -9 per side. Wet them out as you lay them up, and be careful to keep the stack straight. Dab a little bit of flox around the sides of the stack to smooth out the edges, the cover the stacks with the 4x8 ply of bid. Just so that we are clear on all this, the 4" dimension in both cases runs span wise, so that the 1.5x4 is oriented like the CLI below, and the 4x8" piece laps down onto the spar cap area. While the glass in the sheer web is still wet, make 10 6" long 1/4" wooden dowels, sharpened on both ends. You will still be able to see the holes in the foam under the sheer web face. Work the points of the dowels through the wet fiberglass, between the fibers, and insert them three inches deep in the foam.

Cover the spar cap areas with peel ply or Teflon coated glass. Use a brush to stipple it down against the glass, but don't add any more resin. Let the beast cure. When it's done curing, put the CLI jigs back in place with drywall screws, running the screws back into the same holes in the fence jig that they came out of. The holes in the aluminum are now your drill guides. Use a 1/4" drill bit, and be careful to drill perpendicular to the surface (that's why you drilled them with a drill press to begin with.) You may want to use a stop on your drill. In any case, be sure that you don't drill out the threads in the nut plates. Drill slowly, and as soon as you start to see red eraser rubber pull up through the hole ease off even more. Repeat until all 6 holes have been drilled. When they are done, remove the jigs.

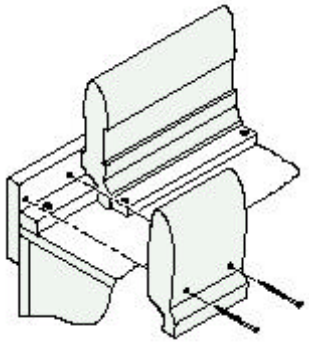
Find the Canard Lift Tabs (CLT's), 1/4" thick aluminum, with three 1/4" holes in a row. (NOTE FOR EARLY KITS: If they don't have a 3/16" hole drilled in the center of the radius in the round end, drill them on a drill press.) Sand the pads and the CLT's thoroughly, smear the pad with flox, and press the CLT's into place. Screw in the 6 1/4"-28 bolts (with washers) and tighten them down, squeezing most of the flox out, about 50 inch pounds.



Next, you'll need to fit the leading edge foam back, just like you did with the main wing. The wooden dowels will make sure that it goes back on in its original orientation. You'll need to relieve the aft face of the leading edge section, to fit over



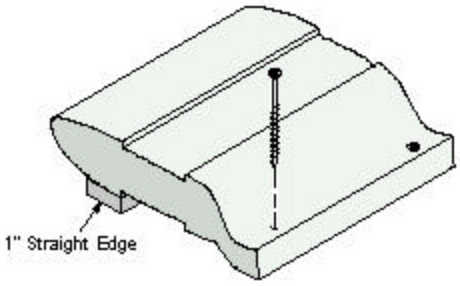
the CLT's and the glass pad build-ups, so measure and carve, then trial fit the LE on the dowels. You'll also notice that the sheer web is thicker in the center, so mark the TE aft face and sand it down slightly to match. Repeat until the LE is straight - just sight down its length. Try not to put the LE on and off more than you need to, since each time you do so you increase the tolerance (and decreases the accuracy) with which the dowels align things. Once the LE fits, pack the CLT's with micro, and micro the aft LE face like you did with the LE's for the main wing, place it on the sheer web face, and hold it in place with drywall screws. It's OK to run a couple of screws through the LE and into the sheer web glass. When the LE's are in place, apply micro to the canard ends and the canard tip foam, set the tips in place, and drywall screw the tips to the canard and to the fence jig. Let the whole thing cure, then undo all the screws, and take the fence off the table.



Congratulations - you are done with the sheer web, and you are ready to lay up the bottom spar cap and skin.

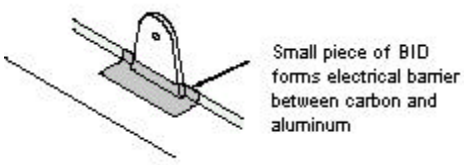
BOTTOM SPAR CAP AND SKIN

Just like the main wing, you'll be doing the bottom skin first, then re-prepping the canard for the top spar cap and skin. The jigging for the bottom skin is marvelously simple. Since there is no twist or taper or sweep, all you need are a couple of straight, parallel surfaces to keep the canard straight. Surprise - the surface of your table is one of them. So put the canard upside down on the table. Take a piece of something straight (we use an aluminum extrusion, you can use plywood or Douglas fir) that's 1" thick, and set it under the extrusion, right along the sheer web face/aft side of the LE. This should put the bottom side of the canard just about level with the table - if it isn't quite level, that's OK, remember, the important thing here is that there be no twist. Screw the TE to the table with long, coarse drywall screws - about one every 6 to 8 inches. Screw them in until they are just under the surface of the foam. Remove the peel ply from the bottom spar cap trough, and thoroughly sand the glass with 36- grit sandpaper. Repeatedly remove the dust generated as you sand, and make sure that you remove all vestiges of gloss from the glass.



Go to the end of the core and mark a chord-wise line .75" from the end with a sharpie marker. Use a small piece of 36-grit sandpaper to remove a little bit of the foam outboard of that line - sand down .025" - .030". Don't sand the last 5/8" of the TE (Dave got this wrong on the videotape). This will ultimately form a depression in the skin of your canard that will let you lap glass from a sculpted canard tip, without having a bulge. Repeat the process on the other end. When you have created the depression, bevel the lip so that the canard skin will conform to the surface nicely.

Now - before you actually start laying anything down, go ahead and pre-cut the spar cap tape and glass skin pieces. The tape lengths are below. You need 2 pieces of uni, 131"x12" (review the 3rd canard tape for a couple of tips for cutting this cloth), with the grain span wise. You need three pieces of bias-cut bid, again, slightly wider than the chord width of the canard, and as long as you can cut them on the diagonal. Cut them, cut off the selvage edges, mark the pieces, set them aside, and continue. Use a sharpie marker to mark the LE foam just ahead of the spar cap trough every 6 inches, as reference marks for the ends of the spar cap tape.



Cut 2 small pieces of bid, about 1"x3", and lap it from the floor of the spar cap trough onto the TE side of the lift tabs. It should run far enough up the lift tabs that the carbon, which will soon fill the spar cap trough, won't touch the aluminum of the lift tab. This is the same thing that you did for the hard points on the main wing - eliminating the possibility of galvanic corrosion.

Lay up the bottom spar cap just like you did for the main wing. The tape length schedule is as follows:

Ply 1 108"
Ply 2 108"
Ply 3 108"
Ply 4 96"
Ply 5 84"
Ply 6 72"
Ply 7 60"
Ply 8 48"
Ply 9 36"
Ply 10 24"
Ply 11 12"

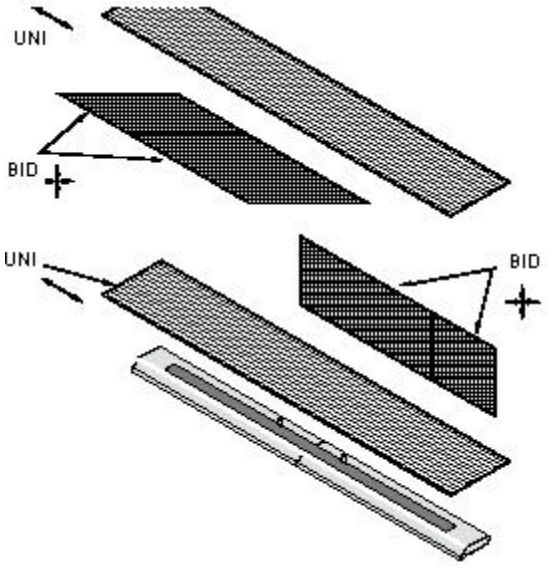
Just as with the spar caps in the main wing, these lay up length are the MAXIMUM you should use. We give you these lengths only because if you use more, you will run out of carbon fiber spar cap tape before you are done. But you should

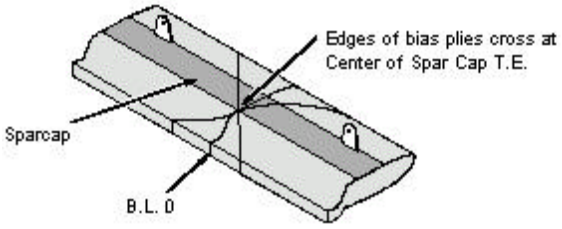
NEVER OVER-FILL THE SPAR CAP TROUGH!

In this lay-up it's even more critical than the wings, because you aren't using vacuum bagging on this structure, so there won't be any chance to compress the laminate. The object is to fill the trough completely, but not overfill. If you are going to err on one side or the other, leave them slightly under filled (by no more than .032"). The airfoil is pretty critical, and it's easier to fill a depression in the final skin with micro than it is to sand down through a high point, patch it and feather it in with the rest of the surface. One trick, to let you more accurately fill the spar cap trough, is to cut the plies of spar cap tape at an angle. That way you get less of a "step" at the end of each ply.

Tape the leading edge of the foam, just like you did for your main wing. Flox fill any step - transition between the last ply of spar cap tape and the surface of the foam, and micro-slurry the entire bottom surface of the foam. Be careful not to get any micro on the spar cap itself. Run a strip of peel ply tape - about 5/8" wide - down the trailing edge. You'll use this the same way you did on the wings and winglets, to help you do a glass-to-glass transition when you do the top skin.

Once the foam is prepared, lay down the first skin ply - it's uni, the grain orientation is span wise, and it covers the entire bottom of the canard. Again, this is an operation where a helper is just about mandatory. You'll need to give the cloth a good tug, lengthwise, to straighten out the fibers, then gently set it down on the core, correctly oriented for-and-aft. Then use a pair of scissors or a sharp blade to cut span wise slits for the lift tabs to poke through. The bid comes next.
The first piece starts at the centerline of the TE, and goes one way, the second overlaps the first, again starting at the TE centerline, and going the opposite way. The third piece gets cut in half, and buts against the ends of the first two pieces. If you don't understand, look at the illustration and the video, it's not as complex as it sounds.





The final ply is again span wise uni. Different verse, same as the first. Do it just like you did the first ply. Let it partly cure, then do a knife trim along the centerline of the leading edge, the TE and the ends. Let it finish curing (to the point where it's hard, but still chemically active) and fill with micro ONLY UP TO THE LAP-DEPRESSION in the foam core (the point where the second skin will lap over the first) as demonstrated in the video.
Sand out the surface using your long bar sander and 36-grit sandpaper. The first thing that you should try to sand straight is the sharp down-curve toward the trailing edge. Since the original hot wire was going around a sharp curve there is the possibility that the center area of each inboard core section is scalloped in this area. But the end cores and the two ends of the inboard cores will be accurate, so you can fill and sand out and depression in between them using the ends as guides. You can sand the in-curve section of the TE "S" shaped curve with 36 grit sandpaper on a broom-handle or piece of PVC pipe.

Finally, use your sanding bar to feather the last inch of the bottom skin plies as they come up the LE centerline. Again, this is just like on the main wing, and it will let you avoid a ridge along the LE centerline when you are finished.

THE TOP SKIN AND SPAR CAP

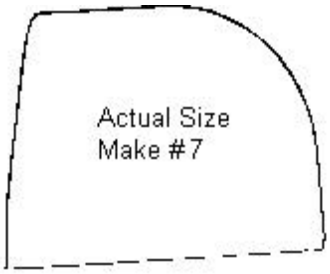
The first thing you need to do for the top skin and spar cap is re-jig the canard. This is going to be easy. As you remember, we told you that

the upper surface of the jig-fence that you attached to the long edge of the table had to be absolutely straight, and be 2.75" above the surface of the table.

You might have figured out that it didn't actually have to be either that height or straight for that application. In fact, we gave you those specifications then so that you could use that same jig here to establish the final twist (or rather, lack of twist) in your canard. You will need another fence to jig the trailing edge - we used extrusion in the video, but only because we had it handy. You can use plywood or 1x6, cut to 4.25" wide. Set the canard on the original fence-jig with the LE hanging out over the edge of the table and the lift tabs pressed against the inside of the fence jig, then set the second jig so that it supports the trailing edge. Measure the distance from the TE to the exposed corner of the second fence jig, and make sure that that measurement is the same the entire length of the canard. You'll se us doing just that on the videotape, for the extrusion, 1.15" is exposed, if you are using plywood, it should be 3/8" or so. Use some of the shelf support brackets from your wing jigs to keep them in place and vertical.

Use several blobs of bondo to secure the canard to the #1 (forward) fence jig, weighting the canard down where there are significant gaps (more than .020") between the canard and the fence-jig. Then use super-glue to bond the TE to the #2 (aft) fence-jig, again weighting it down to remove any gaps. Don't use Bondo on the TE. The super glue is less resilient than the Bondo, and it will be easier to remove without damaging the TE Once the Bondo and the super-glue has set your canard will be absolutely straight. If you cannot get the super-glue to bond down the TE all is not lost. Go ahead and do the lay-up, then cover the aft section of the canard with plastic (Saran wrap, 4 or 6 mil plastic, stretchy vacuum bagging film, etc.) and weight it down. As long as the top skin cures while the canard is in a straight, untwisted condition it will stay that way for as long as you both shall live.

Cut off the TE foam jig with a hacksaw blade - let the aft end of the blade ride on the fiberglass and keep the forward end above the contour of the foam, just like you did on your wings and winglets. Shape the foam to its proper contour with a light file and sandpaper. Then get hold of the peel ply (you did lay it down before you did the bottom skin, didn't you?) and strip it, and the last 5/8" of foam and micro, off the glass underneath. Bevel the aft edge of the foam so that the skin will make the transition nicely.



Next you will insert several blocks of 6 LB density PVC foam into your foam core, to act as semi-hard points for the elevator hinges. In your A kit you should have received a block of light brown foam, 1" thick, and about 4"x8". Cut out the template here on the right and use it to cut 7 blocks from that foam, that exact size and shape.

Go back to the canard and mark the TE and LE jig fences to indicate the centerline - BL 0 - where the two halves of the canard core are bonded together. Then, mark where the 6 foam blocks are going to be inserted into the blue foam. They all will go in directly aft of the spar cap, and the BL numbers, which follow, are the CENTERS of the foam blocks. Since the blocks are 1" wide, they will have .5" on either side of the BL lines that you are about to mark. They are 1.75" long (chord wise) but if you remove some of the foam that remains between the hard foam insert and the TE, don't worry, it will fill in with dry micro.

But stop. There is a decision to make here. Are you going to put your control stick on the right side or on the left side? There are two things to consider. First, are you right or left handed, and second, do you plan to fly in IFR a lot. The logic some people have used is that they want their weak hand on the joystick, so that they have their dominant hand to copy down IFR clearances. ***(Personally, I fly with my*** *dominant right hand, and switch on my wing leveler whenever I have to copy - Author's note)* The numbers here are for putting the joystick on the RIGHT hand side. If you are going to put it on the left reverse the left and right measurements. 'Nuff said.

Another note - on the videotape, Dave got a couple of things wrong. He called out a Right measurement because he was going to his right, but it was the left side of the canard. He also called out an incorrect number for one of the positions. These are the right numbers.

OK, here we go - remember, measure from the centerline, BL 0, toward the ends of the canard.

Left side of the canard, looking from the TE: BL 9.2, BL 34.1, and BL 59.

Right side of the canard, from the TE: BL 7.8, BL 9.2, BL 34.1, and BL 59.

Mark these points, then measure back 1.75" from the aft edge of the spar cap, and measure .5" on either side of the BL line indicated. Mark that rectangle, and dig in. Remove all the blue foam down to the bottom skin, as shown in the videotape, using a sharpened hacksaw blade to make the cuts and a wood chisel and a vacuum cleaner to remove the foam pieces. Do a preliminary insertion of each block, and shape them as necessary to get them to fit in the depressions. You want them to fit in so that they are slightly below the surface of the surrounding foam. Number them, and number the holes that they go in, so that they don't get mixed up. You can easily pull them out of the core for further sanding by threading a drywall screw into the top and using that as a handle mix up several shots of 2187, add micro to form loose, wet slurry. Coat the inside of each hole and the outside of each block, in turn. Add some extra slurry to the bottom of the hole. Insert each block, press down to squeeze slurry up around the block. Keep pressing until the block is below the surrounding contour - that way it won't pop up above contour later. Then, go to the ends of the blocks and sand a slight depression there, just like you did for the first skin - the last .75" of the core, and take it down .025"-.030".

Once that's done, it's time for your favorite lay-up - the spar cap. This is a cause for rejoicing, however. This is the last spar cap you will ever have to do on this airplane. (Darn, and just when I was getting good at it.)

