Europa Tech Talk
Mod 78 Tips for success
January 22, 2013

The glider wings have been in service for a number of years and in 2010 a concerted effort was made to update the glider wings to the new gust loading criteria for aircraft design. This gust loading factor is necessary because of the high cruising speed, long wing span and light wing loading of the motor glider. These factors could easily cause a Europa Motor Glider to be overstressed when flying or descending at high speed in turbulence fully loaded at 1370 lbs gross weight. Motor Glider (MG) owners know that the Europa MG is capable of exceeding the 127 knot Vne of the glider wings in level flight when equipped with the Rotax 912S or 914 and an Airmaster fully feathering prop. Based on these concerns, it was necessary to upgrade the spar of the MG as soon as possible. Testing followed, and in the testing it was found that just at six Gs, the spar bent enough under loading that the shear web (the bid wrap around the spar tang) cracked about 6-12 inches from the end of spar. Carbon fiber is incredibly tough, but is somewhat brittle and resistive to bending on its cross axis. The shear web could not take the bending. Knowing that there is a possibility of an overloaded MG flying in strong turbulence or mountainous areas with a high probability of being subjected to momentary loads that could cause a crack in a major structure, action was needed. Engineering and practical solutions were completed to stiffen the spar center section capable of withstanding the new higher forces necessary to meet these stringent criteria associated with gust loading. Mod 78 was finalized and tested by the factory. The original, highly tapered spar was modified by increasing the height to reduce the spar bending between the pins and a new thicker shear web was added, increasing the spar thickness slightly. However the mod did not fit the existing aircraft. So the mold has a manufactured cut off end and a manufactured hump in it for clearance and shear strength. The result was an incredibly stiff spar which no longer needed the spar strap, saving space in the spar tunnel. The modification of the spar was simplified and procedures were published to safely accomplish this modification in the field by experienced personnel. This Tech Talk article will amplify the instructions, give some techniques and clarify procedures for those in the field.

General comments from the field on Mod 78:
The glass materials are of great quality and the instructions were clear, however in doing the field modifications some amplification of certain parts of the procedure were necessary.

WARNING: If the mod is done incorrectly it may compromise the wing spar causing possible wing spar failure and loss of the aircraft.

If the builder is not fully prepared, equipped and experienced, with a qualified helper, also experienced in fiberglass layups, the mod should be referred to a properly experienced facility.

Before starting anything, we found it best to test rig and drill the spar bush holes as per the build manual before beginning any work on the mod.

Mold Preparation:
Prepare your mold and aircraft before the beginning any glass operation.
The mold for this mod is supplied by the factory, and is <u>not</u> finished ready for molding. The prudent builder will test fit, and rig the mold to the spar, then disassemble the mold, sand, fill, sand and then finish the mold with a finish of epoxy or polyurethane to a smooth finish. (Later, just prior to glassing operations disassemble the mold, wax it thoroughly and buff to a smooth finish (3 coats minimum) and reassemble. Allow to dry and apply two to three

coats of a PVA release agent.) The dimensions and orientation of the mold under load are shown in figure 1 below. Once prepped, study the orientation of the mold so you don't do the mod upside down as we did once...

