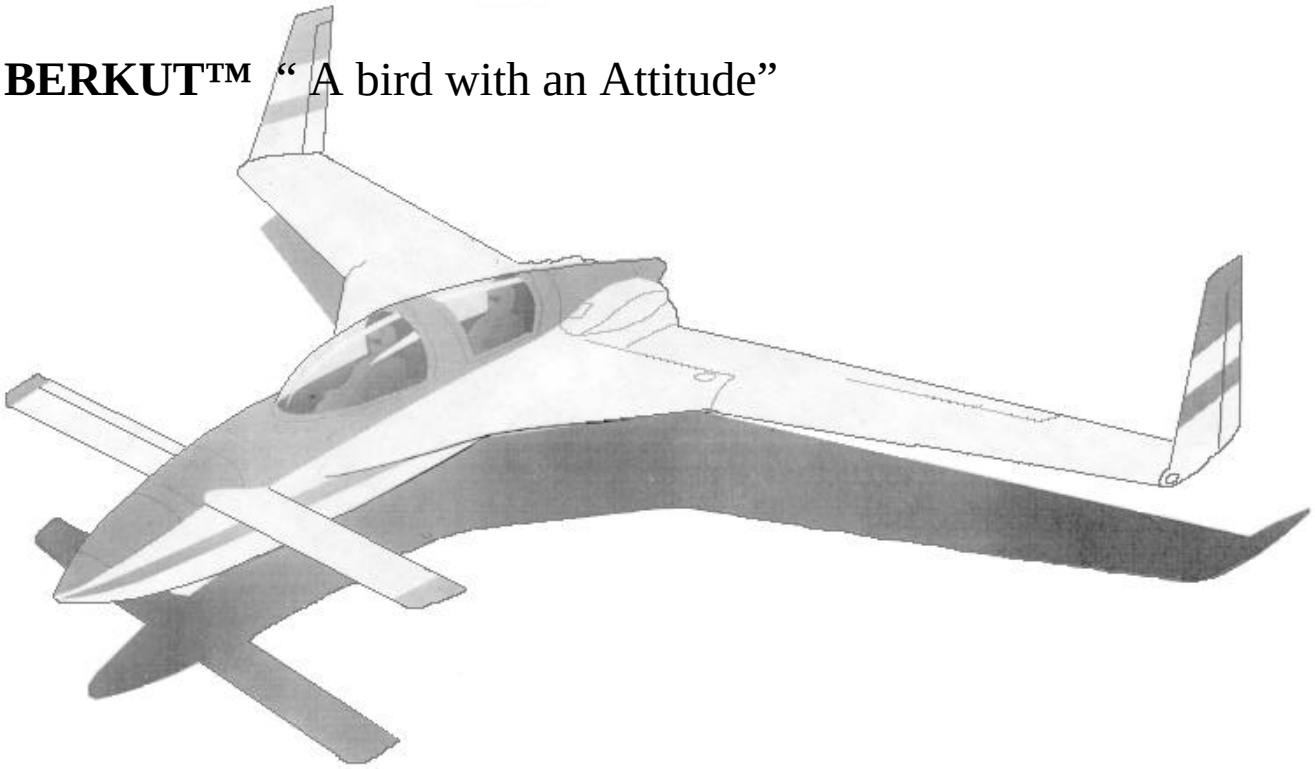
Volume

A

BERKUT™ ENGINEERING

BERKUT™ " A bird with an Attitude"



BERKUT™ A-Kit Manual

Construction: Molded wings

BERKUT™ ENGINEERING

ASSEMBLY MANUAL

BERKUT™ ENGINEERING
3025 AIRPORT AVENUE
SANTA MONICA, CA 90034
(310) 391-1943

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ABOUT THIS MANUAL

This manual contains a few additions to previous versions.

Since the last version of this kit there have been some major improvements in the kit itself. Mainly a molded canard upper and lower halves and molded main wings with the winglets molded in place.

We advise viewing the entire tape before starting each section of construction. Errors are intentionally left in the tapes so that you can see how to correct them. By viewing the entire tape on each part before starting you can avoid many of the pitfalls.

Many people have dedicated their time and effort to putting together this part of the manual. The information itself is the work of Dave Ronneberg, the designer of the Berkut™. Shari Lee did the transcription and the illustrations and did the formatting. Ric Lee patiently proofread every page. And much thanks to Vicki Cruse who took digital pictures, sent a million E-mails, and encouraged all of us to keep going and finish this tome.

Chapter

1

WINGS

"SO, YOU 'VE FINISHED YOUR CANARD 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 !!!!!"

Well, actually, it's not that bad.

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 molded wings that should insure that your wings will come out straight, light and strong. The winglets and wings are molded as a unit further ensuring consistency and symmetry. 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'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 canard, but there are some additions.

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.

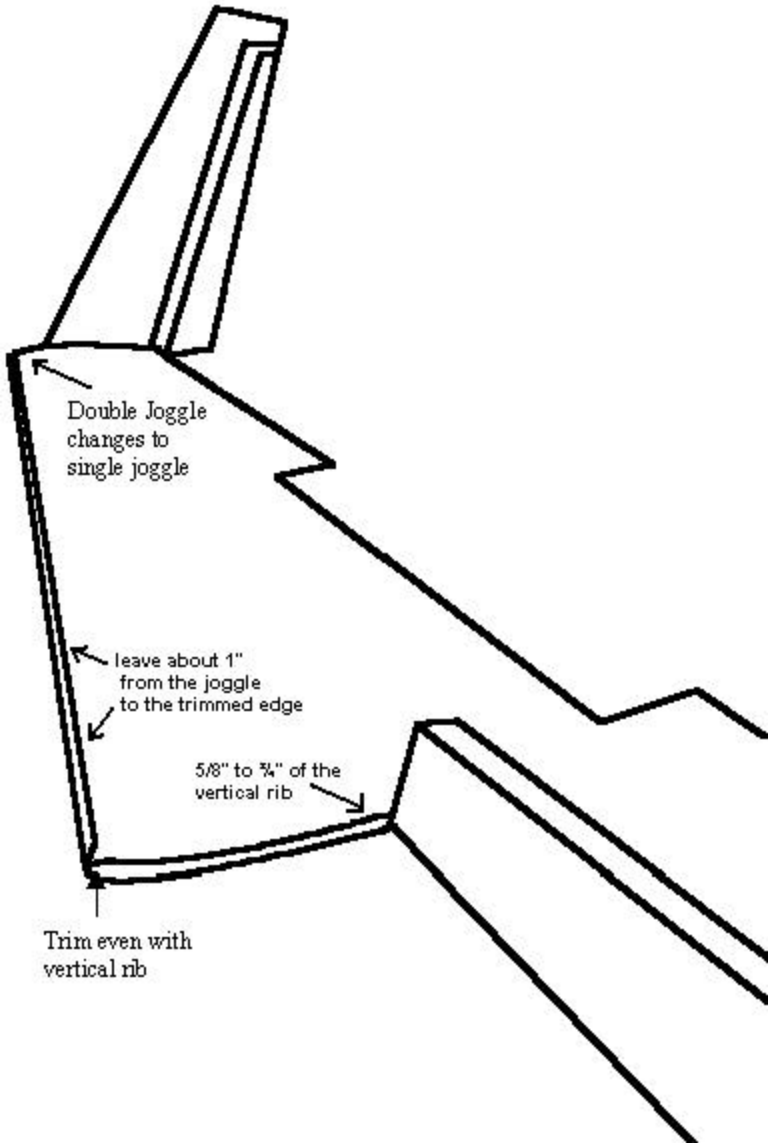
First let me explain some things about your molded wings. You will notice a few differences between the left and right wings. As you examine the left wing you will notice that it has a classic "double Joggle". The canard is "single joggle" as is the right wing. The single joggle construction has been fully tested and flown. Both processes work very nicely. The "double joggle" method has some structural redundancy. If you are uncertain of your bond at the leading edge of the wing, you can be reassured by the fact that you have secondary laminates on the exterior. (The bond on a single lap surface is more than sufficient. You just have to make certain that you go through the bonding process exactly as described in the tapes and manual to ensure that your structure has a good bond on the leading edge.)

Trimming the Parts

We are going to start off with the basics; trimming your parts. We were endeavoring to provide you with fully trimmed pieces that we cleco'd together with our tooling, but our production schedule did not allow us to do this in a timely fashion or a financially reasonable fashion. (At the time of this writing we produce a wing skin every day and a half. It would significantly delay delivery time to put everything back in the tooling and fit it together.) We can assure you that your wing skins do not change shape when they come out of the tool. When you receive your water jet fixtures from us and place them properly, your wing will fit those fixtures precisely. The wing skins will nest into the fixtures with little or no gaps. There is no weight necessary, affirming that your airfoils are correct and the joggle assembly will be easy.

None of the wing skins that are produced are absolutely pristine perfect. You should expect some minor imperfections, which we will show you how to correct. A minor spanner in a bag will cause a

small depression in the primer. If a guy misses a little bit of flox along a leading edge it will cause a small flaw. We have excellent registration on all of our parts but it will not always be perfect.

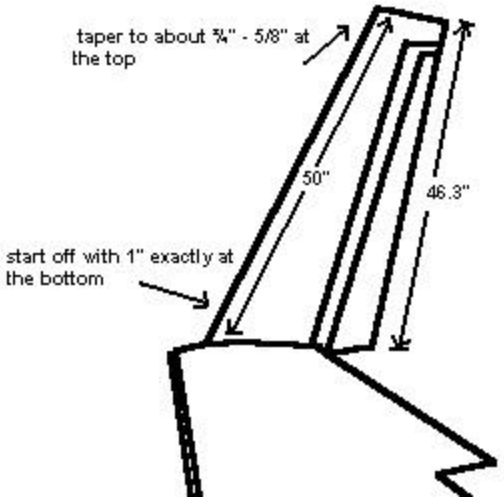


Lower Wing Skin

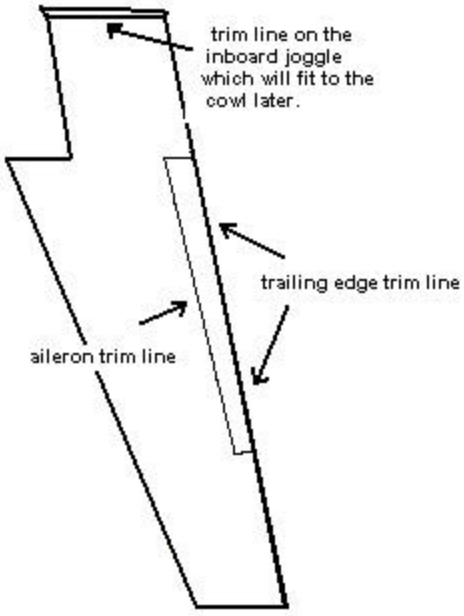
Begin by trimming along the part line at the inboard end of the wing with your fein saw right along the face of the inboard rib at the leading edge. On the close out rib leave 5/8" to ¾" of the vertical rib leaving a return on the inboard end.

On the video, Dave marks the trim line along the leading edge with tape making it easier to see. Tape along the leading edge to mark the cut line. The tape is ½", and leave a gap between the tape and the leading edge joggle of ½". Trim to the outside of the tape leaving about 1" from the joggle to the trimmed edge. Trim along the entire leading edge to the outboard end where the leading edge meets the outboard end of the wing. You can see a change in the joggle at the outboard end; notice the double joggle along the leading edge changes to a single joggle in the area along the outboard edge. This was a very difficult surface to develop and it just isn't conducive to a double joggle. Trim the outboard lip all the way to the tape that you placed on the leading edge. This line should be clearly marked on the part. If there's a little bit of primer along the surface of the joggle that doesn't belong here, just scrape it out with a razor blade. The surface of the joggle will all get sanded for bonding later. Your foam on the top skin will taper to carbon-to-carbon along the leading edge, just short of the one-inch width of the joggle.

On the leading edge of the winglet, start off with 1" exactly at the bottom. Taper the lip to about ¾" - 5/8" at the top. The load is tapering and the structure tapers as well. Double check the part line along the top of the winglet. The distance along the trailing edge of the winglet from the bottom edge to the tip is 46.3". From the crotch where the leading edge of the winglet meets the end of the wing, to leading edge tip is 50". Trim along the top edge of the winglet following the part line. Your part line along the trailing edge of the winglet is printed and you can see it on the outer surface of the skin. In the video Dave highlighted it with a pen, but you should be able to see it clearly on your part. Trim just to the outside of the line and then sand it to the line.



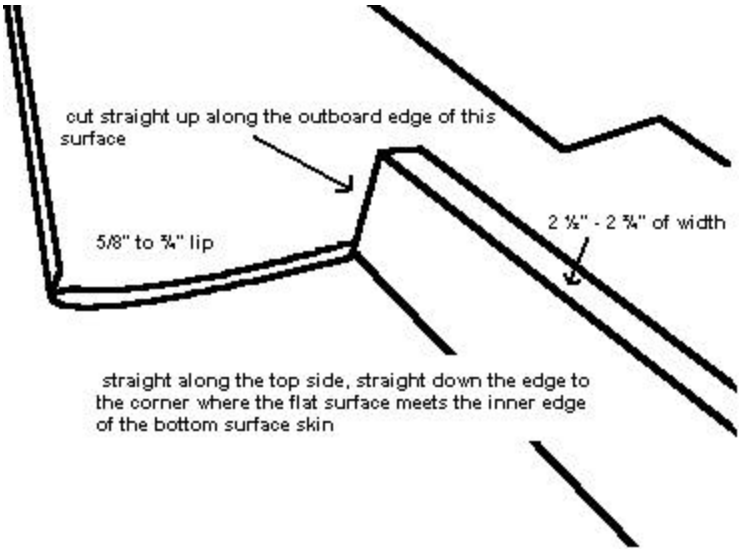
Locate your 1/8" by 6' long ruler; place it just beyond the part line and in glass-to-glass area. Secure it with an over center clamp in the glass-to-glass area at the winglet tip, place a second clamp on the other end. As you cut it is possible to bend the straight edge a little bit so it doesn't hurt to place extra clamps. As you clamp don't crush your foam just ahead of the trailing edge. You only have 2/10" of glass-to-glass area on the trailing edge, endeavor to place your clamp close enough to the edge that pressure is applied only to the glass-to glass portion. Now take a Fein saw, which has a 20/1000" thick blade. It is a very, very thin blade and does a superb job of cutting. We place the blade against the surface of the straight edge, directly perpendicular to the surface of the winglet and we make a cut through the glass. (You can actually grab hold of the blade, because it oscillates 20/1000" per second and doesn't actually rotate. It's only made to cut hard material.) As you make your cut; you can leave your straight edge in place and ride right along the edge of it. You can move the straight edge up to the final position of the part line and sand to the straight edge if you are not concerned about compromising the edge of the straight edge for future purposes.

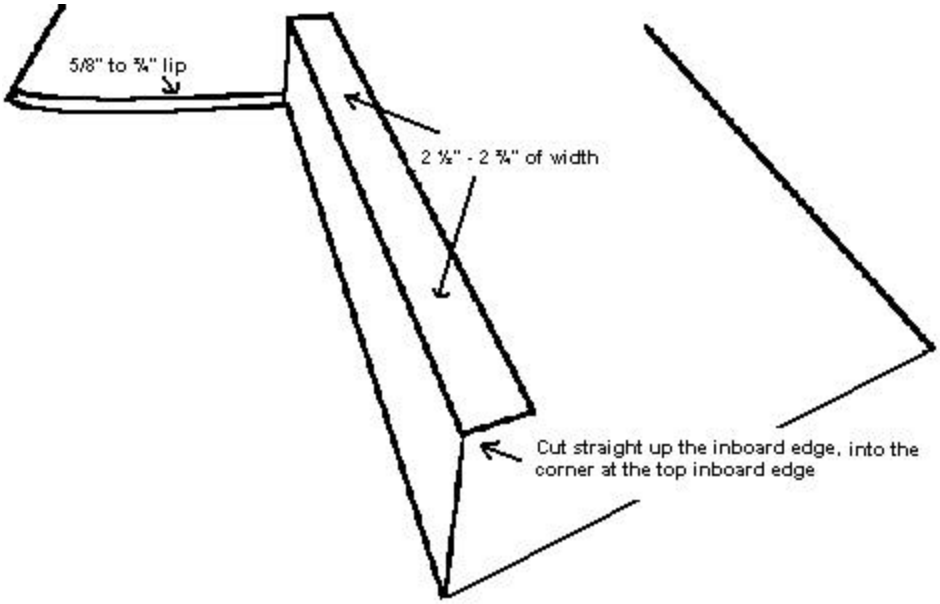


On the underside of the wing, where the lower trailing edge of the winglet meets the trailing edge of the wing, there is a part line that defines the triangle of the lower portion of the rudder, and a part line that runs down the trailing edge of the wing.

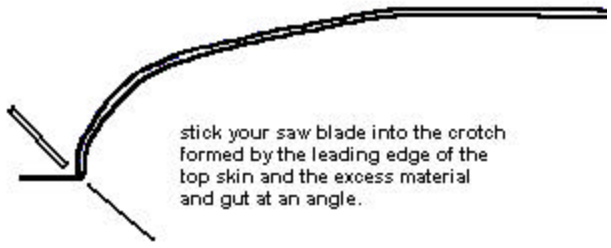
Looking down your wing at your wing surfaces, you should be able to see the aileron trim line, trailing edge trim line, and the trim line on the inboard joggle which will fit to your cowl later. Trim the trailing edge of the wing down its entire length. Don't cut out the aileron at this stage. On your joggle, your trim line is clearly visible along the bottom edge. On the aft edge of the joggle trim straight out 90 from the edge. On the leading edge come about ¼" from the leading edge aft and cut straight out. This will get modified later when you get ready to fit your cowling.

On the inboard end of the wing, you're going to trim straight up in the corner of the flat vertical surface, which will eventually mate to the main spar. You will cut straight up along the outboard edge of this surface, straight along the top side, straight down the edge to the corner where the flat surface meets the inner edge of the bottom surface skin, leaving 5/8" to ¾ lip all the way to the leading edge.





Along the top edge of the vertical section, leave yourself 2 ½ - 2 ¾ of width. The width in this area is not absolutely critical. This is nothing more than a sheer web support for the laminates that we are going to put in. Cut right into the corner at the top inboard edge of the vertical section, you can clearly see the part line on this section.



On the leading edge of the wing you've got a surface that sticks out horizontally, you stick your saw blade of your Fein saw into this crotch formed by the lip of the leading edge and the excess material and cut off the excess. On the lower skin there is no concern about whether there is an angle to that cut. On the upper skin though we will cut through at an angle. Your fixture corner is defined by the cleft molded into the leading edge of the lower skin and running along the length of the wing, where the leading edge of the upper skin sits on this cleft actively positions the wing skin into its final shape.