Cut the skin before you go any further - 3 full plies of span wise uni, and 3 pieces of bias bid, the same size that you did for the bottom skin. The spar cap sequence is as follows:

Ply 1 108"
Ply 2 108"
Ply 3 108"
Ply 4 100"
Ply 5 92"
Ply 6 84"
Ply 7 76"
Ply 8 68"

Ply 9 60"
Ply 10 52"
Ply 11 44"
Ply 12 36"
Ply 13 28"
Ply 14 20"
Ply 15 12"

As in all the spar caps, these are suggestions; your real goal is to fill your spar cap trough completely. One of the nice things about this lay-up is that you are no longer in danger of running out of spar cap tape - you won't have any more uses for it, so go ahead and use all you need to fill the trough perfectly. Again, you can cut on a diagonal to more closely match the contour. When you are done, slurry the foam (keeping all micro off the spar cap) fill any dings or voids with dry micro, and lay up the skin. The skin goes on the same as on the bottom, but with one additional uni ply. The sequence is full span uni; bid (again, overlap the plies diagonally between the lift tabs) then 2 (yes, that's two) full span plies of uni. The plies will all wrap around the LE and lap onto the first couple of inches of the bottom skin, up to the lap depression mentioned earlier.

Let the whole thing cure, knife trim the TE and both tips. Use a slim knife blade to peel the TE away from the #2 fence jig, and then use a saw blade to cut the bondo. Sand the edge of the top skin where it wraps around the LE and ends at the lap depression. While the skin is still chemically active, fill it with WEST/Micro, let the fill set, and sand it out.

Do the finish fill and shaping as shown in the video.

Well, that's it; you're done with the main structure of the canard.

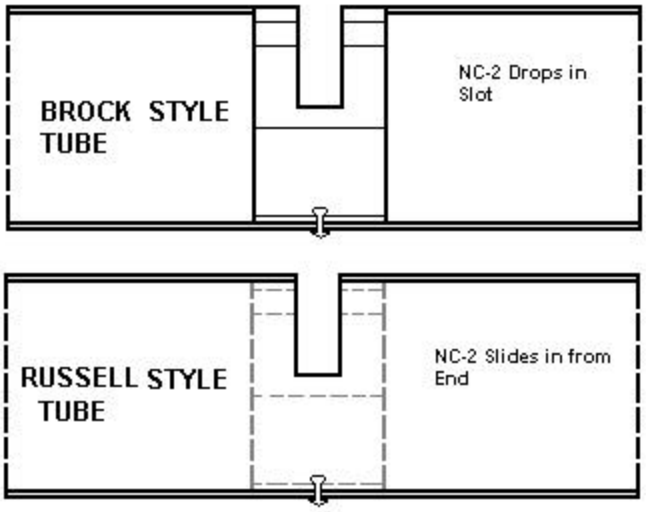
Store it, on its leading edge on some scrap blue foam or cushions, someplace where it won't get damaged.

The canard tips will come later, after you mount the canard and elevator.

ELEVATORS

Chapter 7

The elevators are very simple structures. An aluminum tube makes up a portion of the LE, and a wedge-shaped piece of hot-wired and sanded foam makes up the body. The first slightly tricky (and, of course, critical) part about building them is getting the slots that have been cut into the tube in the right twist orientation to the body of the elevator.



The first step is installing the NC-2 hinge inserts. Please note - the videotape shows the installation of the Brock style NC-2, and the first 16 or so builders received Brock NC-2's and torque tubes. Subsequent builders received the Russell style tubes and plugs, and those are much easier to put in. The only difference between the two is that the Brock tubes have full width slots milled in the tube, and the NC-2 (the aforementioned plug) drops in through the slot with only a little filing necessary. The Russell tubes have slots that are the same width as the slots in the NC-2's, and the NC-2's slide in from the end. Both are bonded in place with super-glue, then drilled and riveted in place permanently.

Note: The first thing that you must determine - which tube is the right tube, which tube is the left tube. This is best done graphically. We'll do this whole process on your jig table. Long tube (72.1") on the left, short tube (55.1") on the right, for those of you who are building canards for a right handed stick. Obviously, you will reverse all this for a left-handed stick. You'll notice that both tubes have a slot the same distance from one end of the tube, exactly 9.5 inches from the end. This is the OUTBOARD end of each tube. Point them outward.

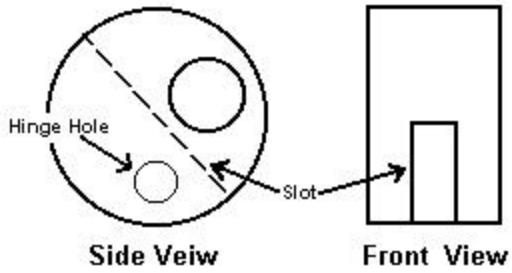
Occasionally we have seen tubes (particularly the Russell style tubes where the machinist has suffered from an adverse alignment of the planets. The only result has been that some of the slots are deeper than others. So, before simply assuming that all plugs reference to all slots the same way you must check the slots for equal depth and rotation on the tube. We have found that if there are slots that are deeper, one edge of the slot will almost always match up down the length of the tube. There are many ways to check, this is just one. The tubes are about 4 feet long, so get a piece of 1/2" thick plywood or particle board, with one straight edge. Lay it on your jig table, put the tube up against the straight

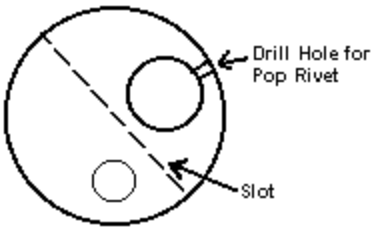
edge, and rotate the tube so that the end of one slot is just against the corner of the plywood. Then check the other slots. If they are even with the corner as well, all is good, use a sharpie marker to put a little tick mark by that end of each slot.

If the ends of the slots are not in line, turn the tube and check the opposite ends of the slots. They should line up. They have on every tube we've checked. If they do, mark them. If they don't, call us and we'll figure something out. In either case, check and mark the second tube.

Clean the NC-2's with lacquer thinner, MEK or acetone. Clean the inside of the tube with the same thing. If you want to be totally obsessive about this, you can also clean out the inside of the tube with a tuft of Scotchbrite on a rod or (for the ultimate in pointless obsession) with a stainless "tornado" 12 gauge shotgun cleaning brush. Don't use a brass brush. Put Vaseline in the holes of the inserts.

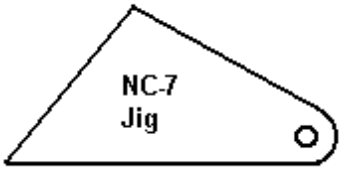
Orient your inserts, with the tubes laying on the table in the proper orientation, point the slots on the tube away from you. The inserts should be oriented with the small holes downward. Drop (Brock style) or slide (Russell style) the NC 2's into their position. Rotate them so that their slots line up with the sides of the tube slots that you've marked. Double check to be sure tubes and inserts are in proper orientation. Look down the inside of the tube, all the holes should line up. When one is lined up get out your rarely used bottle of "Hot Stuff" super glue. ***(Be careful with this stuff, it wants to capilate all over everything it touches. Like, don't take off the cap with your teeth unless you want your teeth*** *glued together. -- The Voice of Experience.)* Stick the end of the applicator against the end of the slot, and slowly squeeze to capilate glue in under the NC-2 plug. Repeat until all five NC-2 plugs have been securely glued in place.



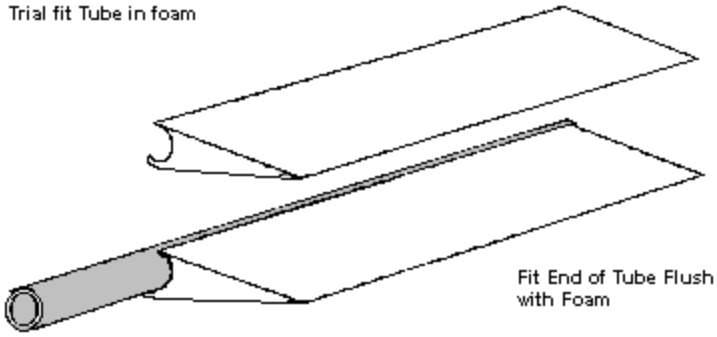


Then roll the tube over and put the backside against the plywood straight edge. If you look down the tube, you'll see that there are two holes drilled in each plug - a larger, 3/8" hole and a smaller 3/16" one. The large one comes very close to the outside edge of the plug. Look down the tube and mark the center of that larger hole on the outside of the tube. You need to make a similar mark at every plug - if you like, you can use the corner of the plywood, and mark a line. Mark the center of the plug, left and right, so you'll have a point just opposite the large hole in the NC-2 where it comes closest to the outside of the tube. Place the tube on the jig table, slots down, and use a # 30 drill to drill though the tube and the plug at the point marked. Rivet the plugs in place with Cherry BSP- 43 or Avex 1601-0410 pop rivets.

Next find the NC-6 inserts. They look very much like the NC-2 inserts, but without the slot. The NC-6 inserts have a threaded hole instead. Fit the NC-6's into the outboard ends of your tubes. Line up the small hole so that you can slide the hinge pin through the small hole and into the small holes of the already installed NC-2 plugs. Look down the tube to be sure that the small and large holes are aligned. Mark the location of the drilled hole on the outside of the tube so you can find it later. Glue them in place, and then rivet them in the same way you did the NC-2 plugs.

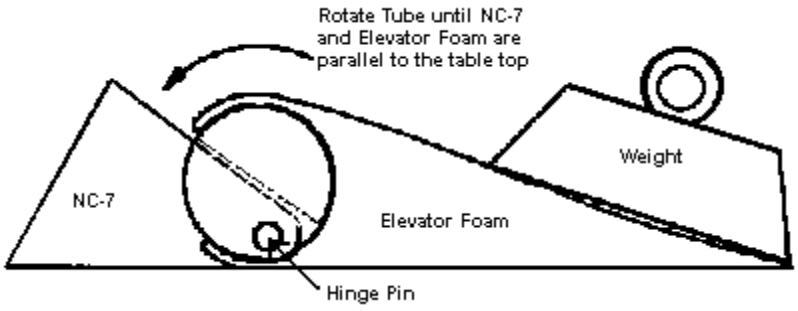


The next step is to test fit the tubes into the foam cores. Your first reference - your cores will fit flush to the outboard ends of the tubes. *I hope you have already cleaned your tubes inside and out.* You'll place the tubes into the foam core. Enlist the help of a friend -- as they hold the core carefully, you will push the tube in from one end, determining that you have a tight fit. Included in your parts is a small triangular piece of aluminum with a 3/16" hole drilled in one corner, labeled as an NC-7. This is used as a hinge jig, and its appropriate placement in the tube is as per drawing below. It's relationship to the tube, tube insert, the hinge pin and the foam core is referenced in the same drawing. Do a trial fit - with the tube in the foam core (core down, slot up), run the hinge pin through and capture the NC-7 in the slot in the midspan NC-2 per the drawing. If everything looks good, disassemble the beast and proceed on to bonding.



Thoroughly sand or Scotchbrite the outside of your tubes. Set out the tubes, hinge pins, and foam cores in their real-and-genuine locations. Right tube in the right place, left tube in the left place, outer ends out, slot forward, foam cores behind them with TE's aft. Mix up a couple of shots of wet WEST micro. Coat the inside of the foam core. Again, have a friend hold the foam core and slip the outer end of the first tube out through the inner end of the foam core. As you push on the tube push down on the inboard end of the tube so that the end of the tube will ride up-and-away from the inside wall of the core, and will allow slurry in-between the core and the tube, rather than scraping the slurry off the foam. The technique is demonstrated in the video.

With the tube flush with the outboard end of the core once again run in the hinge pin and trap the NC-7 in the midspan NC-2. Remember, the long leg of the triangle ends up parallel to the underside of the elevator foam core, so make sure that the NC-7 is in the right orientation when you put the hinge pin through it.



Then set the assembly on the table, bottom of the core down. Rotate the tube forward (we won't say clockwise or counterclockwise, that will change from side to side and end to end) until the NC-7 locks against the wall of the NC-2 slot and the table. This will not generate a parallel condition between the bottom of the NC-7 and the surface of the table, so you'll then rotate the tube back, just a hair, so the tabletop and the bottom of the NC-7 are parallel. You'll probably find that a tongue depressor is just about the right thickness to fit between the NC-7 and the

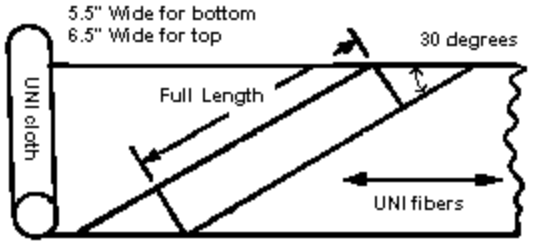
table. Weight the core down to the table; over it's entire length, while pressing it against a straight surface, ensuring the straightness of the core and the tube during cure.

Check the slots in the NC-2's for resin, and clean out as much as you can. Repeat on the second elevator, and allow to cure.

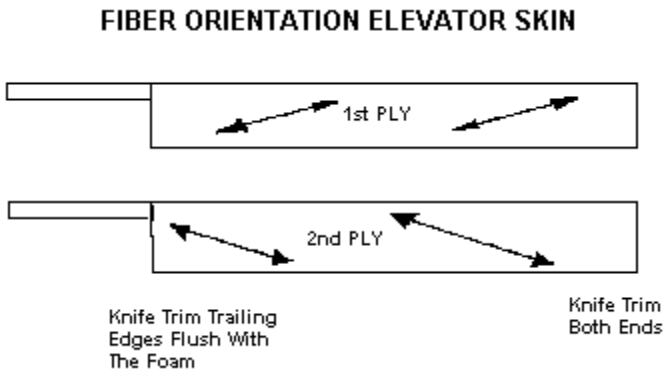
Shaping your Elevators

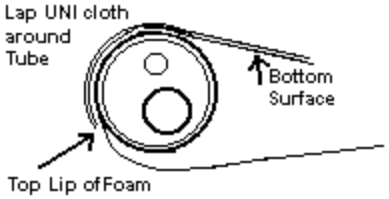
We'll start with the simplest part of this process first. Take a black marking pen (Sharpie or equivalent) and mark a black line on the bottom of the elevator foam right along the trailing edge. Take a sanding block with 36-grit sandpaper and sand the bottom of the elevator foam keeping the same angle of the foam to tube. *(i.e. if you sand 1/8" at the front; sand 1/8" at the back.)* This process will make the bottom of the foam perfectly tangent to the bottom of the tube, and the foam taper to nothing at that tangent point. Your trailing edge is rather fragile, and it shouldn't be sanded too thin at this point.

Clear your table and roll out your uni. Your bevel gauge is still set at 30 degrees; use it to mark a 30? line on the table. Then roll your cloth out so that it is parallel to the table's edge, and use the line to cut across the uni at a 30? angle. Cut 4 strips about 5.5 inches wide and 4 strips about 6.5" wide.



Get out your bevel gauge and your protractor, set the bevel gauge to 30 ? Mark the bottom side of the elevator lightly with the sharpie pen 30? to the trailing edge, as per drawing below. Spread some 6-mil plastic on your table, enough to put both elevators down on with plenty of room to spare. Cover the NC-2 slots with silver tape -try to lap the tape about 1/8 inch onto the aluminum in all directions, and no more than 1/4". Slurry the bottom of your foam with WEST micro, then lay up two plies of 5.5" wide UNI on each, at +30? and -30?, with West or E-Z-Poxy. (*Choice of resin depending upon the temperature of your shop and how quickly you can work. E-Z-Poxy is stronger and gives you more time. West is lighter, cures faster and is strong enough for this application.)* The glass should start at the trailing edge of the foam and come forward to completely cover the aluminum tube, stopping where the top lip of foam starts. Cover the bottom surface of the elevator with 6- mil plastic and rub it down with a squeegee. Then set the elevators down on your table BOTTOM DOWN, the new lay-up against the surface of the table, with a couple of sheets of plastic in-between. Weight the





elevators down thoroughly, and butt the tube against a straight edge the same way you did bonding in the tubes. Let cure.

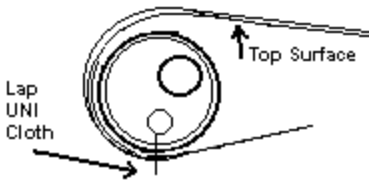
THE SECOND SKIN

Use your elevator templates to make sure that you are shaping the top foam correctly. Mark about every 4 - 6 inches with the template chord wise from the TE forward - sand with 36-grit to eliminate any gaps or bumps, the foam should taper to nothing against the tube like the bottom. At the trailing edge the foam should taper to nothing right at the end of the skin from the first lay up.