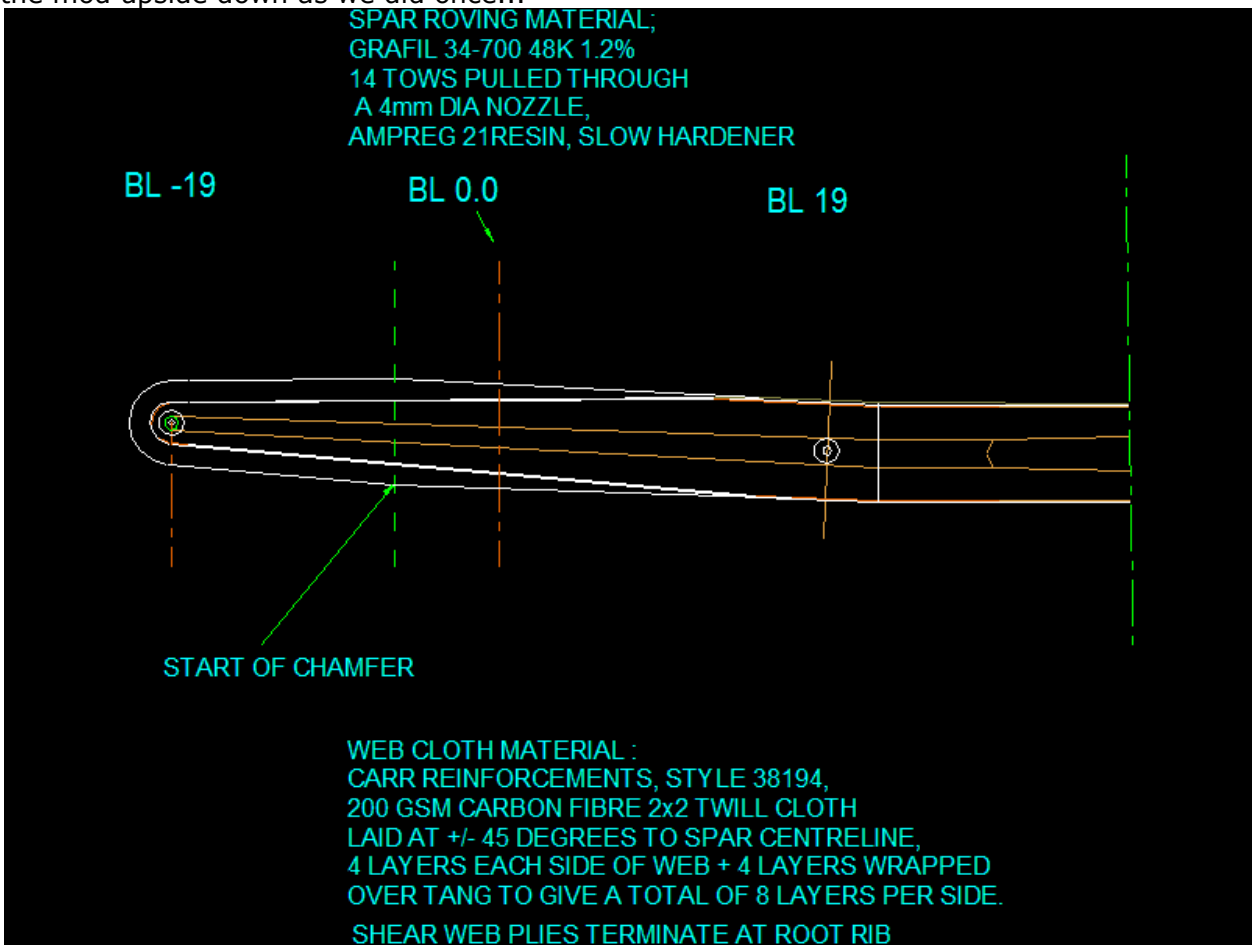


Figure 1a above is an engineering drawing. The figure can be confusing as it looks like the hump is on both sides of the spar. Also in the Mod 78 bulletin photos it appears that the hump may be on the top. Essentially the hump is on the bottom as the top of the spar needs to be flat on its upper surface to clear the fuel tank.

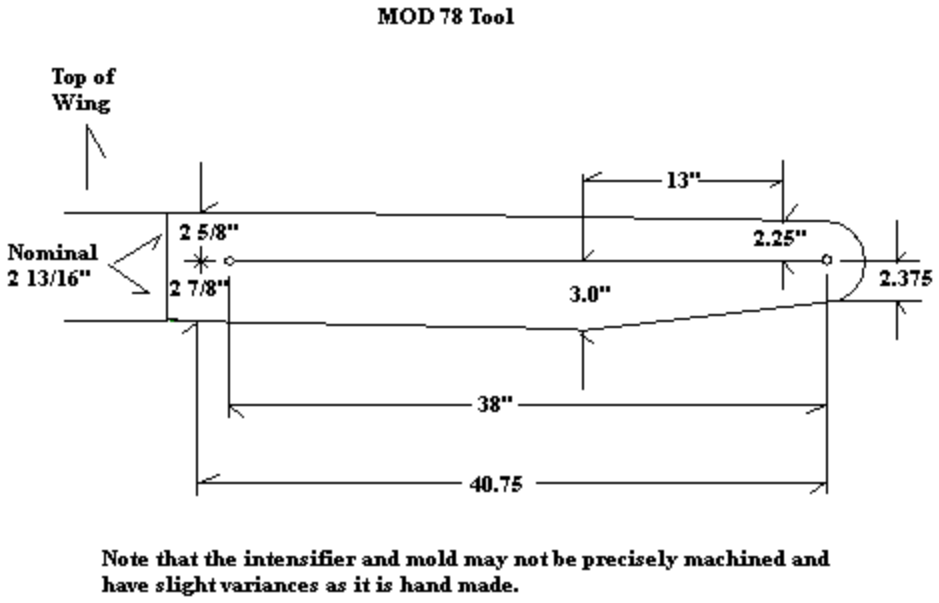


Figure 1b is a drawing showing the dimensions of the tool and the most needed orientation of the hump which is clearly on the lower side of the spar.

