

PROJECT45

L45-SAM (Shell Assembly Manual)



Shell L45-002 Completed! (The Project45 Flagship)

Thank you for your interest in the **PROJECT**45 L45 Type Aircraft “Basic” shell kit created by me, Ron Rollo. View my personal L45 project at www.project45.us to see the latest news and updates! This basic kit is designed to be temporarily put together with common hand tools in just a few hours. You will soon be able to see the basic shape of your new home built flight simulator, however, there is much more work still to be done to achieve the full potential of this cockpit shell as depicted above!

The purpose of this assembly manual is not only to assist new L45 shell owners, but also to show home builders that the cockpit shell of their dreams can be achieved with common tools around the garage or workshop. Please take the time to read over this entire assembly manual to get the overall idea of this project before starting. It may also be helpful to print a copy of this manual to have close by during assembly for quick reference. Each L45 shell will be given a frame number to insure accountability and to help create the experience of owning a real aircraft frame. In this hobby, flight simulation is not just about flight, it can also encompass all aspects of aviation!

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Please respect the L45 shell by NOT coping, duplicating or sharing the L45 design with others. It should be noted that over 1,000 hours have been invested into the research and development of the L45 shell to perfect the design to its current state.

The kit is designed to be completed in 10 phases:

- Phase 1: Temporarily assembling the kit.
- Phase 2: Bolting the ends of the frame sections to prevent splitting.
- Phase 3: Notching and installing the lateral strips on the outer shell.
- Phase 4: Trimming the kit so that the compound curves flow properly.
- Phase 5: Caulking and painting the frame up to this stage.
- Phase 6: Installing aluminum sheeting between each of the frame sections.
- Phase 7: Caulking and painting the aluminum inside the shell.
- Phase 8: Installing and shaping the foam on the outer shell.
- Phase 9: Cover the shell with your choice of material.
- Phase 10: Installing the windscreens!

Before we get started, please know the difference between NOTES, CAUTIONS and WARNINGS!

NOTE: Points out something of special interest or importance.

CAUTION: Could cause damage to equipment or to the structure.

WARNING: Could cause physical harm to personnel.

With that said, there are several things that you should know before you start assembling your shell. Medium Density Fiberboard, (MDF), is a great product for this type of project although I have found that it has a few wants and needs. On the other hand, I have also found that it can be forgiving if a mistake is made.

NOTE: If you do not have a cordless drill, please get one now. You will thank me later. (There are over 700 screws in this kit! Further more, the frame will be taken apart and reassembled a few times during the first few Phases.)

CAUTION: If you have little or no experience with MDF, please be careful drilling into the edge of it. Drill slowly so the MDF does not split. Always drill pilot holes at least the same size as the shaft of the screw to prevent splitting. Do not over tighten the screws.

CAUTION: Always keep MDF away from water, moisture and high humidity. Moisture will cause the MDF to swell. Do not drop the MDF parts as this could cause damage to the corners or edges.

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WARNING: Unless you are 4'11" tall, always remember to duck in and out of your shell. The clearance is barely 5 foot just like the real L45 aircraft!
(I had to get a WARNING in there.)

NOTE: Wood glue, clamps, sandpaper, razorblades and wood putty are just a few of the items that could be used to fix a mistake, so don't sweat it if you do end up damaging something.

Prior To Assembling Your New L45 KIT:

I recommend assembling a 4' X 8' base frame on wheels so that the shell can be moved around your work space easily. It is very important that the base is level especially during Phases 1, 3 and 6. I would also suggest drawing a 12 inch grid system on your base. In other words, divide your 4' X 8' base up into 32 equal squares. This will help to identify the center line and maintain a square shell especially during the initial fitting.



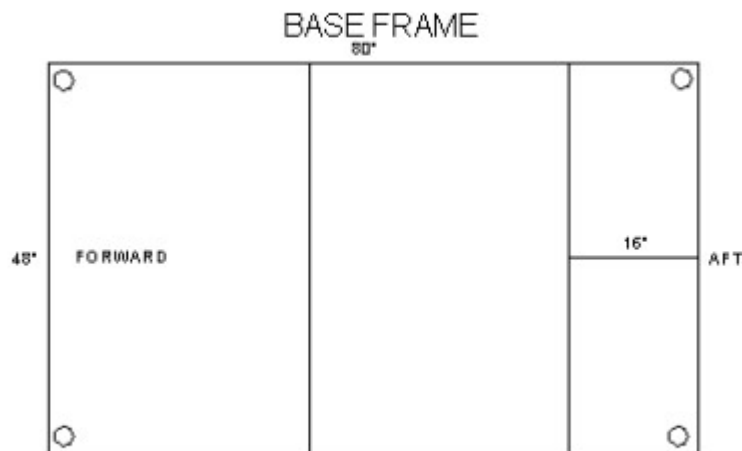
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If you want to skip ahead and build your base so that the shell fits on it perfectly, use this diagram of the base frame below. After I was about half way finished with the shell construction, I discovered that it was 16 inches longer than it needed to be. Further more, by removing the unneeded 16 inches and adding a few extra supports in key areas, it made the base structure a lot more solid especially when stepping in and out.

The base frame is constructed with 2"X 6" and has roller caster wheels in all four corners to easily move the cockpit around your shop floor, (hangar deck). The 16" 2X6 support at the aft end of the base frame serves as extra support for the entire weight of the pilot(s) as he/she is stepping into and over the seats. This extra support will insure that there is no flex what so ever in the base frame!

One of the nice things about the design of the L45 shell and it's major flight control components is that there is very little happening under the floor base. The columns will fall in between the two major cross over supports so that there will be no issues with structural conflicts. Refer to my website, www.project45.us for more information about the flight controls and their placements.



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NOTE: This is your shell so feel free to deviate from these instructions if you have other methods in mind. The compound curves and shapes are the real value in this kit design which took hundreds of hours to develop. This is a 1 to 1 scale model of the real deal!
Any additional material or items needed to complete all ten phases of this kit can be found at your local hardware or discount store.

NOTE: You may also want to route out all of the frame holes before assembly like pictured below. I did this to my shell because I plan to run wires for various systems down the sides of the frame. I won't have to worry if the sharp edges of the holes are wearing into the wires due to vibration or motion.



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Let's Get Started!

Phase 1: Temporarily Assembling the Kit.

Step 1: Do a quick inventory of all your shell parts using the included Parts List and then separate the “P” (Port) pieces from the “S” (Starboard) pieces. You will see that all of the pieces are predrilled, marked and fitted to eliminate all of the guesswork.

CAUTION: BE SURE TO USE THE PREDRILLED HOLES, ESPECIALLY IN THE EDGES OF THE MDF. ALL OF THE PARTS SHOULD LINE UP PERFECTLY IF YOU LINE THE SCREWS UP WITH THESE HOLES.

NOTE: One of the frustrating things about MDF is its tendency to split if drilled and screwed into the edge. This is the main reason I choose to use $\frac{3}{4}$ inch MDF rather than $\frac{1}{2}$ inch. If you have minor splits, don't worry too much about them unless you are planning on a motion base platform in the future or you are not going to cover the outer shell and they will be eye sores. For the larger cracks, I have developed a method called “Bolting” that will fix a split and insure it does not reoccur, see Phase 2. This method does not require the need for glue and clamps. The bolts act as a permanent clamp on the ends of each piece!

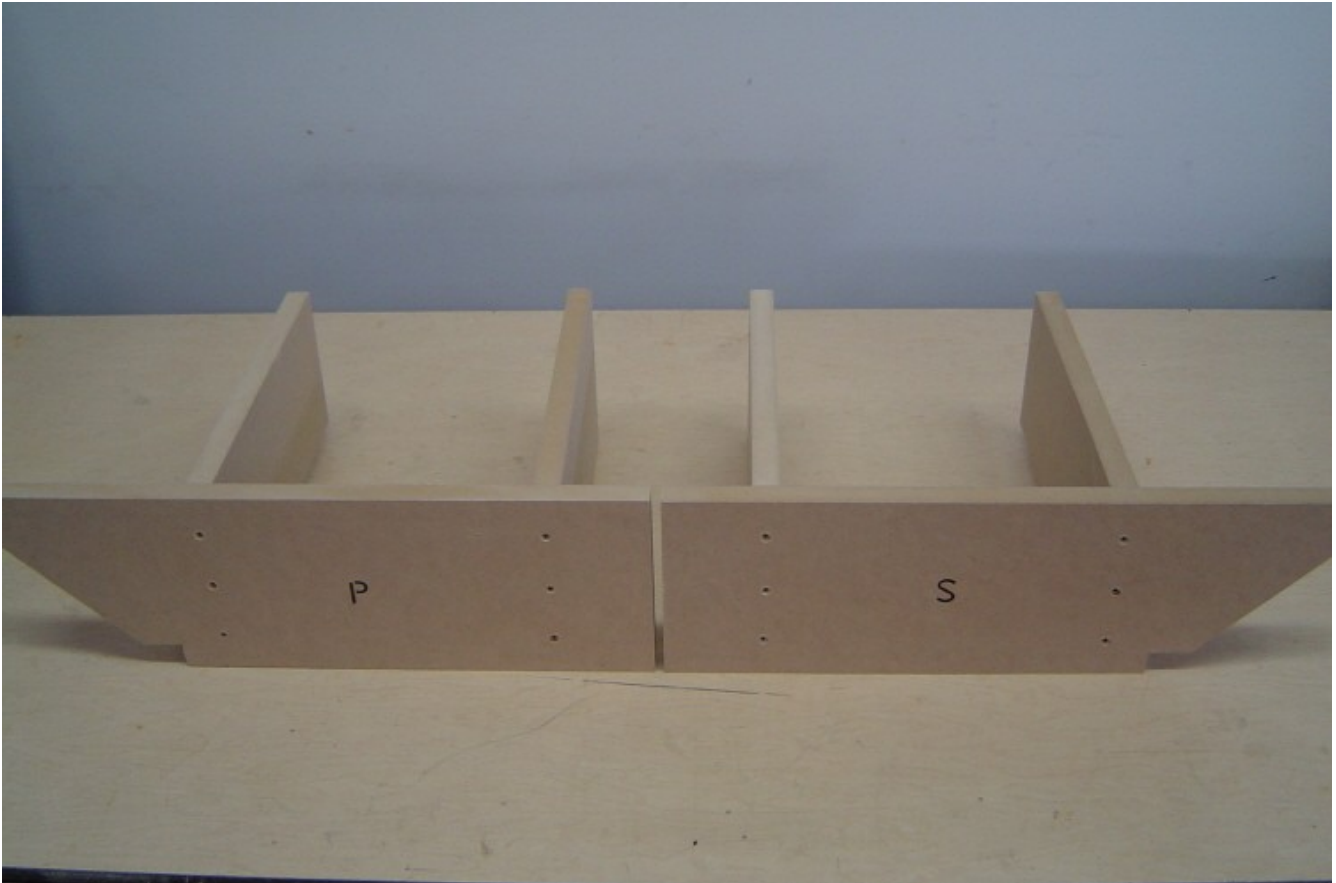
Running the included $1\frac{1}{4}$ inch bolts through the end of the parts with two large washers on both sides will pull the splits back together. I “Bolted” all of the parts on L45-002 where possible because I plan on having a motion base platform in the future.



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Step 2: We will begin with the Pedal Assembly Floors first. Each side has three frame pieces and of course the floor plates. Start with the Port side frame. Make sure to use four of the longer stainless screws to assemble the frame. Six screws are required to hold the three piece frame together.



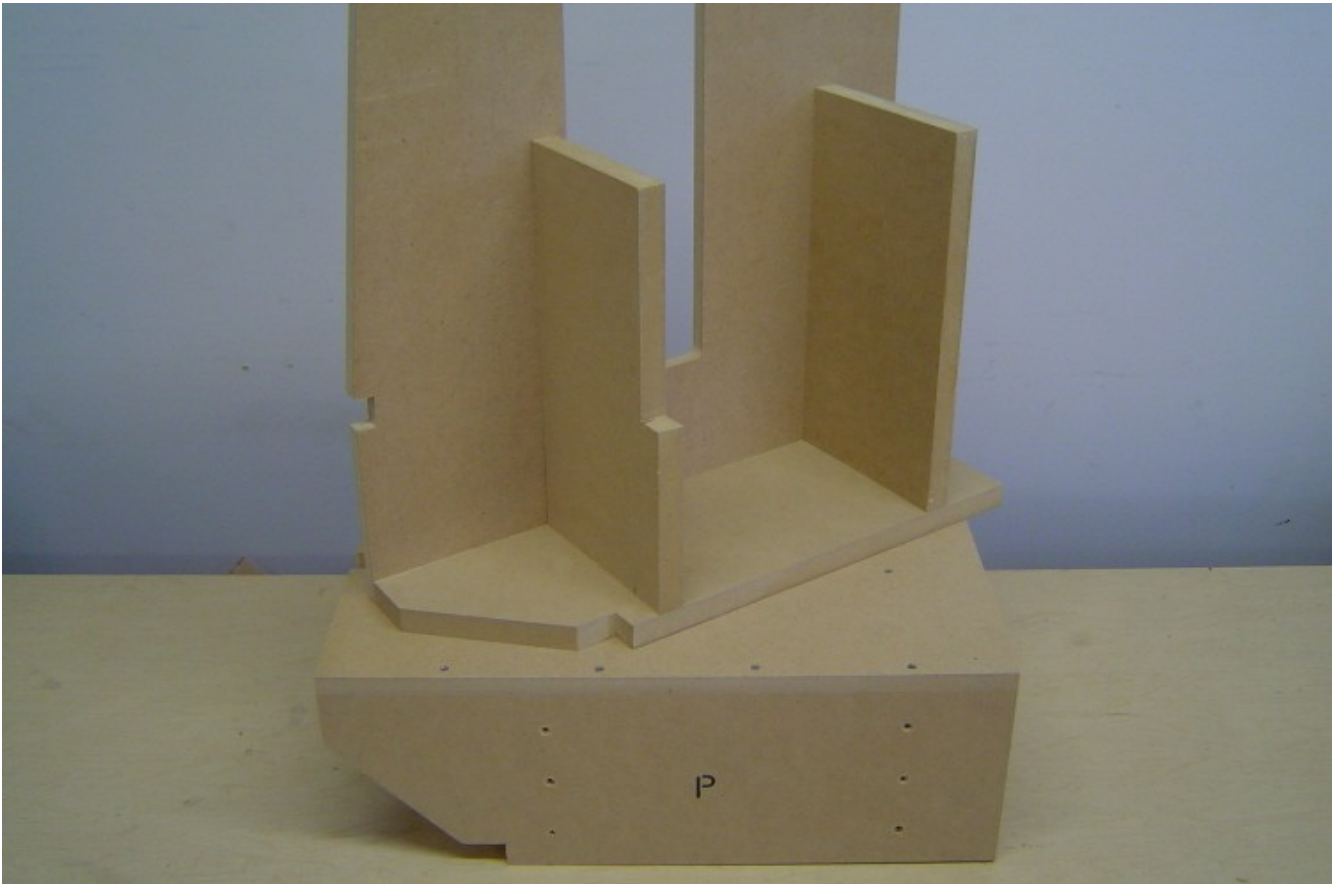
NOTE: The outboard lateral frame pieces are notched on the bottom to fit over the Floor Plates.