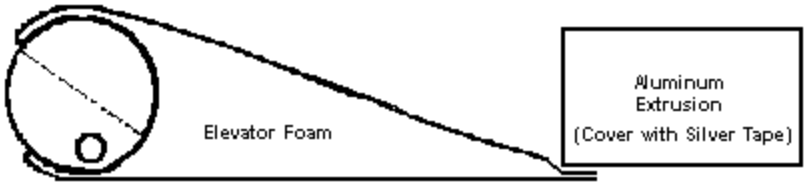
Use a straight edge and mark a line parallel to the TE, 1/4" forward of the TE. Use a wood rasp to carefully remove the foam on the TE aft of that line. Remove the foam until you are down to the micro slurry that you applied before the first skin. Sand the micro cleanly to the bottom skin.

Use a sanding block with 80 grit sandpaper to bevel back the foam that now sits at the trailing edge - it should bevel up at about a 45 degree angle. At the same time, you can lightly sand the now-exposed surface of the TE glass, preparing it for a bond. Sand the glass on the leading edge to a paper-thin transition and prep for the overlap of the top skin.

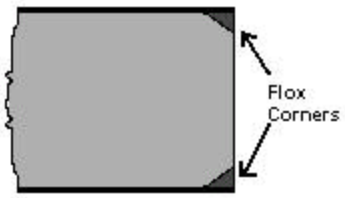
Then use a permanent marker to mark the foam the same way that you did for the first lay up - 2 diagonals at 30?.



You should have 4 pieces of 6.5" wide UNI cloth that you cut when you did the first side. Mix up slurry. Slurry the elevator upper surface. The laminate sequence is the same as on the first side - two plies on each elevator +30 degree and -30 degrees. Wrap both plies over the leading edge. Both should lap 1" over the bottom edge plies. Cover the surface of the elevator with 6- mil plastic and rub it down with a squeegee. Then set the elevators down on your table TOP SIDE UP, the old cured lay-up against the surface of the table. Weight the trailing edges with a piece of aluminum extrusion along the trailing edges on the ¼" glass-to-glass transition. Let it cure.



When the skin is cured and solid, but still chemically active, mix up some dry WEST micro and fill the depression in the glass-to-glass transition that you have formed along the TE. When cured sand to a thin edge, just thick enough to hold paint.



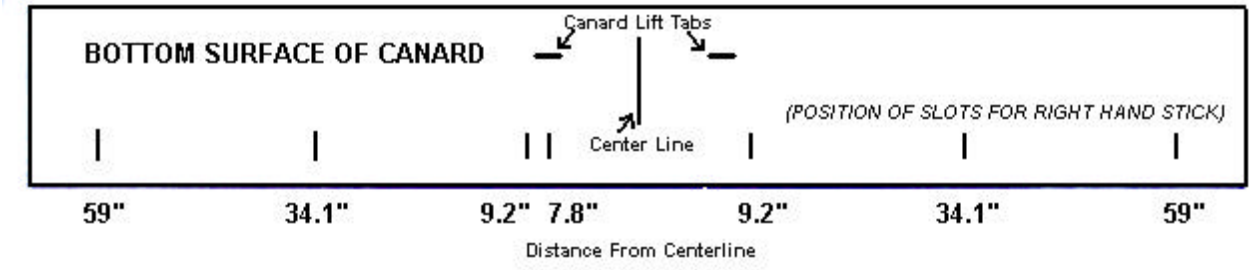
Use a Dremel to remove the glass locally in the area where the NC-3 hinges will insert into the NC-2's. Remove the silver tape that you applied, and clean up the edges.

Square up the outboard ends of each elevator, sand the foam smooth. Use a small flox corner (OK to use dry micro instead of flox here) and lay up 1 ply of BID over the outboard ends.

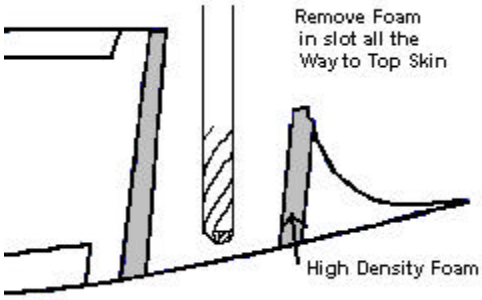
Trim the inboard ends. The total length of the foam and glass part of the elevator should be 51 ¾" measured from the out board end. Square them up and lay up with one ply of BID and flox corners like the outboard ends.

Mounting the Elevator

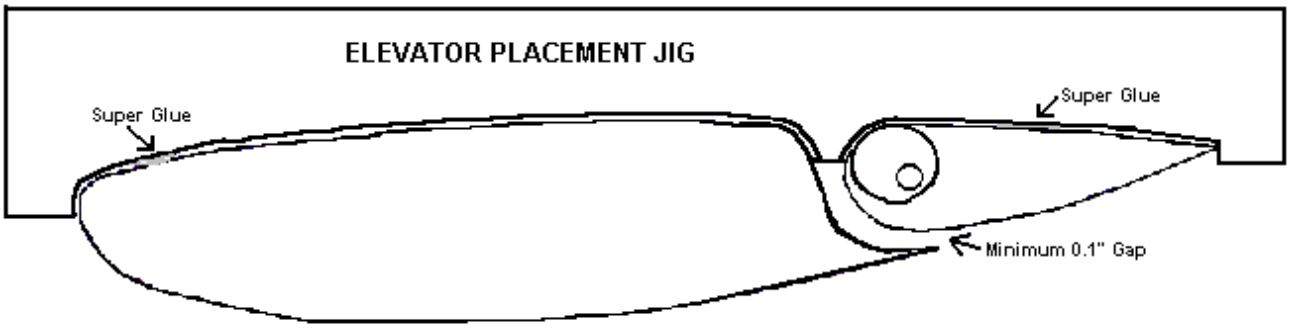
Re-establish the centerline of the canard. Mark the locations for the NC-3 hinges by measuring from the centerline, or by mounting the hinges in the elevator and transferring directly. The centers of the slots should be 7.8"(control stick side), 9.2", 34.1", and 59" from the centerline. Mark the length of the slots using the skreet template included.



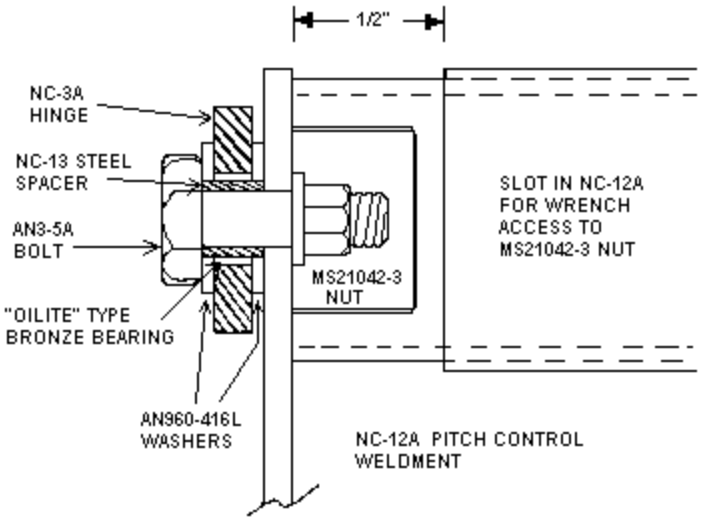
Using a drill with a ¼" bit as a "router", cut out the 7 slots to about ¼" wide. You should be able to smell the PVC foam to be sure you are in the right location. Gently remove the foam all the way to the top skin. Slide the NC-3 hinges into the slot to ensure good clearance.



Check to see that you elevators are perfectly straight. If not see the tapes to show how to correct this.

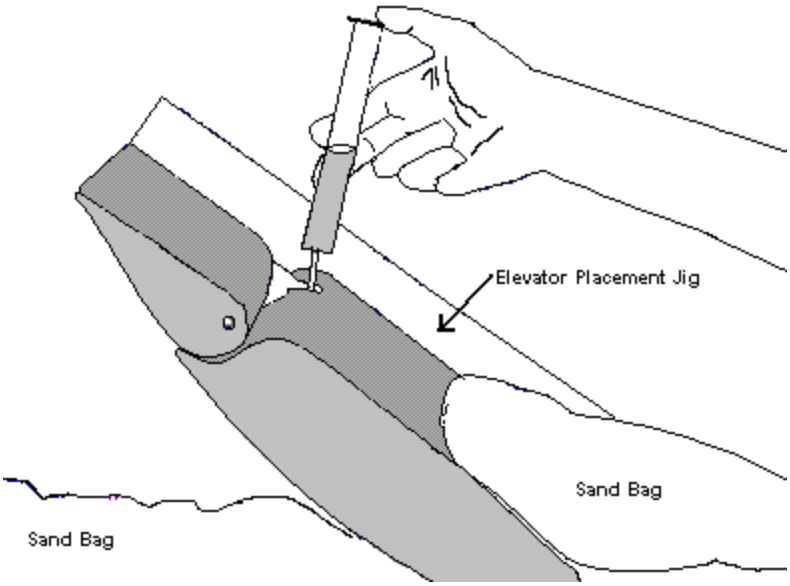


With the NC-3 hinges mounted and the canard lying upside down on the jig table, mount the elevators to the canard using 3 jigs on each elevator, one near each hinge point. Start by attaching the jig to the canard with small dabs to super-glue or bondo. Then fit the elevator to the template. Slide each of the NC-3 hinges into their respective slots. Be careful of the gap between the canard trailing edge and the top of the elevator. This gap of approximately 0.2" is required so that the slot works properly and to ensure adequate nose down (elevator tailing edge up) authority. Be sure that it is exactly the same width along the entire length of the canard/elevator interface. Small irregularities can be sanded after the hinges set up. The jigs should position the elevators in precisely the correct relationship to the canard. (Assuming that your canard and elevators are the right shape.) Use small dabs of Super Glue to secure the jigs to the elevators. Slip an appropriate width piece of metal or tongue depressors between elevator and canard in the gap at the same station as the jig to maintain the proper relationship.

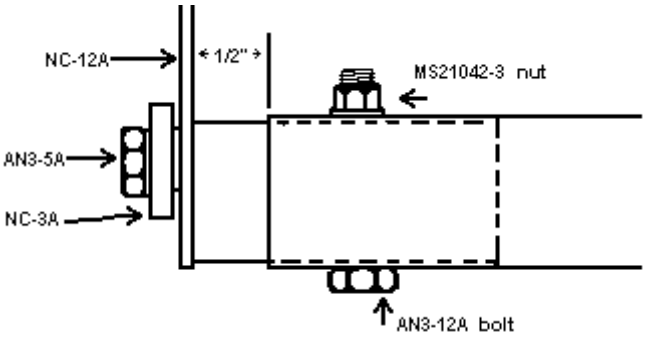


Slip the NC-12A weldments (horns) into the inboard ends of each torque tube. Line them up by sighting down the tube. The hinge holes and the bolt hole in the NC-12A should be in perfect alignment. Mount the NC-3 hinges in each elevator. If you have trouble pushing the hinge pins into the elevator carefully bend them slightly to align them by pushing and rotating them. Temporarily mount the NC-3A hinges using an AN3-5A bolt and 10-32 hardware store mock-up nuts. (*There are three methods you can chose to secure the NCC-12A weldments in place for this process: place the permanent bolt, superglue them, or "float" them until you get the NC-3A hinges potted in place and set-up. Chose the method you are most comfortable with.)* Be careful handling the left elevator; it is delicate at the inboard NC-2 insert at this point. Mount a bushing with a bolt between the two horns to ensure that the two elevators a perfectly aligned with each other.

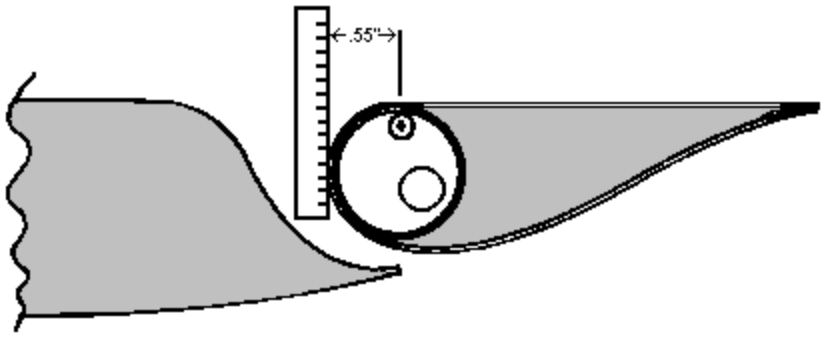
Use sand bags to position the canard/elevators so the slots are facing upward. (*You may want to fill the bottom of the slot with a small amount of wet flox at this point.)* Mix up a batch of wet flox. It should be about the consistency of honey or slightly thicker. Inject it into the slots with a syringe or pastry bag, jiggling the NC-3 hinges to remove any bubbles. (Air is a poor structural material.) The slots should be slightly under filled so the wet flox doesn't run out all over the canard. Spills are a real nuisance to sand later. Allow to set up to the B stage, and then top off the slots with thicker flox that is less prone to running.



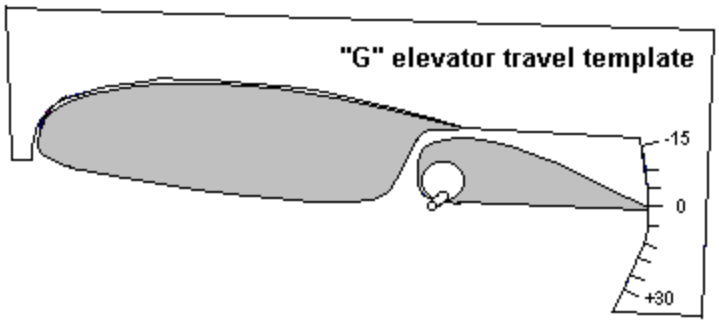
Allow to cure.



Now, if you have not already done it, drill the #12 holes through the elevator torque tubes and the NC-12A weldments to secure them in their correct positions. Check that the NC-12A weldments are correctly positioned by bolting them to each other using an AN2-21A bolt and appropriate spacer (a piece of scrap tubing 2 ¼" long. Swing the NC-12As fore and aft by pivoting them in the torque tubes. Hold a small straight edge vertically against the leading edge of the torque tubes. Measure from the edge of this vertical reference Aft f0.55" as shown. This position should agree with the previous position you determined from "sighting" down the hinge holes.



The AN3-5A bolts (hinge pivots) should be centered at this 0.55" point. Use a clamp to carefully squeeze the torque tube onto the NC-12A weldments, and drill a #30 hole through the torque tube/weldment. Change to a #12 drill and carefully open the #30 hole to #12. Install an AN3-12A bolt and MS21042-3 nut on each elevator torque tube. The bolt should be clear of the slot at both the fully extended and fully retracted positions.



Break off the (L) jigs and check your elevator travel using the (G) template. Your elevators should easily swing trailing edge down (nose up command) to the +30º position shown on Template (G). They should also swing trailing edge up (nose down command) to -15º. If you have not done this right, (perhaps your elevators are too fat), you may not be able to get to -15º. A little judicious sanding of the underside of the canard trailing edge will help. Consider -12.5º to be the absolute minimum nose down (trailing edge up) position. Less than -12.5º will not give you sufficient nose down authority.

Canard Tips

We are including the canard tips here for clarity but suggest you actually wait to install them until after mounting the canard in Kit-B.

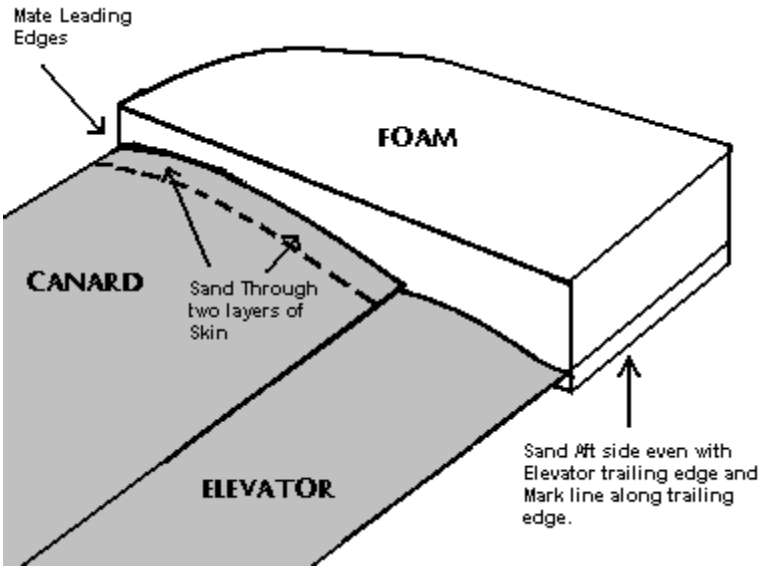
Reinstall one jig (L) on each elevator to position the elevators at 0º which should correspond very closely to the cruise position of your elevators in flight,) at least at a mid to mid/aft CG position).

Locate the precut foam cores supplied in your kit. They should be mirror images of each other. The blocks should be at least 13" X 4 ¾" X 3". First you need to decide which type tip you are going to carve, the straight tip, which follows the contour of the canard and elevator or the curved tip. The tip that you choose is largely a matter of taste and esthetics. It does not seem to affect performance or handling noticeably.