Spar Preparation:
Prep the spar by grinding off the existing bid shear web.
Follow the Mod 78 instruction manuals information on safety when grinding on the spar.

Remember that carbon is very conductive and electronics will be ruined by carbon dust. You also must be protected from inhaling the carbon dust and the resulting black lung disease which may occur from breathing black carbon dust. It is advisable to read and follow the MSDS sheet warnings for the materials being used. Use of Tyvek or similar protective coveralls must be used, as well as proper mask and eye protection. Use air tools without self oiling devices to grind the bid off the spars. (Automatic oilers spray oil on the work surface and will prevent a proper bond without laborious cleaning. Most composite shops never use oil in their air tools as the tool is cheaper than the labor to clean up the oil residue.) See figure 2 for what a properly protected worker should look like. It takes about 4-8 hours per spar, depending on equipment and experience, to grind the bid off the spars. Questions arise about grinding close to the rib. We found by angling our 3 inch 90 degree die grinder and sloping our bid, we were able to get close to the rib and make a smooth transition to the bare spar.

Figure 2 shows the builder properly protected.

Some spar and aircraft dimensions and tool orientation should be noted.
Once the spar bid is removed, the wood and glass thickness should be one inch. Note that the supplied spar bushings are 1.25 inch from face to face. The spar finished thickness with all 8 layers of shear web bid wraps must not exceed 1.25 inches or it will not fit in the aircraft. If you have previously rigged your wings completely, and or are modifying flying wings, it is important to note the thickness and position of your spars. Look carefully at the clearance between the front face of the port spar to the fuselage bulkhead. It is normally very close or in contact. Only the bushes held the wing aft of the bulkhead. This means that the area around the bushing flanges on the spar must be rebated (routed out to about 1/16 inch or 4 layers of glass) to allow the bushes to fit flush and be fully seated to give a final 1.25 inch wide spar width.

The prudent builder would take his intensifier board or mold flat board and fit it into the airplane to familiarize himself with the new spar orientation, and fit. We found it was necessary at this time to remove the fuselage spar cup, sand and smooth the area, clear the area of any screws or fasteners that cleared the previously narrower spars, as the new spar will fill the entire area from the tank overhang to the bottom of the opening of the fuselage wing spar hole. Take a long straight edge and check for any other bumps or flox dabs that would interfere with the soon to be wider and thicker spars that will be fitted into the fuselage. Finally measure from the forward edge of the intensifier board or your straight edge forward edge to the CS08 bolt heads and note that distance. The spars, when finished should be 2.5 inches total, and normally the distance from the glass around your outer fuselage to the rear of the module bulkhead (the CS14 C section hole reinforcement plys) to the CS 08 bolt heads and or the Quick Disconnects (QD) is about 2.67 to 2.75 inches. As you can see the clearance is tight. In some installations the CS 08 and or cockpit module is not straight and the clearance is reduced to less than necessary for a clearly interference free fit. Contact Europa Tech Support for options.

Another distance to note is the vertical distance from the forward tank overhang area to the top of the fitted intensifier board. This distance should be about ½ inch minimum as the intensifier will be about ¼ inch less than the actual spar height and that distance must clear the tank support by a minimum of 1/16 inch. The spar doesn't deflect much, and 1/16 inch on the final spar should be sufficient.

An area of concern is for the mono wheel aircraft owners who are adding the MG wings to their short wing aircraft. Assuming the short wings are rigged and the gear and flaps are rigged. Experience has shown that the FL 20 flap drive tube, which connects the gear mechanism to the flap FL15 cross tube, comes very close to the spars. The new spar height and hump on the lower side of the spar is going to interfere in most mono wheel aircraft. Clearly the flap actuating rod (always a problem with spar clearance on an initial mono build, when getting clearances and angles right) may need to be re-bent for clearance for the new taller spars.

Referring to the first figure below, this means the area in red where the contact interference with the spar occurs needs to be moved forward. We feel the solution is to make a new flap actuating tube which is bent as depicted in blue. This moves the contact point with the spar some 3-4 inches forward and should allow sufficient flap drive, airbrake drive and spar clearance.