You are going to find as much as 50/1000 of an inch gap at the front lateral edge of the wing, the section forward of the winglet. The fit here was very difficult to establish. We had a double joggle that goes from a double joggle to a single joggle and back to a double joggle. This is just a very difficult fit here. You may find when you first put your wing skins together after trimming you may find that they do not quite fit well into the depression. So, trim a little in this area and remove any blisters that are present. Forward of where the transition occurs; take the flox off. It tends to set up with a nice crisp edge. Take that edge off.

At the inboard leading edge, the upper wing skin has two extra plies of glass that increase the thickness of the return that makes up the edge that mates it to your strake. We're talking about the external lap that sits on top of this edge. Use the dye grinder there to create a constant thickness along the mating surface on the leading edge.

Upper wing skin

In the corner where the front edge of the winglet mates with the wing, the carbon skins and extra glass come around the corner making the skin a little thicker here. Trim the upper skin down until the upper skin fits into the depression on the lower skin at the outboard end. Trim the outboard end of the wing itself, and then give it a quick scuff with a sanding bar.

On the outside surface of the trailing edge of the winglet, take a pencil and rub the part line. The part line is embossed and it stands out when you rub it. You should be able to see it clearly. Locate your 1/8" by 6' long ruler; place it just beyond the part line in glass-to-glass area. Secure it with an over center clamp in the glass-to-glass area at the winglet tip, place a second clamp on the other end. Place a third clamp in the center section as you did with the lower skin and trim and sand in the same way that you did the lower wing skin.

Your leading edge on the winglet also comes off at an angle. Trim it into the crotch formed between the surface of the winglet skin and the excess material. Position the blade at about the middle of the angle; you want the angle to be such that it helps place the blade where you want it to be. Don't cut straight down because that leaves the entire added thickness. Don't cut straight in because it removes too much material. Cut at an angle. Don't be too cavalier about the process. As you will see this method leaves a little teeny triangle, just sand to get rid of that little bit of triangle. Take a straight edge; make a straight line parallel to the inner surface of the winglet and sand off the excess. It doesn't take much. We don't want to go deeper than the plane of the inner winglet surface. Don't leave any excess that cutting at an angle leaves behind. Trim the leading edge of the wing with the Fein cutter where it sticks out straight at you. Trim at about a 45° angle. Then sand the edge, make just a few passes, we're not talking about a lot of material here, we're talking about 20/1000 of an inch. Be very careful not to over sand. This is the critical area, which ensures that your wing fits together properly.

Trim the excess at the aft lower section of the winglet right into the corner on the rudder, cut it off square. Cut across the depression at the top of the winglet. You may end up removing more of it later to get the two depressions parallel on the two wing skins when the two skins are fitted together. Later when you've bonded the wing skins closed, you'll stick a block of foam into this depression and

carve it from nothing at the front tip, you'll be cutting the foam and shaping it, but we'll be doing that later on in the videos.

Let's go look at the inboard part, and see what we've got as far as trimming is concerned. The tab on the inboard edge is trimmed off at about 1 ½. Trim the aft edge of the tab off almost in line with the trailing edge. I wouldn't trim too much at the front end yet. You know that you are going to be cutting the wing tip off to get a part line at the front edge, straight down because that is the end of your wing. You're not going to have this tab for your cowl to fit on at the front end, and you'll discover why later. For now just trim it off 1 ½ wide, and the back edge in line with the trailing edge.

Leave the return, at the leading edge of the wing about ¾ wide, cut it all the way around. Sand off the lip between the wing skin and the return. That lip doesn't belong there. Sand it off until it is flush with the surface of the return. You don't want to try and paint a razor sharp corner, so eventually you'll end up putting a little radius on the edge that is cosmetically pleasant and paint will stick to it. So trust me you're going to put a little radius on it, don't do it through the flox. You can copy the radius one the front of the molded false spar if you wish. That's molded in and it's a permanent part line that you don't have to mess with. Occasionally there will be little pockets in the surface where air has been trapped. If you find them, break them and fill them with flox or micro. You will primer over them when you get ready to paint. It doesn't happen often but it does occasionally.

Cut out the U-shaped depression in the wing skin for the bolt access hole. Cut it out at the bottom of the depression right to the bottom of the corner, all the way around. Minor gaps and holes in here don't matter. You may have some anomalies in the corner where air has been trapped during the bagging operation, but as long as there is no cracking along the surface of the wing skin, there is really no need for concern. The outer edge of the depression is the area that you want to be really clean, because your cover plate fits in that depression, which is something like 25/1000".

Don't cut off your aileron openings just yet. We'll help you jig in this process.

THE WING FIXTURES

Chapter 2

WING FIXTURES

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
__"X23" (B.L. 23 template)
__"X48" (B.L. 55.5)
__"X38" (B.L. 106.25)
__"X28" (B.L. 157)
Buy at any hardware store
50 1/2" self tapping screws or small wood screws
6 2"x4" stamped sheet metal shelf braces (hardware store)

You will build four fixtures. The BL 55.5, 106.25 and 157 jigs have both a leading edge and trailing edge - the B.L. 23 jig doesn't have a leading edge, so you will only be doing the aft portion of that one. Refer to the drawing on the next page.

We will send you templates for your fixtures, which will be on poster board that will not shrink or change shape. There are pockets cut out at the correct angle for the 1" X 2" extrusion that fits on the trailing edge. In the fixturing process coming up we are going to be placing a 1" X 2" aluminum extrusion at the trailing edge. The wing is only going to sit on top of about 1/8" of it right at the trailing edge and the extrusion is going to be canted so the minor change in angle isn't going change the way that the part sits on the trailing edge. It sits down the entire surface. Your templates will tell you where this goes providing you the right lap on the trailing edge.

Be sure that you have a straight, true edge on the bottom of the plywood pieces. Trace around the template with a sharp pencil. Cut the templates out of the plywood with a jigsaw or other appropriate saw. Position the inboard fixture on your jig table as close to the end as practical. The next fixture should be placed 26"outboard of the first fixture. The next fixture is placed 49.5" from the second one and the last fixture is 49.5"from the third. All measurements are from inboard face to inboard face of the fixtures.

Secure the fixtures in position using the metal shelf braces, screw one arm of the shelf brace to the fixture and the other arm to the table. Position one brace at the front and one at the back end of each fixture. Drop a 1" X 2" aluminum extrusion into the cutout at the trailing edge of the fixture and place

a mark on the extrusion along the inboard and outboard side of each fixture. This will facilitate positioning when you turn the fixtures around to set up for the other wing.

Positioning Wings

Place the lower wing skin in the fixtures on your jig table and check to be sure the measurements are correct. The wing tip should be positioned 5" from the inboard edge of the outboard fixture. You will notice that the outboard end of the wing it doesn't quite fit into the outboard fixture. This is not because the wing is out of shape, but because the weight of the winglet pivots the wing tip backwards of its own weight. Just drop a piece of weight inside the wing skin in the area of the fixture. If you look at the two surfaces you should barely slip a piece of paper in here between the fixture and the underside surface of the wing skin.

You will use these measurements that often and I will be referring back to them numerous times. The distance along the trailing edge of the winglet from the bottom edge to the tip is 46.3". From the crotch where the leading edge of the winglet meets the end of the wing, to leading edge tip of the winglet is 50". If these measurements are not correct sand the winglet tip down to these dimensions.

On the underside of the lower wing skins, find the inboard, forward corner of the aileron. Drill a hole there, just inside of the part line. (Outboard of the lateral part line and just aft of the forward part line, so that when you cut to the part lines the hole is not left on the wing side of the trim line.) From that hole (forward inboard corner of the aileron) to the leading edge tip of the winglet, is 119.9 ". The distance from that same point to the trailing edge upper tip of the winglet is 124.3". This is a significant number because this measurement, on the left wing and the right wing is absolutely symmetrical. All the references to it are identical about the centerline of the aircraft. So when the measurements from the forward inboard corner of the aileron to the leading edge tip of the winglet, and to trailing edge tip of the winglet, are the same on the left and right wings, it will result in exactly the same geometry, not only in out board and in board dimensions, it will also result in the same amount of twist in the two winglets at the tip. Obviously, there's nothing you can do that's going to change the relationship of the lower winglet. It's fixed. But you can change the relationship of the tip by twisting. If you do so, you will get a slip between the upper and lower skin along the trailing edge and leading edge. But if you give them a chance, they will try and align themselves as you unconsciously expect a molded part to do.

On the inboard end you simply push your wing against the joggle that's on the front surface. See the video, Dave shows you exactly where this should go. The front face of the false spar should not fit flush against the top corner of the fixture. Drill a #40 hole at the leading edge of the inboard end of the wing where the wing sits on the BL 55.5 fixture. Drill through the wing skin into the particleboard of the wing fixture and run a 1" drywall screw into the surface. The wing should match perfectly against the template at the inboard edge and match perfectly on the BL 55.5 template. This screw will prevent the wing skin from moving back and forth during the building process. Also place a screw and through the leading edge skin into the B.L 157 template and just forward of the trailing edge of the B.L. 157 template. You want to be careful when you drill. Don't hit the little screws that attach the shelf brackets to the template as Dave did on the video.

Place the top wing skin on the bottom skin. When the top and bottom wing skins were made they were obviously made in a tool in a fixture, which established the return at the inboard end that the top skin sits on. You don't have the fixtures that we built, which place the top skin precisely over the bottom skin. To establish this relationship we will give you the exact dimension of the front face of the wing spar at the inboard end and at the crotch at the outboard end. That will give you the precise relationship. From the outside surface of the upper wing skin on the inboard corner to the outside surface of the lower wing skin is 8.55". The outboard end of the main spar is 6.7". This should give you just the smallest of gaps from the top surface of the sheer web that's attached to the lower wing skin to the underside of the top wing skin. It can be as much as .05" off and not really change things much. We're trying to establish the best relationship between the main spar to the same area on the main wing with as little fill as possible.

While you have the top skin on check to be sure that the winglet trailing edge skin will close easily. You may notice a little interference at the bottom of the winglet trailing edge. If that is present it needs to be eased; a little bump in the same area may need to be taken off on the bottom end.

You need to go throughout your entire wing and check to be sure that the part will do the natural fit that they are capable of. On the leading edge of the winglet we had clecoes placed favoring very close to the fit line here, it was having a tendency to push down on the leading edge and lever off of the inside edge of the joggle. That's because the opposing skin where the foam meets the skin was close enough to the edge of the joggle to cause interference with fitting this edge. It acted as a fulcrum to lift it up off this surface. So as you fit, you need to check the influence of the edge of the joggle and the lip that goes on top of it on the opposing skin. You may have to trim about 1/8" off of the joggle to ensure that the joggle does not hit the foam lip on the opposing skin. If that foam is far enough forward that it interferes more than 1/8", you may have to trim back the foam and re-tape the leading edge of your wing where the foam is now bare. Where the joggle occurs at the top trailing edge of the winglet there is a surface that projects beyond the trailing edge line the three thicknesses of glass that will be on the upper cap later. Trim this area back far enough so the trailing edge surfaces can close. The trailing edge will be rebuilt when you put the winglet cap on.

The area at the leading edge of the upper skin is two plies thicker on the inside and creates a bump. You can grind away the bump on the interior so that the upper wing skin sits flush on the leading edge of the lower wing skin. You should be able to get the leading edge to be absolutely perfect along its entire length and along the leading edge of the winglet with nothing sticking up above the surfaces. The relationship of the two parts will help guide you through the assembly process. Cleco the leading edges of the wing and winglet to secure them for the next step.

Winglet Fixtures

Next we will build a fixture to align the tip of the winglet and ensure that the geometry is correct while assembling the wing. What we are going to do here is actually a rather flexible process, and one that you can modify or improve depending on your shop. The sawhorses are bondo'd to the floor and your jig table is screwed to the sawhorses so that it is not going move. It becomes a stable reference plane in your shop.

Get two nice dry and light studs, long enough to attach to the jig table and extend to the tip of the winglet. Position them vertically. Play with the positioning a little bit as Dave shows on the video and

attach them to the table with drywall screws in about 4 places per 2" X 4" paralleling the fixture. Your front 2" X 4" should be back a couple of inches from the leading edge, and the aft 2" X 4" should be ahead of the trailing edge about two and a half inches up at the tip. Reinforce the 2" X 4"s with a shelf bracket and two by four blocks to stiffen and to make sure that they are ridged enough to justify themselves in the fixture. Keep the trailing edge clear for an aluminum extrusion on the trailing edge of the winglet to keep it straight.

Check the dimensions that I gave you earlier, from the reference hole at the front inboard edge of the aileron to the winglet tips. It should be 124.3" to the trailing edge tip, and 119.9" to the leading edge centerline. The trailing edge fixtures will secure the winglets to keep them stable during the rest of the building process. Take two pieces of ¾ or 5/8" particleboard about ___" X ____", we will put the aft one up first. Have an assistant pull the measuring tape in position with no load at the tips. Clamp the particleboard to the front side of the aft 2" X 4" near the tip with small C-clamps, and play with the position of the wing tip and the particleboard piece. When everything is just where you want it, we push the winglet inboard, put a piece of masking tape underneath the plywood, and stuck it down to the wing surface. Dribble super glue against the face of the winglet, down the edge of the particleboard. Literally let it run down the leading edge of the fixture. Fix it with the zip kicker. Check the placement again.

Now we do the same thing at the leading edge. Put the particleboard in place just touching the skin of the winglet. In actuality the skins do a very nice job of self-jigging. Just move them in and out just a little bit, just enough to fit the plywood to kiss the surface of the winglet skin. Clamp the plywood to the 2" X 4"; check the dimension from the hole at the aileron corner to the winglet leading edge. Make certain that the inboard edge of the particleboard is touching winglet skin along the entire length, so that when you glue it in place you are not deforming the winglets in any way. Push the skin away and put masking tape on the surface of the winglet skin where the particleboard touches it. So the only thing really attached to your winglet is the masking tape itself. Dribble super glue against the face of the winglet, down the edge of the particleboard. Superglue to the tape and nothing more. When you go to pop this free you will leave nothing behind sticking to the winglet and there will be no damage to your primer or holes in the skin.

Check the wing to winglet tip dimensions again to make sure that they are spot on. These dimensions must be symmetrical on both wings for these dimensions diagonally to really be symmetrical. These dimensions must match on both wings or you will end up with an asymmetrical situation. If they are not, we can move the boards, reclamp and recheck until the dimensions are correct. Once that's established we leave the fixture in place until we are finished with assembly.

Fixturing of the Right wing

You notice that we have an extrusion here and one on the centerline. This extrusion and these weights are here to make sure that the top of the spar cap is straight when we do the T-tapes. We did the T-tape last night and as we brought it down and made sure that it was the right position we noticed that this had a tendency to sit up just a little bit. There was a slight buckle here. We checked the rest of the geometry and everything else was fine, but we are putting the right wing into the fixtures that were evolved off the left wing. Now, this slight buckling here is ever so slight. And it didn't really result in enough of a problem to scare me that we had any major asymmetry going on.

The way you are going to make certain, that when you do this T-tape you have a straight edge 100" long, running from the inboard edge of the aileron all the way to the end of the wing. It ends about here, 3-4" from the end of the wing. And that way you make certain that you have a straight line here, you have a straight line through here, you have a straight line through the leading edge and you know that your airfoils are correct. The fact that we have bent this winglet in .4" to maintain symmetry with the other wing is what put the minor pressures and changes in this area. Not a concern, you won't find that the amount of pressure that you require is any indication of a misfit either. The fit has more to do with the fact that we have bent the wing in slightly at the winglet. And now we are pushing it into a fixture that was designed off of the right plug. If you have any questions about this, give me a ring when you reach this stage.

We're going to show you something here that I should have showed you earlier. You notice the cut out here in the aileron do that early and cut the top one out early. So that when you do your T-tapes on top of your shear web you can reach up through here and scrape out much of the micro that you would otherwise have to sand out or chip away later. Last night Misha made an interesting little fitting, a tube, which is about 6' in length and has a tongue depressor at the end facing inboard. And used it to scrape excess micro from the open outboard end, reducing the amount of labor to remove the excess micro to minutes. I've got a little bit of goop left on the underside of the T-tape, but very little, so little that I can scrape it out without having to chip it out.

I was also able to make up a one ply tape and reach in from the inboard end of the wing with a straight edge and apply it on the underside of the T-tape while the T-tape was still wet. This way I have this much of the shear web already one ply taped so that, when I pop the top skin off it decreases any likelihood that the T-tape will pop off of the sheer web. Also it ensures that when you check your original fit that you have at least one of your three plies taper out on to p of your original shear web. That also decreases the likelihood of this popping off. On the outboard end I have at least one ply on top of your compression lay up, your L-tape. If you are of a mind to you can sand the top surface of the pre-shear web and continue the release tape on the under side of the upper skin all the way to the outboard end of your pre-shear web, and pile it on with flox. You do have a gap on here you might as well fill that up now and get that process over with. That way your entire surface document is ready to go for your final bonding right from the get-go.

Chapter 3

WINGLET LOAD TRANSFER AREA

We will now start doing the structures on the inside of the wing.

Begin by sanding the interior of the wing skin at the outboard end, the corner where the wing meets the winglet. Sand from the top of the bevel on the winglet, at the edge of the taper, across the glass to glass area in the corner, across the transition between glass and carbon and then up to the same transition point on the wing side of the corner. I'm going to sand from approximately an inch forward of the crotch where wing and winglet meet at the front edge, all the way into the area of the flush order horn depression, up the front face of the step and a little bit on the top of it. We're going to cut a block of blue, polystyrene foam two-pound per square foot density. Cut it to fit and match the interior surface. The foam block will go from the peak on the exterior surface of the winglet, to the peak on the bottom surface of the wing, where the transition occurs on the interior surface. It is not as visible on the interior surface as it is on the exterior surface. If you have trouble seeing this transition, drill a small hole from the outside through the skin in two or three places to locate precisely where that transition occurs. That's where the compression occurs when the lift on the winglet puts force inboard and puts tension on the inside skin creating a compression load downward and outboard into the two surfaces in the corner. It is a very important load condition area and the first one that you build on the wing.

We will cover each of these separate issues step by step as we proceed with building your wings.

The first thing that you need to do is to sand all of the gloss off of all of the possible bond surfaces. Sand from the front edge of the winglet all the way back to 2" aft on top of the flush order horn depression, up to the edge of the foam transition on the winglet, up to the leading edge of the winglet, around the front corner where the leading edge of the winglet meets the wing tip. You are not going to intentionally bond to the area in this front corner, but if you happen to have excess glass lapping out, it's hard to cut out. At least we know that it will bond to the surface that it's lapped onto. Continue sanding 1 ½ forward of the front corner of the winglet on the interior of the wing skin. Sand the interior wing surface all the way to this inboard to the foam transition at its highest point. Sand all the gloss off and get it ready for the foam block.