Carve slowly and carefully to avoid breaking or gouging chunks out. Shape both tips moving back and forth between them frequently rather than completing one first. They will match more easily.

Place the curved template on the foam and draw the leading edge curve with a sharpie. Carve the leading edge curve or cut out on band saw. Compare the two tips to be sure that they are perfectly symmetrical before bonding in place. Note that the hinge pins NC-8L and NC-8R will protrude out of the end of the elevators and through the wingtip foam blocks. When you micro these foam blocks onto the ends of the canard, you will have to sand a slot to allow the hinge pins to protrude through. Sand the slot large enough to allow installation of a brass tube in the foam block, surrounding the hinge pin. It is probably easier to install these brass tubes after the tip is glassed, just before glassing the bottom skin. Note that these blocks are deliberately oversize. They should allow some excess foam along the top, bottom and aft surfaces to allow for contouring,

Sand the canard tips to create a lip ~1 " wide reducing the thickness of the skin by two or three layers.



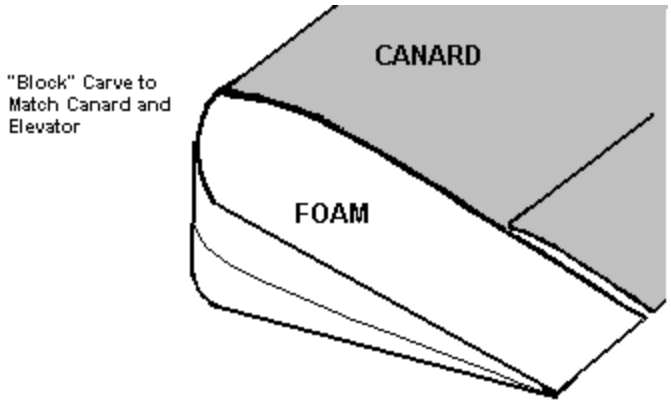
Straight Tips

Bond the tips in place using West or 5-min. Epoxy or EZ-Poxy and micro. Hold the foam in position with dry wall screws the same way you did when bonding the wing sections.
Allow to cure. Then remove the screws.

Sand the aft edge of the foam to match the trailing edge of the elevators. Draw a straight line across the trailing edge of the foam in line with the trailing edge of the elevators. Mark the center leading edge of the canard and draw a line along

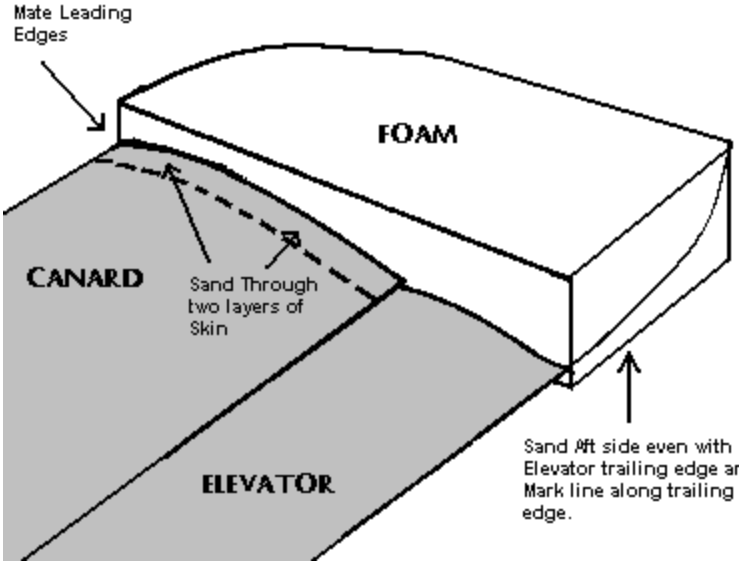
the lateral edge of the foam connecting these two points.

Rough shape the upper surface of the blocks to match the upper contour of the canard and elevator with the elevator in neutral position. The shape should be parallel to the canard surface, just enough lower than the surface to allow for two layers of glass. When this surface is "block shaped" on both tips to your satisfaction, flip the whole structure over and shape the bottom surface in a similar fashion.

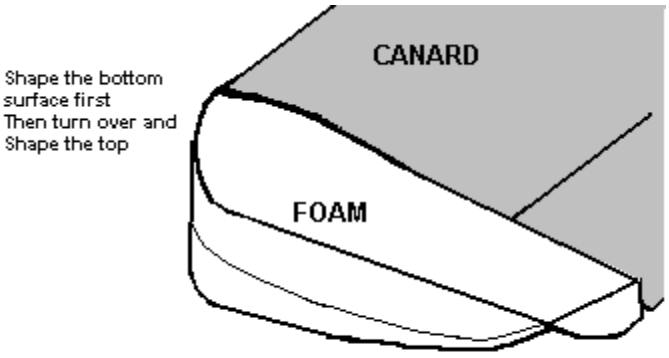


Radius the tips of the lower surface up to, but not sanding the center line that you established on the lateral side of your block.

Upsweep Tips



Begin with two foam blocks the same dimensions used for the straight tips: 13"X4 ¾"X3". Place the curved template on the foam and draw the leading edge curve with a sharpie. Carve the leading edge curve or cut out on band saw. Sand the slot for your hinge pin. You will mount the block slightly below canter on the canard to allow for the up sweep. Draw your guiding lines on the foam block. The trailing edge should be a semi-circle starting at the elevator trailing edge and sweeping upward to the upper-outer corner of the block. The side begins at the leading edge centerline and follows the same line as the straight tip to about halfway along the side. From the halfway point to the trailing edge it sweeps up to meet the line along the back edge, in the corner.



Attach the foam blocks to the canard tips with dry wall screws; you know the drill. Do not bond the tips yet. We are going to remove them to check their symmetry later.

Start your shaping with block forms first, moving from one tip to the other with each step. Shape the top surface leading edge to match the

leading edge of the canard, leaving the trailing edge intact until later. Flip the canard over, very carefully. Shape the bottom surface leading edge to match the canard leading edge. At about half way between leading and trailing edge begin to sweep the tip upward. Remember the inboard trailing edge should match the trailing edge of the elevator with the elevator positioned at neutral. Work slowly and carefully and step back frequently to get a perspective of your shape. Keep the outboard trailing edge parallel to the centerline of the canard.

Turn the canard over. Block shape the top trailing edge, trimming off the excess foam on the top surface as seen in the video. Radius the leading edge. Taper backward shaping the inboard edges to match the canard and elevator and sweep the outboard edge to match the sweep that you established with the lower surface. Keep all the contours smooth and aerodynamic. There should be on abrupt changes in the surface planes.

Remove the two tips and compare them, holding the two inboard ends together. Hold the tips in front of you on rotate them gently comparing the surface and making minor adjustments in the contour until they are perfectly symmetric. Bond the tips in place using West or 5-min. Epoxy or EZ-Poxy and micro. Hold the foam in position with dry wall screws the same way you did when bonding the wing sections.

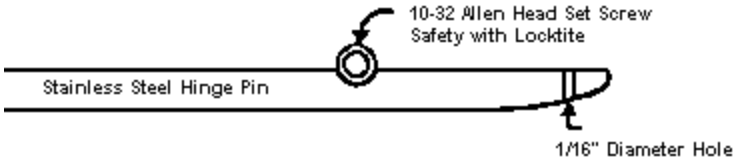
Allow to cure. Then remove the screws.

Both Tip Shapes

Silver tape the elevator surfaces adjacent to the tips to avoid contamination.

Start with the bottom surface. Place jigs on the bottom surface of the canard and elevator to hold the elevator in neutral position. Apply silver tape to the outboard edge of the elevators, adjacent to the tip foam. Double check several contours before you begin to glass: The trailing edges of the elevator and trailing edge of the tips should be in a perfectly straight line looking down from above. The inboard edge of the tip should be perfectly parallel to the outboard edge of the elevator. Outboard edge of the tip should be parallel to the centerline of the canard.

Drill a #40 hole in the tip of your hinge pins about 3/16" from the outboard end.



Fit a 7/32" brass tube over the hinge pin. It should slide over the hinge pin easily without binding. You should have this in your kit, but if you don't, or you ruin yours you should be able to find a replacement at your local hobby shop. Pre-shape the tube to fit in the wing tip, just short of the foam on the inboard side and tapered to follow the wing tip contour on the outboard side. Sand the tube and bond the tube in place with 5-minute epoxy micro, being careful to avoid getting micro on the hinge pin or inside the tube. Pull the hinge pin out carefully and allow to set up. Sand any excess micro to match the original contour of the bottom surface.

Slide a piece of scrap ¼" tubing inside the brass tube to keep it free of debris. Slurry the bottom surface of the canard tips with West micro. Slurry up to, but not over the centerline. Pack thicker

micro around the brass tube to fill any gaps. Paint the "lip" on the outboard edge of the canard with resin. Lay-up two layers of BID cloth, cut on the bias. Leave the cloth long around the edges and let it hang off the edge similar to the way you did on the wing leading edges. Lap the cloth onto the elevator where it is protected by the silver tape. This will give you a nice straight surface, which will be perfectly aligned with the elevators after trimming. Allow to cure.

Trim the excess cloth to the centerline on the outboard edges and feather them to a smooth transition. Trim the trailing edge to match the elevator trailing edge and trim the inboard edge of the tip leaving about 1/8" gap between the elevator and tip. Trim and grind the cloth from the outboard end of the brass tube and slip your ¼" scrap tube back in to protect it. Surface the tip with a thick coat of West micro avoiding the area where the top skin will lap onto the bottom surface. Remove the piece of scrap tubing being careful to not disturb the micro.

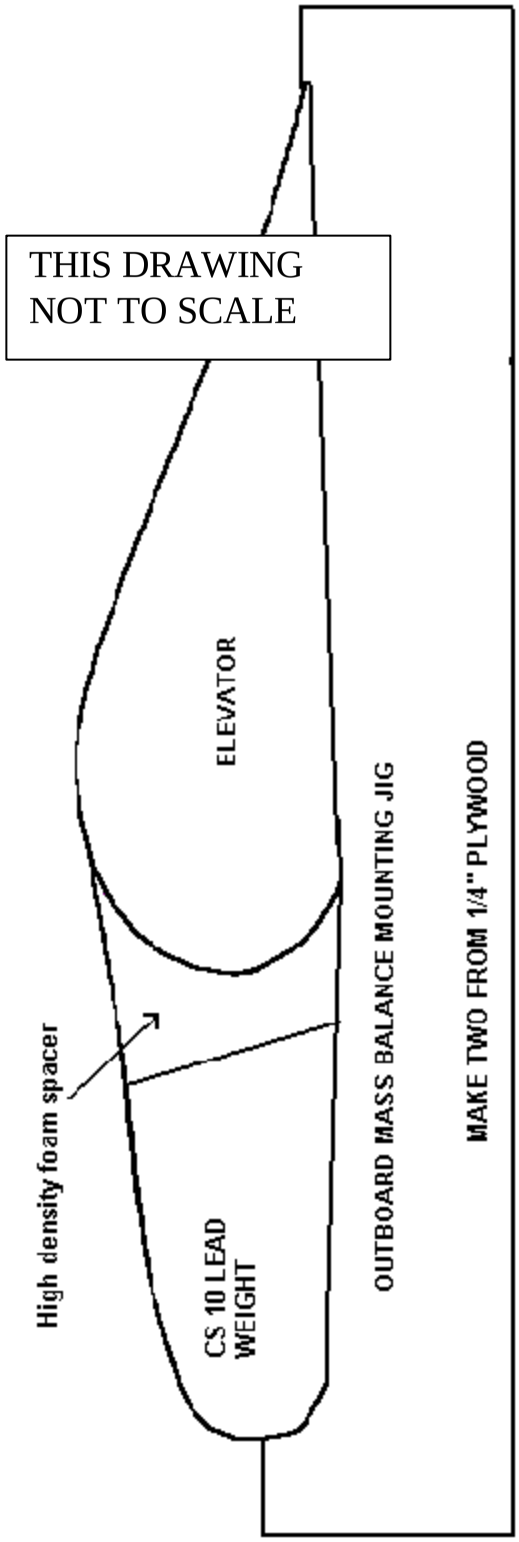
Turn the structure over to the topside. Remove 3/8" of foam from the trailing edge of the tip and around the corner onto the lateral edge where the edge is too sharp to wrap cloth around it. Apply dry micro *(or flox)* in this area. (*Micro will be strong enough to protect the tip from people who walk into it inadvertently, but if you want to eviscerate them for being so clumsy around your precious airplane use flox.)* Slurry the topside. Paint the "lip" of the canard. Apply two plies of BID cloth to the top surface lapping over onto the bottom surface about ½" to ¾" as far along the edge as you can. Trim the edge and leave it unwrapped where the edge gets too narrow and along the trailing edge. Cure to the B-stage and Surface with a thick coat of West micro. When the micro is cured, sand to a nice smooth surface.

Confirm that the inboard edge of the canard tip and the outboard edge of the elevator are parallel. There should be enough gap to allow the elevator to move freely with the addition of one layer of BID to the tip foam. If you haven't glassed the outboard elevator edge you will need to do that now as well.

Clean around the edges of the skin and tube about 3/16" wide like you are prepping for a flox corner, but you will use micro instead. Brush the surface with pure resin. Slurry the exposed foam with west slurry and pack the depression with dry micro. Lay-up one layer of bid over the surface. Cure and trim. Drill out the opening to the brass elevator hinge pin tube.

Elevator Counter Weights

Make your counter weight jigs from the template. Rough cut the spacer blocks from high-density foam. Hand file the curved surface to exactly fit the torque tube.



Bond the lead weight to the foam using 5-minute epoxy. When it has set up, sand the edges of the foam to final shape (leave the top and bottom a little over size for now) and reconfirm the fit to the torque tube. Sand the lead weight in preparation for bonding the carbon fiber straps. The outboard counter weight will be placed 6.7" from the outboard end of the elevator. Position the weight on the elevator using the jig that you made earlier. Slurry the curved section of the foam spacer and the tube with 5-minute epoxy micro and clamp the counter weight and jig in their proper position on the elevator as shown in the video. Confirm that the weight is square to the tube and not twisted. Allow to cure.

Sand the bottom surface of the foam block flush with the bottom surface of the elevator and the top surface of the foam so that it forms a nice smooth line with the top surface of the elevator.

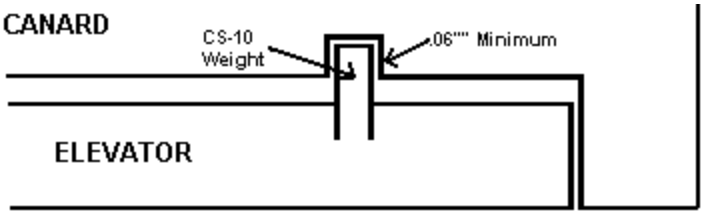
Set up some foam blocks and cut a notch to hold the elevators in a vertical position with the counterweight upright. Cut three straps of Carbon fiber UNI about 1" wide (allow a little extra width for the inevitable raveling of the cloth) and long enough to wrap from 1 ½" from the trailing edge on the top surface of the elevator, over the top of the counter weight and down the bottom surface to within 1 ½" from the trailing edge.

Paint the area the straps will go with EZ-Poxy. Lay-up the straps as described above. The second strap should "step back" ½" per end, i.e. end 2" from the trailing edges. The third should "step back" another ½", i.e. end 2 ½" from the trailing edge. Place peal ply over the portion over the elevator and squeegee to form a smooth transition. If you are tempted to sand this area after cure to form a smooth transition, DON'T. This is one area where strength is far more important than cosmetics; just leave it alone and fill as little as possible.

After everything has cured, paint the sides of the foam spacer block with epoxy and micro balloons to seal the sides.

Next, you will cut the slots for the counterweights in the canard. Mate the elevator to the canard. Mark the sides of the slots by drawing a line on either side of the counter balance weights. Cut straight down into the skin an each side and forward edge, just short

of where you will eventually trim. Take a chisel and remove the skin and foam in this area as per the videotape. Clean out the foam down to the inside surface of the top skin. Do a trial fit.



Clean and trim the slots to allow enough room for free movement of the weight in the slot plus room for 2 plys of BID cloth. The gap should be a little over .1" per side and leave ample room for the weight on the forward side. Move the elevator up and down to ensure room through its entire travel. If necessary sand a little of the trailing edge of the canard to allow room for the build up of the straps holding the counter weight in place.