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Use six of the smaller stainless screws to attach the floor plate to the floor frames. Repeat this step for the Starboard side pedal assembly.



NOTE: Are you wondering why the lateral frame pieces of the pedal frames are shorter than the floor plates? It's to accommodate the dual pedal cable system in the future!



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Step 3: Now that we have one task finished and out of the way, let's start with the Port side of the shell, so grab the Port Floor Plate and set it on the left side of your base with P1 towards the front and P9 to the rear. Find P9 which is the rear wall and set it up so that the Floor Plate slips into the notch. Try to set P9 on the grid line 12 inches from the rear edge of the base. Use a square to insure that P9 is sitting level at a 90 degree angle from the floor.



CAUTION: Do not worry about screwing any of the pieces into the floor plate until later. You **WILL** find **PREDRILLED** holes in the bottom of all the pieces starting with frame number L45-006 and newer!

NOTE: There are four ¼ inch holes in each floor plate to bolt the shell to your base when you are ready. Eight nuts and bolts and sixteen washers are included in your kit when the time comes to permanently attach your shell to the base.

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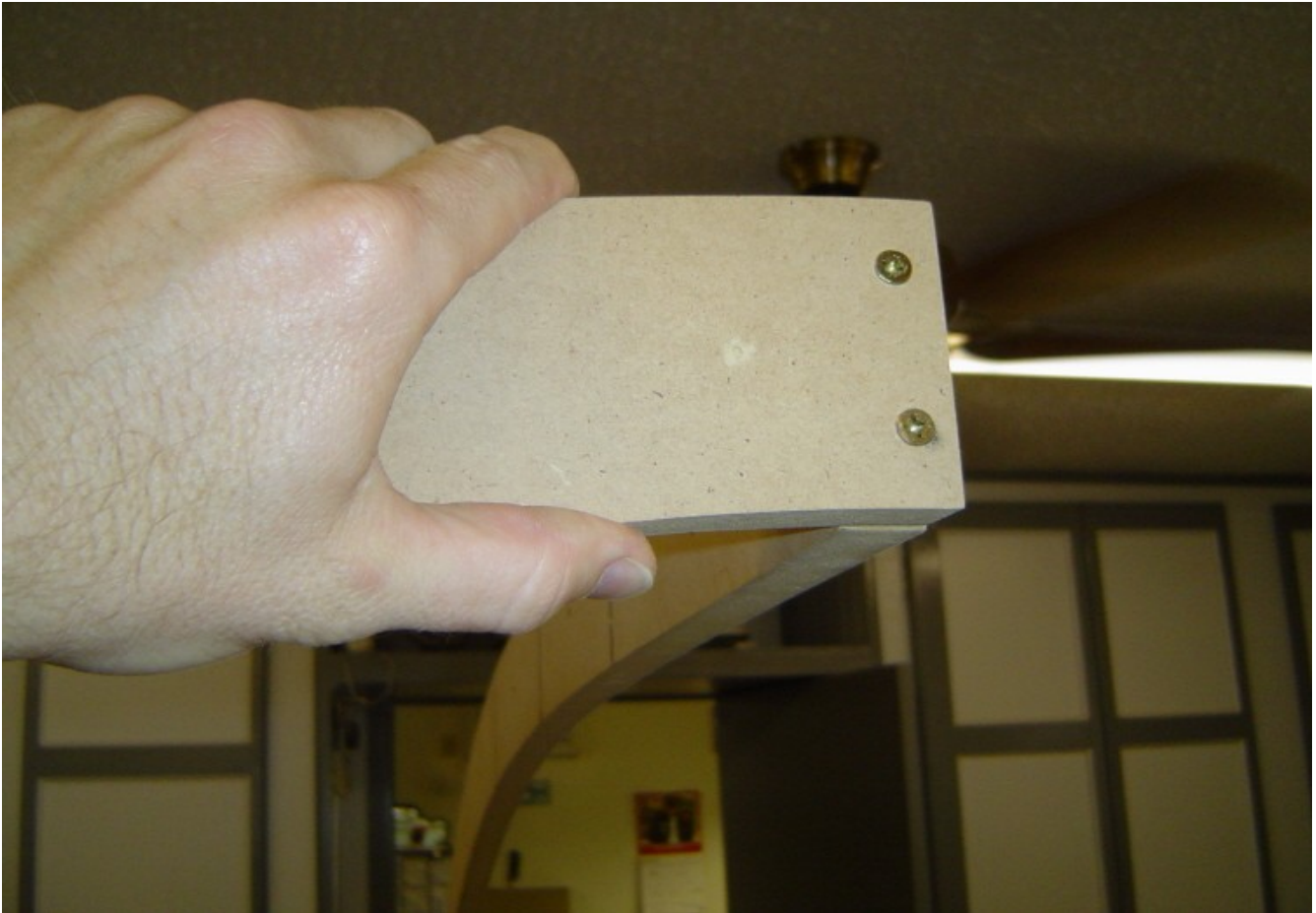
Step 4: Take P3 and set it up so that it also fits in its designated slot on the Floor Plate. Have a partner hold P3 and the front of the Port Center Windscreen Frame. Use two frame screws and attach the rear of the Port Center Windscreen Frame to the top of P9. Now attach the Port Center Windscreen Frame to P3.



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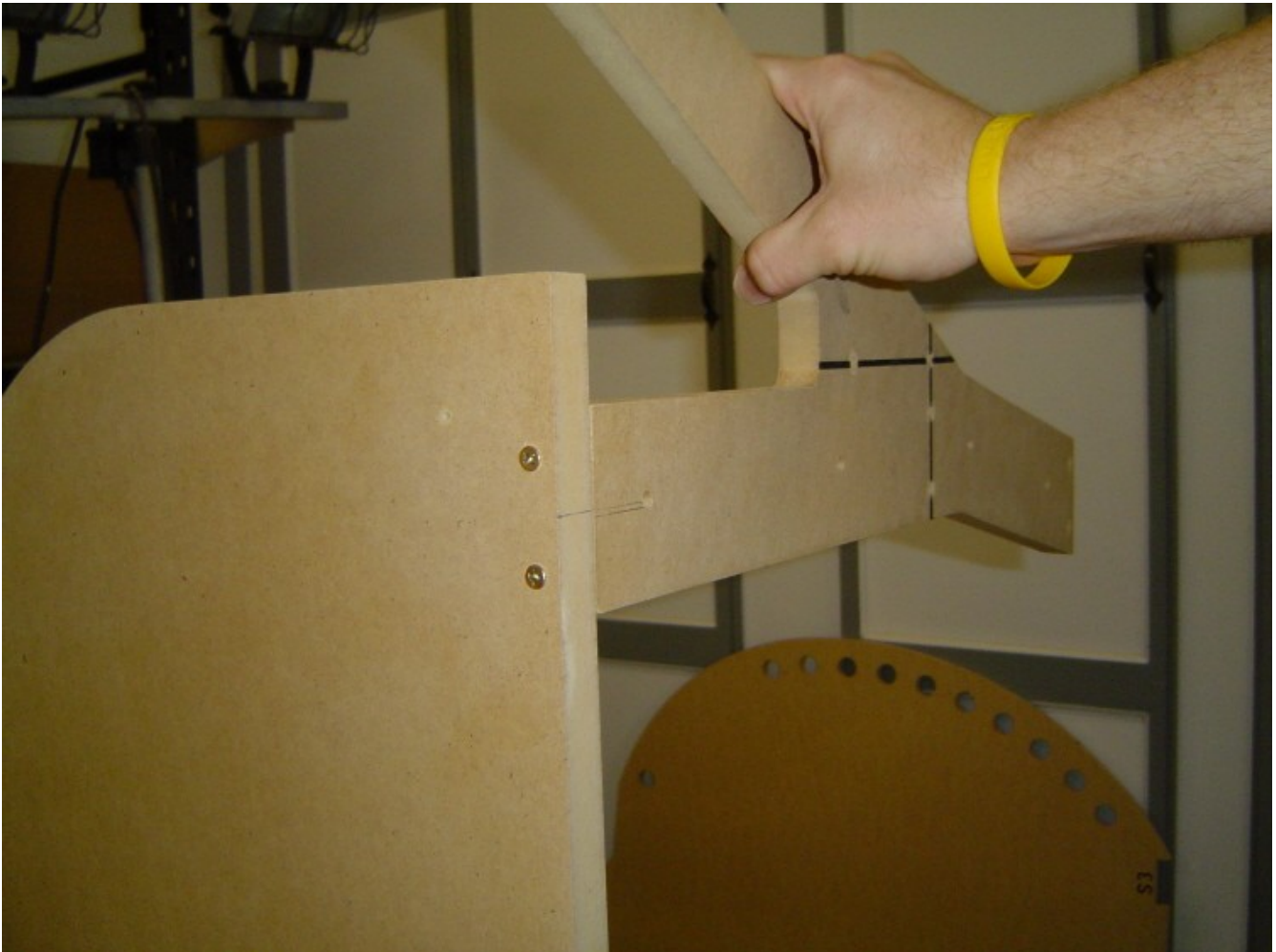
Here you can see how F9 and the Center Windscreen frame meet up at the rear. This step definitely take two sets of hands to insure that the MDF does not split.



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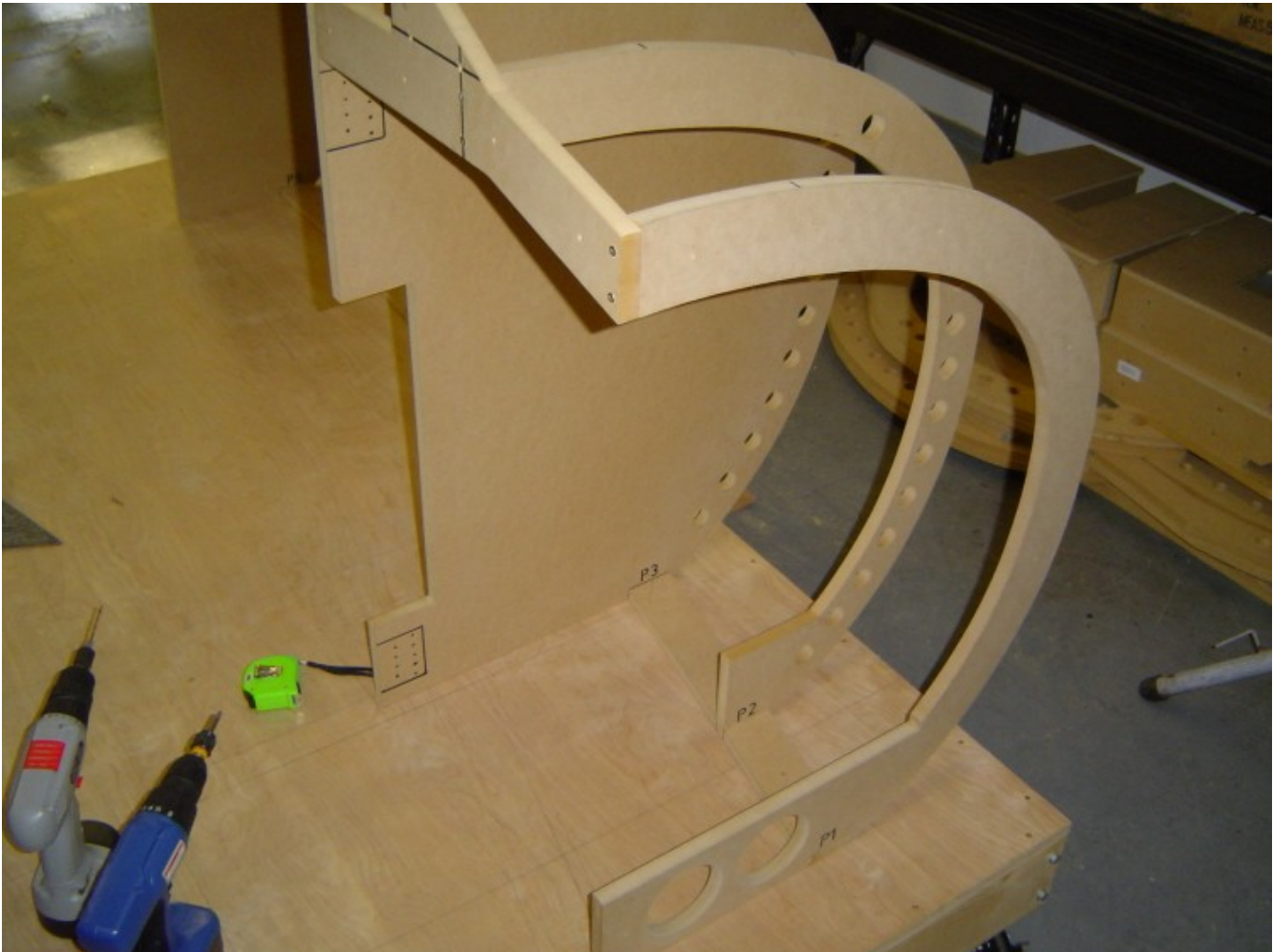
This is the forward end of the Center Windscreen meeting up with F3. This is where the second set of hands will be when attaching the three parts together.



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Step 5: Find P1 and attach it to the front of the Center Windscreen Frame with two more frame screws. P2 will follow with ease.



NOTE: The two large holes in the front of P1 are for access to the surge protectors or other items under the nose bay floor.



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P8 is next and again should be pretty easy to fit into place. Remember, don't worry about the screws that hold these parts to the Floor Plate. All the screws from the bottom will be done at the same time.