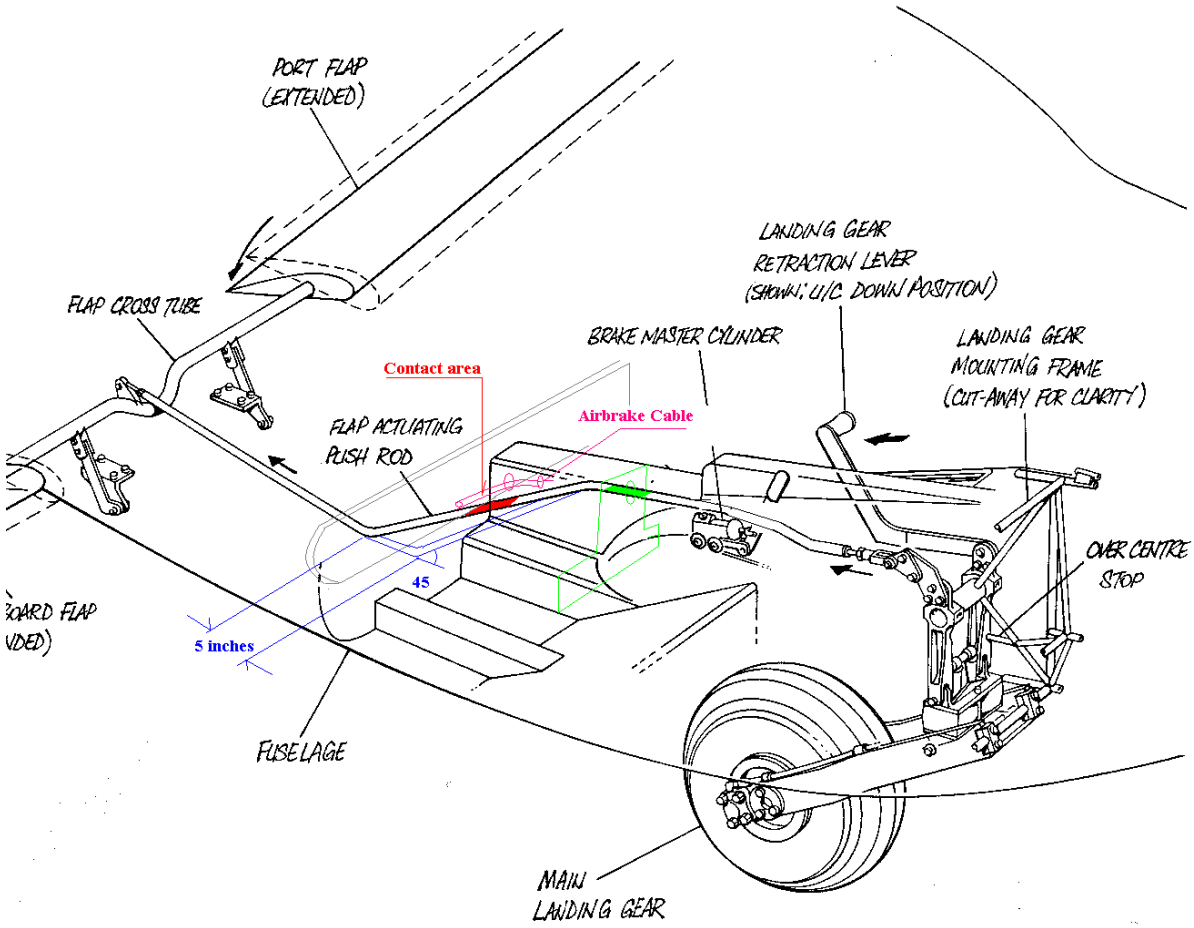


Figure 3 Mono Flap Drive Tube

To aid the builder in the field, our solution is to supply a short section of new re-bent flap drive tubing for the installer to custom fit to his particular aircraft. By cutting the existing FL20 tube, and using proper mandrel bends, a new section of tubing one eighth of an inch larger could be manufactured and slid over the existing .049" tube. This would allow the owner in the field to mark the interference points and remove his flap drive tube, accomplish his mod 78 and slide on the modified section over his now cut flap drive tube so as to adjust his particular clearance issues inside the aircraft. The field installer then could drill the tube to pin it temporarily for a reference point. The installer will then have a properly certified welding shop, weld the modified section in with a fish mouth weld (V cut on the overlapping tube). By enlarging the tube one size, the bending force that the tube can take is increased slightly, and it will be strong enough for driving the flaps without difficulty or need of reinforcing braces due to the larger angle of bend.