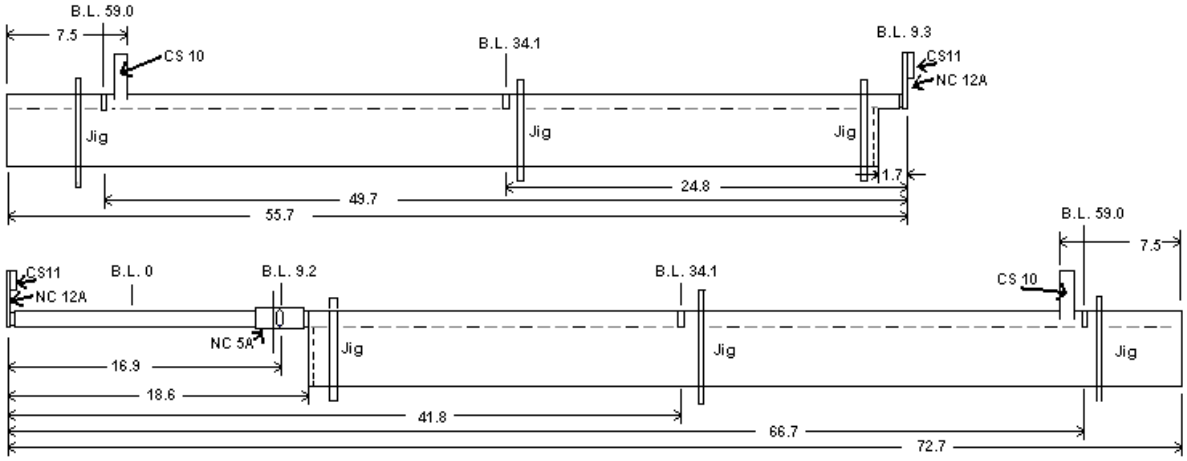
Sand the slot and remove a small rim of foam to form a flox or micro corner. Cut two pieces of BID cloth on the bias about 7" X 5". Slurry the sides and back of the slot. Paint the exposed underside of the canard skin with pure resin. Place the cloth inside the slot and wet out with EZ-Poxy, being careful to avoid wrinkles and get the cloth pushed into all the corners. Apply second cloth in the same way stepping the second layer back about ¼" from the trailing edge to avoid build up in this area. Be sure to wet out both layers to the very edge. Cure to B stage and trim.

The inboard weight is attached to the NC-12A weldments, it doesn't really matter which side. Dave mounts them to the outboard side in the video. Drill the holes in the rectangular lead weights found in your kit. Spacing is not critical. Drill slowly through the lead. Mate the weights to the NC-12A and mark matching spots, and drill to 3/16". Counter sink the outboard side of the lead weight 3/8" in diameter and just deep enough to allow two MS2104-3 nuts to end up flush with the surface.

Attach the screws (standard machine screw will do) and nuts - don't over tighten. Remember the lead is soft.

Attach the elevators to the canard the elevators should hang with the weights down, (trailing edge up). If there is any tendency for them to balance the other way sand your elevator to remove as much weight as you can. If they still balance the wrong way remove them and start all over. *(Remember they must balance after paint is applied.)*

Install the elevators. Push the hinge pins in flush with the wing tips. (You did drill those little holes in the hinge pins so that you can get them back out didn't you?) Use a sharp scribe to scratch a mark on the pin through the 10-32 tapped hole in the end of the elevator in the NC-6's. Withdraw the hinge pins by placing a small Allen wrench or awl in the 1/16" hole in the hinge pin. File a notch in the hinge pin at the scribed mark. This should be just deep enough to allow a 10-32 setscrew to be installed in the ends of each elevator to lock the hinge pins into the elevators. File a little at a time until the screw will just barely thread into the hole.



ELEVATOR OVERVIEW

Antenna

What follows is the way I did it; the first time I installed a copper foil antenna on the bottom of a Berkut canard.

Lay out the precise position and placement of the antenna in pencil and check for lack of continuity in the zinc primer [grey] or titanium-dioxide based [white] primer, both All Grip. After having determined lack of significant continuity and/or conductivity I decided to take a chance and install the foils directly on top of the primer, the primer thus serving as my insulator. Sand the area for bonding with 220-grit, sand lightly just enough to get a bond do not sand through the primer to the carbon fiber. The primer will remain chemically active forever so don't worry about just lightly sanding. Wipe off all the dust, pack down and rub the foils with a tissue to make sure they are down.

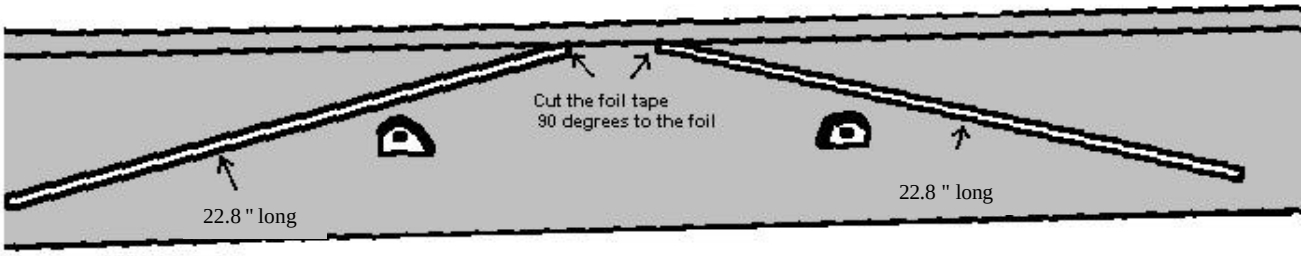
Check the continuity again, there should be none. Then lightly sand the foils with 220-grit. We have to assume at this point that all of you understand the basic antenna assembly methods (torroid beads, angle of foils, length of foils, RG58AU, etc). I will leave all the other details out.

You can use veil, the 2 oz or 4 oz cloth would be sufficient over the foils but the glass tapes are so thin that one should be reluctant to ever sand these surfaces. Before they cure completely, fair in the surface with micro and allow to cure. After curing, sand them out carefully making sure not to sand through the veil of light glass. This is exactly how I installed the foils on the Estonian airplane and the VOR worked fine.

Dave

Lay out the position of your antenna in pencil on the surface of the canard. It should make a "V" starting at the aft of the canard centered between the canard lift tabs and running forward and outward toward the front of the canard. Each tape should be 22.8 " long.

Lightly sand the surface of the canard with 22-grit sand paper, being careful not to sand through the grey primer to the carbon underneath. Trim the end of the copper foil tape, tack the end of the copper tape to your mark at the left outboard end of the canard, tack the foil along the line and pull the little piece of backing paper with it. Cut the foil tape right at your mark on the canard (22.80") at 90° to the foil. Try not to handle the sticky side of the copper tape with your fingers because it will lose its tack. Place the end of the next section of the tape at the right outboard end and tack it down along the line in the same way. Pull the tape tight and straighten it out. Cut the end off. Take out a paper towel and wipe the whole tape clean. Don't use your finger because your finger will rub on body oil and nothing will want to stick to the top of it. We're still going to take 220-grit sandpaper and etch it, in an attempt to get the glass to stick to the top of it. Really the glass is only capturing it so that it doesn't move. Even if the copper tape debonds and lets go it will be floating inside a fiberglass tape envelope within which it
sits.

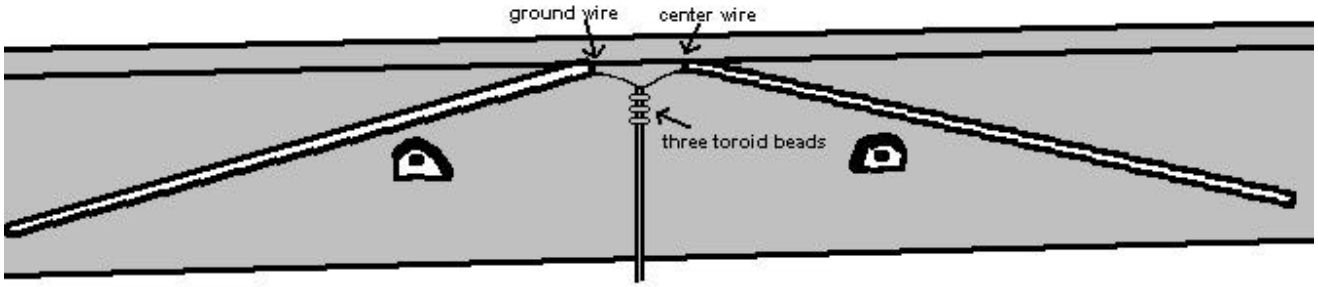


Cut two single ply glass tapes 1" by 24" position them over the foil antennas leaving the inboard ¾" uncovered for soldering to the RG 58AU. You can use veil, the 2 oz or 4 oz cloth would be sufficient over the foils but the glass tapes are so thin that one should be reluctant to ever sand these surfaces. Before they cure completely, fair in the surface with micro and allow to cure. After curing, sand them out carefully making sure not to sand through the veil of light glass.

The torroid beads are going to be placed on the RG 58. We'll strip back about 1" - 1 ½" of the material covering the RG 58AU and open up the shield, not having damaged the shield. The first torroid bead is going to be the thickness of a toroid bead onto the insulation on the RG 58. Then leave a space the thickness of a toroid bead and place another toroid bead. Leave another space the thickness of a toroid bead and place the last toroid bead. Now you have three toroid beads on the RG 58. Super glue them in place.

Strip the end off the tip of the center wire and the ground wire. Put the ground on the left copper foil strip and the center conductor on the right copper foil strip. Solder it at the corners. Then super glue the RG 58 with the beads in place, directly to the skin of the canard. Super glue the RG 58 in place at

the front edge of the copper foil, lead it straight forward to the leaking edge, holding it to the skin at the leading edge.



Do a continuity check with an ohmmeter or continuity meter. Start with the middle conductor at the far end of your RG 58, it should have continuity with the right foil strip. Then go to the left foil strip, there should be no continuity with the middle conductor. Now switch the wire at the opposite end of the RG 58, there should be continuity between it and the left foil strip, but not with the right strip. If at anytime you check it with one of the meter's wires on the right foil strip and one of the meter wires on the left foil strip and you get continuity across the two points; you have a dead short in your system; your radio will not work right and you are likely to fry your radio. So, do be careful.

Take micro and packing it over the top of the toroid beads so that a layer of glass can conform. You don't want a lot of material; you don't need a lot of material. You do want to isolate the toroid beads from vibration. Put a little bit of micro out onto the coaxial cable as well. Cut one small piece of glass that covers the toroid bead area and laps out about ½" all the way around and put that over the top of the beads and micro. Then you can apply little glass tapes in a few positions along the RG 58to make sure that it doesn't move.

Let everything cure.

You will need to file a groove in the F-10 bulkhead for the RG 58 to pass through. More about that in B-kit manual.

Chapter

8

AILERONS

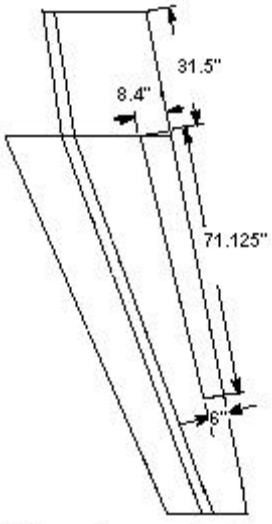
Overview - Aileron installation:
In this chapter you will cut your ailerons from the wings, shape the aileron well, shape the inboard and outboard ends of the aileron well, glass the interior of the aileron well, shape the forward section of the aileron, bond on the counterbalance weight, install the torque tube stub into the aileron, insert and bond the hinge reinforcement plates into the aileron, glass the re-enforcement plates and counter balance weight to the forward section of the aileron, and glass the ends of the aileron.

Rounding the trailing edge

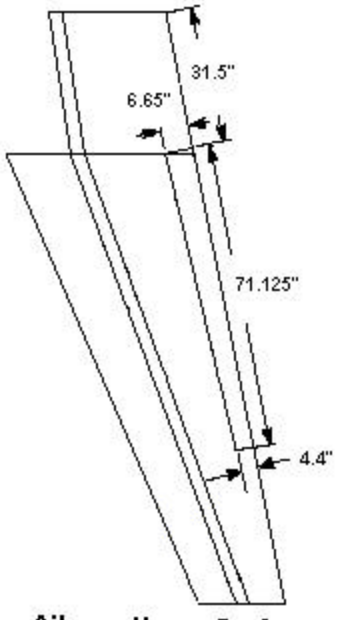
Before we do anything else sand off the razor-sharp TE of the wing, and round it slightly. This is a bit of a judgment call for you, the criteria is simply that the TE is round enough to be able to hold paint. Take your 6" long sanding bar with 80 grit sandpaper and make full, long passes from one end of the wing to the other. If you sand forward about .1" this will create a TE about .05 to .07 thick. Just remember, whatever you do here, you are going to have to be happy with, because all the dimensions from here on out will be measured from the new TE.

Cutting the aileron out of the wing

Take the top and bottom templates you made when you laid the ailerons out on the foam core of your wing. Accurately replace them on their respective skins, and carefully mark the 4 corners of the ailerons - the aileron TE inner and outer, and aileron LE inner and outer, top and bottom. Then use a straight edge to mark in-between these 4 corners on both the top and bottom surfaces. You may be able to see a shadow of the peal ply under the wing skin to further verify that your placement is correct. Remember that the ends of the ailerons are perpendicular to the TE, so you can use a carpenter's square to verify them. The upper surface of the aileron is smaller than the lower surface. The top surface is 6.65" wide at the inboard end and 4.4" wide at the outboard end. The lower surface is 8.4" wide at the inboard end and 6" wide at the outboard end. It is 71.125" long.



Aileron Lower Surface



Aileron Upper Surface

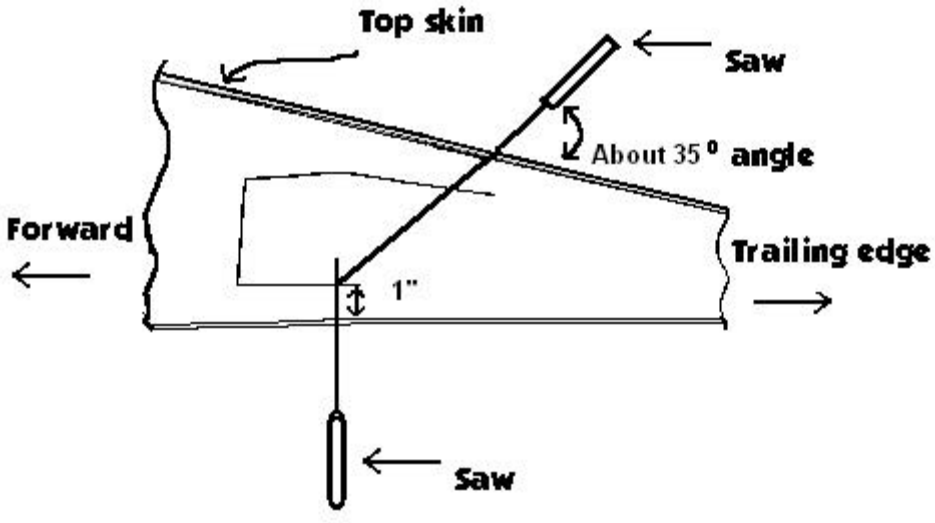
Next, you'll need a saw blade, something with small teeth. If you have the

saw that Dave shows on the video for cutting into the canard core and placing the high density foam hard points - a hacksaw blade with the back side sharpened and brought to a point - use that. If not, make or buy one of the appropriate thickness -- X-ACTO makes a super thin backsaw that will do the job nicely. You want to have the cuts for the ends of the ailerons precisely in plane and in line with one another. Set the wing on its LE and stand over the TE so that you can see both the top and bottom surfaces simultaneously. Then use your saw to cut into the wing from the TE, following the lines on both the top and bottom at the same time. Cut into the wing about .5" or so in this manner, then lay the wing down and make the rest of the cuts through one skin to the aileron LE, flip the wing, and cut the second skin all the way to the aileron LE. Go to the opposite end and repeat.

This is very important. If you hold a straight edge along the line to guide your saw it will result in a perfect or near perfect straight cut. The straighter the line, the better the aileron.

Then, use the same saw blade to cut through the top skin along the aileron LE. Again, use a straight edge to guide your cutting blade. Use a 6" long metal ruler and super glue it to the wing in half a dozen points so it will hold the ruler steady, but not so well that you cannot get it back off later. Glue it to the aileron side of the cut line. (If you do go astray on your cut line the wing side of the cut is easier to repair since there will be five layers of carbon fiber lining the well.) This is particularly important for the cut for the upper skin aileron LE - it will ultimately be the hinge line, and it must be perfectly straight. **As you cut, be careful that you cut just through the skin, and minimize the depth that you cut into the foam core - you will be cutting the core later, and at a different angle.**

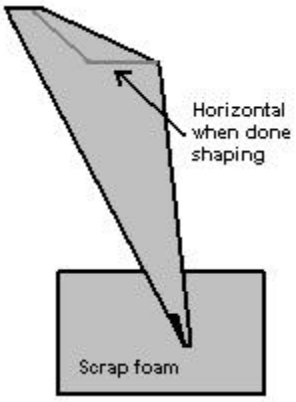
Then turn the wing over and cut the bottom skin aileron LE. On the bottom you can cut deeper into the foam - in fact, you should try to cut at least 1" into the core as you go. Remember that the foam inside the well is going to be removed later anyway. The knife-edge and point on the saw blade will help with this. You'll find that when cutting forward and down from the top skin through the core this blade will be invaluable.