(PICTURE AREA TO SAND)

Double-check the fit of the top skin on the bottom skin. Be sure the winglet trailing edge will fit closed. Don't worry if you have some the disparity between the trailing edge of the top and bottom skins. If one is left a little long, you can sand it back to one common trailing edge when the internal structure is done and the wings are closed permanently. At the top of the winglet sand the outboard

joggle away until the trailing edge of the winglet will close. When you do the final bonding on the winglet, you'll have a straight edge on either side of the trailing edge to squeeze it to a straight line for the final bond. Review the video to be sure that your clearances look like the demonstration.

You're at a stage here where we can promise you just a little bit of frustration, our apologies. You will carve four foam blocks, which will form a support for the load transfer area where the wing and winglet meet. Start off with a 3 to 4" wide block of blue foam. Fit that block into the rear corner where the winglet and wing meet and shape it until the block is touching as much of that surface as is humanly possible. The point of the block on the upper outboard edge should end just above where the radius on the winglet surface changes to the vertical. The lower inboard edge ends where the wing foam transitions to the horizontal. We're going to ultimately trim the block so that the upper outboard edge fits the median line, right where the lower winglet surface goes from the curve to the vertical, but for now leave it a little oversize. On the upper inboard edge the foam block will end where the wing surface goes from horizontal to start going up the taper on the foam. We want the compression to go into where the helix ends. That's about ½ away from the bottom of the foam transition on the lower wing surface. Begin with the foam block larger than where these break lines occur. After the foam block is bonded in place, you will sand the vertical surface outboard and the horizontal surface down, until the horizontal surface is flush with the molded block at the trailing edge of the corner. Ultimately the goal is to have the inside of the upper wing skin to make contact with the foam block, but we don't want that contact to occur in the foam form. We want the foam to end up about 1/8" or less from touching the inside corner of the top skin all the way to about the molded block at the trailing edge corner. When we lay up the glass on the surface of the foam block, it will fill in the gap.

Do the trailing edge block first. Mark a line at the front side, where the block ends. Then take the next block, carve it until the lower surface fits in the corner. Put the block of foam in place, and "whomp on it". Knocked it with the palm of your hand; the foam block that is in contact with the lower wing skin will crush as you hit. The outer edge of the foam block is carved off later so it doesn't matter if it gets crushed with your hand when you hit it. Pick the block up and sand off areas on the lower surface that have been crushed, repeat the process until the block fits well. Then check the fit with the first block, they should mate allowing bonding of the two together. Carve the next block in a similar fashion until it fits. Last, carve the little block that goes in the front.

Now take the front block and bond it to the next block with West 105-205. (We are not going to do the fill at the front of the blocks with West, because it will exotherm. We'll do the minor bonding where the blocks contact each other, and then do the major filling with EZ Poxy or CPD later when we're actually doing the glassing of the surfaces, so we can avoid exotherm.

Mix up the West, we mixed two shots. Do not dawdle. West sets up quickly. Paint the surface of the wing skin where the foam blocks will set. Take the remaining west resin and add miconized glass beads and mix to a medium dry micro, about the consistency of ketchup. Take the first foam block and coat it with micro on the surface that will touch the wing skin and the surface that will touch the next block. Cover it with thin stuff set it in place and go on to the next piece. Check the fit of the next block; cover the appropriate surfaces with micro. This thin layer is not thick enough to fill the voids between blocks and the wing skin. We want to fill some of the voids; we don't want to fill all of them at this stage. We're really priming the foam, if you try to put dry micro on foam it doesn't work. So we prime the foam with a thin mix of micro. Coat each block in the series. Mix the remaining thin

micro to dry micro, which will fill the gaps and is less dense, which in turn decreases the likelihood of exotherm. Put a blob of micro in the center of the first block and a little on the end, and squish it into place in the corner where it belongs. We want to displace as much of the micro as possible, get it to squish out the sides and bottom. If we didn't prewet the surface of the wing skin there would be no way that the micro would have the ability to lubricant the surfaces as it expands. So it is very important to prime the surfaces. But it takes an experienced individual to do that and not push the cure cycle to far. Remove the excess that squeezes out and that will give you some more material to work with. Bond all the sections in much the same way. Remove the excess micro because excess will just exotherm and damage the foam. You will fill the gap at the front later with a much slower mix and possibly some chips of foam before you do your final lay-up.

Let that cure to the "B" stage and do some trimming while it is still soft. You can use sandpaper on it, it will fill up the sandpaper fairly quickly, but sand paper is disposable, so we don't really care. I wouldn't use a rasp on it at this stage it could clog up your rasp and then harden into a permanent coating, ruining your tool. Slide the upper surface into position, give it a smack and hope that it leaves a print on the surface of the foam block that shows the height and the distance in. The foam that touches the inner surface of the top wing skin will leave a print where the foam is crushed. You'll need at least 1/8" of clearance between the inside of the upper wing skin and the foam block before you can lay up the glass on the surface of the foam block. Once you get your print, remove more material. See the video to see how to get it all to match. A wire brush will remove soft epoxy. What you want is for the top surface to go straight horizontal and the inboard surface to go straight vertical. These flat planes will be resistant to buckling for the same reason that a Coke can is resistant to buckling when you are standing on it. Try this experiment. Stand on a smooth undented Coke can with your full weight. It will support you easily. Then have someone tap the side of the can with a ruler. It will collapse instantly. The same principal applies here, we want the surfaces vertical and horizontal so that it will take the compression load. If it is bent, that is where it is going to buckle. The foam will also help you prevent buckling.

Put the top skin back on and peak inside, be sure that the skin is definitely above the surface of the carved foam. Keep going until everything is where it is supposed to be and it mates well, before we continue. The foam core, if it's not obvious to you at this particular point backs the fiberglass so that if the area sees any buckling load it resists the buckling load and allows the glass to develop it's full strength before it does buckle. Repeat the process of fitting, and carving until you get the fit just right. Be sure that you allow room for all the plies that will go between the foam and the skin. When you are done shaping the block, then you radius the inboard corner so that the glass, which you will apply to the surface of the foam, will make the transition.

It is a good idea to glass the area while everything is still chemically active so you can get a good chemical bond.

When you are done with the shaping your dimensions should be approximately as follows (there is some fudge factor as there will be filler between the two surfaces). Drawing straight lines along your foam block at one-inch intervals form a grid and measure along the horizontal surface and the vertical surface. The measurements are made coming off fairly perpendicular to a line drawn fairly perpendicular to the wing tip.

Starting from the front:
It is approximately 1.4" from here to the first line. The rest are 1" apart.

	Vertical	Horizontal
1.	3"	2.2"
2.	3"	2.75"
3.	2.75"	3.125"
4.	2.5"	3.233"
5.	2.32"	3.47"
6.	2.125"	3.5"
7.	2"	3.53"
8.	1.7"	3.53"
9.	1.43"	3.4"
10.	1.125"	3.32"

DRAWING

That should give you clearance between the edge of the foam block and the edge of the upper skin on the underside of the vertical stabilizer to stiffen, to give room for the 8 plies of BID that go over the foam block and the three plies that go around the corner on the upper skin that will end up butting against the foam surface when we do the final fit.

Now we will do the last step on the carving, the radiuses. Carve the radiuses just enough for the glass to go around. At the backend transition the foam so that the glass can make a smooth lap from the foam to the molded block at the trailing edge. You will probably need a little micro across the back edge of the foam as well to make a nice smooth transition. It's not practical to run all 8 plies on the surface of the foam all the way to the trailing edge because the amount of load that is on the surface of the foam is mostly carried in the front area. We will therefore taper the plies on the surface.

Cutting Cloth

The largest plies are going to go up the surface of the winglet 1", across the foam block and onto the wing surface 1". Cut #8 plies on the bias (45º) of BID cloth 8" X 15". A lot of the edges will be cut away.

Prepare your area. You will need: the cloth, a brush, about 1 shot of Jeppco resin and some micro. Pour some of your mixed resin into a separate cup; leave behind enough for your first layer of cloth. Mix the rest with miconized glass beads to turn it into a slurry. Slurry the foam surfaces using a squeegee or wooden tongue depressor. Press the slurry down into the holes in the foam. Take what is left of the slurry and mix it to a dry micro, use that to fill any irregularities that are out of plane or any holes. If you do this while your West that is underneath is still chemically active, the new micro will bond well without pre-sanding. Brush resin on all surfaces that will be accepting the new glass layers. Do not get micro on your brush because it gets between layers of glass and weakens the structure. If you have any surfaces that the glass is not going to conform, you can cover it with micro so that it is not depending on the glass alone for structure. We already have a radius along the top edge of the foam from the squeezed out micro used to bond the blocks in place, if you don't have a smooth radius along the top of the blocks or along the bottom, add a fillet of dry micro, keeping it a minimalist as possible, just enough to allow the glass to transition around the corner.

Take the first layer of cloth and place it on the foam starting in the upper corner near the leading edge. Gently work it into position. Trim off the excess glass fabric, the resin which soaks into the glass helps delineate where the surfaces are, so you know where to trim. When you get to the front corner, pull it out and snip off the excess cloth. You can be a little cavalier with this first layer. Make it wet and don't worry too much about the resin content because the next layers will suck up the excess resin. You want at least ½ lap around the front corner, and the bottom and top edges onto the.

Apply the other 8 plies, you can cut off 1" - 1 ½ triangle at the upper front corner, which will save you all the fiddling around that you did on that first ply to fit into that corner. Each ply should be a little drier than the last, until the last ply should be quite dry.

Depending upon how much time you have to let this lay-up cure, you may want to use a heat generating device (a 100 watt bulb and a reflector) like Dave did in the video to speed up curing. When it has set up enough so that it is pretty stable and it won't move when laying another layer of glass in close proximity, then we can put the two skins together with a micro or flox corner in between the two and let cure. After 8 - 10 hrs of curing we can lay up our glass plies from the top foam surface up the L-tapes, and from the vertical face of the foam across the L-tapes, which finishes the saddle that this portion of the wing sits in, and completing our compression load transfer area.

L-Tapes

Begin by sanding the lumps and bumps out of the inside upper wing skin in the area where the wing and winglet meet. Then we will be placing duct tape over this area to act as release tape. We will be laying up three plies of BID at plus and minus 45°. This is really the only area on the entire aircraft that is like this. We are not depending upon this one layer of carbon fiber that happens to be around this corner for anything. It is really the seven plies of glass and the three plies of BID that are the load bearing member. So just take the bumps out of it, which will make the resultant laminates smoother and easier to prepare for bonding in the secondary bond operation. Sand it until you feel that the surface is worthy of molding, because that is what we are really doing here. We are using this area for a mold. It is the glass to glass to carbon area right in the intersection that we're trying to bond to. You want to make certain that it is all prepped.

We recommend using the thicker duct tape rather than a thin film. Lay it down; right into the crook in the corner. The surface should definitely be dust free so that you don't stick to your mastic. It is OK to have slight laps of the tape along the edges (about 1/8). Do not span around the corner. If you try to stretch the tape to make it do what you want, it softens the tape and that can lead to lifting of its own accord in the middle of a bonding operation. We don't want it to do that. This is an imprint and you don't want a false imprint. It has to match something else later. Lap the tape a little bit and make sure that you get full coverage. If you are really obsessive, you can lap tapes well over each other, cut through the center of the lapping area with a razor blade. Lift the edges and peal out the area that you have trimmed. You can then lay the area back down and it will fit precisely butt edge to butt edge. This sort of detail is not required in this area. Cover the entire area that will have BID tapes with duct tape.

Mix up about two shots of West resin. Cut three BID tapes slightly wider than the area in the corner and long enough to reach both ends. Lay the BID tape in place and stretch it tight, make sure that it's not too wide for the silver tape. But don't worry about the strength because it is really only a form.

This glass is not designed to bear load. It's only designed to hold its shape for the cloth that will bare load. Mark your trim lines along the leading edge as seen in the video. Paint the silver taped area with West. Be careful to avoid getting resin on the clean areas of the wing to avoid excess clean up later. We will put three plies here. (Two might be enough but since we are trying to transfer a form we don't want it to wrinkle or flex.) Lay the plies down one at a time and wet each ply thoroughly, working out all the bubbles.

Put the top skin in place gently and take a look at it first, to be sure that the tapes that we just applied are going to clear the foam block on the lower skin.

Take some of your West resin and turn it to dry micro. Pot the leading edge corner on the lower skin between the winglet and wing, with micro. (PICTURE) That will serve a purpose later.

Then put a bead of micro along the upper inboard edge of the foam block. Tomorrow the excess will be sanded off. Make your micro bead substantial enough that it doesn't move when we pop the top back off tomorrow. It is particularly difficult down in the trailing edge corner because it is difficult to get down in there and smooth out. We don't want any gaps so we have to put on excess. You don't want to use flox, because flox would be nasty stuff to clean out of here. Since we do have to remove the excess later, we have to use micro. Most of it gets removed and then glass is replacing it with flox on top of the glass. Very little of the micro is left, and the micro is not actually bearing the load.

Get an assistant to help you put the top skin in place. Line the top skin up carefully and then ease it into place. Peek inside to be sure that you are making contact along the entire surface. After you get it pressed in place, place the clecoes in the winglet and wing leading edges. Allow to cure. Be sure that the temperature in you shop is adequate for a good cure; you may want to use a heat-transferring device such as a heat lamp.

After the West has cured solidly pop the top skin free as seen in the video. (I'm a little more concerned with the CPD, Jeppco or other resin that doesn't like to cure without some form of post curing. That's why we used West in this area. This really is important to the continuity of our process.)

Get rid of all the "cut you's". The lower corner back at the trailing edge is too tight to work with and doesn't do any compression load transfer so cut that free back there, right over where your rudder cable conduit will go into your depression. The upper portion will seat solidly. Draw yourself a part line on the upper and lower arms of the L-tape and along the back. Leave a little bit more that 1" from the neutral axis on each arm. Trim to your part lines. If you did this process right, you will have a real close corner on the L-tape. You can see it is a real close fit at the leading edge where the wing and winglet mate, so when we lay up the plies underneath from wing skin to foam we'll lap this corner. And when we lay the tapes up on the inside of the upper L-tape, we'll go from the inside of the leading edge across the front of the foam, up the winglet skin a ways all the way around. This area, having the depth that it does, carries quite a bit of compression load.

Next, chip away the excess material from the underside of the L-tapes. You don't want the horizontal plane of the top of the foam and the vertical plane of the L-tape to have a big radius of micro between

them. You want this to be able to carry tension and compression into the corner of the L-tape and it won't be able to do so if there is a big radius of micro. Leave just enough behind to keep it stable during the lay-up. You can use a narrow chisel and pop the excess micro free. Position the chisel at an angle and chip the micro off in chunks. You have to experiment with removal to find a method that works for you. Don't damage your L-tape because that is the structure that you are working to. When you have the majority of the material cleaned away, and then scrape in the corners and sand. Sand until the glass gets a uniform opaque appearance. If you have any depressions or grooves, they will get filled up with flox before you do your 8 plies of lay-up on the top arm and your 8 plies of lay-up on the bottom arm. And if you're thinking, " On the foam core wings you did 10 plies here." On the molded wing, when we lay up the glass in this corner of the mold it becomes substantially stiffer, because the distance from the corner to the beginning of my material decreases and it becomes stiffer.

Cut eight BID tapes (on the bias as always) 5 ½ to 6 " wide by _____" long

Brush on Jeppco or Saf-T-Poxy resin on the underside and inner face of the L-tape area. Coat the entire area that will be taped. It's a good idea to use a relatively slow resin here, especially if you are inexperienced with working with this type of laminate and complex geometry. Make sure that all the areas are completely wetted. Apply a little bead of flox in the corners nice and neat, about 1/8" radius. Lay out 8 plies of glass on aluminum foil. After they have been wet out completely and all the bubbles worked out, cut two strips 2 ¼' - 2 ½ wide. Fold the strips back on themselves (foil surfaces together); place the tape into the upper corner of the L-tape. Make sure that it is all the way into the forward corner. Stick the tape onto the vertical wall first. Run resin on the inside of the aluminum foil on the vertical surface to act as lubricant. Rub out the air. Cut the excess tape off the trailing end and then fold down the aluminum into the curve at the aft end. Wet the horizontal section and smooth it down. Rub the air out, starting in the middle, working the air and excess resin toward the ends. Move outboard slowly, keeping the air ahead of it. Place the second tape on the undersurface of the lower arm of the L-tape. Wet the surface of the foil and smooth out the tape, working out the air and excess resin in the same way that you did the upper tape. Cut the excess off at the trailing edge, because it has nothing to hang onto and it can fall down of its own weight. After you get all the air worked out, fold the aluminum down on itself and just pull out the foil. Do not pull the tape straight out from the glass because it will shear and then it will lift up. Pull it at an acute angle keeping the foil as close to the glass as possible without touching or dislodging the glass. You can use a little tongue depressor or something to help lift the foil away from the wet glass. Inspect the finished glass to be sure there are no air bubbles and that it is stuck well along its entire length. The only real plus for applying one ply at a time instillation, especially if you are using fast resin is that you can be certain that you get all the air out before you lay down the next layer. Using the foil method you have the potential for capturing air. You have to do some of the process of removing air from this laminate by feel. The further aft that you get the less serious it becomes in terms of trapped air because it sees very little load back at the aft edge.

You've left the silver tape behind on the other portion of the winglet and when the tapes are semi-cured you'll set the upper skin back down in place. Any sections that are above contour will push right down and conform to the upper skin giving you the right contour. If you have an area that is below contour, and you want to get really obsessive, you could even put a little flox on there and have it conform. If you do that you take the chance that it might push the laminates out of plane so I recommend that you just leave it as is. You could always go back and add flox fill later after it has

cured, but is still chemically active. You can put a bit of flox in the transition corner at the front edge. Push it in and put your fingers behind it. Double check to be sure that all the bubbles are worked out. Put the top skin in place. Let that cure.

Chapter 4

SHEER WEB AND SPARCAPS

Locate your sheer web. It will be a foam core with one ply of glass per side. On the outboard end is a ¼' thick block of phenolic. Cut the sheer web out of your embossed sheet. Sand one edge perfectly straight. Bevel that edge on the surface that you are going to face forward. The outboard end has been trimmed to go underneath the L-tapes that we did earlier. Sand the lower wing skin on the spar cap face beginning about and inch ahead of the spar cap, the bevel leading down to the sheer web, and an inch aft of the bevel. We are going to sand more of that later. Sanded the entire aft face of the sheer web. On the front side of the sheer web sand 1" of the bottom and bevel the bottom edge at 45°. The next trick is, make little notch at the outboard end to fit underneath the L-tape. Then slide the sheer web in place with the outboard end under the L-tape, and the inboard end to matching the front face of the resistance web.