NOTE: P8 includes the Rear Windscreen Frame, which is the flat part at about eye level if you were sitting in the shell.



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Step 6: Now for the Port Upper and lower Windscreen Frames. First, we may need to temporarily remove P9 (rear wall), if you do not have a short screwdriver to get between P9 and P8. Attach the upper Windscreen with two screws in the front and two in the rear.



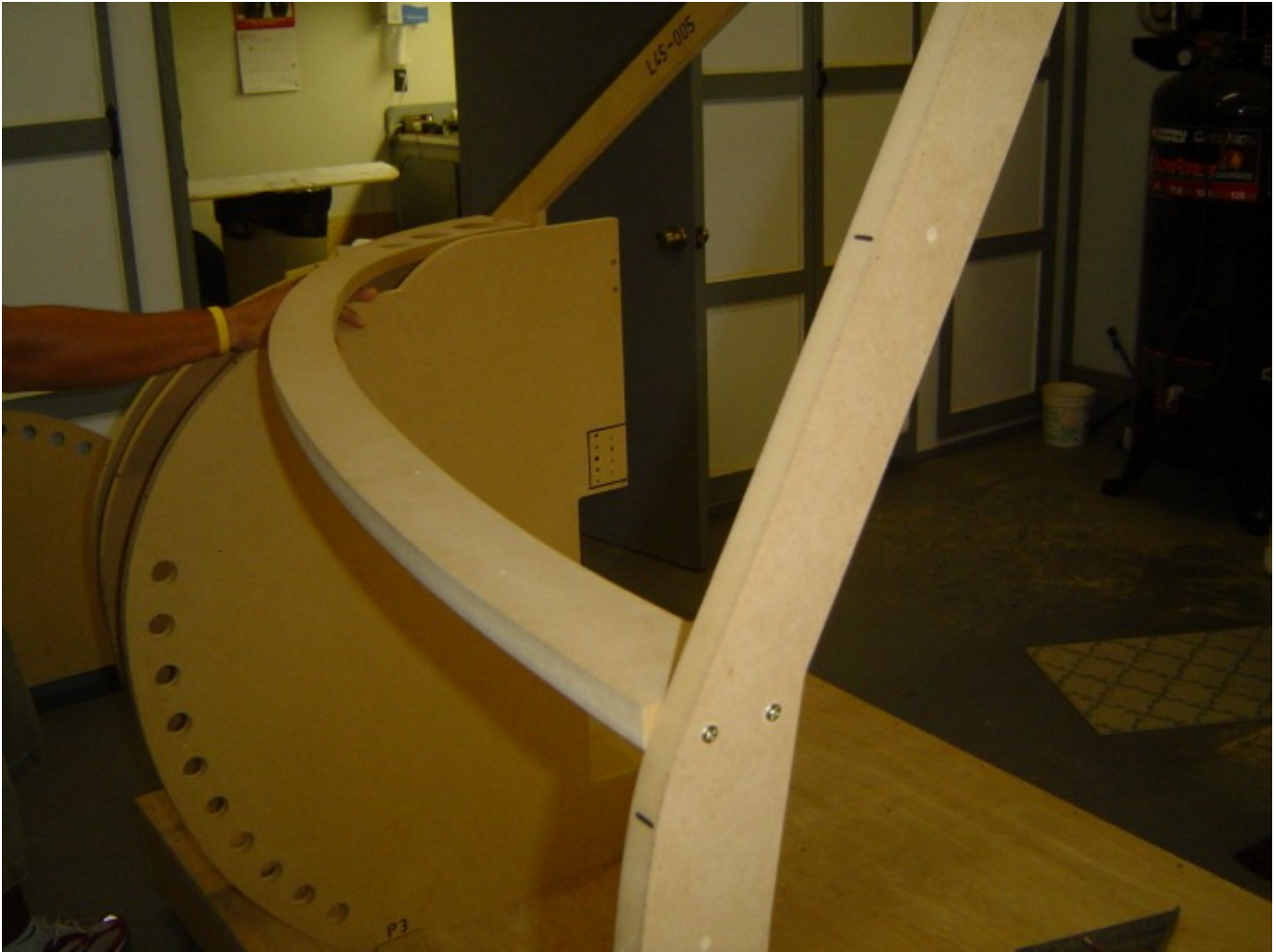
NOTE: This is a good time to tell you about the **OPTION** of leaving the rear of the cockpit open, although it requires some extra cutting and routing. If you wanted the rear open, the best way to achieve this would be to lay P9 (rear wall) flat on the ground and put P8 on top of it lined up with the outside edge. Trace everything but the Rear Windscreen Frame area. Where the Rear Windscreen is, simply connect the trace lines following the same outer edge pattern. With a jig saw, ruff cut the extra material off of your new P9. Next, screw the rear wall and P8 together using P8's jig screw holes. Then route off the last of the extra material with the exception of the windscreen area. This area will need to be completed by hand until you have the finished part. Repeat these steps for the starboard side, S9.

(AGAIN, THIS IS AN OPTION)

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The Lower Windscreen Frame is a little tricky because it needs to bow downward a bit to get the proper L45 look. With help from a partner, start with attaching it with two screws in the rear, (P8) and two at the front into the Center Windscreen Frame.



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This is a great picture showing the attachment lines for P2 and the Lower Windscreen Frame.



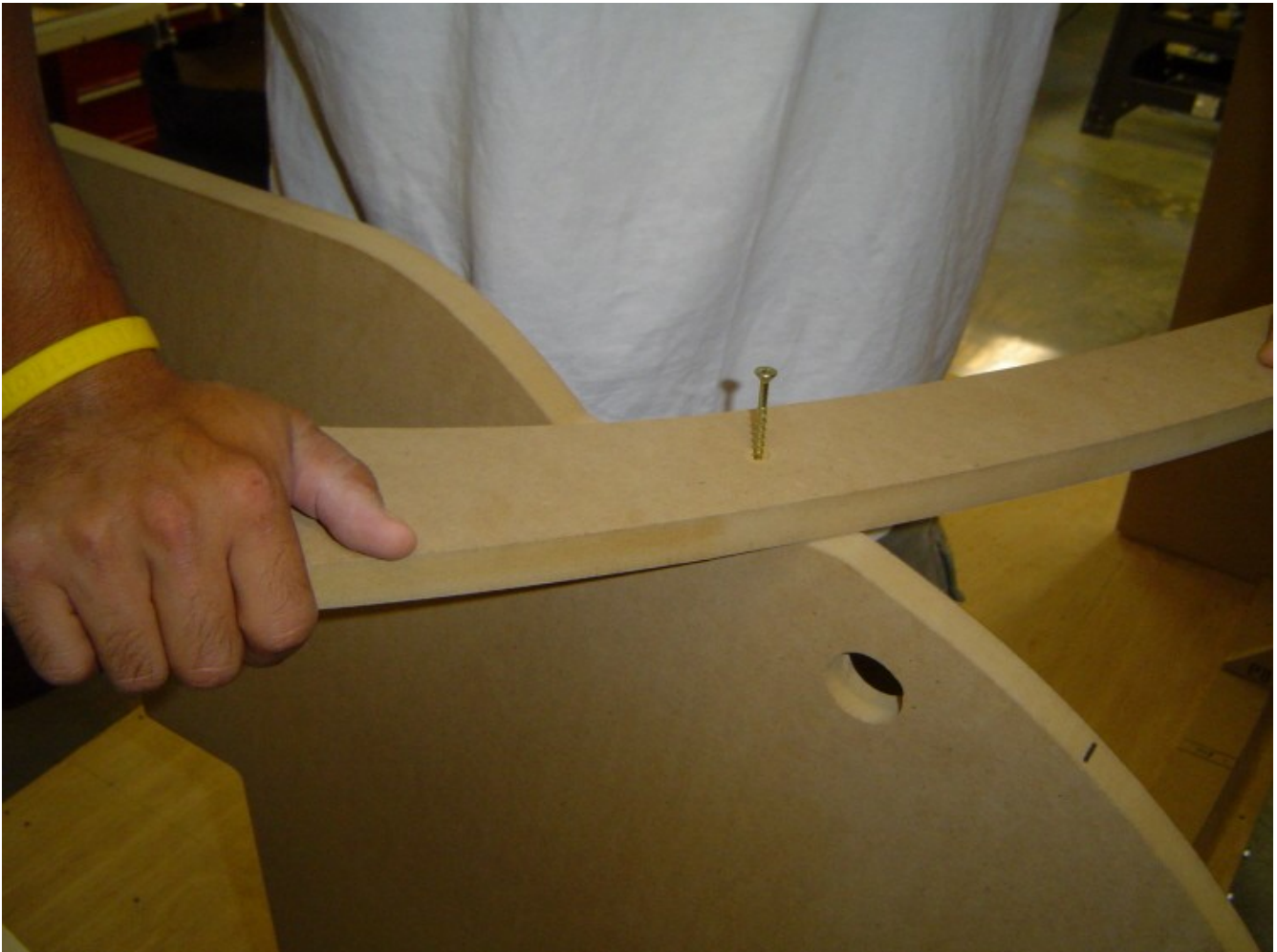
NOTE: The Lower Windscreen Frame will not lay on P3 without downward force. After the shell is assembled, you will be able to see that the Lower Windscreen is bowed down to fit the looks of the L45.



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Have your partner press down on the Lower Windscreen Fame and attach two screws into P3. This will start the bow downward of the Lower Windscreen.



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Reattach the rear wall if you removed it. At this point, you can clearly see the future lines of the L45 aircraft! Fun stuff.



(L45-002 in the background)



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Step 7: The next step is attaching P7 Upper and P6 Upper. Make sure you use the predrilled holes as always.



NOTE: You will observe that the bottom edges of P6 Upper and P7 Upper appear to be short on the Upper Windscreen Frame. Do not panic. This is because of the compound curves of the shell. The extra material on the Upper Windscreen Frame and on the forward edges of P6 and P7 will be shaved off in Phase 4. (It will all make sense the longer you look at it.)

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Step 8: P7, P4, P6 and P5 in this order, will finish up the Port side of your shell. You will note that they seem a little short. This is because the Lower Windscreen Frame has to be bowed downward. Go to step 9.



NOTE: The bottoms of these parts have all been predrilled starting with airframe L45-006 on. If you own L45-003 through L45-005, be sure to use a 9/64th size drill bit to make two pilot holes in each of the parts. This will reduce the chance of splitting the MDF.

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You can now say that you are half finished with your basic kit, no pun intended.



NOTE: Again, one of the frustrating things about MDF is its tendency to split if drilled and screwed into the edge. If you have minor splits, don't worry too much about them right now. "Bolting" in Phase 2 will fix any splits and more importantly, prevent future splits from occurring.



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Step 9: Repeat steps 3 through 9 to assemble the Starboard side. As you are building the Starboard side, you will soon find that staggering the two sides will be necessary in order to get to the attachment points for S1, S2, the forward ends of the Lower and Upper Windscreen Frames, S6 Upper, S7 Upper and S8.



NOTE: Here you can see by sliding the starboard side of the frame forward, the attachment points for S1, S2 and the Lower Windscreen Frame can be reached.



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In this picture, the starboard Upper Windscreen Frame, Upper S6, S7, and S8 are accessible. (That's me.)



WARNING: When you have your shell split like this, always make sure you have at least two clamps holding the two sides together.

CAUTION: When you are sliding the two sides back together, be careful not to catch one of the parts on the edge of your base. This will cause a split.

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Step 10: One of the fun parts, attaching the two sides together with twelve of the included nuts, 2 inch bolts and washers. Be sure to use a washer on the outside of each Center Windscreen Frame. This will help spread out the stress load better. We are also using lock nuts to prevent backing off of the bolts due to vibrations.



This is L45-005 after Phase 1 with L45-002 in the background.

NOTE: It may be a good idea to only verify that the two sides of the shell will in fact line up with each other. I recommend only using three or four bolts to hold the shell together because you will find that there will be a lot of pulling it back apart!

NOTE: It is a good idea to make a spacer 22 ¼ inches long to help maintain the proper spacing at the base of the cockpit door until you are ready to bolt the shell to your base.

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Step 11: Now is a good time to gently push the shell to the edge of your base platform with the help of your partner and attach the Floor Plates to F1, F2, F3, F4, F5, F6, F7, F8 and F9. There are predrilled holes in the bottom of these pieces starting with L45-006 and newer. You will need to raise your platform up on jack stands high enough to allow room for a drill.



NOTE: “F” refers to Frame section including both the Port and Starboard sides of the shell.

NOTE: Simply line up the “F” section pieces with the lines on the Floor Plates.

(Be sure to use a 9/64th size drill bit to make two pilot holes in each of the parts if you have L45-003 through L45-005. This will reduce the chance of splitting the MDF. You will also need to use a counter sink bit to insure that the screws are flush.)

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Step 12: At this point, the basic shell is almost complete, although there are a few more things that need to be completed to insure that the frame is square and secure for Phase 2. There are four Frame Plates included in this kit. You will also find clear markings where the four Frame Plates attach to F1 and F3.

You will have to drill small pilot holes in the MDF to give the screws something to bite into. Each plate requires 18 to 20 screws. Leave the center rows open, as seen here in the picture below . Again, you are probably thinking why not another Frame Plate at the bottom aft side of F3? This is where the rudder potentiometer bracket is going to be mounted in the future.