Flip the wing over again and poke the point of the saw blade through the aileron LE cut on the top skin at about 35° measured off the upper skin. You can place an angle finder on the wing skin and have an accomplice sight down the wing, past the saw blade, to set up the proper angle. While holding on to the aileron you will cut down and forward, meeting the cut from the bottom skin. You don't need to be concerned about cutting too deep - any excess cut will be filled with micro later. The idea

here is to leave more foam than necessary on the aileron, then sand to shape. That way irregularities and gouges will be removed during the shaping process and won't need repair. As your cut progresses down the length of the aileron you will find that the aileron attachment becomes more and more flexible - proof positive that the two cuts though the foam core are intersecting within the foam. Finally, the aileron will pop free. Set it gently on the table and say thanks to the composite gods.

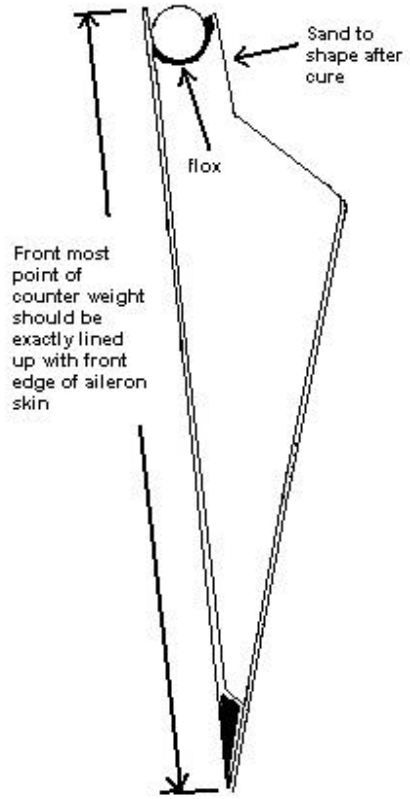
Builder's Tip: Ric and Shari Lee: We used our "Fein saw" to make the initial aileron cuts. This makes a nice narrow cut, but when you cut the angle into the foam from the top surface the cut in the carbon fiber wants to force the saw toward 90 degrees instead of making a nice continuous 35 degree cut along the whole length. It helped to go down the entire length of the aileron and bevel the skin to 35 degrees, then go back and make the cut through the foam. You will be sanding off .1" of the edge and beveling the resultant edge later so this bevel is not critical.



Compare the hinge inserts to the drawing of the aileron cross sections to confirm that they are the correct angle. You may find that bend in the A2s and A5s don't match the angle on your aileron drawings. If this is the case, we apologize -- these parts are purchased from Brock, and we don't check the bend on each one before we ship them. If they don't match, bend them to shape. Cut the correct angles into the ends of the foam using the A2 and A5 hinge inserts. This will establish the angle for the flat face of the aileron. Take a couple of pieces of blue foam, 6" or so wide, a foot long and 8 inches deep, and cut V notches in them. Cut the V notches to hold the aileron as shown in the drawing-- so that when you are done shaping the forward side of the aileron, the large flat face will be horizontal. Once the ends are cut, insert the aileron into the foam. Mark the foam core of the aileron, and check the flat face with a small level to make sure that it's horizontal. Using your long sanding bar with 80 grit sandpaper sand along the hinge line edge of your top aileron skin, just to clean up the saw cut. Your final dimension along the upper surface inboard should be 6.55", +-. 05", and along the upper surface outboard should be 4.3". You want the line to be straight and to the proper dimension, but NOT AT THE EXPENSE OF A LARGE GAP in the hinge line. Repeat this process for the bottom skin - the inboard measurement is 8.3", the outboard is 5.9", all +-.05".

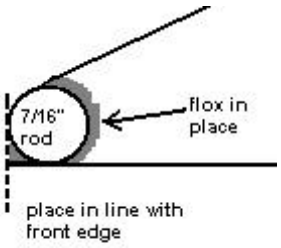
"Thou shalt not defile nor disturb thy aileron top skin LE, for it is thy hinge line, and thou shalt keep it wholly."

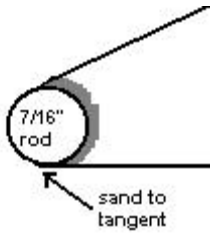
The aileron cross-section drawings indicates the relationship of the counter balance weight and the bottom skin Aileron Leading Edge (ALE). Carefully carve the foam so that you can nest the 7/16" 1018 cold rolled steel counter balance weight directly against the bottom skin Aileron LE, having sanded off the micro that's adhered to the inside of the aileron skin. (Leave the extra foam between the flat portion and the counterweight until after cure) Be careful here, the skin is only 2 plies of carbon uni, .009" thick, so clean the skin, don't remove it. Be sure that your steel rod is perfectly straight before you install it. Cut it exactly to length (it will be the same length as your aileron, of course), clean it with lacquer thinner other degreasing solvent (MEK, Acetone, whatever you choose to kill off those pesky surplus brain cells) sand the whole thing vigorously with 80 grit sandpaper, brush WEST resin on the portion of the counter-balance where it will bond to the aileron core and the



bottom aileron skin, coat the matching core face with WEST flox, and set the counter balance weight into the depression. Let the thing cure.

Use sand paper (80 or 36 grit) to remove just enough of the skin so that the LE itself is perfectly tangent to the weight, and tapered to eliminate any joggles there.

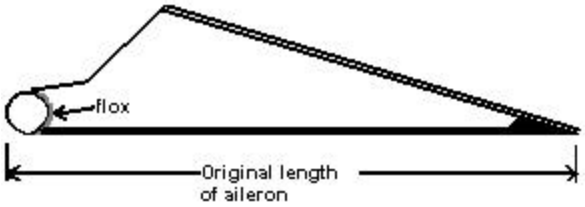




Let's be thoroughly redundant about this. You want to have an utterly smooth, rounded, perfect transition from the aileron lower skin around the counterbalance weight. You will soon be wrapping bid over this, and you want it to be right.

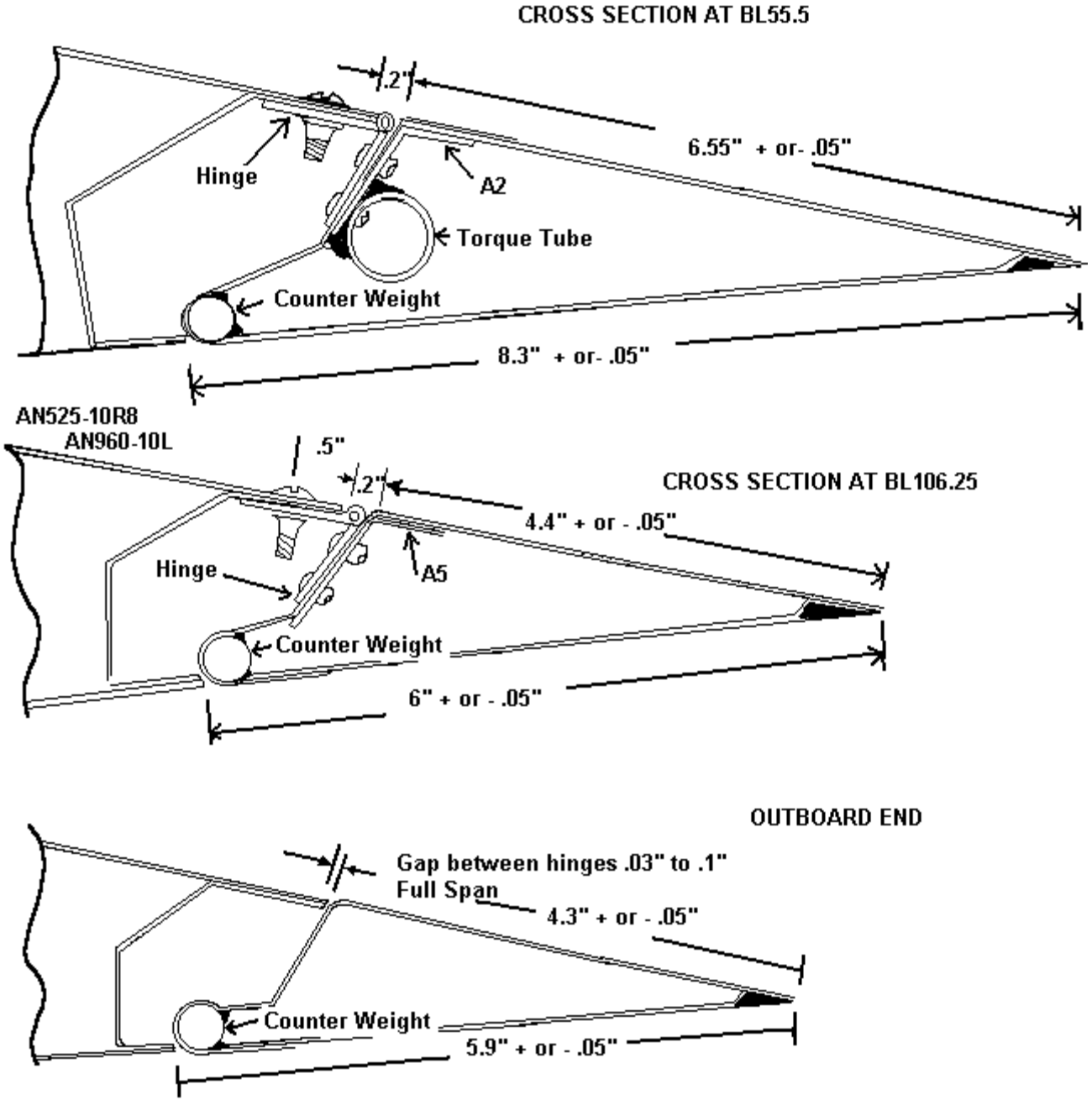
> IF YOU LEAVE ANY JOGGLES, RIDGES, LIPS OR SQUARENESS IN THIS AREA, IT WILL MESS UP THE FEEL OF YOUR AILERONS IN FLIGHT. WE GUARANTEE IT.

Builder tip: James Redmond: As an alternate method of placing the counter balance, calculate the amount of aileron skin which needs to be removed. Trim or sand the skin down to that dimension. Release tape a perfectly flat surface (aluminum extrusion or ruler) Apply a liberal amount of flox along the edge of the aileron and counter weight and squish the counterweight into place. Double and triple check to ensure that the leading edge of the counter weight is exactly the correct distance from the trailing edge of the aileron at both ends and let cure.



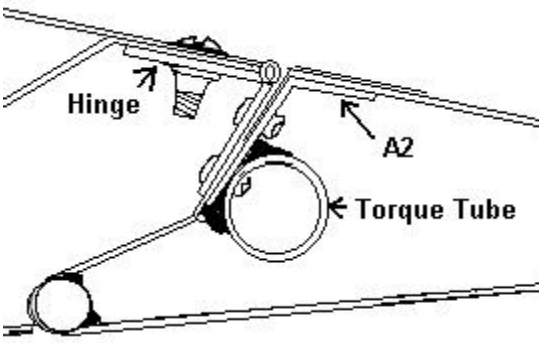
Theoretically, the flox along the aileron lower LE will fill any gaps making the edge absolutely laser straight. If it is, then all you have to do to make the lower skin perfectly tangent to the counter balance weight is to fill any gaps. Of course, this is probably not the case. There may be a couple of places where your cut line wavered enough that portions of the lower aileron skin protrudes forward past that point of tangency. If this is the case, use sand paper (80 or 36 grit) to remove just enough of the skin so that the LE itself is perfectly tangent to the weight, and tapered to eliminate any joggles there.

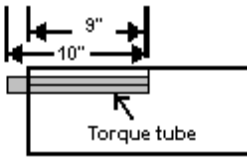
The drawing of the aileron inboard end shows the placement of the aileron torque tube. It sits beneath the A2 insert that, in turn, goes beneath the upper skin. Before we go into the placement of the torque tube we will notch under the inboard upper skin with a hacksaw blade the length and width of the



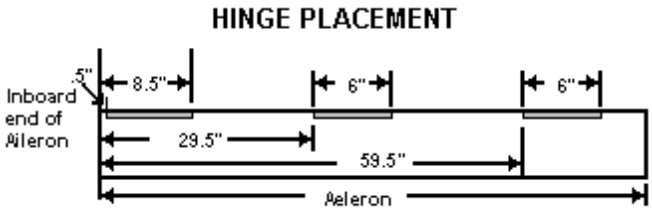
inserts. There are three. As you remove the foam from beneath the skin try to keep the blade directly against the skin, and as you cut scrape to remove micro from the underside of the wing skin.
You don't have to remove all of it - after all, you'll be using flox to bond the A2 insert in place.

You have both 2 A2 and 4 A5 hinge inserts. The A2s are the 9" long ones. Slide the A2 into the slot so that the inboard end of the insert is flush with the inboard end of the aileron, and the long edge is flush with the aileron leading edge foam. Mark on the foam around the perimeter of the A2 insert. Remove the insert and sand the foam down approximately the thickness of the insert. Locate the Stub torque tubes. You will need two (one for each aileron). They should be 10" long, 2024-T3 aluminum, ¾" OD and either .063 or .065 wall. Again checking the dimensions in your drawing, use rotary file that you used to dig out the foam for your bolt access holes to cut out a trough for your torque tube stub. Be certain that this places the tube far enough under the A2 insert so as to provide enough overlap of A2 over the tube to make pop riveting of the tube to the A2 definite. You need 1/8" to 1/4" overlap. The tube extends 1" past the end of the aileron.

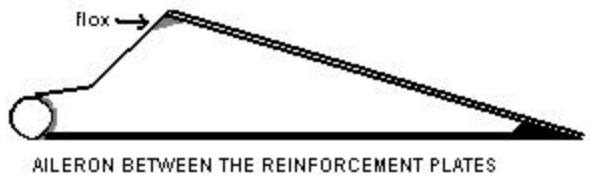




So, mark where your hinges will go. The inboard hinge will start flush with the inboard end or ½" from the inboard end of the aileron, and then extend outboard 8" or 8.5". The starting point of the first hinge depends upon how you cut your ailerons. If you cut them exactly on the BL 55.5, then the hinge is placed flush with the end. If you cut your ailerons a little inboard of the BL 55.5 , then you should shift the hinge outboard or it will not line up perfectly with the other hinges and hang up. (Remember the wing changes angle at BL55.5.) The middle will start 29.5 inches from the inboard end of the aileron, and is 6 inches long, extending to 35.5". Finally, the outboard hinge will start 59.5" from the inboard end of the aileron, and it too is 6" long, extending to 65.5".



The inserts are 1" longer than the hinges. Mark the dimensions on your other two inserts - the A5s - and prepare the aileron for them in the same way - the middle one will go from 29" from the inboard end of the aileron to 36", and the outboard one will go from 59" to 66", again from the inboard end of the aileron. The end result is, the hinges will be centered on the inserts with 1/2 " on each end. Place the inserts under the skin, mark their perimeters, and sand depressions for them, leaving them flush with the diagonal foam face. In-between the A-2 and A-5 inserts, along the aileron top skin LE, remove a small, triangular wedge of foam to form a flox corner, as in the drawing.



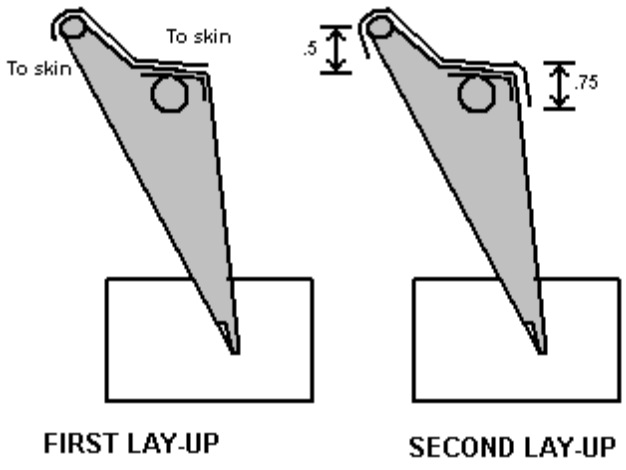
(I f thou did defile thy holy hinge line, anoint it with ample amounts of flox

and restore it to wholiness.)

Prepare the A2 and A5s for bonding. You can either sand them thoroughly or use Alumiprep (follow the directions on the bottle, and don't dissolve them entirely).