As for interference in the fuselage with the re-bent tube, the fuel selector, fuel lines, and the rear wheel well bulkhead are installed in that area. By bending the tube between the points shown (the aft most point through the bulkhead to the beginning of the straight aft end to the flap tube), the relative clearances through the bulkhead should remain the

same. (Refer to figure 4 Mono Flap Actuating Clearances below.) The bend in the tube as it exists will most likely interfere with the glider wing airbrake drive cables as they pass through the tunnel in this area of the flap drive tube bend. The airbrake cable for the starboard wing passes through the tunnel from a height of 2 to 3.5 inches on about a 45 degree angle through the tunnel. The angled starboard airbrake drive cable is very close to the existing flap drive tube. By increasing the flap drive tube bend angle and moving the bend forward, it should clear more comfortably.

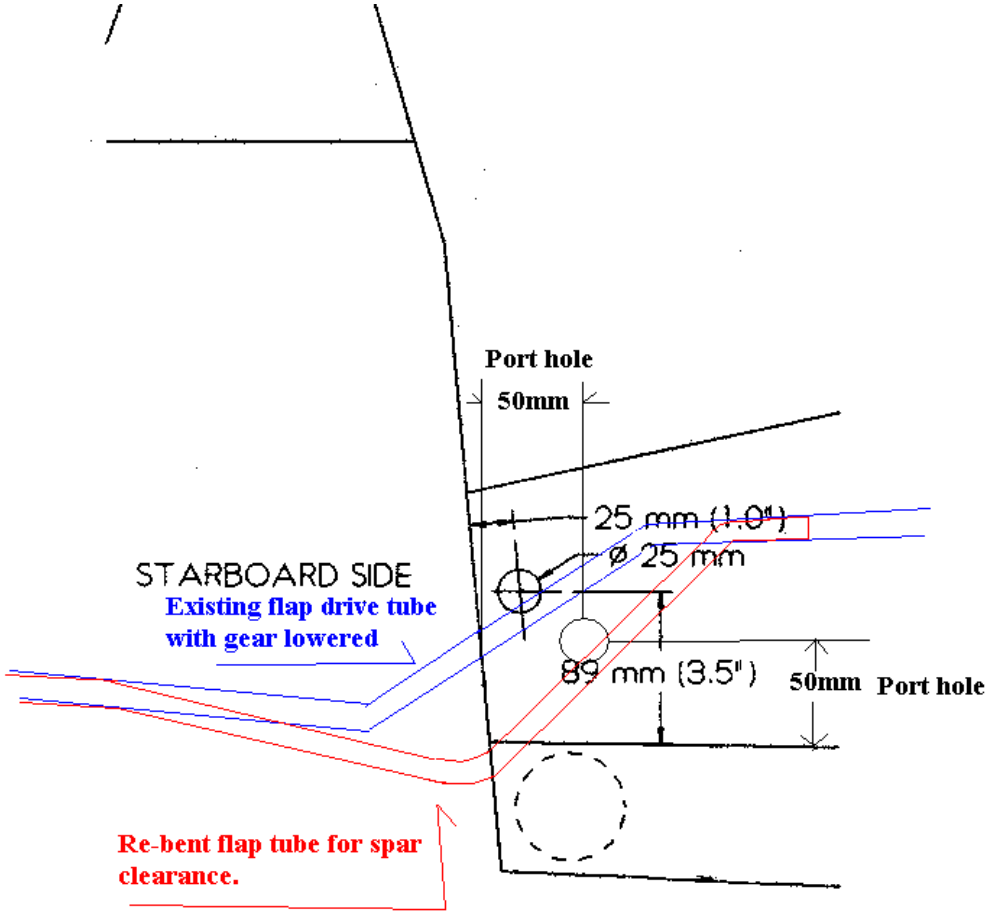


Figure 4 Flap Tube clearances in the tunnel.

For field installation prior to installing mod 78, it is imperative to mark the flap drive tube at the point it penetrates the rear wheel well bulkhead and then retract the gear and mark it again. This area must remain straight so as to allow freedom of fore and aft movement. Then remove the flap drive tube, cut it and reinstall it in the aircraft. Install the new tube by sliding into place the new section and note the gear down clearance from spars and cables etc. **Then retract the gear and again check for clearances.** The only assured check of clearance is to look at it in person as the tube moves fore and aft and up and down.