You clamp an extrusion to this front end of the sheer web. The extrusion sits on the return on the inboard end. On the out board end sit the extrusion on top of a block, so that you have access to the sheer web reaching under the extrusion. Place a piece of aluminum spanning from the reinforcement, back to the trailing edge to hold the sheer web up against the extrusion keeping the front face of the sheer web perfectly flush with the adjacent molded face of the wing skin false spar edge. 5-minute epoxy the sheer web in place. Put a dab of 5 minute epoxy about every six inches or so. Let it cure, making sure that there is no twist in this sheer web going from inboard end to outboard end. We are going to evolve the ribs from the sheer web so we want to start off with a straight plane. You shape the ribs individually so if the sheer web goes a little wonky along the course, you can correct for it. The sheer web sees mostly compression load. As soon as the 5-minute cures, we pop the aluminum off. Remove any excess 5-minuite epoxy.

Brush resin into the 45° bevel on the front of the sheer web, fill the bevel full of West micro, except in the area of the phenolic reinforcement, put flox in that section. Pack the micro in really well until it oozes out the other side a little bit. Fill the corner at the outboard end of the sheer web with micro. Clean the excess off the backside so that you don't have so much to remove later. Let the micro partially cure. Paint the surface of the sheer web along the bottom of the front side with resin, for about 1" up the face of the sheer web. Also paint the adjacent area of wing skin. Put one ply of BID tape about 1 ½ wide along the front corner from the forward face of the sheer web onto the wing skin to stabilize the sheer web. The tape should lap about ¾ onto the sheer web and the same amount onto the adjacent wing skin. The tape should extend onto the vertical member of the foam that we constructed earlier. Add a second ply in the outboard corner. Then add a third ply in that corner extending all the way from the T-tape at the top to the wing skin at the bottom. Wet the entire length; keep it light, you can even use a little bit of heat, but not much. West doesn't tolerate very much heat. Let everything cure.

T-TAPES

Take a long straight edge and place it against the shear web on top of the L-tapes at the outboard end of the shear web to the top of the shear web

at the inboard end of the wing. Draw a line on the shear web and cut the top of the shear web off just below the line. Use a "saws all" to cut the phenolic off. Put the top skin on and check the fit. There should be about 1/8" to 1/16" gap to allow for the T-tapes.

There a couple of things that you can do at this point to make sure that your airfoil is right and that your spar cap is straight. The first thing is look at the straight edge along the hinge line of the aileron it should be absolutely dead flat. It might be up a 64th in the center, but generally extrusions aren't as perfectly straight as you might think that they should be. Now we will show you how to determine where your spar cap is really easily. We're out about 8/10th of a span here, tap on the wing skin with a quarter. Mark where the tapping changes pitch, as seen in the video. Mark the inboard end of the spar cap. Take your extrusion and place the inboard end on the mark you made at the inboard end and the outboard end on the mark, in about 1" from the end of the wing. Check to be sure that the spar is straight. The most important points are the straight line along the hinge line and that it is relatively straight along the spar.

Place duct tape on the under side of the top wing skin running from about 2" in front of the spar cap, to about 2" behind the spar cap, running down the entire length of the wing. It will be approximately 6" in width. Reach inside the wing skin and mark on the duct tape with a sharpie where the front of the shear web is; project that line down the entire length of the wing. The inboard end of the shear web is easy to determine on the upper wing skin. The outboard end is a little more difficult. Measure the distance from the front of the shear web to the front of the wing skin, then mark the underside of the top skin to indicate the location. Measure 1" forward of the shear web line and make a line the full length of the upper skin. Measure 2" aft of the shear web line and make another line the full length of the wing. The T-tapes will be laid up between these two lines. After curing we will trim the tape to its final width. If you look at the amount of glass in the shear web, 2 plies the full length, then 2 more plies stepping back 25%, 2 more stepping back another 25%, and two more another 25%, the thickness of the tape tapers to reflect the amount of load transferred in the corresponding area. There is very little shear load at the tips so you will reduce the width of the tape at the tips to reflect that. It will be about 2 ½inches wide at the inboard end and ___" at the outboard end.

Find the section of the shear web, which has the reinforcing piece of phenolic. This block will help transfer the load from your tie down through the sear web and into the top spar cap. When you drill a hole in the bottom wing skin, your drilling through the bushing and the exterior skin so that you have a record of where it is. You will come back and drill the other direction and then counter sink in the bottom of the wing with a flush head screw. This prevents your bushing on the interior from rusting, you can even put grease up in there if you would like. That also plugs the hole on the bottom of the wing. You are going to make certain that the bushing doesn't have access into the inside of the wing, so we are going to cap off the back side of the bushing. Use a dremel or other appropriate tool to create a slot about 1" long and ¾ wide.

It would be a bummer to say the least, if you went to pop off your top skin after your lay-up and discovered that your T-tape stuck to the top skin instead of the shear web. To prevent that from happening and increase the odds that the T-tapes will do what they are supposed to do; sand down about .1" on the top edge of the shear web and expose as much glass as is practical. Remember that the glass is only 1 ply thick so don't over sand. Shave off a small section at the inboard end. This way the micro that we pack on the top of the shear web is not just sticking to foam; it is sticking to

glass as well. Sand the front face of the shear web and false spar, so that there is less sanding later when the area is harder to reach.

Lay up your tapes on the top skin in the area that you marked on the duct tape (1" in front of the shear web to 2 3/4" behind the shear web). It will be 3 plies of BID, cut on the bias stretching the entire length of the wing.

Mix about 2 shots of 105-205 West. Paint the inside of the groove on the top of the shear web. Avoid getting resin on the front or back face of the shear web. Mix a small amount of flox into the remaining resin, and then mix in glass beads to form a dry micro. The flox helps keep the micro from fracturing when you pop off the top. Stack about 3/16" of dry micro into the groove that you created on the top of the shear web down its entire length. Push it into the base of the groove first, and then stack up micro on top of the shear web. You want to make sure that the micro touches the T-tape when you put the top skin in place.

Position the top skin over the bottom skin and get everything lined up. Lower the skin into place being careful to keep everything lined up and careful that you don't push the micro off the top of the shear web. Cleco the top skin in place. Put the straight edge on the topside to make sure that it is still straight. Check the hinge line to be sure that it is still straight.

Reach inside the wing and gently remove excess micro that has squeezed out leaving less to clean up later. Be sure that there are no gaps along the entire length. Allow to cure.

Pull the clecoes out and pop the top off. You can see through the topside of the T-tape to check for any gaps in the micro. Mark the width of the T-tape down its entire length. The back edge is 1 ¼' at the wing tip and ¾ on the front edge from the front edge to the centerline of the sheer web. The inboard end is the full width of the support structure on the back edge that's about 2 ½ wide and ¾ to 1" wide on the back edge. Trim to the line with your fein saw. Sand the rough edges to remove the "cut-yous". Sand underneath the T-tape and sand and chip off the excess micro leaving a smooth transition from the shear web to T-tape. Put your hand on top of the shear web and look up under it. You will be able to tell by the shadow how much abrading has actually been done. Be careful of the one layer of glass on the shear web surface; abrade it without sanding all the way through the surface. If you find any areas where the T-tape popped off the shear web brush resin underneath while it is still chemically active to reattach the area.

Cut 1 1/2" wide BID tapes on the bias long enough to reach the entire length of the T-tape. If you do not have a smooth radius of micro along the front intersection put a tiny bead of flox in the intersection and at the out board corner where the T-tape transitions onto the L-tape. Paint the area of the intersection with resin. Lay up a one ply BID tape along the front intersection the entire length of the shear web and lapping from the T-tape onto the L-tape and down the front of the shear web at the outboard end. It should reach all the way to the trimmed edge of the T-tape and lap about ¾ onto the shear web. In the area of the phenolic place three plies of BID the width of the phenolic plus ¼' on each side and stretching from the underside of the T-tape across the shear web and lapping 1 " onto the wing skin. Remember the hole that you cut in the wing skin just in front of the phenolic? The three plies cover that hole completely. Dab off any excess resin from the BID tapes to get rid of any

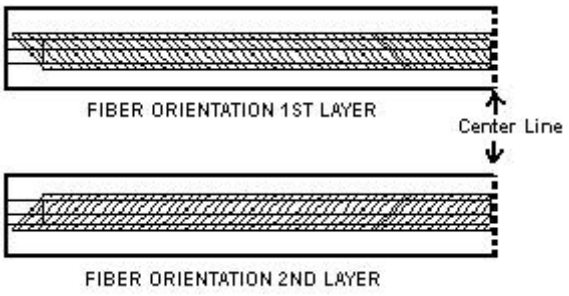
excess weight. Last, reach up into the intersection and feel along the entire length to make sure that you do not have any lingering air bubbles. Air is very light but makes a lousy structural material. Let cure, trim and sand off the "cut yous"

While the front side is curing you can prep the backside of the shear web. Clean off the excess micro from the intersection. Sand the entire face of the shear web, the underside of the T-tapes, the backside of the molded in shear web section and onto the wing skin for about 3" along the entire length of the shear web. Smooth out any transition areas.

Flip the entire wing and set it up vertically with the forward face of the shear web facing down.

Cut 14 strips of UNI cloth on the 45°, 14" wide the entire width of your roll of UNI cloth. (Review the general instructions section if you aren't sure you remember how to do this.) Lay out a length of heavy-duty aluminum foil about 140" long on your jig table or other suitable flat smooth surface. Place marks on the foil with your trusty sharpie: a length wise line down the center of the foil from end to end, a length wise line on each side of the centerline 7" to each side of the center at one end and 4" to each side at the other end, and several crossing lines on the 45° to use to orient the grain lines. Measure up from the narrow end of the shear web cloth and make a line at 34 ½, that represents ¼ of the total length of the tapes. Measure up from the narrow end of the shear web cloth and make another line 69" that represents ½ of the total length. Make one last line at 103 ½.

Lay the first layer of UNI cloth on the foil for the entire length. Cut the excess off the end. It should reach all the way to the lines at the wide end and there will obviously be excess at the narrow end. You should be able to see the diagonal lines drawn on the foil through the cloth. Orient the cloth 45° from the edge using the grain orientation lines drawn on the foil. Do not overlap the pieces of UNI where they mate. (It will take about 3 pieces depending upon the width of your roll of UNI cloth.) But the edges so that they just touch. Begin your wet out of the cloth by placing a small dab of resin at the 45° marks to attach the glass to the foil and stabilize the glass in the proper orientation. As you apply resin to the glass be sure to follow the fiber orientation with your brush or squeegee to keep the fibers nice and straight and in the proper 45° orientation. Wet the entire 140" of the glass strips for the shear web.



The second layer of UNI will be oriented opposite of the first layer, along the other 45° marks, which you placed. (They are 90°to the first layer.) Begin by placing your first piece of full-length glass at the end of the shear web opposite from where you started the first layer. This will ensure that your but lines where the pieces meet will end up in different places on the two layers. It is very important to get your grain orientation perfect on each layer of this lay-up. Do not let the glass dictate what it wants to do. You are the boss and you do what you must to get it to lay down and behave. Don't panic if it does not immediately behave. The slow curing epoxy gives you time to manipulate and "massage" the glass into place.

The third layer of UNI cloth will be oriented like the first one. Place it at the 34 ½ mark. Do not trim off the diagonals at the ends. The diagonal ends of the third and fourth layers cross at the 34 ½ mark.

The fourth layer of UNI is placed opposite orientation of the third, (same as layer #2). Again start at the 34 1/2" mark and wet out the entire length.

The fifth and sixth layers should be placed at the 69" mark. They should be placed with the same grain orientation as the last two layers, with the diagonals crossing on your 69" mark.

Layer seven and eight are done in the same way, stepping back once more to the 103 ½ mark.

Cover it the entire laminate with heavy-duty aluminum foil end to end. Work the air bubbles out working them from the center out. (Measure your shear web to be sure it is the same a Dave's, 14" at the center tapering to 6" at the tips.) Measure the length of your cloth; it should be exactly the same as the length of your wing shear web. Cut the ends off first. Use your Olfa cutter. Push hard enough to cut through all layers of foil and glass.

Transfer the marks that you made on the first foil layer to the topside of the new foil layer. Mark the centerline of the tapes lengthwise. Mark the width 14" at the inboard end and 6" at the tips (remember we originally marked 8" at the tips, planning to trim to 6") tapering equally on both sides of the centerline; cut along these lines. It is hard to use a long straight edge and cut along it like you did on the canard, because the laminate is so thick you really have to push hard. Flip the entire strip over. Peel the first aluminum foil off. Pull the foil horizontally as we have in the past with other lay-ups done on foil. The exposed glass should have no visible "laps". It should be one long continuous glass surface with the cut ends "butted" together.

Applying Shear Web Tapes

Your wing should be oriented vertically with the back T-tape section oriented upward. Brush resin on all the interior surfaces of the shear web and T-tape backside. Examine the shear web area; there are some areas that the tapes are not going to wand to adhere to. Apply a very thin area of flox to the sharp corner between shear web and wing skin at the inboard end of the wing. Apply flox to any sharp corners or depressions as shown on the tape. Apply fox around the aluminum plates for the wing attachment bolts. Apply a radius of flox down the entire shear web-wing skin corner.

Pick up the strip of fiberglass tapes that you laid up on the foil and trimmed. You may want to place the strip on a long aluminum extrusion to carry it over to the wing. Flop the strip over into the trough on the shear web in the wing. Fold the strip along its length. Draft some helpers and gently pick it up. Position the tape in the trough formed by the top surface of the T-tape and the face of the sheer web. The strip should be positioned in the center of the trough with the same width of tape lapping onto the wing skin as is lapping onto the T-tape. Take a little excess resin and apply to the surface of the foil as a lubricant. You will have a fold where the shear web turns upward on the inboard end of the wing. Rub the foil up slowly; the layers of glass will slide on themselves and the foil will fold

getting rid of any problems in the area. Smooth the glass along the shear web face. Push the glass into the corners between the shear web and skin and between shear web and T-tape first. On the tape Dave was about ½ short on the inboard end but it is really no big deal. Try and move as much air toward the edge of the tapes as possible. There will be some air that will be unavoidable; you'll be able to see it through your glass plies. I've got a little elephant going right there. I go right down the middle and push it laterally, toward the corners. Do this over the entire surface. After you feel that you've got 90% of the air out trim off the excess glass, then you can pull the foil. Remember to pull the foil horizontally to avoid sheering forces that would separate the glass from the underneath surface. The bubbles are clearly visible. Stipple to remove the bubbles. Apply heat with a heat gun if needed and work all the bubbles out. The outboard end is really easy to stipple out because it is only two plies thick, but it is more difficult when you get to the inboard end and there are more plies. Stipple right into the corners. The T-tape surface is actually easier because it is translucent and you can easily see the bubbles through the surface. Don't add extra resin there is plenty of resin in the lay-up. Put one more ply of BID on the backside of the hard point so that it has actually 5 layers over the top of it, 4 sheer web and one extra BID. Let cure.

Winglet

Now we're going to go to the winglet. Cut two winglet members out of the flat stock sheet. Place a two-inch wide block of foam between the two; place them on the winglet one inch on either side of centerline. We beveled the edges, just like we did the sheer web and put them in place with 5-minute epoxy. Use about 4 blobs on each one. Let that set up and remove the foam block between them.

Sand between the two members and the outside surfaces and about 1" onto the adjacent winglet skin. Wet the surfaces with West 105-205 resin. Fill the area of the bevel with a bead of micro and place one layer of BID along the intersection ½ onto each surface and no more. After it is all wetted out and bubbles worked out, dab the BID with a dry paper towel and remove as much excess resin as possible. You don't want to reinforce the back of this vertical member with a full ply of material, just enough to pick up the glass on the shear web. You can go with as little as ¼' onto each surface if you wish. We cut the tape at about 1 ¼' wide and stretched to about 1" total width. Treat the other member in the same way. Allow to cure.

You may wish to tilt the table back up to level to make the area more accessible. Make sure that you put a tape going in the corner between the winglet member and the reinforcement area between the wing and winglet as well. Of note, the members that we are placing are not perpendicular to the winglet skin surface. It should be half the angle between the inside and the outside surfaces. The one on the tape Dave put a block in and made it perpendicular to the winglet surface. We really should have had it the same distance from winglet trailing edge to the edge of the member as it was from the ____ to the edge of the member. Let cure.

After the two longitudinal members have firmed up, sand to get rid of all the "cut yous" and rough edges.

ANTENNA

Chapter 5

We've showed you the placement of the antenna stock which is ½ wide adhesive backed copper foil. It will be cut to 20.3" in length running from the winglet tip to the horizontal line drawn on the winglet skin as Dave shows on the video and another one from that line running downward. Sand the area where the antenna will be placed about to ½ wide behind the line and ½ in front of the line, lightly scuff the area all the way down on both sides of your line.

Sand very well in the area where your riblets go so that you will get a good bond there. The rib dimensions: centerline of back end of the top rib 18 ½ from the tip of the winglet top skin, 35 ¼' to the middle of the bottom rib. Leading edge of the top rib is 16 ½, leading edge of the bottom rib is 33". Because of the extra glass in the leading edge and the fact that there is no load there specifically, the ribs are going to end just behind the D section of the leading edge making the ribs much simpler to install. This leaves the leading edge essentially hollow. This allows your cable to run down there without being caught up inside the laminates. After this is all sanded and cleaned up, vacuum the area and wipe it out make sure it is all really clean in there with no dust left. There is not much mastic potential on the copper tape and if there is any dust on the winglet skin, the tape will stick to the dust and it will not stick to the winglet surface.

Cut out your ribs from flat stock using the templates provided in your kit and fit them in place. Sand the ribs for ½ along the edges. Be sure that the rib does not distort the leading edge of the winglet. You are going to put 5-minute epoxy along the long edge of the rib, place it using a square to confirm that it is perfectly square to the winglet skin. Let it cure, then trim and shape.

Trim the longitudinal members to be sure that the top skin of the winglet closes without touching.

Reconfirm all of your positions on the winglet skin. Dust the interior as much as you can. It wouldn't even hurt to hit it with a little lacquer thinner unless you are concerned about losing your marks. My friends tell me that there are optimum shapes for tapes at the end of antennas. As I recall, that was 90°. Trim the end of the copper foil tape, tack the end of the copper tape to your mark at the end of the winglet tack the foil along the line and I pull the little piece of backing paper with it. Cut the foil tape right at your mark on the winglet (20.3") 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 far end of the next section of the tape at the outboard end and tack it down along the line in the same way. Go slightly longer, at the bottom end, then pull the tape tight and straighten it out. Cut the bottom end off. Then take out your 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 80-grit or 150-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.