Finally, prepare the stub torque tube for bonding. Again, use sandpaper or Alumiprep, but this time, in addition, you will "Golf ball" the exterior of the part. This involves using a drill -- approx. 1/8" dia. -- to drill small depressions into the exterior of the tube, approximating the dimples on a golf ball. Don't drill all the way through the wall of the tube -- you don't want a hole, just a dimple where hardened epoxy will mechanically grab onto the tube. If you happen to drill all the way through the tube in a few places, don't sweat it; you just don't want to place those holes under the A2 where the pop rivets will ultimately go. Drill a ___ hole 3/8" from the inboard end to attach a universal joint. Be very careful when you drill the hole trough the torque tube and universal joint. It is critical to get a nice round hole with a velvet smooth fit of you're AN-3 bolt. Any sloppiness in this fit will translate to strange handling characteristics in the ailerons, such as "grabby ailerons". When you mount the torque tube orient the tube so that this hole is horizontal.

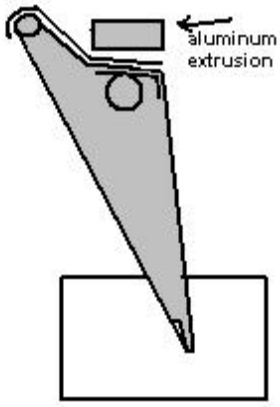
Get out your roll of bid glass and cut two pieces 6.5" wide on the bias, full width across the roll. Then cut two more 3.5 wide by the full diagonal width. The reason for the different widths is that the first ply will go from the hinge line to the bottom of the counter balance weight, where the bottom skin ends. The second ply will lap fully .75" on the top of your aileron, around the hinge line, along the counter balance upper surface, and .5 inch onto the bottom surface. The reason the second ply is over wide is that you will pull it, to stretch it longer and make it just the perfect width at the wide end. As you do so the fibers will splay wider than 45 degrees, and make it easier to wrap the cloth around the hinge line. Even stretched it will be wider than it needs to be at the narrow, outboard end, so you'll trim it to the proper dimensions.



The next step will entail the placement of the aileron stub torque tube, the placement of the A2 over the tube, the installation of the A5s and the filling of the flox corner along the hinge line. Any other imperfections along the diagonal foam face will also be filled with dry micro at this time, in anticipation of skinning. To proceed with all this, you must have already prepared the A2s and 5's, and the torque tube stub must be cleaned and prepped. A2 and 5 slots must be prepared and perfect. Depressions for A2s and 5's in the diagonal foam face must be prepared, and the aileron must be properly placed in foam blocks. West resin is going to be used for this step, with the slow hardener (206). Mix up a couple of shots of WEST and mix to a slurry consistency. Use this slurry to coat the inside of the stub torque tube depression. Paint the torque tube with pure resin and squish it into the

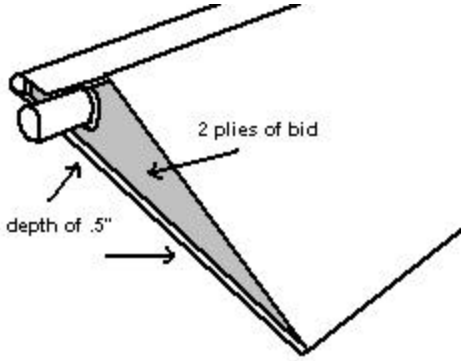
slurry mixture at the bottom of the depression. Fill what voids are left with very dry micro till it fits flush with the bottom of the A2 depression.

Take the pure resin that you have mixed, add micro till it is just thicker than pourable. Trowel, push and force the material into the A2 and A5 slots, -push in enough that there will be no voids left. Make sure that Pick up the A2/5 and push them into their respective slots. Paint pure resin into the .25" flox corner slot between the hinges, pack with flox. Apply the 3.5” BID, lay it up right along the hinge line at the top, and it should be long enough to wrap just to the tangent point between the weight and the bottom skin. If the ply isn’t long enough, don’t lap a second piece -- cut the first piece off square, and then " butt" the second piece up to it. The A2s and A5 are probably riding just above contour on a cushion of dry micro. That’s OK - you’ll ultimately want them flush as you can with the diagonal foam face, but it’s even more important that they be in plane with one another. There is a simple way to achieve that - use a straight aluminum extrusion to force them into their final position. First, make sure that there aren’t any voids around the edges of the plates - if there are fill them with dry micro. Cover with peel ply or Teflon release material. Then cover the extrusion with a release film of one kind or another - silver tape, etc. Use the extrusion to press the A2 and A5s flush with the foam, then leave it there resting on the A2/5s. This is the reason we wanted the aileron to be at an angle in the foam blocks, so that the extrusion doesn’t slide off. Allow to cure.



After cure pull the peel ply and lightly bar sand the hinge line surface to a radius just large enough for glass to go around easily - about 1/32" radius, the thickness of a pencil lead. Carefully sand a 1" wide swath of the carbon fiber on the wing skin, just aft of the flox corner that you just radiused. Sand 1” directly adjacent to the counter balance weight on the bottom side as well.

This lay-up will be in EZ poxy, and it should be resin rich rather than lean (this is all forward of the hinge line, so any extra weight will only help to counterbalance the mass of the aileron.) So stretch the 6.5" wide ply of BID, lay it up .75” beyond the hinge line, down the diagonal face and across the counterbalance lip, and let it hang down off the weight. Trim it so it will wrap .5” beyond the weight on the bottom side. Then wet it out along the bottom. If the ply isn’t long enough, don’t lap a second piece -- cut the first piece off square, and then " butt" the second piece up to it. If the ply That you applied earlier wasn’t long enough, start the second ply at the opposite end, so if there is a second but it will be at the opposite end. Lay them up, and let them cure.



Next, you need to close out the ends of the ailerons. Dig out the foam from the end of the aileron, to a depth of .5" You’ll dig out the entire end of the aileron, including the lip that goes out to the counterbalance weight. There should be a strip of peel ply tape just about that width on the inside of the skin. Once you have removed the foam, lift the edge of the peel ply with a utility knife, grab it and strip it away. If your fingers aren’t strong enough use a pair of pliers. Then sand the inside of the skin with 80-grit sandpaper. Then sand the

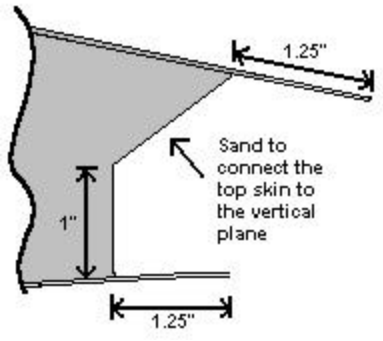
bottom of the depression flat, using 36, then 80 grit sandpaper. This is kind of a miniature version of the inboard end of the wing, just .5" deep instead of 6". Apply a micro fillet to the corners, slurry the foam face (be cautious not to get any micro on the inside of the aileron skin) then lay in 2 plies of bid into the depression, having cut your glass large enough that it will exceed the glass-to- glass area around the perimeter by .25". Use WEST epoxy. When you do the inboard end, make sure that you thoroughly sand the portion of the torque tube in the depression so that the glass will bond to it as well.

Aileron Well

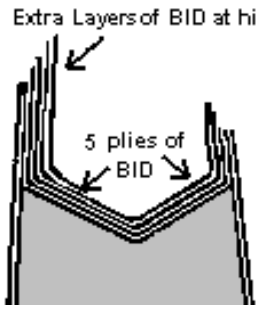
You will find this a rather interesting challenge. If you follow the step-by-step instructions, you will find that the angles define themselves and it is tedious but not difficult.

The Berkut carbon fiber wings are much stiffer than the Long EZ wings and give a much quicker faster roll rate. We will glass the aileron well with carbon fiber BID to match the stiffness of the wing itself. Order about 5 yards. You want enough to do the job but without a lot of excess. (You could probably do it with 4 yards, but there will be absolutely no margin for error.)

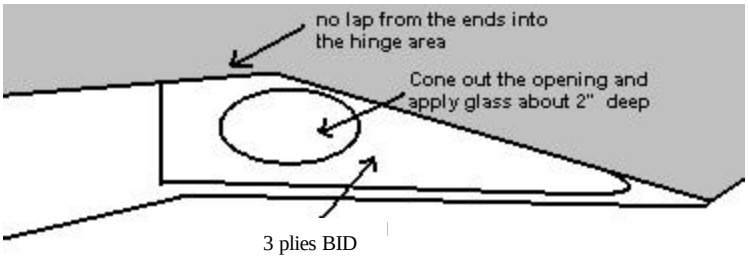
When you did your wing skin you applied peel ply tape 1" wide, both top and bottom, along this line. This will be a glass-to-glass area just forward of the hinge line. Go ahead and remove enough foam so that you can grab hold of the peel ply tapes (providing you put them there - if not, you'll have to sand off the micro slurry on the inside of the skins, no big deal) - grab them and pull them out, then sand the inside of the skins with 80 grit. Since we are adding 5 plys of carbon fiber in the well, sand the carbon fiber back just a little farther making these glass-to-glass areas 1.25" deep. Use a coarse wood rasp to remove the majority of the foam Then change to a sanding block about 1" wide and 3' long. Start with 36-grit sandpaper, then 80-grit and sand the foam smooth.



First sand a 1" vertical plane approximately perpendicular to the bottom skin. Then sand a plane connecting the top skin to the first plane. Once the faces are sanded dig out the two ends of the well to a depth of .5", just like the ends of the ailerons. You may have to have to make some special tools to do this - a popular one is a piece of tongue depressor covered with sandpaper, glued to another tongue depressor as a handle. Glass the faces, 5 plies of carbon fiber BID on the bias, the full length of the well. Then cut 2 plies of carbon fiber BID and one ply of glass BID for each hinge (3 per wing, 6 hinges, 12 pieces of carbon fiber BID and 6 pieces of glass bid total) the length of the hinge and 3" wide. The inboard hinges are wider than the outboard, so make those plies longer to match. Carbon fiber and aluminum do not mix, so apply the two plies of carbon fiber BID covered by one ply of glass BID for insulation. Apply these three plies to the hinge areas under the upper skin, from the TE, halfway down the foam face.



Glass the ends with 3 plies bias bid. Cone out the aileron torque tube hole to allow full travel of the torque tube in both up and down positions. You can shine a flashlight in the inboard end of the hole and watch while an accomplice articulates the aileron up and down. Glass about 2" into the opening and add a third layer along the side that the torque tube approaches most closely, to add extra protection in case it bounces around in turbulence. Be careful as you glass the inboard ends that there is no lap of the glass from the end plies onto the upper skin where the inboard hinge will go - if there is, it will build up the thickness in that area and make it nearly impossible to place the hinge in straight.

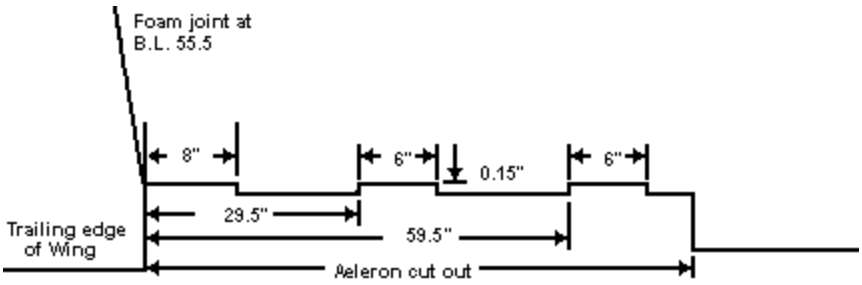


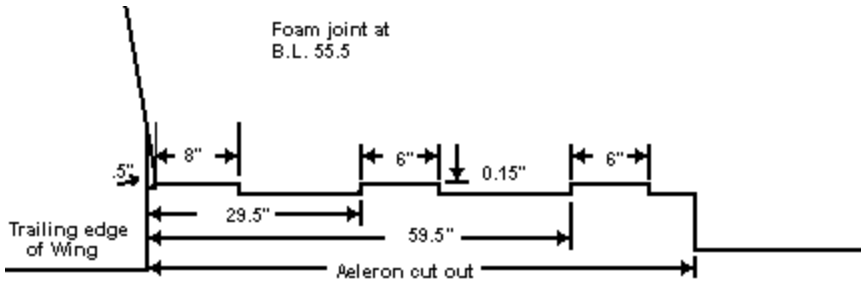
Installing the aileron into the well.

The first basic step is to slide the aileron into the well and check the fit. Is the gap at the hinge line large enough? (~ .03" to .1") Is the gap between the counter balance weight and the bottom edge of the aileron well large enough? (If there is little or no gap here do not fret. We can sand the well to fit after the hinges are placed.) Are the gaps at the ends of the ailerons large enough? If not, trim to the absolute minimum sufficiently so that the aileron will fit when the trailing edges match. There probably won't be enough clearance for the aileron to actually articulate. What we are trying to do is to minimize the tendency that most builders have of making too large a gap both at hinge line and between the balance weight and the lower skin of the aileron well.

So, mark where your hinges will go. The inboard hinge will start flush with the inboard end of the aileron, and then extend outboard 8". The middle aileron will start 29.5 inches from the inboard end of the aileron, and is 6 inches long, extending to 35.5". Finally, the outboard hinge will start 59.5" from the inboard end of the aileron, and it too is 6" long, extending to 65.5". The gap at the aileron upper surface, along the hinge line, should be about .063" along its entire length before you start trimming. You will trim forward about .15" into the aileron well at every hinge location to clear the hinge itself. The side view of this notch is in (DRAWING).page76. When the hinge is appropriately placed .063" of this hinge projects aft of the aileron well.

When preparing to make these cuts place a straightedge .15" forward of the upper surface of the aileron well along it's entire length-measure at the outboard and inboard ends. (Remember to make the hinge cut outs match the placement of your hinges, depending upon how accurately you cut the aileron in reference to BL55.5.) With a fine, ball point pen, in the area of the hinge draw





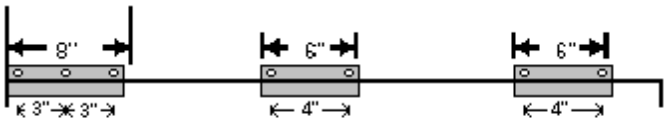
a line and trim carefully to it. Then, in those same areas, bevel the underside of the skin down and forward to approximate the curvature of the hinge. You will also find that the hinge may be just a touch too wide for the 1.25" glass to glass area on the top skin, so appropriately trim the back edge of the hinge half that will go into the well.

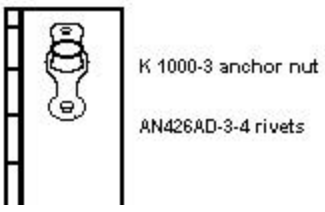
This is expensive stuff -- $100 for a 6-foot length -- so be careful with it. You know how a regular hinge goes together. Pull the pin out, and flip half the hinge over 180º. One half of the hinge will face up (Print up) and one half will face down (print down) Don't cut your hinges to length till you've pulled the pin and reversed the hinge, then replace the pin and make the cut using a standard hacksaw. Nest the hinges into their slots determining at that time that they seat into the slot the same depth all three. Go find your long straight edge and place it aft of your hinges so as to determine if all the hinges are perfectly in line with one another. If so, clamp them in place with C clamps and tack them in place with tiny drops of superglue. Then remove the C clamps.

Flip hinge before cutting to length

Place the aileron into its well against the hinges to determine if the hinges are placed deeply enough to allow the aileron fully into its well. The trailing edge of the aileron shouldn't extend beyond the wing TE either outboard or inboard. If it does you must deepen the hinge slots and, quite likely, sand the rest of the aileron well upper edge further forward for clearance. If the aileron fits well, remove it, leaving the hinges glued to the underside of the aileron well upper lip.

Your next job is the placement of the screws that will hold the aileron hinges to the wing. Measure and mark the lip per (DRAWING page 76) -- .5" forward of the hinge line (which is now .15" farther forward that it used to be). Three points along the wider, inboard hinge, 3" apart (one in the dead center, and the two end ones 1" in from either end.) The 6" hinges in the middle and outboard each get 2 holes, 1" in from the ends, 4" apart. Use a C clamp or similar clamp to hold the hinge to the lip while you drill through both glass and hinge with a #40 drill. Once you've drilled them all, cleco them in place, then remove the clecos and re-drill with a 3/16" or #12 drill, one at a time, re-securing with large size clecos. Test your 100º countersink bit WITH A DRILL STOP on a scrap of aluminum, and then CAREFULLY countersink the holes in the wing skin. Remove the hinges, and install –K 1000- 3 nut plates on the bottom sides of the hinges with the appropriate rivets. It works like this - drop an MS24694-S49 flush head screw though the hole, thread on the nut plate on the backside. Use the holes in the nut plates to guide your #40 drill and drill though the hinge



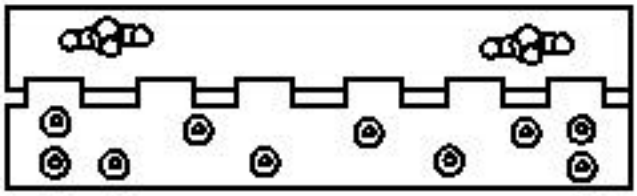


on one side. Cleco, then drill the other, countersink both with a #40 pilot 100º countersink, and rivet the nut plate in place with AN426AD 3-4 rivets.