Finally, the starboard spar will be truncated after it is removed from the mold to clear the aileron bell crank. We suggest making a cardboard, or masonite (pressed paper) template

to check the dimensions on your existing short wings, or on an initial build, find the position of the bolt head of the fuselage mounted bell crank QD. It is not uncommon to have to move the belcrank bolt in the spar outboard to allow for existing shims added to the fuselage QDs for the short wing. You should pre-assemble the spars and test mount the QD to check clearances spar to spar, then install the port wing in the fuselage to check for clearances in the aircraft.

Mold / Intensifier notes:
The spar bushing holes will need some sort of bushing to center the ½ inch bolts for proper mold attachment and orientation. We used plastic water pipe and a bit of tape for a nice snug fit. We also have used the old spar bushings with the flange removed but be sure to use release tape (no grease) around the bush so it will release after gluing. During the procedure, the nut and washer on the bolt holding the spar mold during the rope layup will need to be removed to install the intensifier board. If the nut and washer are removed, the whole thing may sag, or fall to the floor with all your wetted ropes. Be sure to support the mold while installing the intensifier. C clamps work best on the inboard end of the spar tang, but they must be loosened to install the intensifier also. Once the spar mold is filled with the rope, the mold is heavier and needs a strong helper or trestle to hold it in position.

Now that you are familiar with the tool orientation, airframe considerations and clearances, here are some notes on the prep for doing the many rope layups.

Glass Ropes Prep:
A professional, shop is equipped with 15 rolls of the carbon cheeses (roves) on spindles and the tech only needs to pull the 15 strands through the guide and then wet as he goes on a long table. As owner/builders we don't have such a luxury.

Two techniques are offered below which should help the small shop or qualified owner builder execute the layups.

First Technique:
In a large shop, set up two 8 foot tables together (16 feet), covered with plastic, and put nails, with smooth tubing over them to prevent tearing the fibers, while unrolling the cheeses around 3 laps of the table (15 meters) times 15 to make one rope. Don't get dizzy running around the table. Then roll the un-wetted ropes on to cardboard tubes carefully. We suggest you make all 8 ropes for the wings in one day. The next day, set up the glassing area. The rolls of dry rope were set to slide on to a spindle. However, by using the covered nails as a holder, one can do without the spindle. Wetting the fibers is done by pulling off the dry rope onto the table and stippling with epoxy to wet out the fibers. However, to speed production, two trays may be placed on the table, one to wet and the other to catch the drips while rolling the wet ropes onto another plastic coated roll. It is important to dry run your wet out procedures and mold layup before you start.

In the picture below one can see the long tables, trays and the rolls of flat dry ropes ready to begin laying up.

Figure 5. Tables and rolls ready to work. Note the second tray is normally placed 90 degrees to the first when rolling the rope onto the plastic coated rolls to catch the drips.

To begin the wet out, the first tray was partially filled to a shallow depth with epoxy. The rope was pulled flat across the tray, laid in the glue and stippled. Then the wetted glass was pulled through our fingers and rolled onto a plastic covered paper roll nice and flat. The second tray picked up the drips. Keep your eye on the clock for working time as the entire installation must be done in one shot. Doing all four rolls at once put us to close to the epoxy kicking without working like mad men. Experience showed it was best to wet out two ropes at a time on the second spar and it made for a nicely paced layup. Each spar layup only took one hour with two working side by side. From start to cleanup was a 4 hour day.

For those with small shops and tight working conditions, use an 8 foot table and pull out a rope length of about 75 inches (based on the rope length you need 15 times), using smaller batches of epoxy and a stipple brush, wet the rope roves and gather it together and lay it into the mold. It takes longer, and requires some stamina, a good helper and steady work to meet the 1.5 hours of pot life and a cool shop to get the ropes installed before they start to cook off in the mold. This takes a bit longer and requires a well deserved beer at the end of the day.

Figure 6 shows a small shop setup. Good help is essential to get the job done right.

Compressing the ropes:
The ropes should be fairly level with the spar thickness, but a bit of extra is OK. However a bit more is too much. Don't overdo the rope packing. Use a stick to push the ropes outboard until full, but don't let it climb high up on the metal outer flange. Keep it tight and just above the level with the spar. Once satisfied, you are ready to apply the intensifier. Support your mold with a trestle or strong assistant and remove the spar tip nut and remove the rear clamps and install the intensifier. Then while your trestle or assistant is holding the mold tool in place install the intensifier with the bolt and nut and reset your clamps loosely, then pull down the nut just snug. We used 8 clamps and tighten them uniformly to get an even tightening. We then draw the clamps alternately until tight. You

should see some epoxy and a bit of carbon squeeze out and you may find a need to put straight timber on the sides to keep the mold metal flange outside surface nice and square as it may lean outboard due to the squeeze out.