Now we take the RG 58AU and run it 90° to the leading edge of the antenna tape. 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. Bring the center conductor though here. Strip the end off the tip of the center wire and the ground wire. Put the ground on the bottom copper foil strip and the center conductor on the top copper foil strip. We could have left it spread 1" because we are only going to solder it at the corners.

The toroid beads are going to be placed on the RG 58. The first toroid 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. Then super glue the RG 58 with the beads in place, directly to the skin of the winglet. After we stick the foil down and solder the RG 58 to it and the three toroid beads on the RG 58, then super glue the RG 58 in place at 90° to the copper foil, lead it straight forward to the leaking edge, holding it to the skin at the leading edge.

Drill a hole 3/16" or slightly larger in the bottom front corner forward, in a place that will keep you away from the influence of the strobe light. We're going to run the RG 58 through here and then it will drop into a conduit that runs to the inboard end of the wing.

Tack the ribs in place. This is 5-minute epoxy. I am only bonding to the foam of the rib, nothing else. Put the bottom rib in place on the winglet and square it up. When it has set up enough to stay in position trim the rib, place the top skin in place and look down the winglet from the end. Make sure that you have clearance between the rib and the winglet skin. Do the same with the top rib and square it up. Put the skin back on once more and check for clearance. This is not going to take long to cure. Scrape off any excess before it sets up. Be really careful over the copper foil to not damage it.

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 upper foil strip. Then go to the lower 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 lower foil strip, but not with the upper strip. If at anytime you check it with one of the meter's wires on the top foil strip and one of the meter wires on the bottom 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.

At this point you can do the taping on the winglet ribs or you can place the wing ribs and save the winglet tapes for one large mass taping session later. The instructions for winglet taping will be given here and repeated later when we do the wing tapes.

Brush resin over the foil strip the bottoms of the winglet ribs have glass to glass rather than a bevel. Place the teeniest little radius of flox in the corners between rib and winglet skin, trying to keep the weight low. Brush resin over the areas where the BID cloth tapes will go on the ribs, the copper antenna foil and the RG 58 horizontal portion, you're going to tape over the top of this, but not before taking micro and packing it over the top of the toroid beads so that the 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 because you will never going to be able to get to it again. 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 we can apply little glass tapes in a few positions along the RG 58to make sure that it doesn't move. We'll tack that in place. Apply one ply BID tape over the copper foil lapping about ¼' onto the winglet skin. Apply narrow BID tapes on the ribs between the rib and winglet skin and between the ribs and the vertical members of the winglets. Let everything cure.

Rudder Ribs

(This process is shown on the video at the end of the section on the rudder retract spring.) Add two small ribs on the back edge of the winglet in the rudder area. Trim and fit bottom surface of the ribs leaving the top surface a little big for trimming after bonding in place. You will be provided with templates for them. Because these ribs are going to see very little load, and the load they do see is in compression only, you do not need a very elaborate process for installing them. Sand the winglet skin and apply a small amount of 5-minute epoxy to the surface of the winglet and on the edge of the lower rib. This foam is so tough that we are going to get away with just bonding to the foam. You do not have to go all the ways back to the tip of the trailing edge because that will be sanded away during the fitting process. Put the lower rib in position and let cure. Take your trusty chisel and chip off the excess 5-minute epoxy from the edges and the winglet skin. We want to keep the weight as low as possible aft of the hinge line.

Slide the upper skin in place and trim the top of the lower rib to fit with as little gap as possible, because you are not going to T-tape these ribs. Look in through the top of the winglet to get this trimmed perfectly. Place the upper rib in the same way. Let it cure and trim to fit in the same way.

Next we will place the close out rib at the very top of the rudder. Make yourself a gage, which has an 85 degree angled corner and is .063" thick. Because the winglet is swept back at an angle at the tip it tends to exacerbate any condition that the rib isn't perpendicular to the travel and you can have trouble as the rudder moves, that the two surfaces hit. So we set this rib .063" above the part line and set at 85 degrees from the winglet skin so that as the rudder moves it swings away from the close out member and actually opens the gap. Then when the rudder closes it brings the two bevels closer together and actually closes the gap and makes a nice tight seal. Trim and fit the close out member and the rudder tip member. Sand the winglet surface where they will set. Glue the close out piece in place with 5-minute epoxy and let cure. Now position the rudder end piece, put 5-minute epoxy on the edge and position the piece so that it has a .063" gap between the two members as shown in the video. Make sure that it is flush with the vertical close out in the front and let cure. Clean off the excess. Put a little bead of West flox along the junction between the rib and winglet skin.

Drill vent holes in the rudder ribs and in the front of the tip section to allow pressure equalization.

WING RIBS

Chapter 6

Measure along the leading edge of the wing from the inboard end of the leading edge. The first dimension is 83.5" measured from the front inboard edge of the leading edge, along the length of the leading edge. The next one is 56.5". The next one 30" even. And the last one 2 ½ There is a rib at each point, And that rib is perpendicular to the shear web, so that when you pick up each of these marks along the leading edge, you do so with your square and transfer that mark to the shear web. Make a vertical mark on the shear web.

There is a little box at the outboard end. We measure from the joggle edge at the outboard leading edge, along the leading edge 2 ½ and make a mark on the leading edge. Then take your square and line it up with one arm against the shear web and the other arm touching the mark you placed on the leading edge. Put a mark on the shear web at that point. You're going to build a little box across the outboard end of the wing and isolate it entirely. We're not going to drill it or port it to any other portion of the wing. The light will be common to this aperture and to the conduit that is behind the back of the shear web and no other portion of the wing. (Most wings will be running conduits down the front. The one in the video they are not doing that because there's going to be a fuel tank in the front wing area. So they're going to make certain that there are no electrical components that run through the tank.)

Start with the outboard ribs, working inward one at a time. Exactly the same process as the winglet ribs and doing it for the same reason. If I go anywhere else, I visually close off and lose the ability to inspect the outboard rib for trimming.

Mark out the positions for the ribs and sand the areas for bond. Locate the wing ribs on your flat stock and cut them out. Fit them so that they fit into their respective positions. Trim them down until the wing closes without touching them. They should fit within about 1/16" down the entire length. The foam of the trailing edge of this wing was just a hair thicker and too far aft so we had to trim it down to the trailing edge, so that the wing skin at the trailing edge could go down and touch the skin.

The farthest out board rib in front of the shear web and the out board rib in back of the shear web go in first. You have an open bay to be able to look all the way down to the outboard ribs without the obstructions of the other ribs. Put the 5-minute epoxy on them, put them in place and let them cure. Then trim the tops of both those ribs down. Then go to the next inboard rib and do the same. We progressively do each rib from out board to inboard until we have them all. Don't be tempted to do them all at one time. If you did you would not be able to look in from the end and see the first ribs for fitting. The most outboard rib on the front side is only held on with 5-minute epoxy because it is only a close out rib. It doesn't carry any load. We didn't even bother to bevel the outboard side. We beveled the inboard side of the rib to the edge and closed it out all the way around. Do not leave any opening; we do not want any air to be able to get through here.

You can see the projected contour on the front of the outboard rib; it's glass to glass on the front edge. And we also know that the rib has to be the thickness of the foam below the plane projected from the leading edge skin and the front edge of the T-tape. The contour of the rib is going to start even with the T-tape then step down just a touch as you move forward and then it is going to come back up to meet the level of the leading edge at the front. Your kit will have a template of the rib, or a printed embossed rib. Now put the top skin on and take a look in from the inboard end. You should clearly see if there is light coming from the outboard end and that indicates that the rib is about 3/16" too high, so it is really easy to see. Mark on the rib with a pen to indicate approximately how much you want to remove so that you have something to shoot for. (It's amazingly hard to judge how much material you have removed without some mark on the rib.)

Place the rib at the 56.5" mark and trim it in the same way, then proceed to the 30" mark and place the front and back ribs. The rib at the 2" mark requires some special consideration; its position needs to be precise.

Go to the trailing edge at the inboard edge of the aileron. Place a red mark on your aluminum extrusion; transfer the location from the underside of the bottom skin to the extrusion surface. Locate the forward, outboard corner of the aileron and drill a small hole if you have not already done so. Draw a line from the front edge of the hole to the corresponding hole in the front inboard edge of the aileron. Then measure forward 1 ½from that line and transfer that point onto the two ribs on the back side of the shear web in the aileron area, so that you can tell where your false spar runs from the farthest outboard rib, picking up the face of the two short ribs in the aileron area, and the next inboard rib. It will also receive a T-tape. Position this rib using the WPRP (winglet position reference point); place the outboard surface of the rib on the edge of the hole, which represents the part line for the aileron. And placed the back outboard surface of the rib on the edge of the red mark that you made on the aluminum extrusion. That is how you get the back rib position and how we determine where the aft surface of the front rib meets. We want the front and back ribs opposing one another. The surface of the rib is perpendicular to the wing skin surface. Sanded up an inch or so on the lower edge of the rib surface and an inch or so on the front surface of the rib and the face of the spar, just as we did on the other ribs. The biggest difference is that this rib and the one just inboard of this position are going to carry a larger portion of the torsional load transmitted to the outboard wing attachment hard point. The inboard hard point sees shear from bending loads. The outboard wing attachment hard point sees a combination of shear and torsion so this will be the beefier of the two preparations.

Prepare the inboard surfaces of the rib for a three ply BID lay-up. Sand 7" from the shear web surface back along the surface of the rib. You're going to have one ply that runs from 7" on the inboard surface of this rib to the shear web across the face of the shear web and onto the outboard surface of the next rib. It will be a 21" long piece of glass cut on the bias. It will lap onto the surface of the wing skin 1" and the under surface of the T-tape 1". Which means its total height will be 8". It will lap under the T-tape that we will have in place on the ribs as well. This becomes the torsion box that transmits the load in the outboard wing attachment area. The most inboard rib ends right on the edge of the plate already in position on the shear web. After those three plies of BID are in place we'll place three plies of Unidirectional carbon spar cap tapes over the wing attachment plate, coming from the width of the spar cap up to the width of the shear web here, followed by another layer of BID that covers the entire carbon fiber. It will be about 4" wide and run the entire length of this surface area, about 9" - 10". This is followed by a layer of aluminum 2" tall and 3" wide, and one up here 2" tall

and 3" wide. These will be radiused on the upper edges and the outer edges (inboard) where it meets the rib. That forces all the shear into the lower inboard corner, the vertical wall along the shear web and inboard rib and the upper inboard corner.

(After all the ribs are fitted, we will brush in resin, apply dry micro and apply our one ply BID tapes on all of the ribs except the inboard ones. The two back inboard ribs will see thicker heavier lay-ups.)

Locate your false spar and cut it out of the flat stock pieces. It is 1 ¾ tall at the outboard end and 2 3/4" tall inboard. It's 76" in length. Position your false spar running from the farthest outboard rib, picking up the face of the two short ribs in the aileron area, and the next inboard rib. Tack it in place with drywall screws into the short rib ends and super glue. Cut and shape the back rib positioned at the outboard end of the aileron and secure it with super glue. Position and shape the short rib at the inboard end of the aileron and the most inboard wing rib and secure them in place.

Determine the position of the aileron torque tube. From the trailing edge here, the inboard lengthwise member essentially isolates the torque tube from the rest of the wing and we are going to make certain that this compartment remains isolated and only breaths from one end to the other and not into the rest of the wing to avoid getting water into the rest of the wing. The aft face of this member is 8.2" from the trailing edge at the position of the rib at the inboard end of the aileron. It is 2.25" tall at the rib and the inboard end is 4.75" tall, we are going to trim these down obviously. It should be a straight line from the aileron rib to the inboard end. Set the panel up with drywall screws through the panel into the end of the short rib in the wing hard point, holding it in place. Everything should be pre-sanded on the backsides, front sides, etc. Every one of these ribs has been beveled.

Now get out your power automatic applicator for glue. Snap in the cartridge. Prime it and take the tip off and place the applicator tip. Glue all of these devices in place en mass as seen in the tape. You want a glob of glue at least ever 6 - 8". It wouldn't hurt to have a person chasing you to make certain that this material is pushed in the appropriate surface to make sure that you have good contact. Be sure that all the beveled surfaces have a glob of glue. Clean everything up before the glue becomes rock solid. Let set up. Then pull the screws.

Trim the inboard lengthwise member and the false spar. You know what kind of gap we have in that area so put your straight edge on top of the member and marked it across the top, you can fudge a bit here and go just a hair above. Trim the excess off with your Fein saw. Sand all the areas where 5-minute epoxy has gooped onto other things. Sand off the gloss on the surfaces of the 5-minuite epoxy so that when we bury it under micro and under tapes that the 5-munute actually sticks to the other laminate.

Brush resin into the depressions, fill it with dry micro, wipe off the excess and put one ply of tape in all the intersections except for the box in the wing attachment hard point area. The box in the wing attachment hard point area will have more laminates and structural epoxy. We can use West on all the secondary items and we'll use Jeppco or CPD on the higher stress areas of the box in the wing attachment hard point area and the inboard rib.

If you saved the winglet rib taping for now we begin with that area. The bottoms of the winglet ribs have glass to glass rather than a bevel. Place the teeniest little radius of flox in the corners between

rib and winglet skin, trying to keep the weight low. Brush resin over the copper antenna foil and the RG 58 horizontal portion, you're going to tape over the top of this, but not before taking micro and packing it over the top of the toroid beads so that the 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 because you will never going to be able to get to it again. 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.

On the wing ribs where they are beveled, brush on a small amount of resin in the corner and fill with a small bead of micro.

Start out with 24" wide single layer of BID glass cut on the bias and laid up on aluminum foil. Get the resin content just right; not too wet, not too dry. Then cut at least ½of it into 1 ½ wide strips on the foil. Start with two 9" lengths, on the top and bottom of the top winglet rib, then two 16 ½ lengths covering the top and bottom sections of the copper foil and, then two 12" strips on the lower winglet rib.

The tapes are applied to the wing sections using the same technique for all the sections except the area in the wing attachment hard point. Place a bead of micro filling the groove along the bottom of the lengthwise members and ribs. Scrape off any excess. You don't want micro between layers of glass. The micro should only span areas where there is foam exposed. Where you don't have foam exposed, any areas the upright members have the edge of glass right against the wing skin and where ribs and lengthwise members touch vertically, fill with a very small bead of flox. Apply just enough flox to allow the glass to lay smooth. Measure the length of each section and cut a BID strip for each section. Do one section at a time, and brush on just a little bit of resin, just enough wet the intersection. Apply the tape in the intersection. Single plies don't fold very well so just lay it right in the corner and play with it until you get it to go right into the corner. Add just the slightest amount of resin to the top of the tape which helps act as a lubricant for rubbing. Rub the air out of it. The rough edges get trimmed off later after the tapes are semi-cured. Get hold of the foil and pull it off as close to parallel as possible. Work the bubbles out with a stippling brush or your finger. Be careful about not getting too much resin in the tapes, make sure that you don't paint too much resin in the intersections to make them excessively wet. Try not to get micro into your resin. Do each of the other tapes in the same way. All the ribs are one-ply tapes, the bigger ones can be a little more awkward to manipulate. Start working the air out from the center first and then out toward the edges. We can manipulate the tapes a little bit at this stage while they are wet, but not a whole lot. After the tapes are cured, but still just a little it green you can trim the edges that extend past the ribs and scuff up any edges that have rough spots or "cut yous".

Now proceed to the special section that we talked about before in the wing attachment hard point area. In the wing hard point attachment area lay up three plies of BIID that will cover the shear web, lap up under the underneath side of the T-tape and onto the inboard and outboard ribs. It will lap onto the wing skin at the bottom and it will be the same all the way around, three plies, stepping back on each end, getting shorter as they go forward on the ribs. Following the BID tapes there will be three plies of unidirectional carbon fiber spar cap running vertically over the inboard area of the box. Those will begin at the edge of the T-tape cross the shear web and going to about the middle of this bolt access hole. All of the tapes go all the way to the edge of the T-tape and step back ½ each tape on the wing

skin edge, 4", 3 ½' and the 2 ½' from the corner. Then place one ply of BID on top of that so that the aluminum is not touching the carbon fibers.

We've made up two plates two inches wide and three inches long. Radius two of the edges on each plate. Grit blast them and coat them with epoxy to keep them from oxidizing. Put enough flox on here to provide good contact and to get some oozing on all sides. Place them with the radiused sides toward the corners. Place one all the way up at the top and pressed into the corner and the other one all the way down at the bottom. That will pick up the centers of the wing bolts and distribute the load in shear into the corners. Put a piece of plastic over the top of the aluminum plates. Clamp the top plate with a large C-clamp and put a brace or tube to hold the bottom plate in place. Allow to cure.

Now at the inboard rib, B.L. 23; apply 1 ply of BID glass over the entire inboard surface of the rib, lapping about 1" onto the surface of the wing skin, one inch onto the shear web and one inch underneath the T-tape. Cover the intersections with 1" wide 2 ply BID tapes along the bottom of the rib, the front at the shear web intersection and under the T-tape, making this rib a two-ply surface and a two-ply tape. The second tape doesn't have to go all the way to the back of the rib because there's no load at the back end of the rib. That finishes essentially putting all the ribs and tapes in place.

Trim and Prep for T-tapes

After the tapes have cured, but are still on the green side you can take some 36 grit and scuff the edges to get rid of the parts that will cut you.

Trim the tapes while they are still green if possible. Trim all of your pieces and get rid of all the little hairs. Leave nothing projecting above the top edges of the ribs and lengthwise members and false spar. Remove any braces and disconnect the clamp that you placed to hold the aluminum plates in position. Remove the piece of plastic on the aluminum. Peal that off. Clean the area up. It is easier to clean up the areas when the material is still relatively uncured.

Brush West resin on the area of the aluminum plates. (You can use Jeppco, Safe-T-Poxy, E-Z-Poxy, or whatever but we use West here.) This is just a capture layer. Put flox around the perimeter of the aluminum plates after. Put one ply of BID over the top of the entire area. Let cure.

Take some fresh sand paper, stick it together, and fold it on its edge. Use that to remove the material from the top edge of the ribs. Go down about .1". Then make certain that the vertical glass is exposed. (You will do it the same way that you T-taped the shear web.) That is really only to prevent a de-bond when we pull the skins. Ultimately all the strength in a T-tape is transmitted from the skin of the rib to the underside of the T-tape by the tape, which you place from the surface of the rib to the underside of the T-tape. Do all of the ribs except the ones on the vertical stabilizer.

The T-tapes are a little different at the aileron close out. We will look first at the inboard aileron close out rib. You can't run a tape around the corner toward the aileron area. This was designed for this rib to close out the wing surface at a nice sharp, clean 90° line at the aileron well. So to do that, we remove a 45° angle of foam from the topside of the inboard edge of the aileron close out rib so that the outboard skin here has almost a 3/16" purchase on the flox corner that we are going to put on the inboard edge to a cosmetic edge. It's the only way we're going to get any structure out of the skin

that faces the aileron well; it's only one ply of glass. An eighth inch is probably sufficient. We don't have nearly as much required at the trailing edge. You will T-tape the rib, but it will only really be an "L" and we'll get glass on the inboard side of the rib as well making the whole rib more structural. At least to the part line, make the top of the aileron close out rib a flox corner and make it deeper, cut it at a diagonal. Do that at the inboard and the outboard aileron close out ribs.