Builder's tip: Center punch the locations for the rivets on the hinge before super gluing to the aileron. If you center punch the hinge afterward you are likely to pop the superglue loose and have to start all over to align the hinges again.

When you've done all the hinges, screw them into place with MS24694-S49 flush head screws. Use small pieces of wood superglued to the upper surface of the wing hinge line, projecting aft .5". You will use these pieces of wood to place the aileron upper surface in the same plane as the wing. Also place scraps of wood under the wing, so that the counterbalance weight will sit flush with the lower well TE. Slide the aileron into place, up against the hinges, check the fit and clearance down the entire length of the aileron, and superglue the hinges to the forward diagonal face of the aileron. Use a very thin piece of metal sheeting to slide into the gap and push the hinge against the face of the aileron. Remove small pieces of wood from the upper surface of the wing and articulate the aileron - gently, so as not to break the superglue. The lower aileron well edge may prevent you from moving the aileron. Fret not; you will carefully trim the lower well edge to a clearance of .05" when the aileron hinges are fixed to aileron and well.

Unscrew the hinges from the wing and remove the aileron. Make reference to drawing at right for the placement of the holes to be drilled through the hinges and into the ailerons. Mark the hinges, drill with a #30 drill. Pop the hinges free from the aileron, clean up both surfaces, remove any burrs or chips, and sand the face of the hinge and the diagonal, front face of the aileron where the hinge will bond to it. Brush both surfaces with WEST epoxy with just a little flox, then rivet the hinge in place with 1/8" pop rivets. *The correct rivets for attaching the aileron hinge to the aileron face self plugging rivet, CR9163-4-4. . Dave told me to buy 100. I got mine from Spruce.* Be careful not to get flox into the articulating part of the hinge.

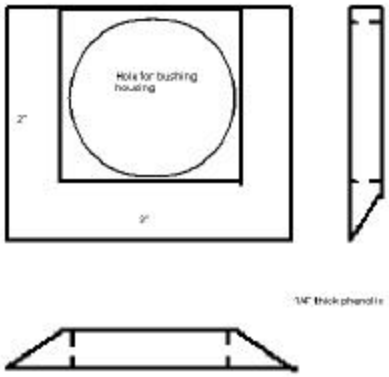


RIVETS ON MIDDLE AND OUTBOARD HINGES

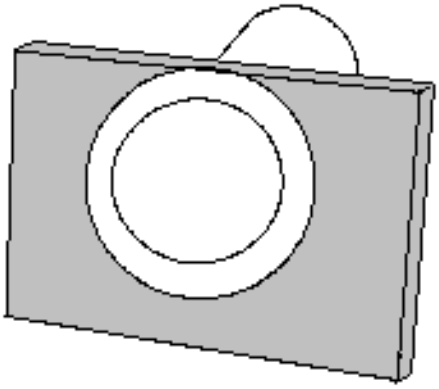
Builder's tip: If you have trouble getting the hinges to superglue firmly to the ailerons, align them the best you can, drill #40 holes for 2 clecos. Remove the hinges clean them up and superglue using the clecos to hold the superglue. When it dries, reattach the aileron to the wing and check for fit.

Aileron Torque Tube Installation

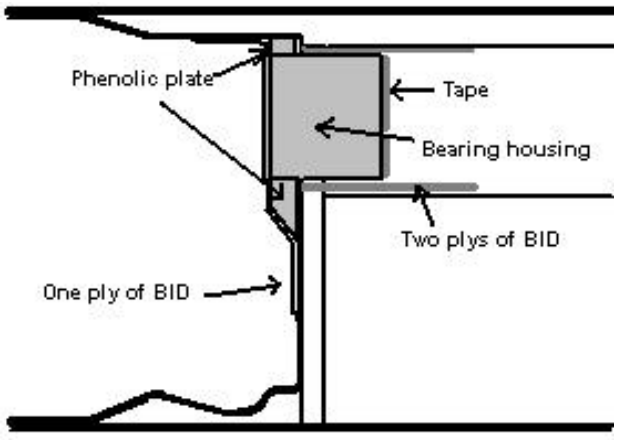
The Berkut uses a bearing and housing attached to the glass rib at the inboard end of the wing. (If you are cross-referencing with the Long-EZ plans, they do not use this part.) Find the bearing housing supplied in the kit. You will have to order the bearing that goes inside it. The bearing can be obtained from Precision Bearing, (310) 836-6656 and have several part numbers: Astro ADW-10, MS21232-10 or Helm NRG-10. The retaining clip is part #5000-118.



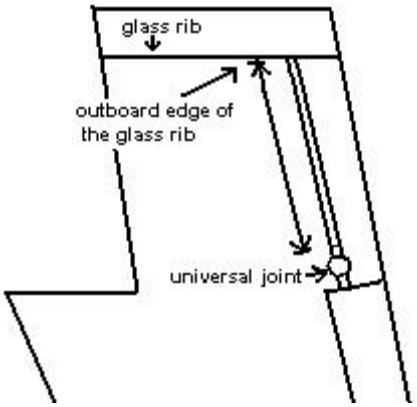
First we will fabricate a 2" tall by 3" wide 1/8" phenolic mounting plate for your spherical bearing housing. The housing will sit near the top edge of the plate. Drill a hole for a slip fit over the bushing housing. Bevel the edges of the phenolic. Install the bearing housing in the hole in the phenolic block using a small amount of West flox to secure it. Let cure.



At the inboard end of the torque tube hot wire hole, open up the hole that you glassed over when you finished the end rib of your wings. (If you have not already done so.)

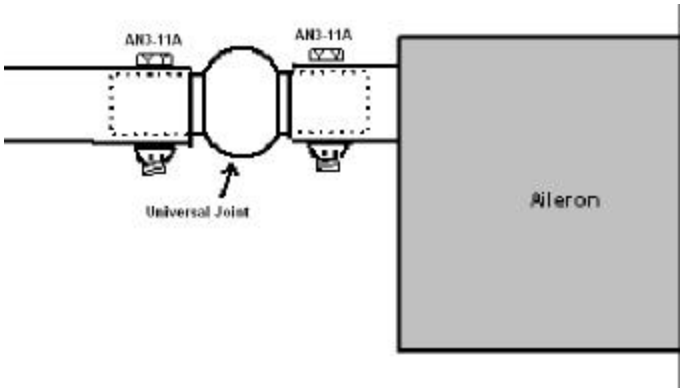


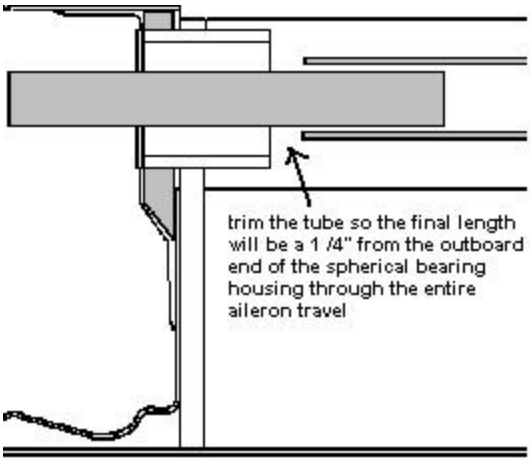
The mounting plate holding the bearing housing will fit over this hole. When you have the mounting plate and bearing housing fitting well remove the mounting plate and place 2 plies of fiberglass BID inside the hole extending about 2" into the opening. After cure you are ready to install the plate with bearing housing. Tape up the outboard end of the housing. Apply a generous amount of West flox to the outside on the housing and outboard side of the phenolic plate. When you insert the housing in the wing you want to have full contact all around the bearing housing and hole through the wing. Place one ply of BID over the entire mounting plate lapping at least 1 /2" onto the wing rib surface. After cure re-open the hole.



Now we will fabricate the portion of the aileron torque tube that is inside the wing. Attach the universal joint to the aileron torque tube stub. Position the aileron on top of the wing with the aileron lined up with the aileron well. Measure the distance from the inboard position of the tube just outboard of the glass rib to the Universal joint where the outboard end of the tube will rest. Now have your friend measure it. If you agree on the length, cut your piece of torque tube. We will trim this down a bit later. (It should be approximately 30" long to start with and will be trimmed to about 27.5" later.)

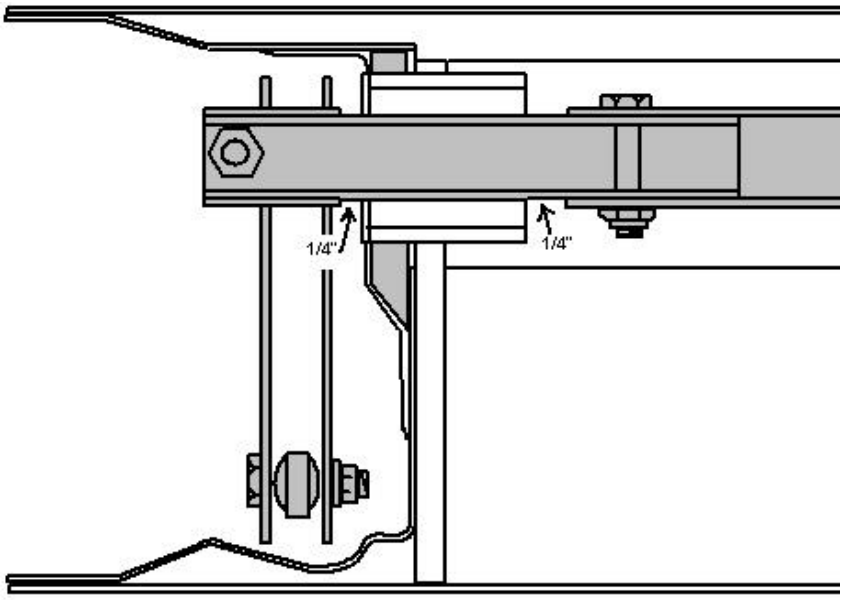
Remove universal joint from the aileron and drill a hole with a #13 drill bit, horizontally through the universal joint and torque tube for an AN3-11A bolt. This hole should be parallel to the one through the stub tube and universal joint. Remember that all boltholes in your control system should be a tight interference fit. Any play will cause you to have strange feeling controls. Reassemble the aileron, universal joint and torque tube with the AN3-11A bolt head facing forward.

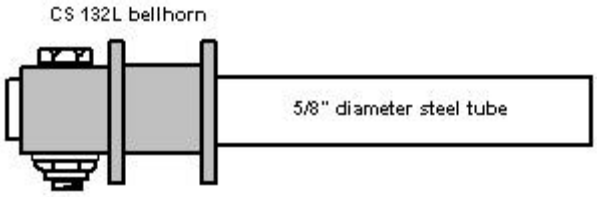




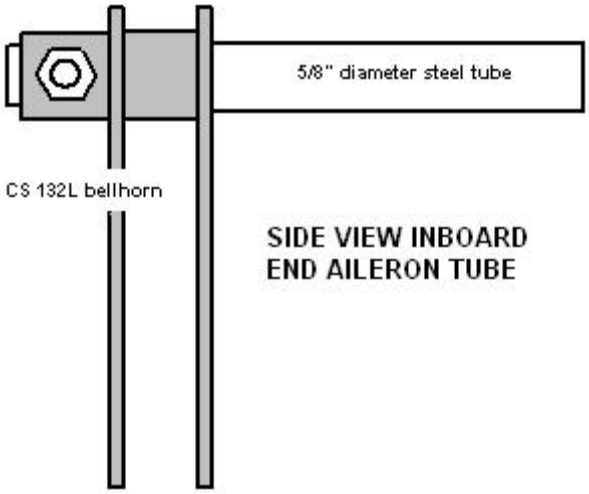
Install the aileron. If the tube is cut just a little long it will need to go into the spherical bearing housing a little way. Have a helper move the aileron through the entire range of motion while you watch how the end of the tube moves in the bearing housing. You will trim the tube so the final length will be a 1 /4" from the outboard end of the spherical bearing housing through the entire aileron travel. That way it will not put any stress on the internal bearing race when the entire assembly is installed. There should also be a short 5/8" diameter steel tube, CS157 (About 3" long) included in your kit. The end may need to be polished a little to slide into the Torque tube. *During the finishing process nearly all these tubes ended up too large to fit through the spherical bearing. Polish the outboard end so that it just slides into the tube, no larger. Polish the inboard end so that the spherical bearing will slide on. This will leave the fit of the bellhorn a little loose, but as long as your bolt has no slop, it should not affect the feel of your controls.*

Slide the steel tube inside the new torque tube. Slide the CS 132L bellhorn over the steel tube to determine the proper length of the tube. Leave about 1 / 4 ” space between the phenolic block and CS 132L bellhorn. The distance from the inboard end of CS 132L bellhorn and the outboard end of the torque tube should be about__”, this will vary from plane to plane depending upon a whole lot of variables so start a little long and cut back as needed. Mark the position on the torque tube. **The bell horn must be positioned perfectly vertical with the aileron in neutral position or you will not get full aileron travel.** Remove the bellhorn and aileron from the wing. Drill a #13 hole through the torque tube and steel tube, vertically for an AN3-11A bolt. Leave the steel tube bolted to the aileron torque tube. Reinstall the aileron with the torque tube inside the wing and the steel rod protruding though the inboard hole of the torque tube hot-wired hole.



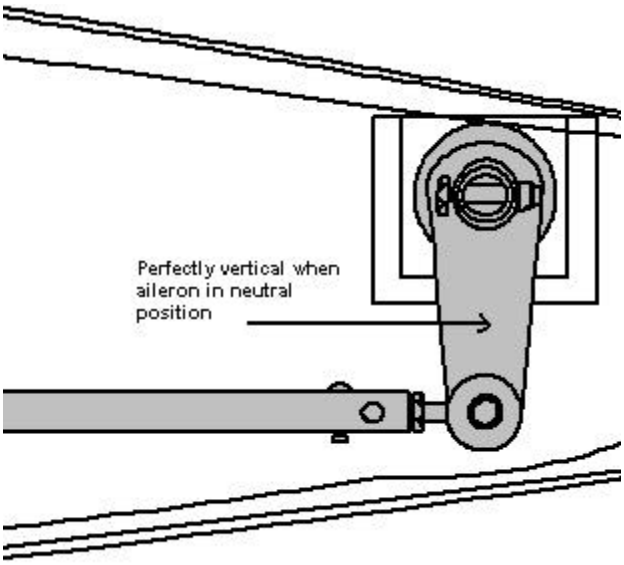


TOP VIEW INBOARD END AILERON TUBE



SIDE VIEW INBOARD END AILERON TUBE

Reinstall the CS 132L bellhorn. You should notice that the bellhorn included in your kit has a double arm. (The original Long EZ plans called for a single arm, but it had a nasty habit of failing in flight.) Position your aileron in neutral position and secure it there with a clamp or a clip designed to hold chip bags shut. Position the bellhorn perfectly vertically in relation to the wing. Mark the position one the steel rod. Remove the entire assembly. Drill a #13 hole horizontally for an AN3-11A bolt. Bolt these together.



To repeat myself, this point is very important!
The bell horn must be positioned perfectly vertical with the aileron in neutral position or you will not get full aileron travel.

REMAINDER OF THE AILERON CONTROLS WILL BE INSTALLED AFTER THE FIREWALL. INSTRUCTIONS CONTINUE IN MANUAL C-2.

Index to Illustrations

PARTS REQUIRED (grouped by chapter)

KIT A

Ailerons

Part ID	Description		Total Uses	Mockup
MS24694-S49	Machine screw	countersunk	18	
K1000-3	Nut	anchor	18	
AN426AD-3-4	Rivet	AD	36	
BSPQ-43	Rivet	pop	48	
A3235-028-935	Washer	Tinnerman	18	

Canard

Part ID	Description		Total Uses	Mockup
AN4-10A	Bolt		6	
K1000-4	Nut	Anchor	6	
AN426AD-3-4	Rivet	AD	12	
AN960-416	Washer		6	

Elevators

Part ID	Description		Total Uses	Mockup
AN3-12A	Bolt		2	
AN3-5A	Bolt		2	
AN4-21A	Bolt		1	
MS24694-S56	Machine screw	countersunk	4	
MS21042-3	Nut	stop	8	
MS21042-4	Nut	stop	1	
BSPQ-43	Rivet	pop	17	
BSC-44	Rivet	pop/flush	2	
10-32 Allen head set screw 1/2	Set screw		2	
AN960-10	Washer		4	
AN960-416	Washer		2	
AN960-10L	Washer	thin	14	
AN315-3R	Nut	mock-up	2	Explicit
AN315-4R	Nut	mock-up	1	Explicit
AN315-3R	Nut	mock-up	6	Implicit
AN315-4R	Nut	mock-up	1	Implicit