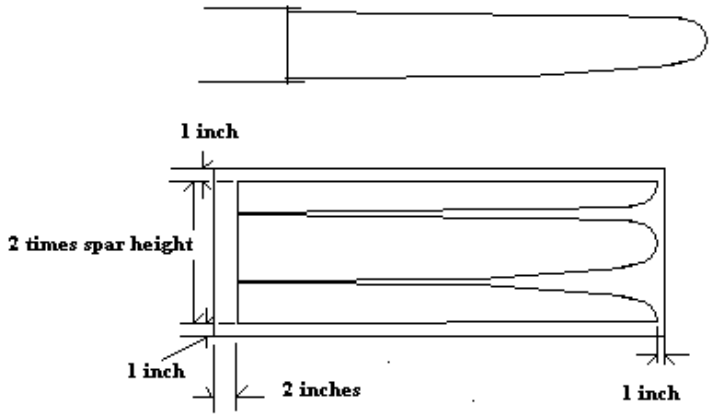
After cure, remove the mold and grind off any squeeze out to get to the final spar dimension of one inch. Slightly round the corners and hand sand to allow the bid to flow around the corner of the spar. If there are any small voids, make some short strands of dry carbon and lay them in and peel ply. Use a wire brush to comb out the tow and make your own carbon flox for the small voids, peel ply and allow to cure out. Cut off the starboard spar as indicated in the instruction. A coarse hack saw works fine. Round the spar sharp edges to about 2 mm. Check the spars for belcrank clearance at this time. If all is well, lay the three 90 degree oriented layers on the truncated spar allowing the sides to stick out about ½ inch and overlapping the top flat area and bottom by about an inch and a half. Peel ply in place. Do not fold over the tip to the sides. This layer is trimmed flush after cure.

Glass bid prep:
Rather than doing a dry layup for each layer, we chose to do wet tapes in the shop. We laid out our patterns, then the cloth. Wet out the bid and then overlay your large tapes with plastic and then squeegee out the tape get rid of excess epoxy (think thin). Cut out the patterns and begin the layups. Pre wet the spar and flox any divots or voids missed. Layups of all the tapes took a little more time and we started getting toward our pot life of the glue, but made it. Eight layers of glass is heavy, gooey and since gravity works 24-7, difficult to keep tight and stuck. To better control the thickness and be able to assure few voids due to gassing off, and the inevitable affects of gravity, we suggest the novice lay up half the bid and then peel ply.

Bid Wraps:
The flat bid sheets require no explanation, and are trimmed to fit the pattern with a 2 inch overlap onto the rib and none on to the tip.

On the wraps which are butted, we chose to again make a pattern as the spar height changes but made it as a trapezoid not square. We laid the template out on plastic, figured the spar was 1 inch and then flopped the template over to the other side. We again laid our mirror image pattern down as shown below.

Bid Wrap Template



Since the actual butt point is near the centerline of the bushes, we made a cut line on the centerline of the marked out plastic sheet and then cut it out and laid it on the wing to check the fit just like a dress pattern. We weren't concerned about the tip so we left our pattern end square with about an inch or two overlap planned. The bid moves enough that we could get the wrap quite accurate and tight by starting on the nearly straight upper side and pulling only part of the plastic off, smoothing, and trimming off the now wet and gooey plastic left unattached. We then took the last bit of hanging bid for the other half of the spar and trimmed the plastic short of the centerline and carefully cut for a butt fit. You may find it best to pull to at least 1/4 inch shy of the line then pull the plastic and worked the bid into shape before whacking it. We then put our time into fitting the tip radius. Once the sides are stuck, we cut off the excess tip overhang on the side of the spar with the split and and then wrapped the other side to lay just across the face making two darts as necessary on the top and bottom for it to lay flat. We then put on the other two flat sides. Of course your previous tip unravels because the carbon is stiff, but we let it. The next wrap comes from the other side and the two bid overlaps can be interlaced and then pulled down with the one inch peel ply from root around the tip. One must squeegee out the bump and wrap the sides nice and tight... It comes out pretty flat.