Check all the areas that are going to receive T-tapes. We are not going to T-tape the lengthwise ribs on the winglet or the false spar in the area of the aileron well. Everything else will get T-taped. We do not need a T-tape on the false spar because once you get the top skin matched up and bond the wing closed you'll do a three-ply tape on the inside of aileron well. We are not going to T-tape the outboard font rib, it's just a close out. You are also not going to T-tape the outboard aileron close out rib, as it would only get taped on the interior.

Place silver tape on the underside of the upper wing skin and winglet skin in every area that will touch ribs or wet micro. Place 3" wide BID tapes on the upper skin surface in the appropriate locations. (You could use narrower tapes if you are absolutely certain about your positioning. Three inch tapes give you plenty of leeway so that you can be sure there is adequate width each side of the rib after trimming.) The tapes do not have to go all the way to the leading edge, there is really no load on the leading edge, and you are going to get a bond to the micro. Notice in the video that the tapes in the corners cross. Make sure that your tapes cross in areas where the ribs make a corner because crossing the tapes really strengthens and decreases the likelihood of a de-bond. Do not lap the tapes from the ribs on top of the spar, because the spar is your final determinator. Do lap the tapes from the back of the short ribs in the aileron cut out area onto the false spar where they meet. On the rest of the false spar, where there are no ribs, we have nothing but micro. The reason for that is simple, once the ailerons are trimmed out and the wing is assembled, you're going to lay three plies of BID from upper skin across the false spar to the bottom wing skin to close out the false spar. So the false spar really doesn't need any reinforcement going forward of the face of the false spar. Remember on a solid foam core wing there is nothing forward of the aileron cut out except solid foam.

Place BID tapes on the winglet skin in the areas of the winglet ribs. You want them to lap onto the vertical members in the same way that the tapes on the wing ribs lap onto the false spar. You do not need to tape the vertical members for the same reason that you do not need to T-tape the false spar. Those members will get tapes applied after you cut out the rudders.

Mix up some West 105-206 resin. Add just a touch of flox. Place micro on the tops of all the ribs and work it down into the area that you grooved, except the inboard and outboard aileron close out ribs, those will have flox. When you place the top skin you are going to have to make certain that you are down all the way on the spar, the leading edge is closed all the way and the shape is the way that we had it before. One of the reasons to try to keep the gaps as small as possible is that you want the rib to help determine its placement. You don't want a huge gap filled with micro, but you don't want to leave any air gaps either. In some cases you may know that you have a larger gap so fill it up a little higher to make certain that the micro picks up the underside surface of the top skin. Make certain that wherever one of the ribs interfaces with the interior surface of the upper deck that you have duct tape down. It is amazing how well West will attempt to bond to a surface that you do not want it to.

Pick up the top skin and position it. Have one person holding the tip of the winglet inboard at the top while you position the corner and straight down. Then let the inboard skin of the vertical stabilizer move against the outboard skin. You cannot slide it in because it will wipe the material off the ribs, defeating our purpose. Weight the middle of the spar and cleco the leading edges and make certain that the trailing edges are down where they are supposed to be. Let everything cure.

Pop the top skin off. Begin by popping loose the edges all the way around the perimeter, then go to the inboard leading edge and release the T-tape; you can see the entire piece. Go to the inboard trailing edge end and make sure that it will release. Progressively pop the entire surface free.

Take a chisel along the backside of the false spar and just chip the excess micro off. Scrape off the excess micro even with the rear face of the false spar. The areas at the end of the aileron well that are flox instead of micro are a real pain to clean off but the flox needs to be scraped off even with the face of the rib. Scrape the excess micro from the vertical members on the winglet in the same fashion.

Trim the T-tapes on the all of the ribs. We'll trim to ¾ inch on each side from centerline. With one inch of glass being able to carry 2,000 pounds of shear, that one-inch will exceed the strength of the material to which it is bonded. So we are not going to trim the T-tapes to a width any larger than 1 ½ total. Sand the edges.

The rib at the outside of the wing attachment point box is a little wider. Go a full inch on the inboard edge and leave the 5/8" or so on the outboard side. As you get back to the backside of the rib taper the inboard edge to something like ¾. This area sees a larger load, so you want a greater degree of bond in this surface area. The inboard rib of the box will be treated in the same way, I'll go 3/4" on the inboard side and 1" on the outboard side tapering to the ¾ at the back end. You should end up with wider T-tapes on the inside portion of the box around the wing attachment area and ¾ tapes on the outside edges. Do a one-ply tape on the outside edges of the box and a two-ply tape on the underside of the T-tapes on the wider side. I'll do that just in the localized area of the wing attachment area.

Chip the excess micro from the underside of the T-tapes and sand in the same way that you prepared the bottom sides of the T-tapes on the shear web. In light of the fact that we have a one-ply rib, we are only going to lay up one ply of glass from underneath the T-tape surface and onto the side of the rib. Place the tiniest bead for flox in the corner and then lay up one ply of BID tape.

WING TANKS

Chapter 7

For those of you who wish to put a fuel tank in the wing, there are a number of things to consider; first of all: what side is your strobe pack going to go on. Is it going to go on the left side or right side? If you put a 90° fitting at the lower edge of the inboard rib and point it up just slightly and it will clear, you can put a quick disconnect fitting connecting to it and loop a flexible gas line back into the pump. But that means that you are going to have to orchestrate where you want your strobe pack to be and make sure that you don't have any interference.

The fitting at the top of the wing tank is a no-brainer. At the top of the tank, you ate going to put a 90° bulkhead fitting, so that you have a service loop to work with. It's going to bolt through the middle of a 1 ½ X 1 ½ piece of ¼" phenolic, well sanded on both sides. You remove one skin from a 1 ½ X 1 ½ square at the top edge of the inboard rib. Remove the foam core and sand the inside surface of the other skin. Put in the phenolic with West flox. Squeeze the block in place and put two plies of BID over the top of it. Both plies of BID will lap underneath the undersurface of the T-tape as well. Apply one extra ply of BID over the interior surface completely covering the outboard surface of the rib and lapping about 8" down the face of the spar. (Since you may let someone else fill your tanks, we suggest you add an extra ply of BID in those areas.) If you haven't run your reinforcement under the T-tape there yet, you can do that at the same time as you do this lay-up capturing the phenolic block and BID tapes. The lower fitting will take a 1 ¾ X 1 ¾ phenolic block, pot it in place in the same manner.

We will walk you through the process step by step, but in general what we will be doing: After the lay-ups cure, you will drill the hole for the bulkhead fitting. (You'll probably do your Jeppco coating on the interior before you do your final installation of bulkhead nut and fitting.) You will install the bulkhead fittings with West epoxy. Tighten them firmly where you want it to be forever; because that's where they are going to be. You should probably place the upper fitting facing forward. You don't want it to get in the way of your bolt access for the wing attachment bolts. Any work that you will be doing in the wing strake area, the wing will be away from the aircraft so you'll have enough of a service loop in the gas lines that you will be able to snap together the quick disconnect fittings. The quick disconnect fittings are used a lot in the auto racing industry and have proved themselves reliable. So you have a dash 6 quick disconnect on the lower fitting. (At worst you'll have a dash 6 line that threads onto the fuel pump.) At the top of the tank you'll have a dash 4 line that will thread onto a bulkhead fitting that goes to your strake inboard fitting that has an exactly identical phenolic in place. All that you are doing is venting one tank into another. The tank in the strake already has dedicated vents. This one will use those same vents without really attaching to them.

On the outboard side of the inboard wing tank rib locate and mark approximately the center of the dash 6 fitting; and the center of the dash 4. The lower fitting is of no concern; it's out of the way of everything. But your fuel cap will be in the back inboard corner, that's the highest point when you are parked nose down for fueling, but not the highest point in flight. The bottom inboard back corner is

the lowest point in flight. So one of the reasons that you need to place the lower fuel line fitting as far forward as we have indicated is because we don't want the fuel line to be in the area where the fuel filler neck could hit, damage, dent or de-bond the fuel line when you are fueling the wing tank. So, your dash 6 fuel line will attach to the bulkhead fitting go where indicated in the inboard lower edge of the rib, go straight outboard about 6" and make a 90° bend, go aft, make a 90° bend, tuck into the back lower corner and come just short of the back of the inboard rib by about ¼". That way you get almost every drop of fuel just minus the thickness of the tube. This end of the tube (at the back) will be captured under one ply of West 105-205 glass, a little thin layer of micro above and below it so that you don't capture any air. This will keep it from getting damaged by your fuel filler neck. The fact that the tube makes a big square along the bottom skin of the tank keeps it far enough away the fuel filler neck can't hit it. You will put one more little ply of BID up at the front outboard corner of the tube, with micro above and below, to keep the tube from buzzing and humming on the surface. In this area, you could possibly hit the surface with the fuel nozzle and damage the surface.

After this is done we cover the interior with Jeppco tank sealant, push it around seal any pinholes. Let that cure and do another coat. The hardener is Jeppco 9700; the base material is Jeppco 9700, parts A and B. The tank volume works out to about 8 gal. per side.

Drain

We are about to start working in the front inboard end of your fuel tank area to put a drain in. We have to build the area in the leading edge inboard corner of the fuel tank with micro, so that when we put the nose of the plane down, approximately the area right back of the leading edge is the lowest point in the tank. We'll go through the interior skin, fill it with micro, cover it with a layer of glass, put down the aluminum, put down another layer of glass over the aluminum, micro transition so that when the airplane is nose down right above the aluminum will be the lowest point in this tank. So, when you push in the flush drain, if there is any water in the tank, it will drain out of this fitting.

You are going to install a hard point at the front that will act as a fuel drain. But the higher the surface of the hard point is above the surface of the wing skin the more you'll have to fill around the edges of the hard point, so that when the nose is down, the center of this little puppy becomes the absolute lowest point in the tank so it can drain any water that happens to get in the tank. Mark around the aluminum block and cut half way through the ¼" foam on the bottom wing skin, which leaves 1/8" of aluminum sitting up above the surface and 1/8" gap underneath it, which is about the thickness of the head of the quick drain that goes on the outside. Drill a hole in the aluminum plate near the center. We'll be using that for locating and visualizing the micro fill that is going to be from the center of the plate up toward the leading edge. You're going to be making a solid micro dam at the leading edge that will tie up into the surface of the rib T-tape and leading edge and will get covered with glass as well.

Mark the surface as we mentioned. Take your dremel tool and grind all the way through to the glass of the outside skin. Clean the hole up. Sand the entire area for several inches surrounding the hole. Make the hole ¼" to ½ larger than the aluminum that is going into it; that is because you are going to put flox into the hole and need a gradual transition around the hole.

Brush West 105-205 resin in the hole in the wing skin, it is very fuel resistant, fuel proof resin. Then put a layer of flox on top of that about 1/8" thick. Grit blast the aluminum block and brush it with resin. Drop it into the depression on top of the flox layer. Press it into place about ½way into the depression, giving us just about 1/8" of flox between the aluminum and the exterior skin. Then put flox around the perimeter, place one layer of glass over the entire thing. It should lap about 1" beyond the edge of the aluminum block in all directions. Let that semi-cure.

Wet the entire area with fresh West resin. We want to make sure that the micro adheres well to the under lying surface. Mix up some very dry micro. Pack micro around the aluminum plate area way up into the front into the leading edge of the wing, and right into the front inboard corner. You should be able to see the dark spot in the center of the aluminum plate, which is the shadow of the hole you drilled in the plate; you want that to be the absolute lowest point. Feather it out and try to ensure that the hole in the plate will be the lowest point. Also fill up the area between the rib T-tape and the leading edge at the front inboard corner on the topside so that when you do your mastic close out you will have a large bonding surface area here that makes certain that the wing tank area will be completely sealed when you close it. (Do the same thing on the outboard tank rib and put a single layer of BID over the micro.) Pack micro along the back edge of the plate to create a nice smooth transition from the wing skin to the hole in your plate. Use a squeegee to smooth the micro nice and flat. After everything is nice and smooth, place a layer of BID glass over the entire thing while it is still wet. A little micro between the layers of glass will not hurt a thing in this area. It is not a structural lay-up; it is just a "ramp" to provide transition to the hole in the aluminum plate. The glass does not have to be perfect, you just want to be sure that there is no exposed micro when you are finished. Let everything cure.

Drill through the layers of glass to reopen the hole in the aluminum plate. Mark the front edge of the fixture in this area for trimming. You are going to trim off part of this fixture to give you access to the undersurface in the area of the drain hole. (Of course if you do not put a fuel tank in the wing you do not have to cut this fixture off.)

Next you will tap the drain hole ___" to from the bottom side of the wing. Put tapping fluid all over your tap. Try to maintain perpendicularity in both fore/aft plane and left/right plane. Have the fitting that you are going to put in there on hand so that, after you have tapped a bit, you can try the fit to make sure that the threads are the right depth. Tap the hole just far enough to thread the fitting into the hole until it meets the surface of the skin. If you have kept your tap perfectly perpendicular to the bottom skin, then the fitting will fit flush against the wing skin all the way around its edges. On the inside you should see the ports in the fixture. We want those to be just flush with the surface of the aluminum plate or just slightly above the surface so that they can drain the maximum amount of water residue. On the outside of the wing skin you will counter bore into the flox that you placed under the aluminum plate. You will need a counter bore just large enough to allow the socket that you use to tighten your fixture to drop into the resultant hole, use a 5/16" pilot on the counter bore. The goal is to countersink the head of the fixture so that it is flush with the outer surface of the wing skin. Finish tapping the hole so that the fixture will go up snug and tight when it is bottomed. If you over tap, the fixture will not tighten up when it gets to the bottom of its travel. Then you have the potential of a leaky fitting.

Tie Down Hard Point

Now go to the hard point for the tie down that we prepared earlier. At the top cut a slot in the T-tape and you make a mark down there in the flox positioned as seen in the video. The reason that was done is pretty straightforward and I'm going to show you here in a moment. Make certain that a 3/16"; long drill bit can go through the tube in your metal hard point. Then place it against the surface of the shear web phenolic block, and having determined that the slot is positioned so that a long drill bit will actually go through the slot and into the tube from above. Take the hard point and I position it perpendicular to the surface of the flox with the flanges against the shear web. Place the long drill bit through the slot and through the tube of the hard point. Drill through the flox pad on the bottom skin revealing the hole previously drilled through the surface. Now from underneath, you can just open this hole up now to ¼'.

The T-tape tab forward of the shear web is of little concern to you as far as structure is concerned; so don't worry about taking the diameter out. Drill through the slot in the T-tape with a ¼' drill bit and drill into the flox pad to open the hole to ¼'. Check the hole with a ¼'bolt from underneath. Ream if necessary until a ¼' bolt slides through. Now we want to make sure that the hard point is perfectly perpendicular to the bottom wing skin. Put a long ¼' bolt though the tube in the hard point and placed though the hole that you drilled in the flox pad. You can look from underneath the wing and see the bolt sticking through the wing skin and make certain that, as we are looking straight at the bolt that the bolt is perpendicular with the surface. Once you know that, then you can look at the hard point plate and make certain that it is perpendicular. Now we are going to take a short drill bit and a 90° drill drive and drill through the holes in the back plate into the phenolic embedded in the shear web, making sure everything is straight. Drop a bolt through the hole in the back plate and phenolic and then drill the other three holes in the back plate. The bolts are going to be 3/16" diameter and about 5/16" in grip. This will be plenty; this particular titanium bolt is not supplied in the kit. It need only go through steel, the glass and the phenolic, the glass on the backside and then a grip of about 3/8" will be fine. Add washers on the backside, MS2104-3 on the back, AN3 bolt, 3/8" grip. All the loads on this area are all directly in vertical shear so whether or not you have a lot of threads on the back is unimportant. As long as you have at least one thread showing beyond the nut on the backside to make certain that the threads don't come loose that is adequate. If you want you can always brush resin on those bolts and make certain that they don't come loose. You will never get inside the wing to replace this flange so you want everything permanently attached. (An AN-525 machine screw will work just fine too.)

Mix a shot of 105-206, (you can use 205 if you want). Make sure that the area behind it is well sanded brush some resin on this area. Don't worry about going in the holes; the holes are just a little oversized. Also coat resin down on the bottom over the flox pad because I don't want any air leakage. We don't want to take any chances that rain or moisture of any kind is going to get up inside the wing. Grit blast the steel tie down, and cover it with West resin. Completely coat the tie down; you don't want any rust on the tie down because it is going to be inside the wing forever.

Mix up your flox and put a good-sized glob on the bottom. Put a small amount of flox behind the plate and bolt it in place.

Tighten all of the bolts up and leave quite a bit of flox around the bottom; you don't want anything to leak. Which means you are going to have to go up to the of the hard point tube and put a ball of flox

over the open hole on the upper side of the tube so that you don't get atmosphere exchange through there.

Fuel Line Connectors

Locate the approximate centers of the hard points that you installed in the inboard rib. The top hard point will be drilled 7/16" and the bottom one will be drilled 9/16". Drill through the bottom hard point at about the center. We do not need to be at the bottom of the wing tank at this time. Start with a pilot hole then drill out with a unabit to 9/16". Drill the top one in the same way, then use the unabit to take it out to 7/16". Check the hole size with the fittings. You are going to bond them in place with flox so it is OK if they are a little oversize. The inboard end of the top fixture has a little shoulder on it. That little shoulder should fit just inside the hole because if it doesn't you won't have enough threads going through to get a purchase on the threads with the bulkhead nut. You are going to thread a bulkhead nut on the top fixture and tighten in place. (For the 7/16" bulkhead nut you will need an 11/16" socket. For the dash 6 fitting you will need a 13/16" socket.)

For the bottom fixture you will need a dash 6 B nut and a dash 6 sleeve, approximately 25" of dash 6 50-52 0 conditioned aluminum tubing. You will need a flaring tool and a good tubing bender and a measuring tape.