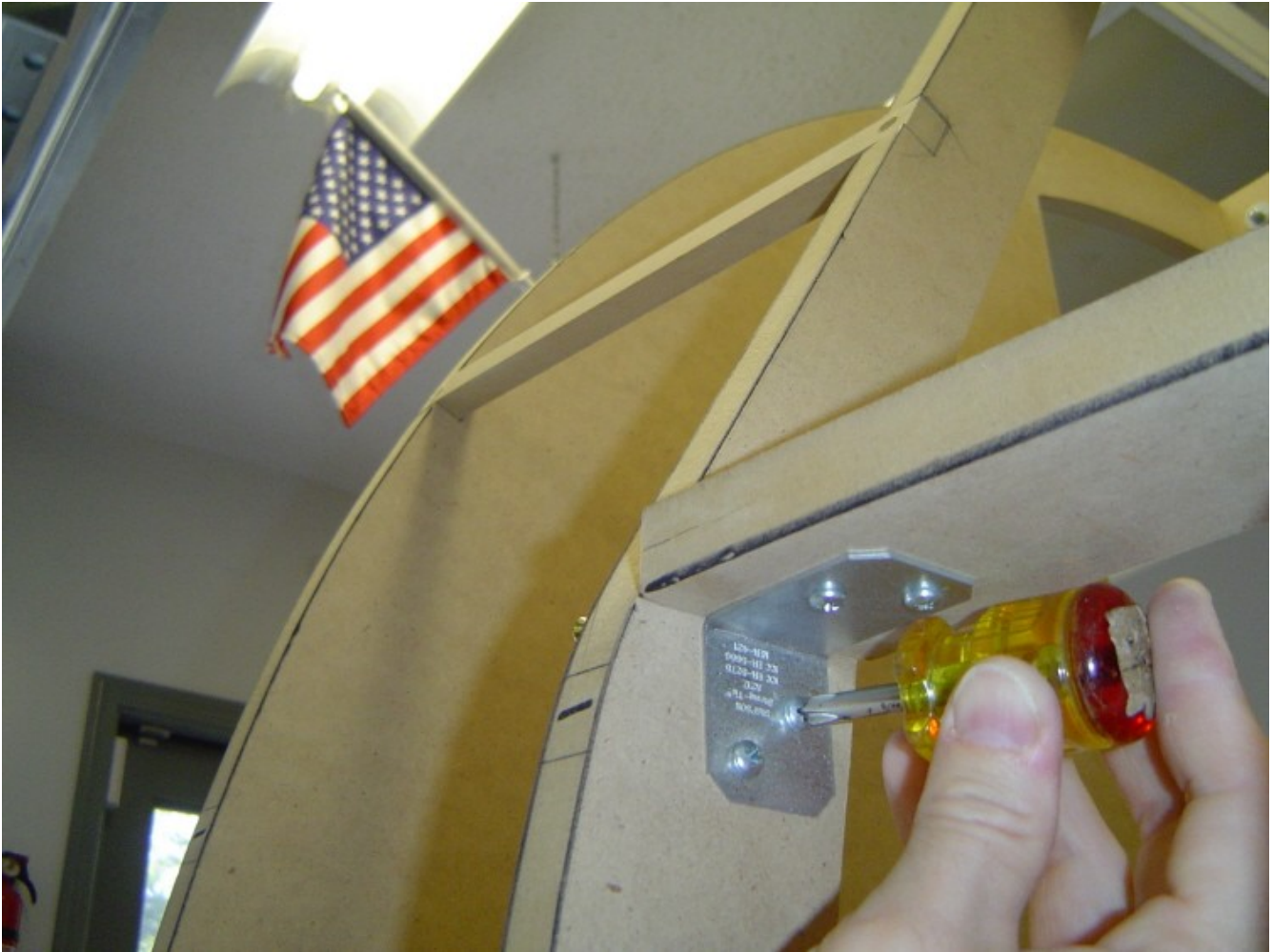


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Step 13: There are two “L” brackets included to give the bottom Windscreen Frame a little extra strength. There is extra stress at the rear section of the Windscreen Frame and these two “L” brackets should solve this problem. Four screws are required for each bracket.



Step 14: Now for the Nose Avionics Bay Floor. This is a great place to house up to four of your computers. Your extra cord and surge protector will fit easily under the floor. The holes in the forward bottom of F1 are designed to be large enough to reach into and turn the surge protector power switch on or off.

NOTE: This is a good time to let you know the reason F3 is solid. You will have many input boards, output boards, modules and circuit boards. Most, if not all of this can be mounted to the forward side of F3. If need be, the aft side of F3 is also available.

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First we need to attach the rear legs of the Avionics bay floor to the forward, outboard, bottom sides of F3. This requires three pilot holes on each forward side of F3. Be careful not to drill all the way through the MDF. Make sure to use the longer stainless screws included to attach these two legs.



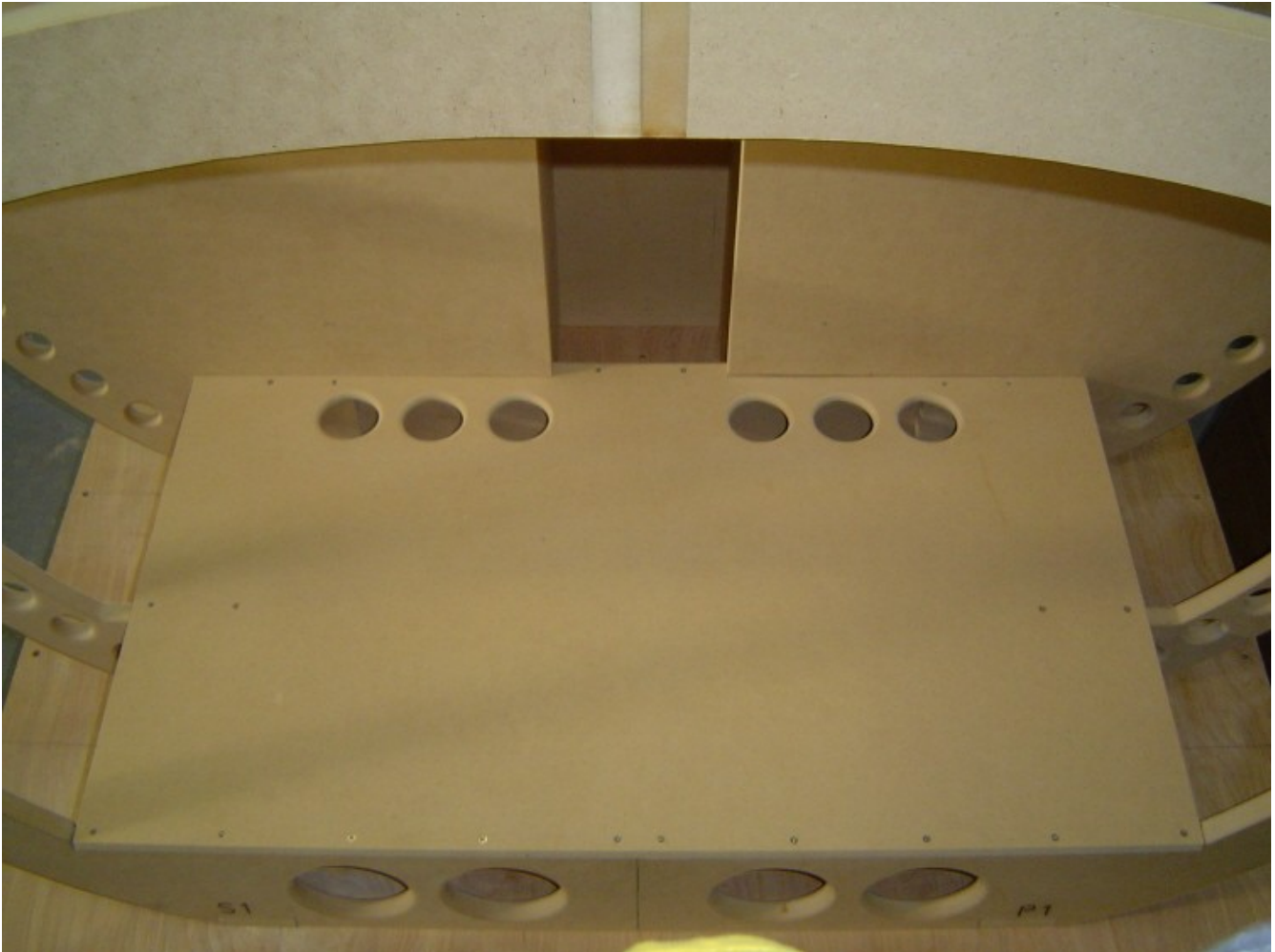
NOTE: You will find that there is approximately six inches of clearance under the Avionics Bay floor for various items.



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The floor will require 20 of the smaller stainless screws. Each screw will need a pilot hole drilled in the respective frame sections as well.



Congratulations! You have just completed Phase 1 of 10, that's the good news. Although you just spent a good amount of time assembling your shell to this point, you are going to have to take it apart at least three times in the up coming Phases.

I promise it will all be worth it!



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Phase 2: Bolting the main frame parts together to prevent splitting.

During the course of assembling L45-002, I found that “Bolting” the parts together was so successful in correcting the splitting issue that I decided to write it into this official Assembly Manual.

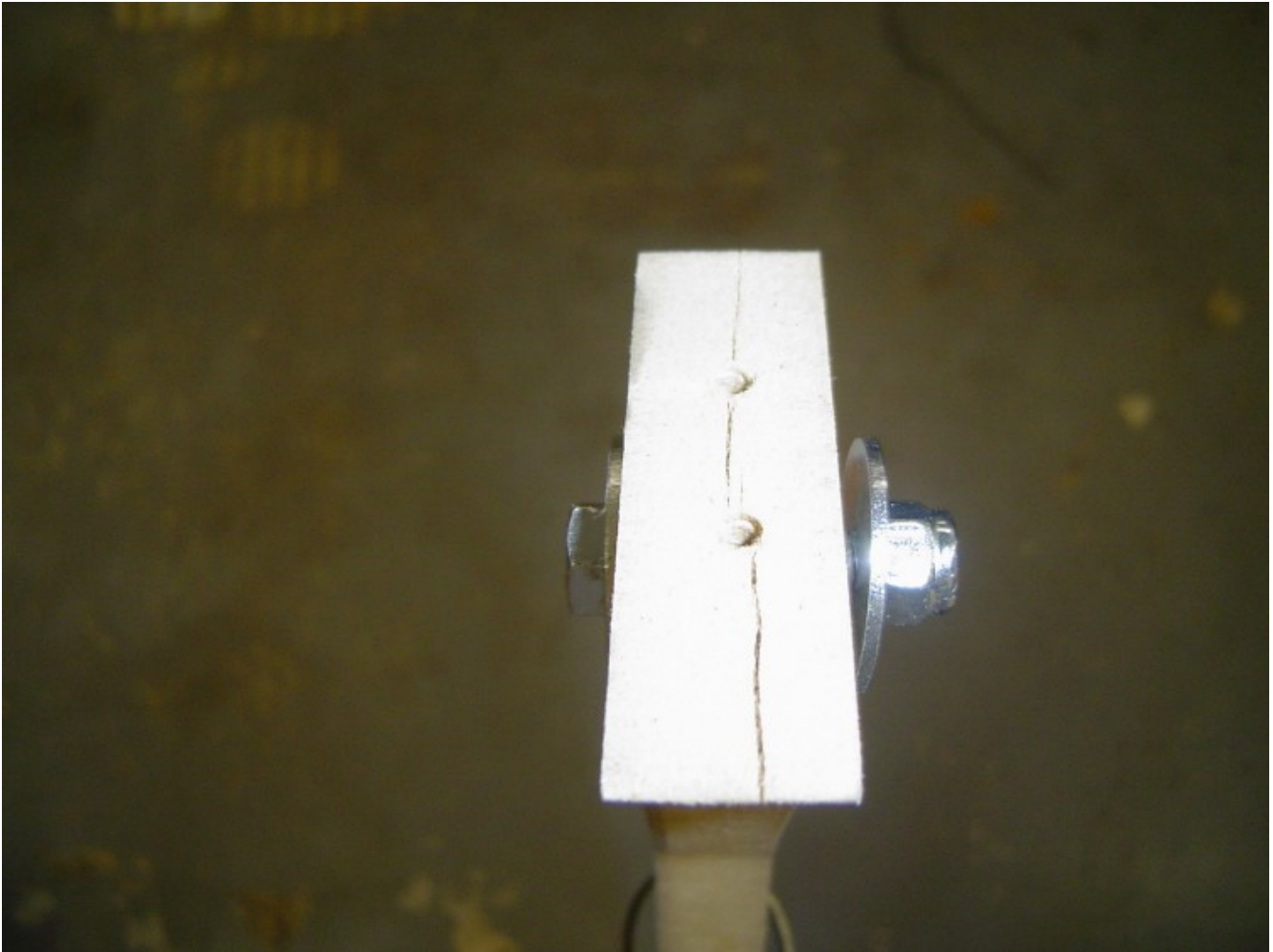
I highly recommend this Phase to the point that I predrilled all of the holes in the frame sections and included the hardware in kits L45-006 and newer. Take a look at this split in the top end of S5 before the Bolting technique in the picture below.



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Step 1: Notice that there are ¼ inch predrilled holes in the ends of each Frame Section. You will also find ¼ inch predrilled holes in the Windscreen sections as well. Find the included hardware in your kit, nuts, 1 ¼ inch bolts and washers. Attach the nut and bolt with a washer on each side to the part.



NOTE: The nut and bolt in this picture is not tight yet. I removed S5 from my frame for illustration purposes. You should be able to install most if not all of the bolts without removing any of the frame sections.



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Step 2: Notice that as you tighten the bolt down, the split closes. Be careful not to over tighten the bolt as this will stress the part to the point that the split reappears.