Warning: Doing all the 8 layups at once is a bit of a chore and definitely at the end of the pot life unless you are very proficient. It is far better, in our opinion, to do half the layups at a time, peel ply, allow to cure, and sand in between. You have better control of the glass and thickness.

Our peel ply technique is to first cut a one inch strip for the tip about 24 inches long. Next cut two long strips into 4 inch strips. Lay the one inch peel ply on to the tip, pull snug and then smooth out any humps on the face. Apply the 4 inch strips by starting at the tip and diagonally wrap the wet glass like wrapping a sprained ankle with elastic bandages so as to overlap the previous layer by a ¼ inch or so. This technique will pull the top and bottom quite tight but will cause the flat sides to be compressed a bit and hump up. Use your squeegee to move your bid to a nice smooth finish as you wrap the peel ply. An assistant is priceless doing this. After cure, pull the peel ply and sand. Peel ply leaves a .01 inch layer of pure stippled epoxy and when every tenth of an inch counts, it is best to sand the epoxy until contact with the bid. You will note the sanding dust goes from white to black

immediately on contact with the bid, so stop when you see black dust. It will also help to make a smoother spar finish. Apply the next four layers and wrap again with peel ply.

Final fitting of spar bushes:
Tap the spar with a hard metal object in the vicinity of the inboard bushing hole which was covered up during the bid glass layups to find the hidden hole. Open both the root and the spar tip bushing holes to 7/8 inch on a previously rigged wing. Insert the spar bushes and mark with a silver fine tip pen or similar around the flange. Using an air die grinder, or similar, with a tungsten or Permagrit flat tipped cutter, rout out the bid to allow the two bush halves to come completely together. Unfortunately, the spar bush fit requires clearance as necessary and is a cut to fit procedure. Do not despair about the structure as the bid is a shear web and there is very little sheer at the pin hole. Do not "Redux" the bushes in at this time.

Fuselage prep:
Rig the wings using appropriately placed trestles to allow the wing to be supported and the spar to sit aligned with the spar holes. The spar bushes are normally inserted only on the forward side for the trial fit. Insert tapered wing pins fully as per the build manual. You may install small strips of phenolic, or similar attached to the bulkhead just, above the spar to act as a spar alignment guide to hold the spar for rigging purposes. Note how close you are to the tank and check clearances between your flight controls, and QDs. Everything should fit if you took early precautions prior to the build to check your clearances. Once the dihedral is set and the incidence angle set, disassemble and prepare to glue in your bushes.

On a previously rigged wing, when you are ready to assemble the wings to the fuselage to fit the wing bushes and pins final, simply apply the Araldite 420 A/B as per the build manual to the bushes, cover the bushes with tape to prevent gluing the spar to the wing. Using a razor knife, cut the tape around the pin holes and insert the wing into the fuselage. If you have found your wing holes are a bit sloppy, try to rig only the left wing first using a ½ inch bolt to affix the starboard pin snug to the bulkhead and pull the left wing into its final position at its correct incidence and allow it to cure. Then rig the other wing. This technique helps to get the bushes installed in their proper alignment.

The taller spars and tight fit in the tunnel makes for installing the GAB 12 cable brackets and hardware in the tunnel a bit tight also. If the heads of the 525 bolts for the airbrake supports are a problem, you may use countersunk screws and Tinnermans for a flush fit.

Finally there is the matter of the front wing pin support. This is a long awaited improvement to the front wing lift socket. It is substantially stronger and will be stiffer and incorporates a bearing, similar to the flap bearing, to allow for pin alignment during rigging if you didn't quite get things straight drilling and threading in your pins. The setup is now slightly shorter than the existing socket to allow the new pin with flange for wrenching it on to fit on a normal wing. The threads on the new pin do not end at the flange but some 3/32 inch prior and it may not screw in completely without a slight rebate of the 8 layers of glass on the root rib. On a new build, they are straight forward to install. On a previously rigged aircraft, in our experience, the left socket is butted right against the root rib or the socket was filed down to clear the rib for proper wing sweep alignment, so there may be fit problems. The new socket should be installed and the old pin retained for clearance issues. Again, contact Tech Support for a solution if problems arise.

The rest is down-hill if you follow the instructions and prep well.

We believe that an **experienced** builder, with proper help, will have little problems with the mod. However, it still will require extensive preparation to execute the mod without any tear outs or rebuilds. Extensive study and preparation are essential. I would not recommend this to any novice unless he is prepared to buy a second Mod 78 kit.

Call us at tech support if you still have questions.

Regards,
Bud Yerly
Europa Tech Support