Measure about 7" from one end and bend to a little less than 90°. Place the sleeve on the tube clean and debur the end and then flare with the flaring tool as demonstrated on the tape. Attach the tubing to your lower fixture. Make certain that, when you tighten nut on the fixture that it will tighten all the way to the nut surface before the B nut touches the bulkhead fitting. Now measure form the corner that you bent in the tubing to the face of the spar. (Dave's was 10".) Remove the tubing from the bulkhead fitting. You are going to put an "S" curve in the tube which will allow it to come from the bulkhead fitting down to the fuselage floor to make contact at about the corner. You don't want much of the tube to be standing out on it's own to vibrate. You can bend it by hand. Measure the tubing and place the second bend; getting the geometry right is loads of fun. The second bend should place the last arm parallel to the first arm with the whole structure forming three sides of a square. Put it back in the wing and determine the length that the last arm of the tube needs to be to fit right into the bottom rear corner of the tank. Cut off the end of the tubing at an angle so that the long end touches the side of the rib and the angle faces down into the corner so that we can use every drop of fuel in the tank. Check the fit. If it doesn't quite fit just play with it a little until making minor bends as needed to get it to just fit. It is a good idea to "crown" the second arm of the tubing so that fuel can flow under the tube to get to the open end of the tube. Keep the top of it lower than the height of the fixture. Place one layer of West BID glass under the tube at any point that it touches the carbon wing skin to prevent galvanic corrosion. Let semi- cure.

Sand the inside and outside of the rib around the holes that you drilled in the hard points. Mask off the fixtures and grit blast the area of the fixtures that will make contact with the rib and immediately coat them with West resin so that it does not oxidize. Now brush resin in the holes and a little bit around the outside of the holes. Mix some of your resin to flox. Place the fixtures in the holes making sure that you have flox on the threads of the fixture where it makes contact with the rib all the way around. As you pull the fixture into the hole apply more flox to be sure that you do not leave any gaps. You should have some flox coming out both sides. Put resin on the threads of the nut and

thread it on the fitting so that it will be permanently affixed. Tighten the nut firmly. This will be sealed inside the tank forever and you don't want it coming loose. The arm on the lower 90-degree fitting should be parallel to the bottom wing skin. The top fixture should have the 90-degree arm parallel to the top wing skin. Clean up the excess flox.

Next you will install the tube. It is OK if there is resin on the fixture at this point because the tube is never coming off. Tighten the nut on the fixture, making sure that you have the tube in the position that you want it to stay forever. Paint resin in the back corner where the last arm of the tubing makes contact with the spar. Use a bit of flox to fill in the gaps around the tubing between the tube and the face of the spar. Cover with one layer of glass. Put a little bit of flox covering the first corner to fill in the gap and cover with a 1" X 1 ½ tape to keep that corner secure. Use a little heat if needed to wet out the cloth. Let everything cure.

Jeppco Sealant

Sand off all of the rough edges and sand the entire inside of the tank and the tank area on the top skin. Blow out all the dust on the inside.

Mix the Jeppco thoroughly. Pour a little bit on the inside bottom wing skin and rub it in to be sure that it fills all the pores and cavities on the inside of the tank. Cover the floor, the walls and ribs. Don't coat the tube, you don't want material to flake off later and contaminate your fuel. Heat the outside surfaces of the tank you will get bubbles in the coating material from the air expanding as it heats. Run over the top of the bubbles with a brush to pop them. As the Jeppco cools the material will we sucked into the holes sealing them. If you really want to get a complete coating, put on a first layer, let it set up to tack then come brush again. Chase any bubbles, runs or sags. If you are really thorough about the application you will fill all the pinholes. You need to do at least two coats.

Chapter 8

CABLES AND CONDUITS

RG58-AU

Route the RG58-AU behind the shear web along the entire length of the wing. You will suspend the RG58-AU at the top of the shear web just under the T-tape. Make your changes in the outboard end of the wing around the winglet corners as gradual a possible. The transmission does try to escape the shield, so make the turns as gentle as possible. It is more critical with the transponder than anything else but it doesn't hurt to be careful with all your wiring.

Route the wire inboard down the wing and into the small bay with the wing attachment reinforcements (past the wing tank) and forward to the area of the last inboard rib where we have created the fuel line attachments as well. Stick it in place with some globs of silicone to keep it in place. You can hold it up with clothespins while the silicone sets. Super glue works pretty well too. If you use super glue you want to use the gel type. Lightly sand the surface, and then spray it with zip kicker. Put super glue on the topside of the cable and stick it up under the T-tape against the sheer web. Do that along its entire length and you won't have trouble with the cable buzzing later. (Superglue process demonstrated on the video #4 at the end of the rudder retracts spring section.)

Drain Holes

Next you are going to drill some "weep" holes so that any moisture that collects inside the wing will be able to drain. Take a 5/16" drill bit and drill a hole in the front lower corner of all the back ribs. Make sure that you place a hole in every bay except of course the fuel tank and the small front outboard bay. You also do not want to place a drain hole in the close out ribs in the aileron bay; we don't want any air getting in that area. The upper end of the winglet is going to be completely closed, and then you will put a breather hole in the upper and lower ribs to drain into the lower area of the winglet. There will be an open aperture at the back of the wing/winglet interface, which will allow any moisture to drain into the wing. There will be no openings from the interior of the winglet to the outside. The winglet moisture will drain into the main wing and pressure differences will equalize through the wing. Put drain holes in all of the bays so that once a year when you take the wings off of the aircraft, you can set the wings so that any moisture that has collected will drain out. Drill holes in the middle of the shear web and middle of each rib in each bay for breathing holes. Captured air inside the wing would be a bad thing; a wing blowing up in flight could really ruin your whole day.

Drill a hole through the trailing end of the bell horn area. Open up a triangle at the rear end for the bell horn. When you get ready to put on the horn it will become self-evident.

Rudder Cable Conduit

Measure from the backside of the shear web back 4.75 inches along the top edge of the inboard rib and mark it with your faithful sharpie. (That will make your resultant mark 4.8" from the front

side of the shear web.) Drill through the rib with a 3/16" drill. Thread your Nylaseal tubing through the hole you are going to route it from the hole you just drilled in the rib, outboard to the hole that you cut earlier. You are not going to run the tubing directly though because that would take it through the aileron well. You are going to take it through the drain hole that you put in the outboard rib just in front of the outboard end of the aileron well. Stretch the Nylaseal from the hole in the inboard rib to the hole in the rib at the outboard end of the aileron well. Mark the tops of the T-tapes where the tubing touches. Take your 3/16" drill and drill through each rib gradually moving the holes closer to the bottom wing skin as you progress outboard. Center the back of the drill on the previous rib hole to create as straight a course as possible with as few angular changes as we can. This will help give as smooth as possible rudder motion. When all the holes are drilled, thread the tubing through them all the way to the opening in the far outboard end of the wing. Stretch the tube slightly and use 5-minuit epoxy to secure it in several places along its length. Place a few tapes along the length to hold it down.

At the outboard end of the wing you need to find the position for the outboard end of the tube in regards to its ability to move and decrease the friction from the change that has to occur in this line. First locate approximately the location of the lower end of the rudder hinge line and mark it. Now use a pair of dividers to scribe and arc from the rudder hinge line forward starting _____. This arc defines the forward end of the rudder horn. It starts to come in more profoundly at the lower wing surface so we have to figure a compromise. By the time the end of the rudder horn comes inside the wing, it doesn't come inside much. Run the tube as seen in the video about an inch from the inside edge of the hole at the end of the wing. You have to have room for the end of the horn, for the swedge and for this to be able to move as it changes angle. It's going to swing down as the horn comes inside. If this is badly placed it will bend the end of the cable and will eventually break the swedge. So you are going to want to compromise and position the tube to reduce the amount of bend. The area at the back end of the wing tapers and you should superglue the tube in place and then put the top skin in place to be sure that the position of the tube does not interfere with closing the wing and that there is sufficient room for the tube to move inside the wing. If the tube cannot move you will have to grind away a little bit of the inside skin to allow it to move.

At the inboard end of the tube you want to have 6" of tube sticking out inboard of the rib. Have an assistant hold the tube at the outboard end and pull the tube taunt. Put a mark on the tube on each side of each rib. Pull the tube out a few inches and sand the tube circumferentially for about an inch in the area that it goes through the bulkhead. You should sand about ¼' on each side of the bulkhead. Do that at each bulkhead. When you get down to about rib nine the tube goes right against the wing surface. With the tube pulled taunt mark the wing surface where the tube rests. Move the tube aside the airframe in flight. At a distance 13" from the outboard hole in the wing and 3 ½ forward of the trailing edge of the wing skin make a mark. The Nylaseal will come straight from the last rib to this point, and then from that point outboard it will describe an arc. The next major point on that arc we will place 9" from the outboard hole and 2 ¼' from the trailing edge. At 7" from the hole it will be 2 1/4" from the trailing edge. (If you go closer to the trailing edge that 2 ¼' then you will not be able to completely close the trailing edge.) Then it pretty much points from there straight at the opening. You are going to end the attachments of this Nylaseal at about this point to allow the end of the tube to move. Sand the first outboard 6 to 8 inches of wing skin thoroughly, and the rest of the skin surface lightly. Tack the tube in place with 5-minuite epoxy in strategic points as seen in the video. Go about every foot or so, you don't need very much, just enough to hold it in place. Every so often check your

glue tube to make sure it isn't getting hot. When you reach the inboard ribs where the tube is above the layer of the wing skin, pack some epoxy into the hole in the bulkhead around the tube. Pull the inboard end of the tube taunt and pack epoxy into the bulkhead hole to hold it in place. Hold some tension on the tube until the epoxy sets. Lay-up some BID tapes along the tube. The first one at the outboard end should be 4 ½ from the opening. Paint the area of the wing skin and tube with West epoxy, pack a little flox around the tube and apply one layer of glass over the top. The tape should be about 2" long and go about ½ on either side of the tube.

Tube for Strobe Conductor

Drill a hole into the wing attachment hard point bay at the outboard lower corner. Start with ½ then open it up a file until it is large enough to pass your insulating tubing through. Open up a hole in each of the ribs to pass the tubing all the way to the outboard end of the wing. The tubing is soft and flexible and you can easily bend it as needed to thread it through. The tube is stiff enough that by the time you get to the end you are not going to have to attach it to anything; you can just let it "float". At the outboard end you will make a bend in the tube to route it forward, through the shear web and into the front outboard compartment where we will place the strobe. Clean up the end. Remove the burrs and rough edges. Pull the tube back out of the hole and rough up the ends and the area where the tube goes through each bulkhead with some sand paper so you get a good bond. Sand around each hole. Push the tube back through the outboard hole and flare it slightly to protect the wires as they exit. Put some 5-minuite epoxy on the outside of the tube and re-insert it into the hole. You want to be sure that you get a complete seal here. Remember this compartment is completely isolated from the rest of the wing interior. Put some 5-minuite epoxy in each place along its course where the tube passes through a bulkhead. This shielded tubing helps ensure that you don't get any noise on the antenna wire that also traverses the wing. These wires have been run before, inside the conduits inside the Long-EZ wing, but we don't want to take any chances. Having the wires inside the tubing makes the strobe parts removable and serviceable. Let everything set up.

Cut off the excess tubing at the inboard end of the tube. Grind the end of the tube leaving a ¼' to ½ protruding from the bulkhead. Flare the end as seen in the video you can use the end of a drill bit, then finish the flare with the round end of a ball peen hammer or the narrow end of a socket.

FUEL CAP

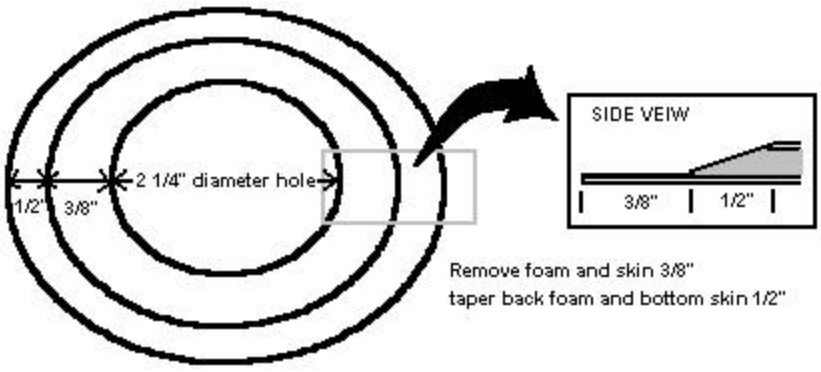
Chapter 9

Dave recommends the "Newton 05-28658", available in locking or non-locking versions. They are light, beautifully designed and the ring is one of the best that is available for bonding into a composite application as we have in the Berkut™. One of the nice things about this cap is that the only way that the cap can be put into the opening is in the unlocked position and once it is turned it cannot come out. (The glass air cap can be dropped in place and closed, but if it is not turned properly it can still come out. You will never have that problem with this cap.) It is very reasonably priced and available through Aircraft Spruce.

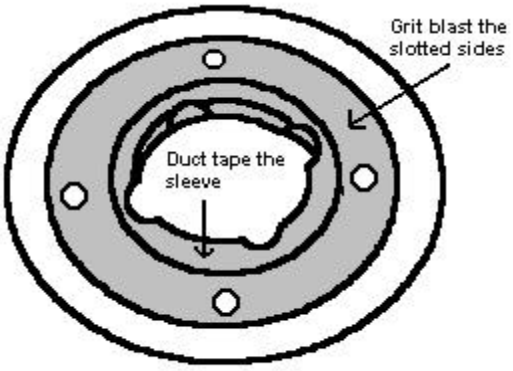
Pace the cap on the inboard end of the wing with the edge of the hole 4 3/4" from the edge of the inboard end of the rib and 19 3/4" forward of the aileron trim line. You are going to fuel this with the nose down as you do with the rest of the airplane; so you need to place the fuel cap in a position that will be the highest point in the tank when the plane is in the nose down position.

Since the wing has a ¼' core from the inside skin to the outside skin, we have to make a bevel from this depression that we are going to cut at about a 45 degree to the surface. Then we are going to cover it with a ply of BID; you do not want that layer of BID to end up between the spar and the inside skin, so we want to position the fuel cap inside those dimensions.

Choose a hole saw that is just slightly smaller than the lip on the inside of the fuel cap ring. Cut a hole through the wing skin in the location that you marked. Flip the upper wing skin over and begin to make the bevel on the inside. Mark the underside of the wing in approximately the area that the T-tapes make contact with the skin. Mark the edge of the fuel cap ring and the edge of the bevel that you will have to carve. There should be enough room between the edge of the fuel cap ring and the T-tape to lap the one ply of BID tape over the bevel and onto the underside of the wing without interfering with the T-tapes. You can still adjust this position very slightly. Open up the hole until the smallest diameter of the ring just fits inside snuggly. Grind away the interior skin in the area of the ring until the fuel cap ring just drops into place with a little bit of extra room around the edge. Use your die grinder to clean the foam off right to the top kin in the center of the hole, then angel it out toward the edge of the hole.



Sand the inside surfaces of the hole, bevel and the surrounding wing skin. Drill a series of #40 holes in the perimeter of the ring. Don't get to close to the edge of the ring. Put masking tape on the backside of the ring on the first lip of the ring which is about ¼' wide. On the inside of the ring tape the push tape firmly on the surface on the interior to protect it. Trim away the excess tape on the outside portion of the ring with a razor blade, leaving the tape on the little rim around the inside perimeter. Minimally grit blast the bottom top and surfaces, you do not want to go through the anodizing. Trim away the masking tape on the little rim on the inside perimeter of the ring as shown on the video, so that it doesn't get caught in the resin. Be sure to wear gloves while handling the grit blasted part so that you do not get skin oils or contamination on the part. Paint the grit blasted surfaces of the ring with West 105-205 resin. Now paint the interior of the hole in the wing skin. Mix some of the resin to flox and apply it to the interior of the hole in the wing skin and to the fuel cap ring. Squish the ring in place in the center of the hole. Check both sides to be sure that the ring is perfectly centered and flush with the exterior. Pack flox over the top of the ring on the interior to make a smooth transition between the ring and the wing skin. You can go right up against the phalange on the underside. Brush resin on the surrounding wing skin and apply two layers of BID cloth. Cut one flat piece with a hole in the center. Trim off the excess. Try to avoid getting any onto the area where the T-tapes will go. Let semi-cure. Sand around the edges. On the outside of the wing clean off the excess with a razor blade while it is still semi-cured.



Underside of Wing Skin

Jeppco Coating

Sand the interior of the wing skin. Leave the marks in place where the T-tapes go. Clean off the sanding dust.

Mix your Jeppco coating material according to the instructions on the containers. Coat the interior with Jeppco. Push the material into the pores into the wing. Keep the material off the areas where the T-tapes will go and the lap on the leading edge. Brush around the area of the fuel cap ring to completely seal that area. It is easiest to do this while the resin bonding the ring in place is still chemically active. Apply a bit of heat to expand the bubbles in the interior and brush across the surface to "pop" the bubbles. Let the coating semi-cure and move the material around redistributing the layer. Move areas of thicker material to the thinner area. You should work with the material when it is set up enough to leave a mark when you squeegee it but the mark should disappear in a few minutes.

Chapter

10

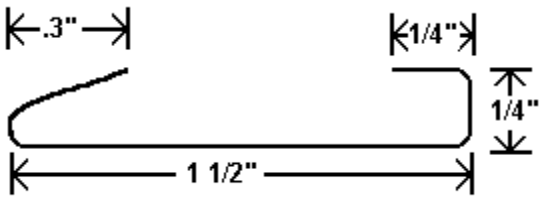
VERTICAL STABILIZER RETRACT MECHANISM

The Retract mechanism is installed on the surface of the upper skin. On the winglet exterior draw a black line on the bottom edge at the hinge line and another one on the hinge line about 4 1/2" - 5" up from the bottom. You should be able to see the line through from the inside of the winglet. Transfer the marks to the inside of the winglet. Measure 4.75 inches from the lower edge of the winglet at the hinge line and 2.25 inches at the back end. Draw a horizontal line connecting the two points. This defines where you are going to put your tube. Also measure from the point where the line intersects the trailing edge inward to the two vertical members on the opposing skin. This determines exactly where the closeout members are. Otherwise you will not know where to put the wire that goes through with the hook on it and you won't know where to place the tube.

Vertical Stabilizer Retract

Take a 4-½piece of your elevator torque tube. Square it up on the ends and then cut some teeth on one end about 1/8" deep. You can use the torque tube like a hole saw, in the video Dave chucked the torque tube in the lathe and led a plywood sheet against it and cut circles in the plywood. Cut about half the thickness of the plywood, which will fit perfectly inside the torque tube. Cut out the rest of the circle just a little larger than the outside diameter of the tube. This creates a plug, which will fit on the end of the torque tube with about half the thickness of the plywood inside the tube.

Assemble the parts for the retract tube mechanism: the plywood pieces, the tube that you prepared earlier, the spring is a Century spring, part number: C-231, 9/16" diameter by 6" in length by .070 wire diameter. (Dave cut off about 1.1" of it but you will custom fit yours. Berkut's have always had a bit of a problem with not being able to feel the rudder and the rudder is very sensitive, so a stiffer spring will give you more feedback on your controls.), a length of 80 thousandths piano wire or hinge pin wire, (we encourage you to use hinge pin wire because it is plated.) and a pair of needle nose pliers or vice grips.