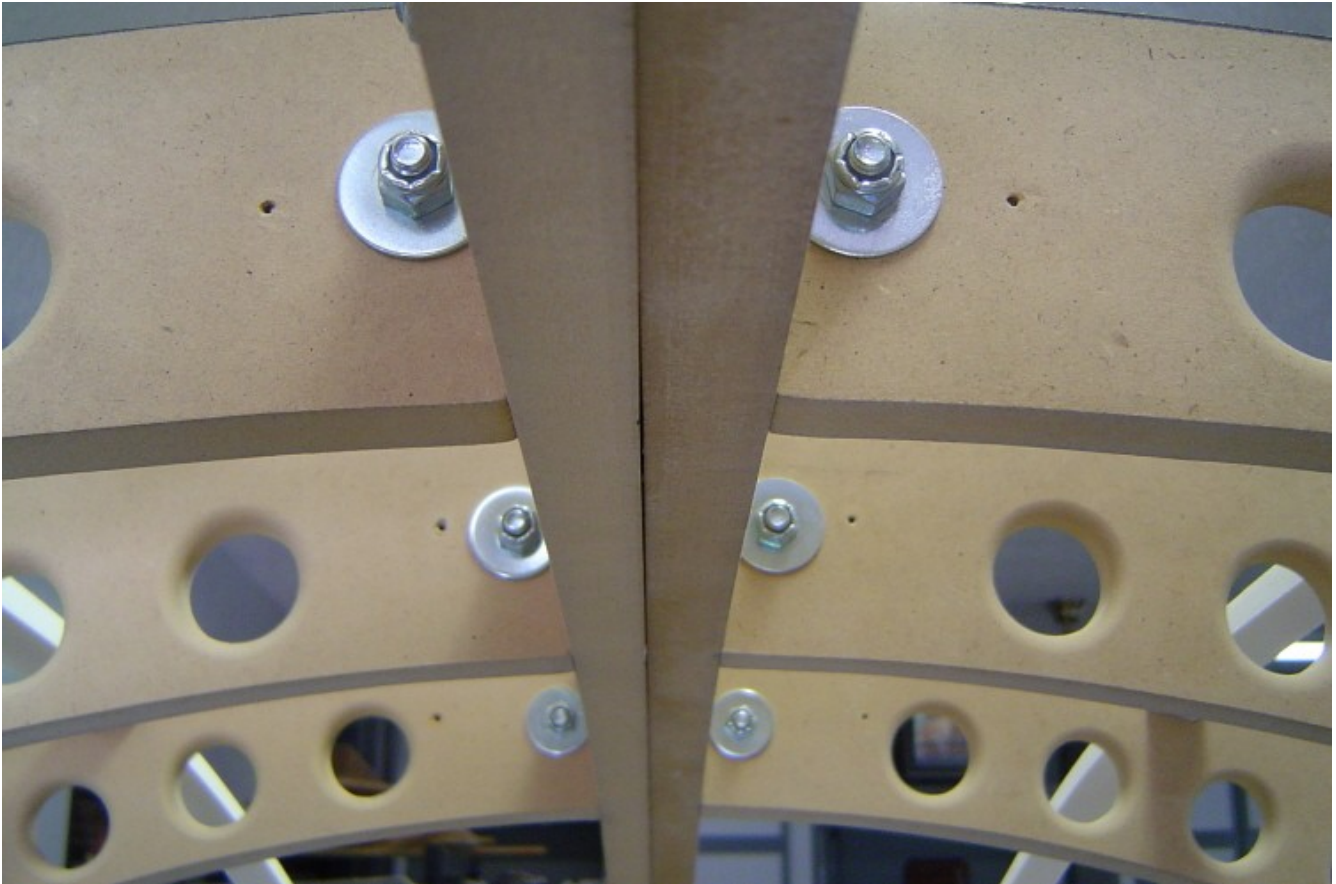
(Shinny and new!!!)



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Here are a few pictures of some of the bolts in place on L45-002.



NOTE: Notice that the overhead access holes are rounded out.

Notice that all the bolts face the same direction. Turn the bolt around at the bottom of F9 (Rear Wall) so that the nut is inside the frame.



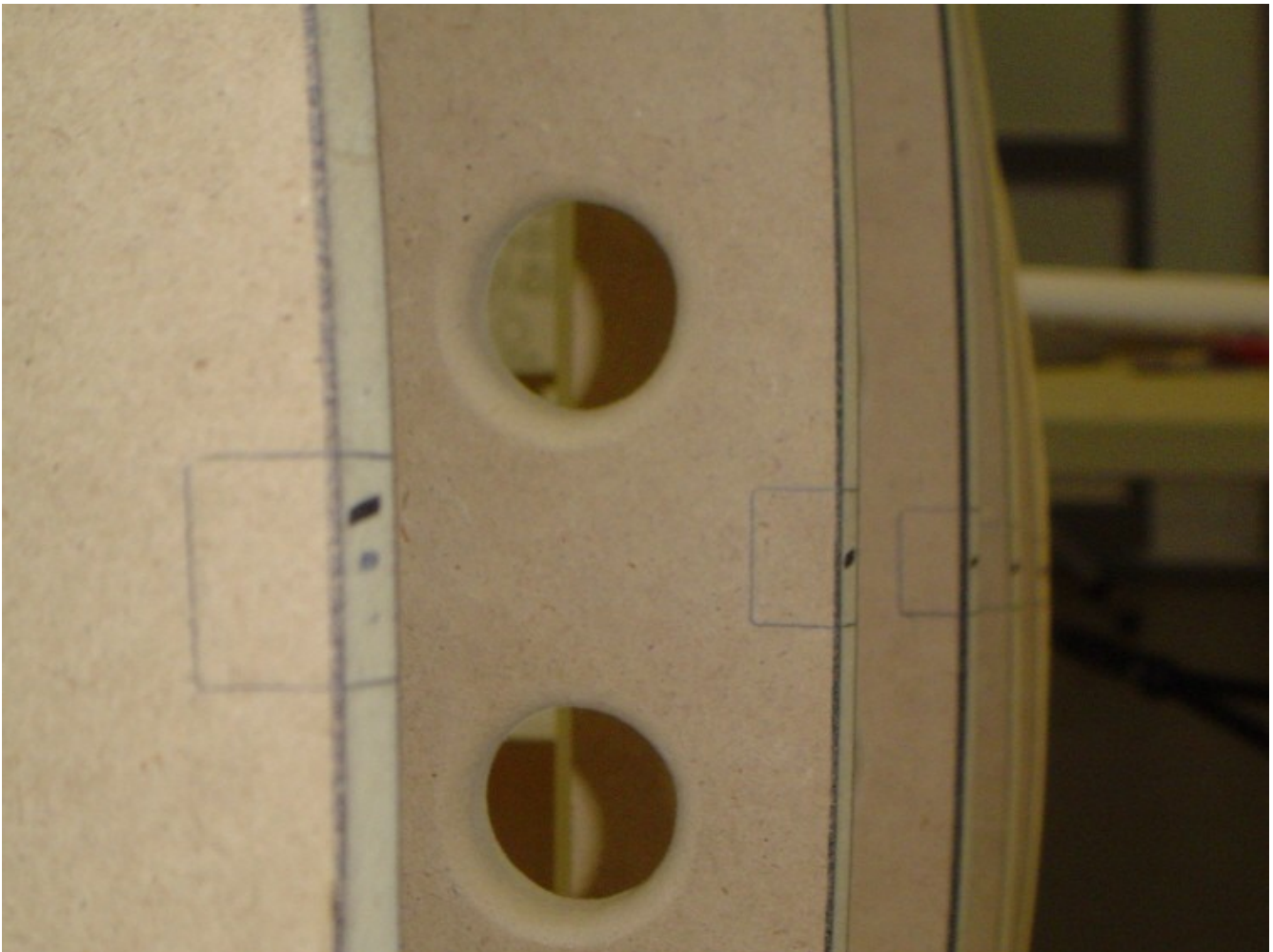
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Phase 3: Notching and installing the lateral strips on the outer shell.

I included the lateral strips to be notched into the outer frame. There are marks on the outer frame ribs which represents where the center of the lateral strips will fall. You should take note that most of the notches will be at slight angles and taper deeper into the frame sections on the forward edge of each part. This phase of my construction technique will be the most time consuming. There are 110 notches to be done, some easier than others. The hardest part is just getting started!

Step 1: With one of the lateral strips, mark the outer cut lines on all the frame sections, Port and Starboard alike, making sure that the black dashes are centered. You may need to do some minor adjusting if you are looking for perfection. (Take notice of the minor dash line correction on S9 pictured below.)

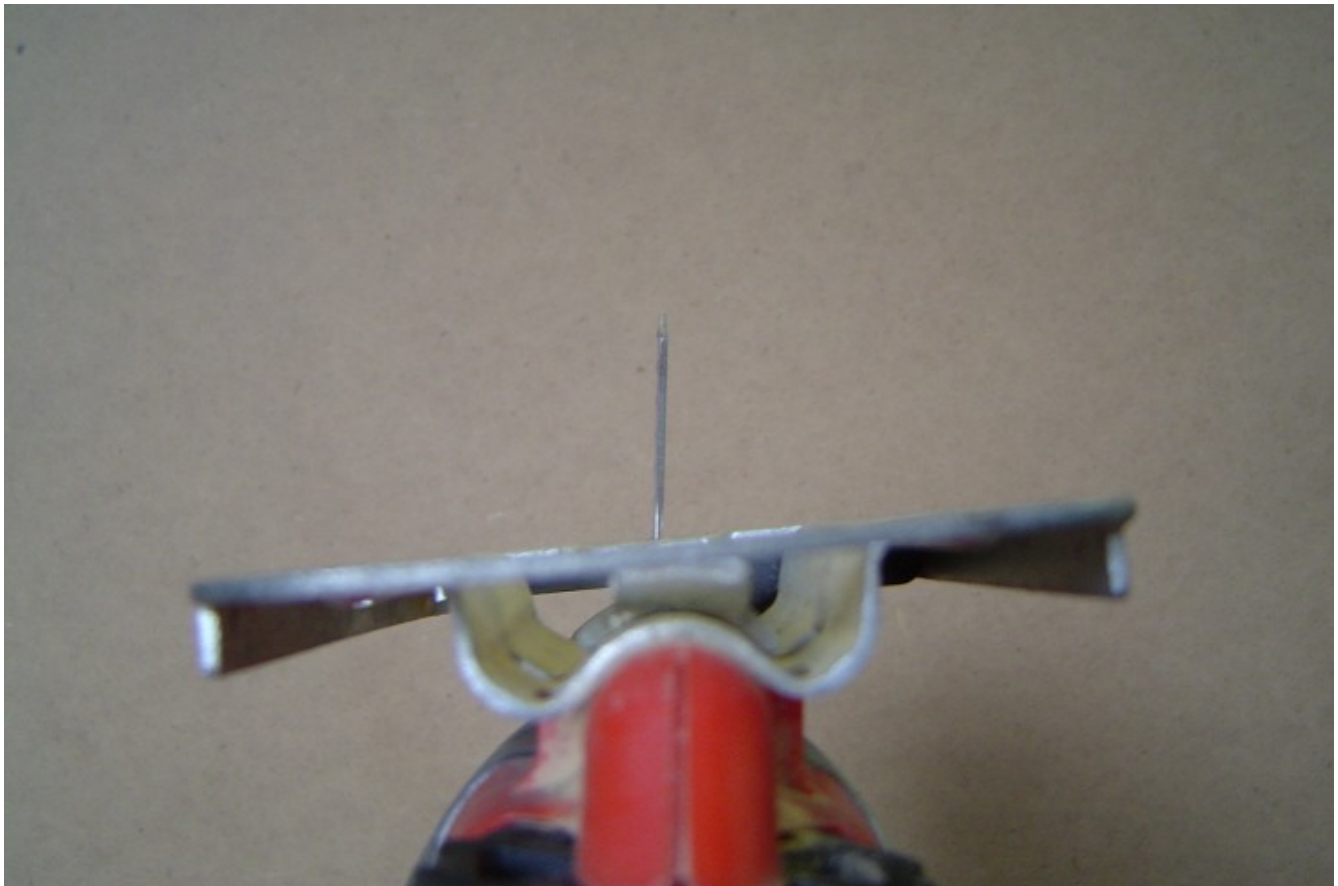


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Step 2: Use the small green MDF block to mark the depth of each notch. You can see the outcome of this step in the previous picture. Make sure to place these marks on the aft side of each frame section! (You can mark the forward side of each frame section also, but the initial cutting will be done from the aft side.)

Step 3: I found that using a jigsaw with an adjustable base works best. In most cases, the base platform of the jigsaw needs to be tilted approximately 10 degrees or so, see the photo below.



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Step 4: Using the jigsaw, cut down the aft line on each of the pieces you are working with. (I found it best to work on one lateral strip at a time in order to stay focused. The notches **MUST** be synced together in order for the outside lines to flow properly.)



NOTE: You will have to remove F7 and the overhead sections to get the jigsaw in between these tight places.



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Step 5: In somewhat of a cross cut fashion, carefully remove the bulk of the material without going past the deep lines.



WARNING: It probably goes without saying, but be careful while using the Jig Saw in this fashion. The good news is if you make it without cutting yourself during this Phase, you will be considered an expert!



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Step 6: Using the teeth of the jigsaw, remove the remainder of the bulk of the material moving the blade in a side to side motion.



NOTE: In this case, because the jigsaw is at a right angle, move it up and down to remove the excess material.



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Step 7: Carefully file the notch until the green block fits flush at the front and rear of the frame section you are working on.



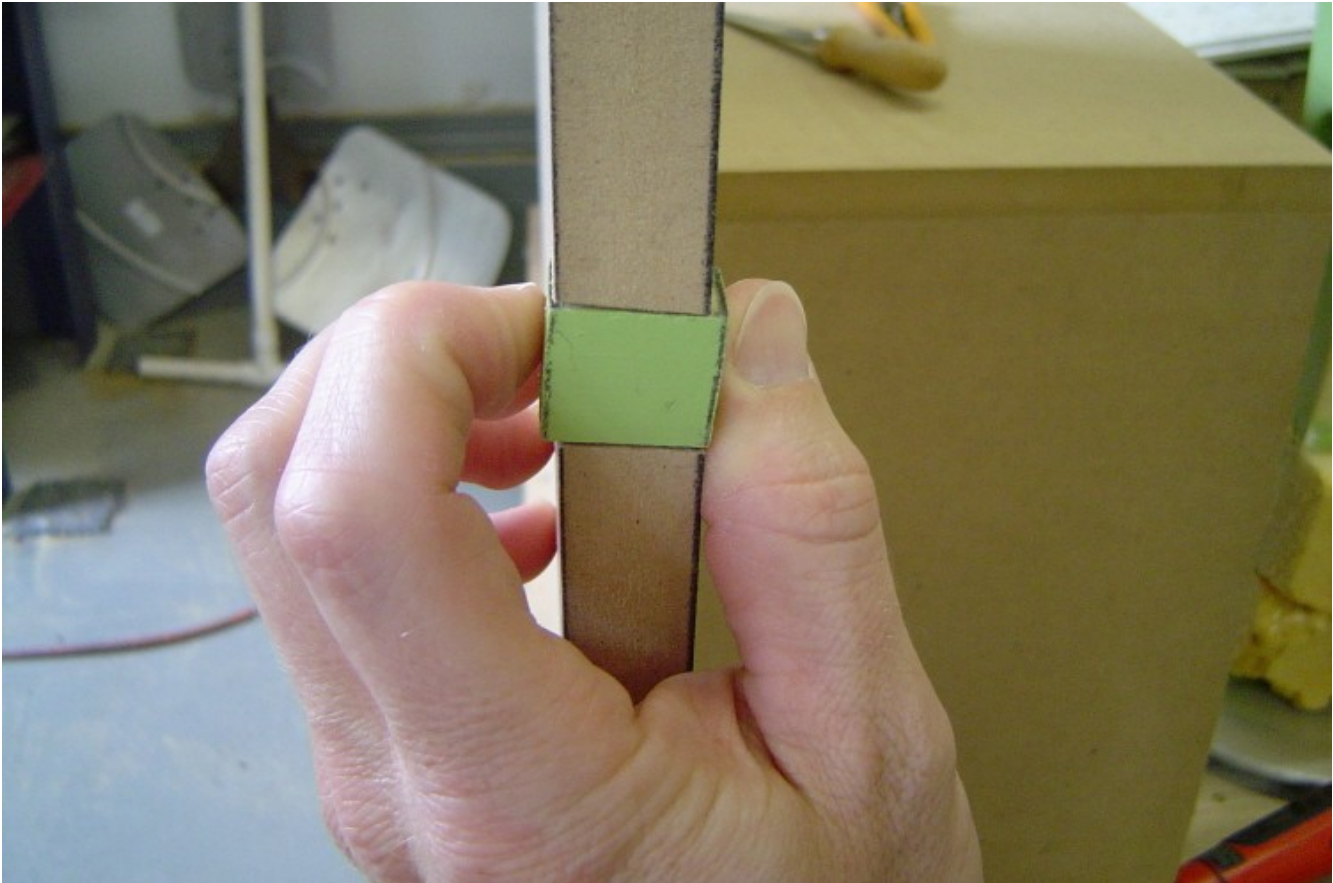
NOTE: If the notch was cut too deep, a small washer can be used to bring the lateral strip back out to its intended position by dabbing a little wood glue between the washer and the bottom of the notch in the F section.