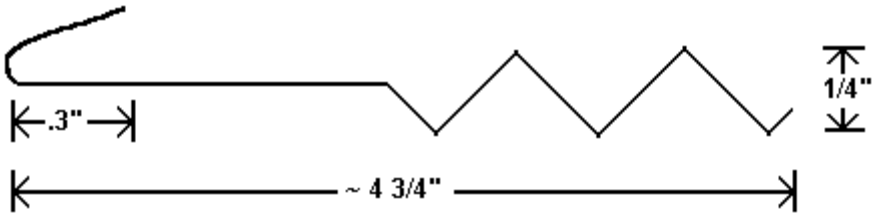
Get a hold of the end of your piano wire or hinge pin wire and bend it 90 degrees. Make a second bend as close to the first one as possible, and bend it 90 degrees. You want the resultant hook to form three sides of a square with the two opposite sides parallel. Take one of your plywood plugs and drill a hole just off center. If you center precisely it will give you a problem on the inside of the tube. (The spring will go inside the tube and it will have to go over a mocked up hook. In order for the spring to go over the hook it has to go up pretty high in the tube. If

the hook is placed in the middle of the tube, you would never get the spring over the hook. If you did manage to get the spring on the hook, you would never get it off.) The position of the second hole depends on how you bent the wire. The wire needs to go up through one hole and down through the other hole. Drill the second hole in the plywood circle and put the wire through the circle. Make the second hook in your wire. The long arm is 1.1" from the wood surface. The hook needs to be .3" from the bend to the tip of the hook. See picture for measurements. Test your bend in the wire by putting the plug on the end of your tube with the wire on the inside. Slide the spring inside and make sure that you can slide the spring over the hook while the assembly is together. Also make sure that the spring can be removed with everything assembled.

Grit blast the inside of the end of the tube. Superglue the plywood plug in the end of the tube. Smooth off the end of the plug and radius the end of so there is a smooth transition. Position the tube on your winglet at the line that you marked earlier. Make sure that the long arm of the hook is facing up. Pre-sand the winglet surface if you have not already. Grit blast the tube and use 5-minute epoxy to hold it in place. The end of the tube should be placed far enough toward the rear that it will end up protruding just a little bit from the bulkhead that you will place later.

Paint the surface of the tube and adjacent winglet skin with West resin. You can also use your West resin to seal the wood plug at the end of the tube. Mix some of your West to micro and pack it along the sides of the tube to make a smooth transition. Place one ply of BID cloth over the entire assembly. You should have about ½ lapping onto the winglet surface. Let cure.

The hook on the rudder portion will be constructed of piano wire with several bends and then a hook, which stops just short of the hinge line. Start off with the hook, that way you can just cut off the end if it breaks and bend the next section. Form the hook the same way that you did the hook inside the tube earlier. Position the hook vertically and determine where your next bend should be. The zigzag bends should all be in the same plane to allow the wire to rest against the rudder skin with the hook in the proper orientation. Bend each leg about ½ per leg with the bend angle about 90 degrees. Put about 5 bends. Put one last little bend in near the hook end to angle the hook out away from the skin surface just a bit.



Sand the rudder surface where the hook will be placed and sand or grit blast the hook itself. Position the hook pointing approximately in the center of the tube on the other side of the hinge line and just short of the hinge line. Secure it in place with 5-minute epoxy. Apply West resin to the zigzag portion of the wire and the adjacent rudder surface. We want to keep the weight behind the hinge line as light as possible and this it probably the lightest way we could possibly attach this hook. Mix some of the epoxy to flox and cover the zigzag portion of the wire pushing it into the gaps. Cover the whole thing with a small piece of BID cloth and wet it out. Let cure.

Sand away the "cut yous". Attach the spring to the hook inside the tube. Mark the spring just short of the hinge line and cut it off. The best cutters you have will be just good enough. Bend the spring end

to give you a loop on the end of the spring. The spring should end up just about .2" short of touching the tip of the hook. This will give you just about the right tension on the spring. Ideally the spring should float above the skin surface or just barely touch the surface. That way the spring will generate less noise during operation.

Trim for closure

Trim the vertical members on the lower winglet sin to allow the retract mechanism to fit. Slide the skins together and make a mark on the vertical member above and below the tube. Trim out a notch about 1" deep. You will need to slide it in place and check and then trim as appropriate until you are satisfied with the fit. You will also need a notch on the rear member for the wire hook. Trim until you can get the winglet skin completely closed.

Rudder Ribs

(This section repeated in the winglet rib section of the instructions. It is included here for completeness.) Add two small ribs on the back edge of the winglet in the rudder area. Trim and fit bottom surface of the ribs leaving the top surface a little big for trimming after bonding in place. You will be provided with templates for them. Because these ribs are going to see very little load, and the load they do see is in compression only, you do not need a very elaborate process for installing them. Sand the winglet skin and apply a small amount of 5-minute epoxy to the surface of the winglet and on the edge of the lower rib. This foam is so tough that we are going to get away with just bonding to the foam. You do not have to go all the way back to the tip of the trailing edge because that will be sanded away during the fitting process. Put the lower rib in position and let cure. Take your trusty chisel and chip off the excess 5-minute epoxy from the edges and the winglet skin. We want to keep the weight as low as possible aft of the hinge line.

Slide the upper skin in place and trim the top of the lower rib to fit with as little gap as possible, because you are not going to T-tape these ribs. Look in through the top of the winglet to get this trimmed perfectly. Place the upper rib in the same way. Let it cure and trim to fit in the same way.

Next we will place the close out rib at the very top of the rudder. Make yourself a gage, which has an 85 degree angled corner and is .063" thick. Because the winglet is swept back at an angle at the tip it tends to exacerbate any condition that the rib isn't perpendicular to the travel and you can have trouble as the rudder moves, that the two surfaces hit. So we set this rib .063" above the part line and set at 85 degrees from the winglet skin so that as the rudder moves it swings away from the close out member and actually opens the gap. Then when the rudder closes it brings the two bevels closer together and actually closes the gap and makes a nice tight seal. Trim and fit the close out member and the rudder tip member. Sand the winglet surface where they will set. Glue the close out piece in place with 5-minute epoxy and let cure. Now position the rudder end piece, put 5-minute epoxy on the edge and position the piece so that it has a .063" gap between the two members as shown in the video. Make sure that it is flush with the vertical close out in the front and let cure. Clean off the excess. Put a little bead of West flox along the junction between the rib and winglet skin.

Drill vent holes in the rudder ribs and in the front of the tip section to allow pressure equalization.

PREP FOR CLOSEOUT

Chapter 11

Begin at the absolute inboard end of the wing in the hard point area. Sand the entire area of the hard point, spar face and underside of the T-tape in that area. Be sure to pre-sand the underside of the top skin in this area as we. After the wing is closed and the material still wet you will reinforce this area with three layers of carbon spar cap tape covered with a layer of BID and then place aluminum reinforcements in the area.

Optional features

Hard point close out In the area of the outboard wing attachment hard point you can construct a box in this area to protect against moisture. The box can be made from scraps of rib material and would cover the hard points and closes the back of the depression so that if you leave your cover off of the access well for the wing bolts, moisture cannot get into the rest of the wing. Of course this is of no concern if you always put your covers on.

Aileron Cut Out Area

Check the positioning of the foam core in your wing skin. The wing skin that Dave uses in the video has the foam core positioned a little bit back of its ideal position and he demonstrates how to fix the minor problems caused by this.

You will have already sanded the extra thickness in the trailing edge of the wing. The other area that may be affected is the taper of the foam in the area of the aileron false spar. The wing skin should transition from the carbon to carbon to foam and carbon right at the point that the false spar rests on the wing skin. If the foam core was poorly positioned this transition may not be in the correct position along the entire length of the false spar. If this is true of your wing skin, you will want to fix it before closing the skin so that the aileron does not strike it when opening and closing.

Locate the markings for the aileron cut out. Sand or grind off the excess foam that is in back of the false spar, between the false spar and the area where the interior skin goes carbon to carbon. Sand the foam and the edge of the carbon fiber to create a smooth transition for the 3 layers of fiberglass that will cover this area later.

Sand the forward edge of the aileron skin in preparation for removing the ailerons skin so that you can see up inside the wing during the closeout process. You want to be able to see as much of the squeeze out as you can. It will give you an indication of what is happening in the rest of the wing where you cannot see. Also sand the backside of the aileron close out member.

Cut out the aileron skin with your fein saw. You can make the cut from the trailing edge forward toward the false spar. Cut just inside the part lines on the skin about 3/8" will do fine.

Prefitting

One of the more critical areas that you need to prepare for bonding is the junction between the wing and winglet. It is one of the most stressed areas of the wing. Put the top skin in place and cleco the leading edge of the wing and leading edge of the winglet. Take a number 40 drill bit and drill about 5 holes into the compression member right in the corner where the winglet and wing meet. (Be careful that you don't drill into your antenna wires.) You know far our opening is underneath; you drill your holes forward of that point. Hold the drill angle at about 45 degrees (about ½the angle formed by the wing and winglet in that area). Take the clecoes out and slide the wing back. Hold the wing skin up off the surface and open the holes in the wing skin up to the diameter of a drywall screw using a #21 drill bit. You don't want the drywall screw to thread into any of the external structure. You want it to only thread into the glass that is behind it. That way when you put the wing skin in place and tighten the screws up, you know that you are squeezing the epoxy into that corner without a shadow of a doubt. Do a trial fit; the screws should pull everything nice and tight. Use about 1" long screws.

You will put weights on the spar cap area to bet sure that there is good contact in that area. You can see inside the aileron cut out area to be sure there is good contact and squeeze out there and you can weight the trailing edge.

To be sure that the winglet skin makes proper contact you will place some screws through the skin into the ribs. Slide the top skin back and drill holes with a number 40-drill bit all the way through the rib and the skin on the outside surface, defining the center of the ribs. (You will eventually fill that hole with micro injected into the hole with a syringe until it oozes out the other side.) Again be sure you don't drill through your antenna. Put a couple of holes in each rib and two or three through the vertical member. Slide the top skin back on and drill back through the hole and through the top skin. Slide the wing skin back and open the top skin holes with the #21 drill bit like you did the ones in the winglet/wing junction.

The screws that go into the vertical member present a special problem. Since the screws are only going into foam rather than into fiberglass so you are going to have to tighten by feel, making sure to not over tighten the screws. In some areas where the structure is thin enough you can use a very long drywall screw and go all the way through and catch the skin on the other side.

At the top of the winglet you can put a drywall screw through the winglet skin, through the rib and right into the winglet fixture. You can tap the surface of the winglet to see where you need to put screws. The areas that have good contact will have a deep solid sound. The areas that don't have good contact will make a "slapping" sound.

Place a long aluminum extrusion along the line previously defined by our holes in the winglet skin. You can place long drywall screws through the extrusion and through the winglet skin to ensure that the resultant winglet skin will be dead straight after bonding.

You can use the same technique to put screws in areas on the wing skin over ribs that you don't think you will get adequate contact. Don't put any in the area of your tank. Be sure that your wing is in precisely the correct position before drilling any holes. Put you clecoes in the leading edges and at least one of the screws in the wing/winglet junction before starting.

The gap between the rudder closeout member at the end of the winglet will get filled with epoxy during the close out process, cut it open before you start. You probably can't go all the way forward to the part line because the fixture is in the way, but you can go far enough to make it easy to find after the close out process.

WING CLOSEOUT

Chapter 12

Remove the screw holding the wing skin to the fixture and raise the trailing edge of the wing just enough to put tape on the aluminum extrusion that the trailing edge sets on. Put the wing skin back in the fixture and place a bit of superglue in strategic spots along the trailing edge letting it wick under the edge to glue the trailing edge to the fixture.

Prepare a piece of aluminum extrusion to place on the front face of the spar. It should be just a little over 33" in length. Drill about four 3/16' holes along its length. Cover the backside with duct tape so that resin will not permanently attach it to your wing.

Be sure that the undersurface of the upper wing skin is sanded in all the areas where it will make contact with the T-tapes or other close out members. Remove any screws that would get caught inside the wing after close out.

There are a number of materials that you can use to close out the wing skins. Dave uses a special resin to close out the wing skin. It is from Gougeon Brothers in Bay City, MI 517-684-7286. It is called Pro-Set 175 Resin/277 Hardener. It comes in two tubes, which are attached and require a special applicator gun and applicator mixing tubes, which attach to the tubes. The only place we know if to purchase the stuff is directly from the company, which anyone can do. It will require about one and a half tubes so be sure that you have at least two tubes available before you start. It's nice for a number of reasons. It is quick and easy to use and it is viscous enough to hold its shape. You can pile it up on top of a rib and know that it will make contact when the wing is closed. (You do not need to use this special material. Structural resin with flox will work fine.)

Put a glob of your closeout resin on a neutral surface. Apply a thin wetting layer to the tops of the T-tapes and every mating surface with a squeegee. Work quickly by thoroughly. Also cover the inner mating surfaces of the upper skin with a thin wetting layer.

Put a bead of resin down the center of every T-tape, rib, false spar and spar. Be sure that every upright member has a bead of resin standing well above the surface. In the area of the intersection between the wing and winglet, you should apply extra to be absolutely sure that you will have plenty to form a solid bond. As you apply the material to the sheer web you should apply a wider bead as you progress toward the inboard end of the wing where the T-tape is wider. Brush a little resin on the area where the rudder actuator tube and mix up some very dry micro. You want to create a dam toward the front edge and inboard edge forming a little micro box that will prevent moisture from coming inside the wing to get trapped.

Draft at least one assistant. Pick up the top wing skin. You need to be careful as you lower the skin into position that you do not "wipe the resin off the leading edge or wipe it off the members of the winglet. Line every thing up and then lower it in place. You should see resin beginning to squeeze out of some of the holes in the skin. Have all of your screws and clecoes ready. When you are sure that the position is correct you will begin to squeeze the wing skin down. You do not want to squeeze down any spots until you have your clecoes or screws or weights ready to place. Once you have it squeezed down you want it to stay down, not pop back up.

Start by placing the clecoes in the leading edge. Then take some duct tape (200mph duct tape not the wimpy stuff) and place straps around the leading edge. Cut a strip of tape about 2-3' long. Position it on the bottom skin first and rub it down really well. Pull it tight (40-50 lbs of pressure) and wrap it around the leading edge and onto the top skin. Put a tape every 4-6" along the entire leading edge. Weight the main spar along its length to be sure top skin is making good contact with the T-tape along its entire length. Place your screws in the wing/winglet junction and get that snuggled down well. Put drywall screws in the areas on the winglet and wing that you prepared earlier.

Clamp the inboard end with a 1" by 2" extrusion and put drywall screws through the extrusion and front face of the wing. (Use a #40 drill bit to make the holes in the spar.) Tighten the screws based on the squeeze out that you get. Tighten the screws until the spar is nice and flat. You should get plenty of resin squeezing out. Look inside the aileron cut out. There should be plenty of squeeze-out over the closeout members and the false spar. Put an aluminum extrusion on the trailing edge of the winglet and one on the trailing edge of the wing.

Take a squeegee and remove the excess resin that has squeezed out at the inboard end of your wing tank area, along the front of the spar, the leading edge and any place else that you can reach. Let everything cure.

Leak Test Fuel Tank

Place a piece of scrap ¼" tubing on the upper 90degree bulkhead fitting. Attach a balloon tightly to the end of the tube with a rubber band. Blow into the lower fitting until the balloon is inflated and then cap the lower fitting sealing the tank. The balloon will expand and contract with barometric pressure overnight but it should hold air enough to show you whether your tank is sealed of not.

Wing Skin Finish

While the leading edge is still chemically active, sand the leading edge joggle. Paint the joggle with resin and then apply two plies of BID tape along the leading edge of the wing and the leading edge of the winglet. Get a large syringe; you can usually get them at a plastic mart. Fill it with a loose mixture of West 105-205 micro. Inject the micro into all of the holes that you drilled for closeout screws. Fill the holes all the way up until you get micro oozing out of the other side. That is

one of the reasons to drill the holes all the way through. When you get micro out the other side you know that the hole is completely filled and there are no voids in the foam. Leave a little micro on the surface to sand down after cure.

On the upper end of the winglet, take a band saw or hacksaw blade and pull it through the area that you cut at the upper end of the rudder. Extend the cut all the way to the part line. (This is much easier to do while the material is still green and has not reached maximum hardness.) Remember the bulkheads inside the winglet are placed at 85 degrees so you should follow the cut that you made on the outboard side of the winglet and make your cut following the angle of the bulkhead inside the winglet rather than the part line marked on the outside of the winglet. (Hopefully the two will be very close together anyway. But if there is a difference; follow the part line.)

Chapter

13

RIGHT WING

Remove the cured left wing from the fixtures and place it in a secure place. Reposition the fixtures on the table. The fixtures will be positioned on the opposite side of the table, but the spacing will be the same. Remember the marks that we had you made on the trailing edge aluminum extrusions? You should use those marks to reestablish the spacing on the fixtures. Be sure that the fixtures are perpendicular to the edge of the table and that you have enough room on the end of the table to properly attach the shelf brackets that hold the end fixture. Screw everything down securely.

Trim the wing skin in the same way that you did the left wing skin and set it in the fixture. Check the fit on the wing skin in the fixtures. There should be less that 1/32' between the wing skin and the fixture. At the outboard end the difference in the taper of the wing skin is so small it is probably not worth correcting for. The inboard end is a little more obvious. At the trailing edge of the wing, the surfaces are pretty flat, but as you move toward the leading edge the difference in the angle becomes more of a problem. Take a rasp and shave off a little bit of the fixture, angling it the other direction leaving the inside edge intact and only removing the outboard edge. Place the skin back in the fixtures. Adjust the fit of the aluminum extrusion and clamp a piece of scrap aluminum in place as seen in the video. Check the trailing edge of the winglet and wing the lower edge of the winglet sticks out behind the wing. You want to support that part of the winglet so that it is in the neutral position. You don't want it sagging. It should be firmly supported by the aluminum. You should position the wing skin so that the corner where the winglet and wing meet at the trailing edge is exactly 5" from the inside edge of the adjacent fixture.

The leading edge of the wing is going to be a little different than the other wing. This wing has a single joggle instead of a double joggle like the other wing. You are going to put the top wing skin on and lay-up two plies of BID cloth wrapping around the front edge of the wing one wide and one narrow. Then surface it. The only difference between the two wing leading edges will be .026" of glass, which will not substantially affect the way that the lift is generated around the leading edges. If you are really concerned about it, template the leading edge of this wing after you are through with it and fill and surface the wing on the other side to match it.

The remainder of the process is the same as the other wing.

☞Index to Illustrations

PARTS REQUIRED (grouped by chapter)

☞MOLDED WING

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