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Step 8: Here you can see how the green block fits flush at both the front and rear of the notch on S9. (Of course this notch is angled down from left to right.) This notch is complete because it does not require the forward edge to be filed deeper.



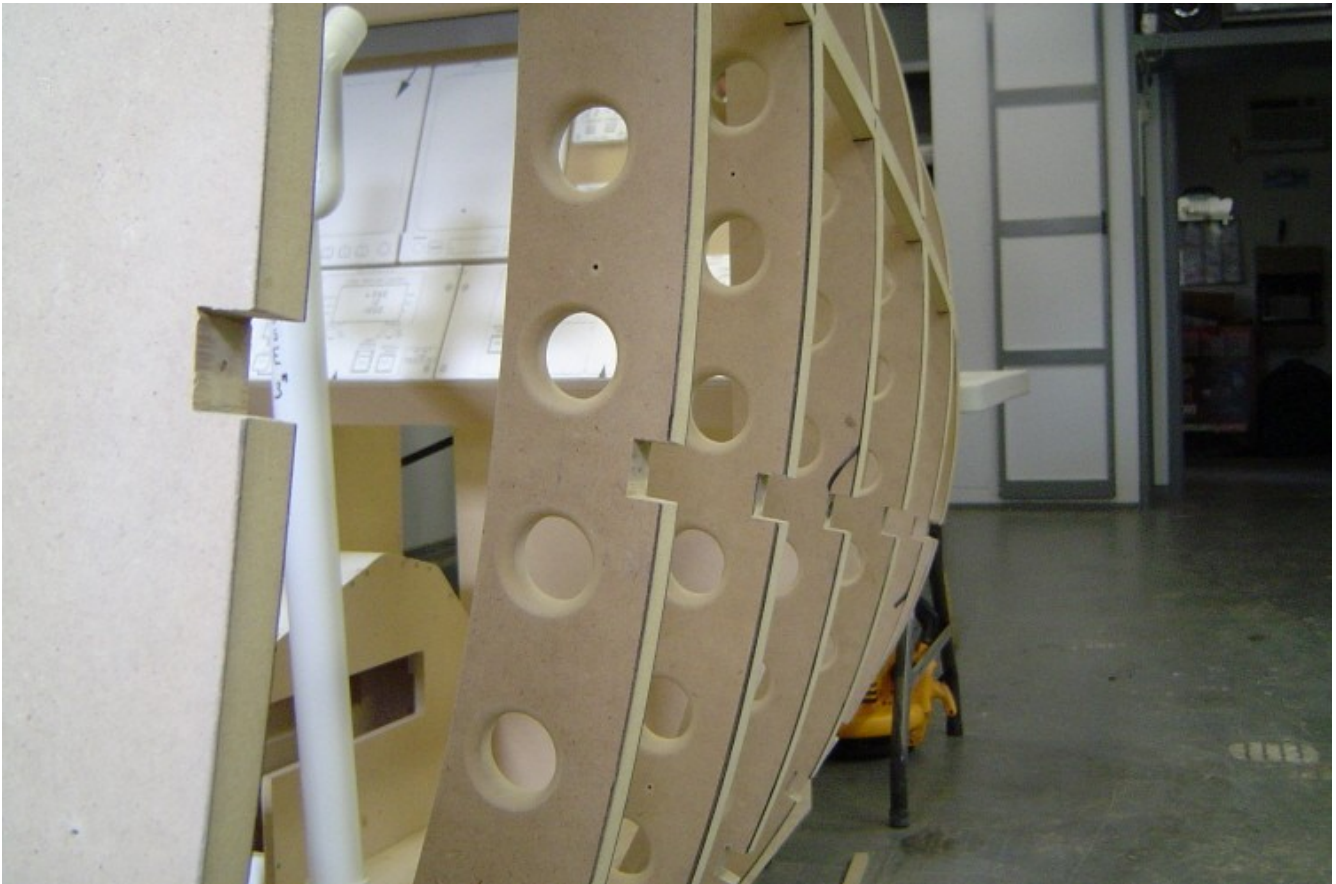
NOTE: F9 and F8 only need flush filing like seen in this picture above. F7 will require that the forward edge of the notch be slightly deeper than the aft edge. Each frame section from there forward to F1 will need the forward edge of each notch be slightly deeper. This will require some trial fitting.



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Step 9: After completing a set of notches, it's time to trial fit the lateral strip. Some additional filing is needed to get that perfect fit!



NOTE: There are nine notches in this picture. The notches in S2 and S1 can not be seen because of the shell curvature. Also take note that I carefully designed the L45 shell so that all the notches fall safely between the access holes so that the overall strength is not affected.



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Step 10: After laying the lateral strip into its groove, you will then be able to see where the forward edge of each notch from F7 to F1 will require additional shaving. A nice gauge to determine how much deeper the forward edge should be is the gap between the lateral strip and the bottom of the notch on the aft side.

Step 11: With the jigsaw, carefully tilt it so that the teeth are in contact with the forward edge of the notch **ONLY**. Move the jigsaw from side to side until you have reached the desired depth of the notch on the forward edge. At this point you will have what looks like a little hill in the middle of the notch, which is by design.

Shade the aft and forward edges of the notch with a pencil as seen in this picture below. With the jigsaw, remove the “hill” from between the pencil shade line. As you make progress, you will slowly see the inner parts of the shade lines disappear, indicating that you are getting close to having a flat base in the notch for the lateral strip.



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Step 12: This is a great illustration of how the lateral strip should sit in the notch of S3, (Starboard side forward bulkhead).



NOTE: Notice that the rear side line of S3 intersects the top of the lateral strip.

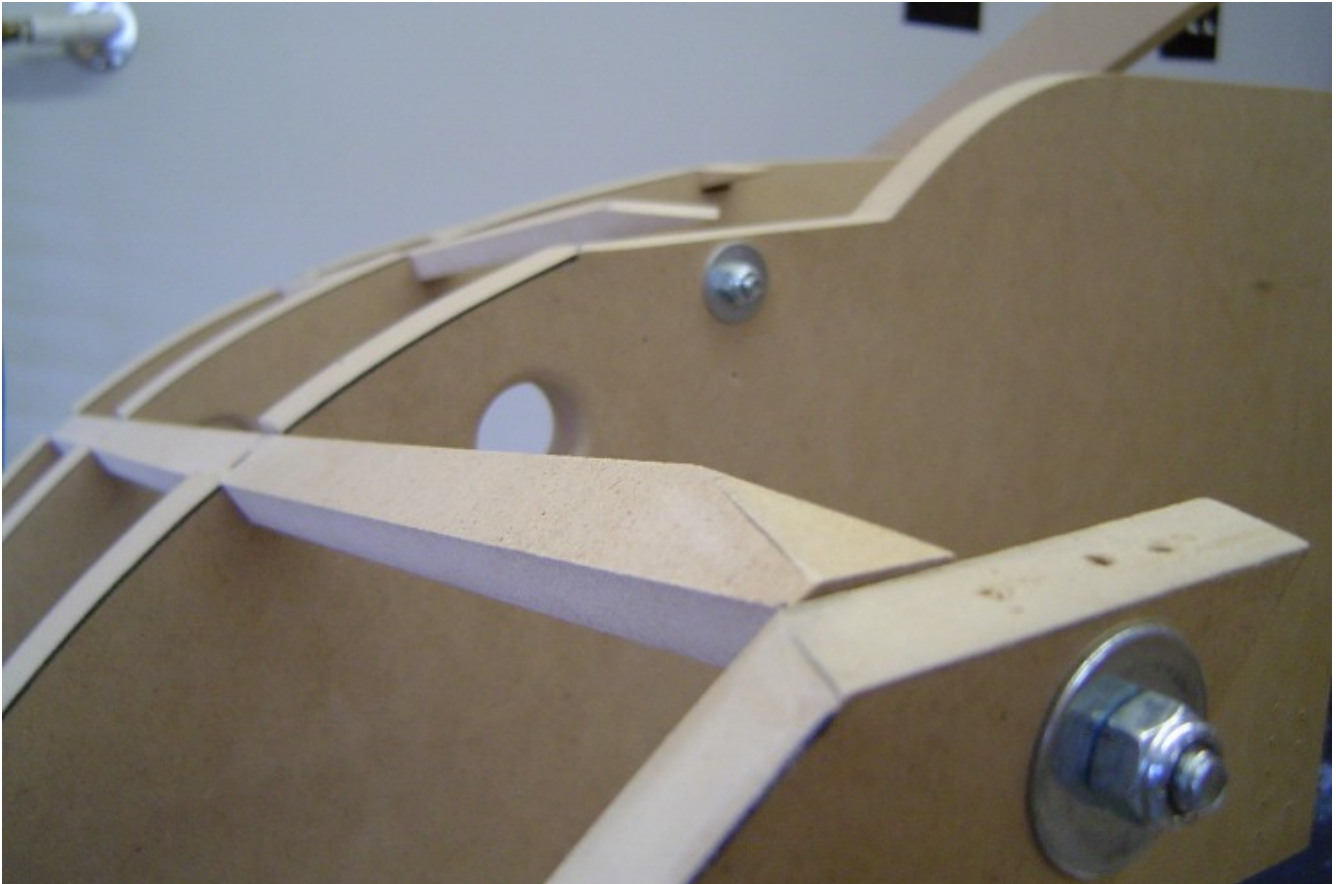
NOTE: If the notch was cut too deep, a small washer can be used to bring the lateral strip back out to its intended position



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Step 13: Working with the shorter nose lateral strips will take a little trial and error to find the correct angle to cut. In this illustration, the Port side Lower Windscreen has been removed to show how each of these three lateral strips had to be shaved.



NOTE: Use a rotary sander like the one pictured on page 50 to help achieve these angles in step 13.

Step 14: Cut the extra material off of the ends on each lateral strip. Because most of the ends are at compound angles, simply mark the three sides of the lateral strips with a pencil next to the frame. I found it too easy to use the stationary rotary sander to grind away the loose ends! Use a sanding block to insure that the lateral strips are perfectly flush with the aft side of the rear wall and the forward side of F1.

PROJECT45

L45-SAM (Shell Assembly Manual)

Step 15: One of the tricky parts in the two longer overhead Polly strips. The only way to get these two pieces to fit right is to skip ahead to Phase 4 and shave the overhead Windscreens. This will show you how far the Polly strips are going to go and at what angle. From there, it is a whole lot of sanding with the table sander and test fitting. **DO NOT** cut the rear of these Polly strips until you are comfortable with the fit at the front.



NOTE: When working with these over head Polly strips, be sure to leave some extra material at the rear until you have the front fitting right.

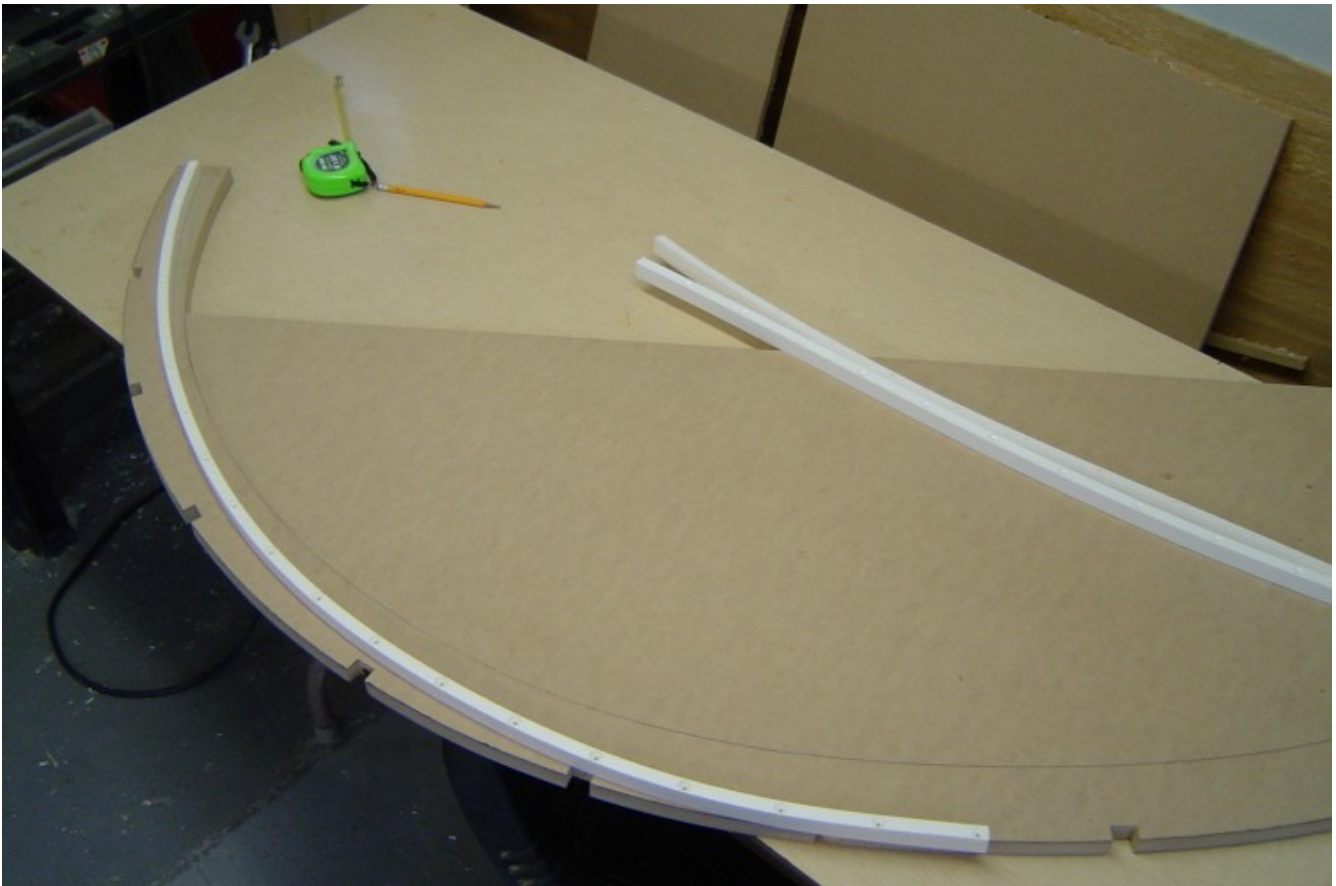


PROJECT45

L45-SAM (Shell Assembly Manual)

Step 16: Included in your kit are four additional Polly strips to make up the attachment points for the interior headliner and inside wall trimmings. This will require the removal of the rear wall, (F9). All four Polly strips have been predrilled with a hole every 3 inches.

One of the neat things about Polly material is that when bent, it remembers the shape it was last in. Notice how the one piece is maintaining its shape by itself?



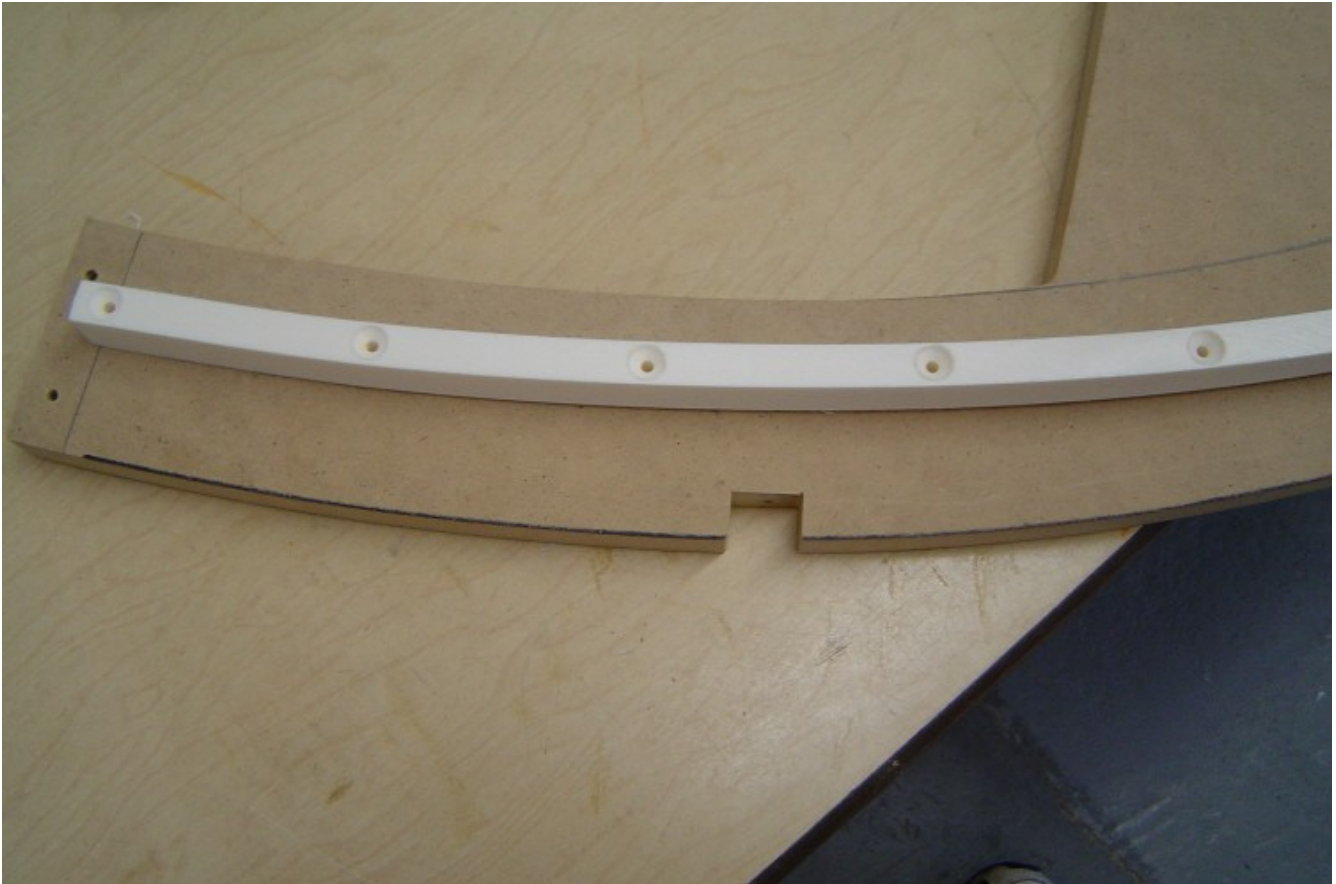
NOTE: A penciled line is drawn from top to bottom on the rear walls where the Polly stripes will be attached.



PROJECT45

L45-SAM (Shell Assembly Manual)

Start by attaching one of the long pieces at the top of F9 with a drill and screw. (Guide holes are not needed during this step because we are not drilling into the edge of the MDF.) Don't forget to back this first Polly piece off $\frac{3}{4}$ of an inch to leave room for the Center Windscreen frame.



NOTE: Use the included Lateral strip screws to attach the rear wall Polly strips. Cut a third Polly strip in half to complete the process all the way to the Floor Plate Bolts. If you choose, you can also use this material to do the same on the inside on F3 near the pedal assemblies.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Reattach the rear wall with the Polly strips in place. When that time comes, you will have a nice place to attach the headliner and inside wall trimming.



PROJECT45

L45-SAM (Shell Assembly Manual)

I describe this whole process in Phase 3 like a long road trip to Alaska. It takes forever but it is well worth the trip once you arrive!



NOTE: Some of the shaving (Phase 4) has been done in this photo above. The upper windscreen frame, lower windscreen frame and the overhead parts have all been shaved.

It is suggested that at least the upper Windscreen Frames are shaved in order to get proper fit and alignment of the two long overhead Polly Strips pictured above.



PROJECT45

L45-SAM (Shell Assembly Manual)

Phase 4: Trimming the kit so that the compound curves flow properly.

This is the point that the shell has to be taken apart, at least one or two parts at a time anyway. I found it easy to shave the parts using a stationary bench top rotary sander like the one pictured below. You can find these for around \$100.



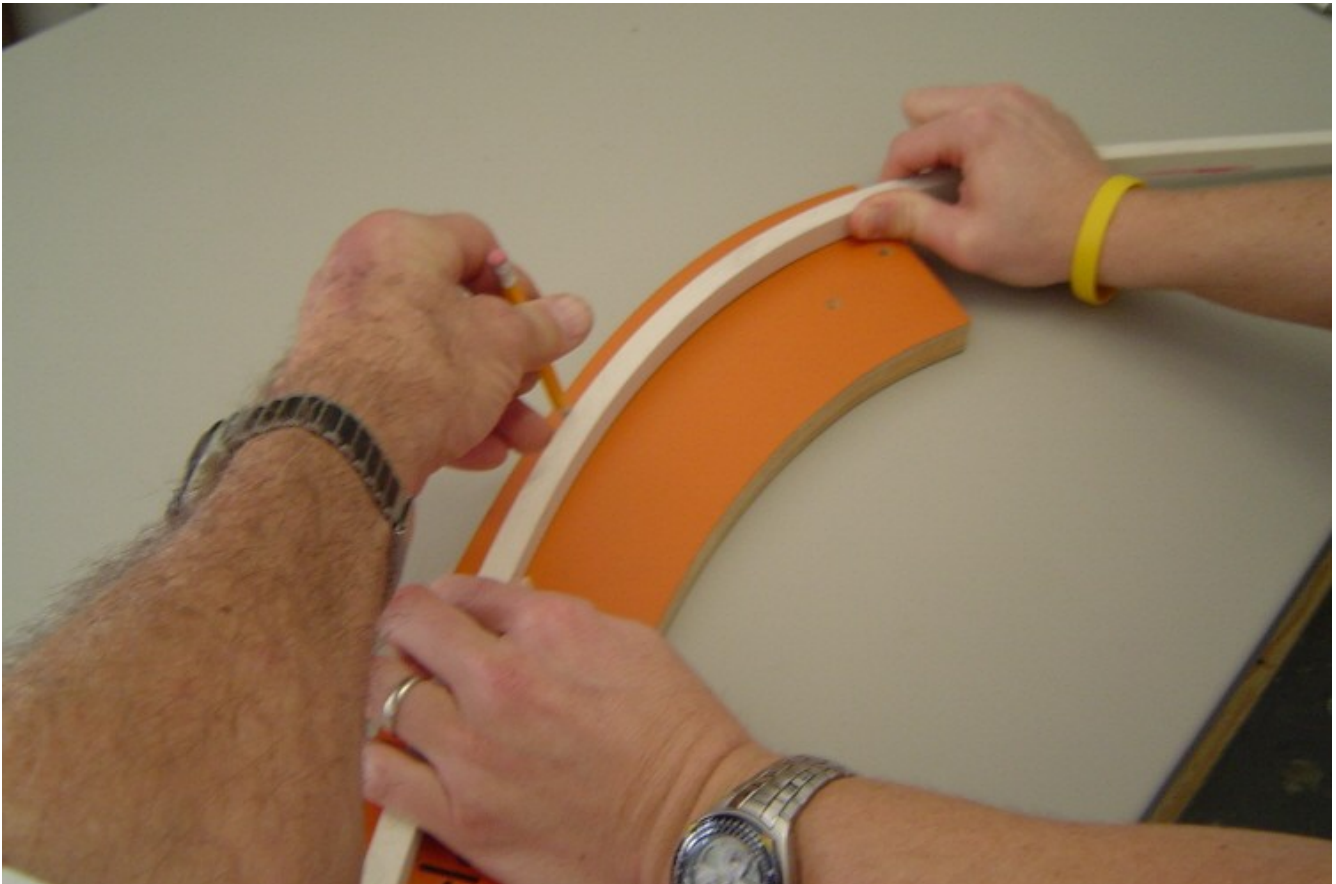
NOTE: If you are not much of a wood worker, like me, you are probably wondering how in the world are you going to be able to shave the edges off of these parts. You need four things: This machine, patience and two steady hands.

PROJECT45

PROJECT45

L45-SAM (Shell Assembly Manual)

Step 1: Separate the Port and Starboard sides of the shell by removing the 12 bolts and the four frame plates. Remove the Port Upper Windscreen Frame. Using a Polly strip, bend it along the points where the inside shave line needs to be placed. It takes at least two sets of hands to do this so have a partner ready to draw a line in pencil once you are happy with the curvature. It does not have to be perfect, only close.



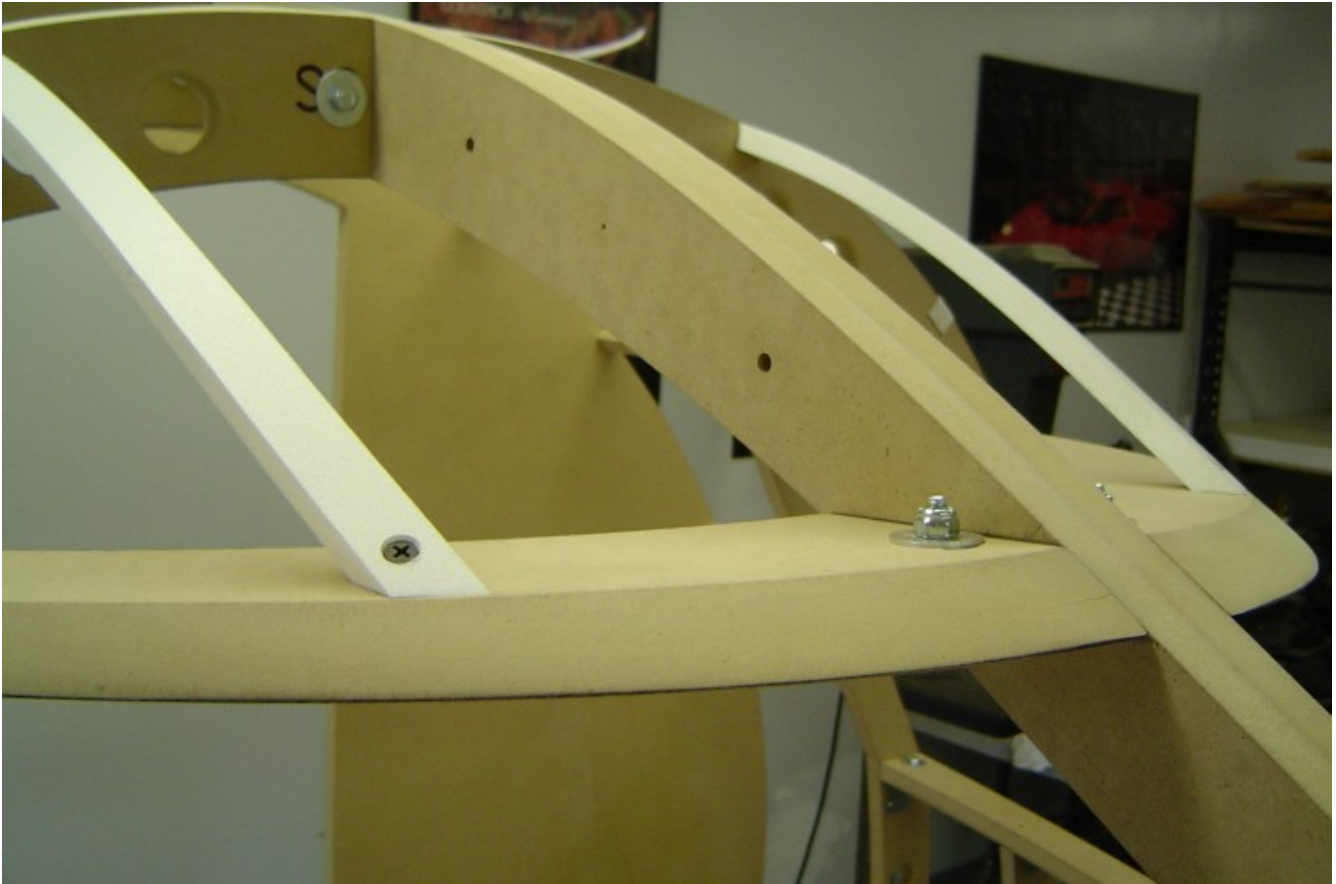
NOTE: Draw about 12 to 16 inches at a time. Keep in mind that especially on the upper and lower Windscreens, the line will start out further away from the edge at one end and move closer to the edge at the other end. Again, this is not an exact science.



PROJECT45

L45-SAM (Shell Assembly Manual)

Shave the excess material off from the outer edge with the bench sander. Be sure not to remove any of the upper or lower lines which represent the outer shell! Reattach the Upper Windscreen Frame but do not put the screws in that hold P7 and P6 upper.



NOTE: Here you can see the white Polly strips coming down to meet the upper Windscreen frames. You will notice that the Polly strips have been shaved at two complex angles at the same time using the bench sander. "Patience"



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 2: Remove P7 and P6 upper. Again, the inside shave lines need to be marked in pencil with the help of a partner. Shave the extra material between the shave lines being careful not to remove too much as stated above. After some trial and error, they should be good to go for reassembly.



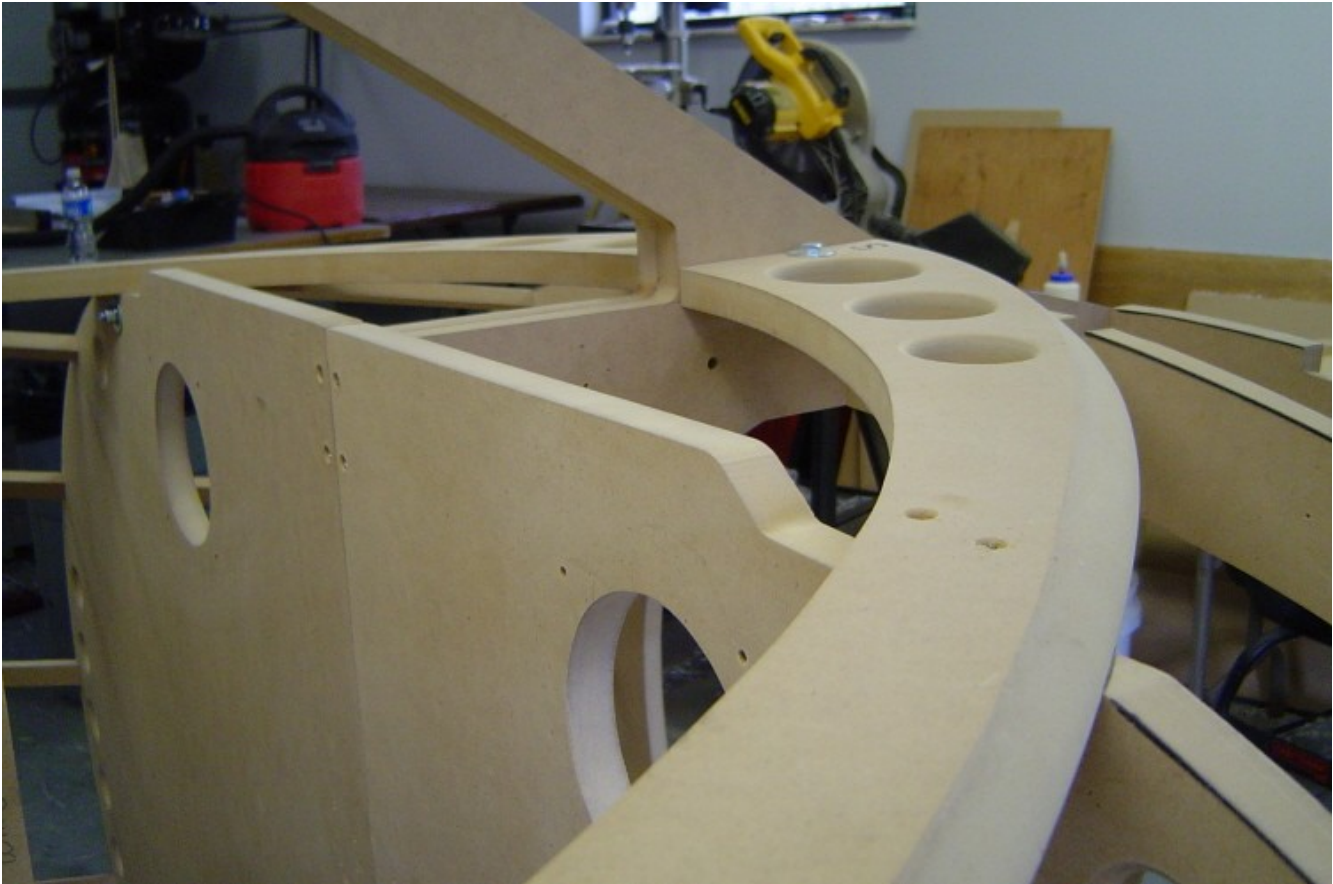
NOTE: You will need to use one of the Polly Strips that you either have left over or one from the rear wall to form these penciled lines. I have already drawn with black marker one of the outside shell lines on the edge of each part that requires shaving. You can see the marker line on the left side of the Upper Windscreen in this photo.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 3: Remove the Port Lower Windscreen Frame from the shell. Draw the lines and shave off the extra material. Reattach the lower Windscreen Frame after you are happy with the finish.



Step 4: Remove P1 from the frame, shave and reattach. Follow up with P2, shave and reattach. P3 is the tricky one because it is the heaviest of all the parts that need shaving. With a steady hand, I was able to work this part on the stationary rotary sander and it turned out perfectly. Another option is to use a palm sander.

Step 5: Repeat steps 1 through 4 to get the Starboard side up to speed. Once both sides are to this point, they can be pushed back together and reattached with the bolts and frame plates.

Step 6: There is no shaving required for F9 and F8. F7, (P7 and S7) needs just a tad of shaving. Use the lateral strips as a guide and mark the forward side of P7 where each of the lateral strips fall. Then again with the help of a second set of hands, use the Polly strip to bend a line around to each of the dash marks. As you know by now, the further forward you move, heavier shaving is required on each frame section. Follow up with F6, F5 and F4, Port and Starboard sides.

PROJECT45

L45-SAM (Shell Assembly Manual)

Phase 5: Caulking and painting the frame up to this stage.

It's time to paint and caulk everything that we have done up to this point. This may seem like a waste of time, effort and money, but there are several reasons why I feel it is an important step. Hopefully, this is a project that you intend to keep around and enjoy for many years to come. Therefore, it should be a project that you are willing to put a great effort of work into. In return, others will marvel at the amount of detail that has gone into your flight simulator as a whole!

The paint will help protect the MDF from moisture and wet spills. Remember, MDF will swell up if exposed to water or other liquids for an extended period of time. You may even want to entertain the idea of "No Food or Drinks" inside the cockpit. It goes without saying that in addition to the shell being constructed with MDF, there will be plenty of electronics that won't mix well with liquids.

The caulking will reduce any annoying creaks and squeaks, especially if you plan to use a vibration generator (Butt Kicker System) and or a motion platform. Second, this is a very complex project that simulates more than just flight. The shell is a canvass to build the real fun within. Furthermore, just knowing that the detail of the cockpit is deeper than what appears on the surface helps put you in the frame of mind that you are in an actual aircraft. Remember, 99% of flight simulation is in the mind! The goal here is to FOOL your brain into thinking you are flying when actually you have never left the room. This is the art of "Flight Simmersion".

After this Phase is complete, the shell will not be taken apart any more with the exception of splitting it down the middle. (I know you are happy to hear that!) This is the time to double check and make sure everything is in order up to this point. A frame section COULD be removed from the shell if it really needed to but it would be a real pain.

I recommend using a "Clear General Use Caulk" between the attachment points to reduce squeaking, especially if you plan to use the shell with a motion base platform. When looking for caulk, there are two things to remember:

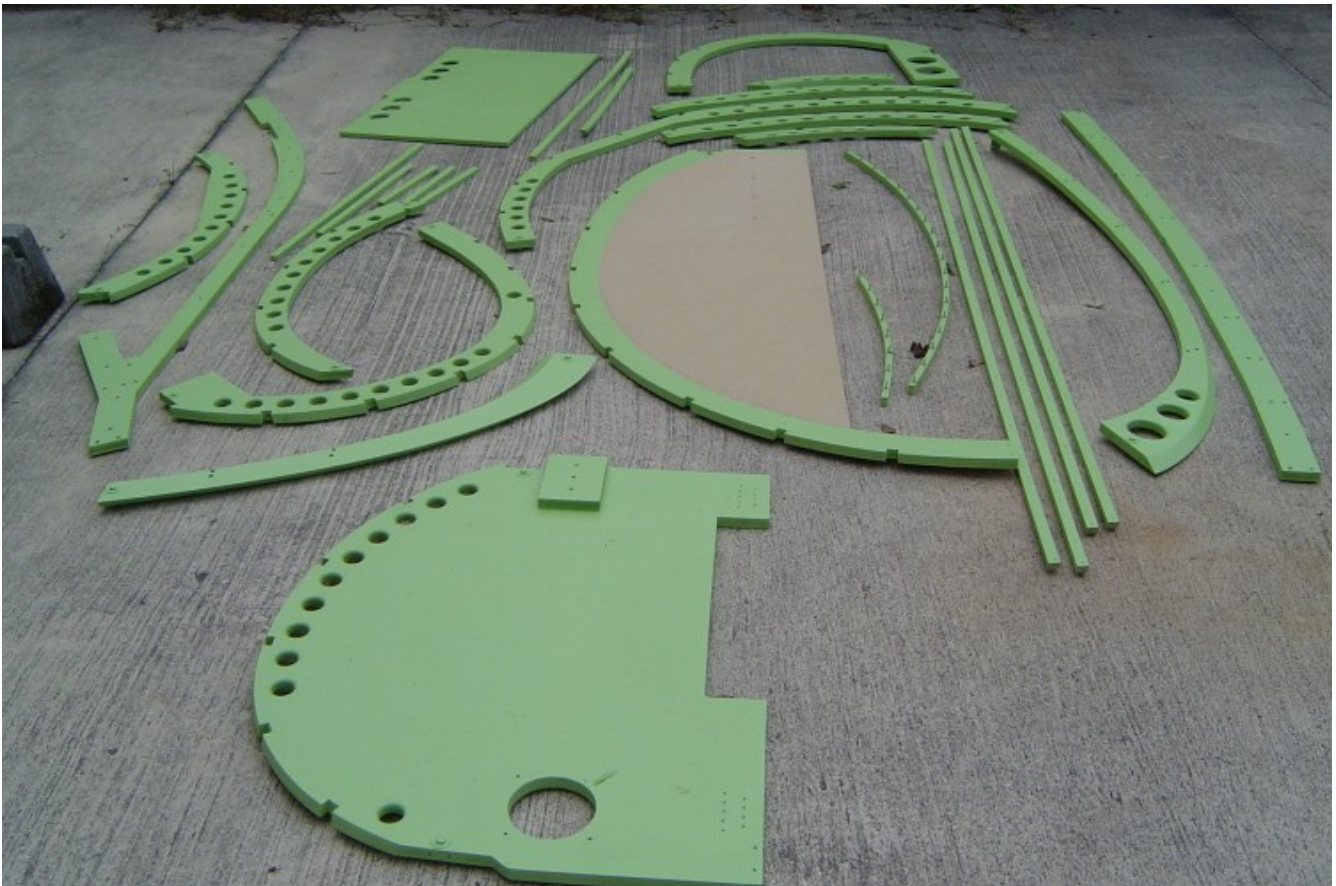
**Permanently Flexible
Paintable**



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 1: Paint the frame your choice of color. I used “Apple Green” spray paint to simulate the corrosive protective airframe paint. By now you have seen the little sample block that I included with your hardware. I also recommend working with one side of the shell at a time so that the parts don’t get mixed up. By now you should know every last part of your frame intimately, so painting over the labels won’t hurt anything. You may also find that some of your parts need to be sanded prior to painting and even sanded between painting each side to knock down the over spray buildup. Here you can see all of the Port side parts baking in the sun after painting the first side.



NOTE: I only painted the outer 3 inch edge of F9 (Rear Wall) to save a few cans of paint. I plan to cover both sides of the rear wall with either contact paper or another undetermined type of material.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 2: Paint the back sides of the Port side of the shell. Here you can see a few parts ready to go for paint.



NOTE: The Bolts to prevent splitting were left in place on all the parts and were also painted green. It should also be noted that the 12 Center Frame bolts, four sets of frame plate screws and the Avionics Bay floor screws will NOT be painted. These hardware parts will be left unpainted so that they can be easily identify to split the frame when necessary. This group of hardware could also be painted “RED” if you choose.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 3: Paint all of the screws that will be visible in the bare shell. I did not paint the frame screws under the Frame Base Plates or the between the Center Frame parts.



NOTE: I did not paint any of the twelve nuts and bolts that secure the two sides together or the frame plate screws. This way it is easy to identify what screws need to be removed to split the shell. They can also be painted “RED” in the future.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 4: After all the parts have been painted to your satisfaction, I found that clear Acrylic Latex Caulk with Silicone works best in between each attachment point, however, you may find other caulking that works just as well. The keys are “Paintable” and “Permanently Flexible”.



NOTE: The caulking appears WHITE when wet but will turn CLEAR after it dries.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 5: Be sure to wipe any excessive caulking off of your parts with a damp rag after tightening.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 6: It goes without saying that obviously, you will have to repeat steps 4 and 5 several times over. Once you have the two sides finished, it's time to bolt them together, reattach the screw plates and reinstall the Avionics Bay Floor. You should end up with something that looks like this.....



Another mile marker reached! You are now 50% complete with the shell and well on your way to having built what only few others have even attempted!

Congratulation!

PROJECT45

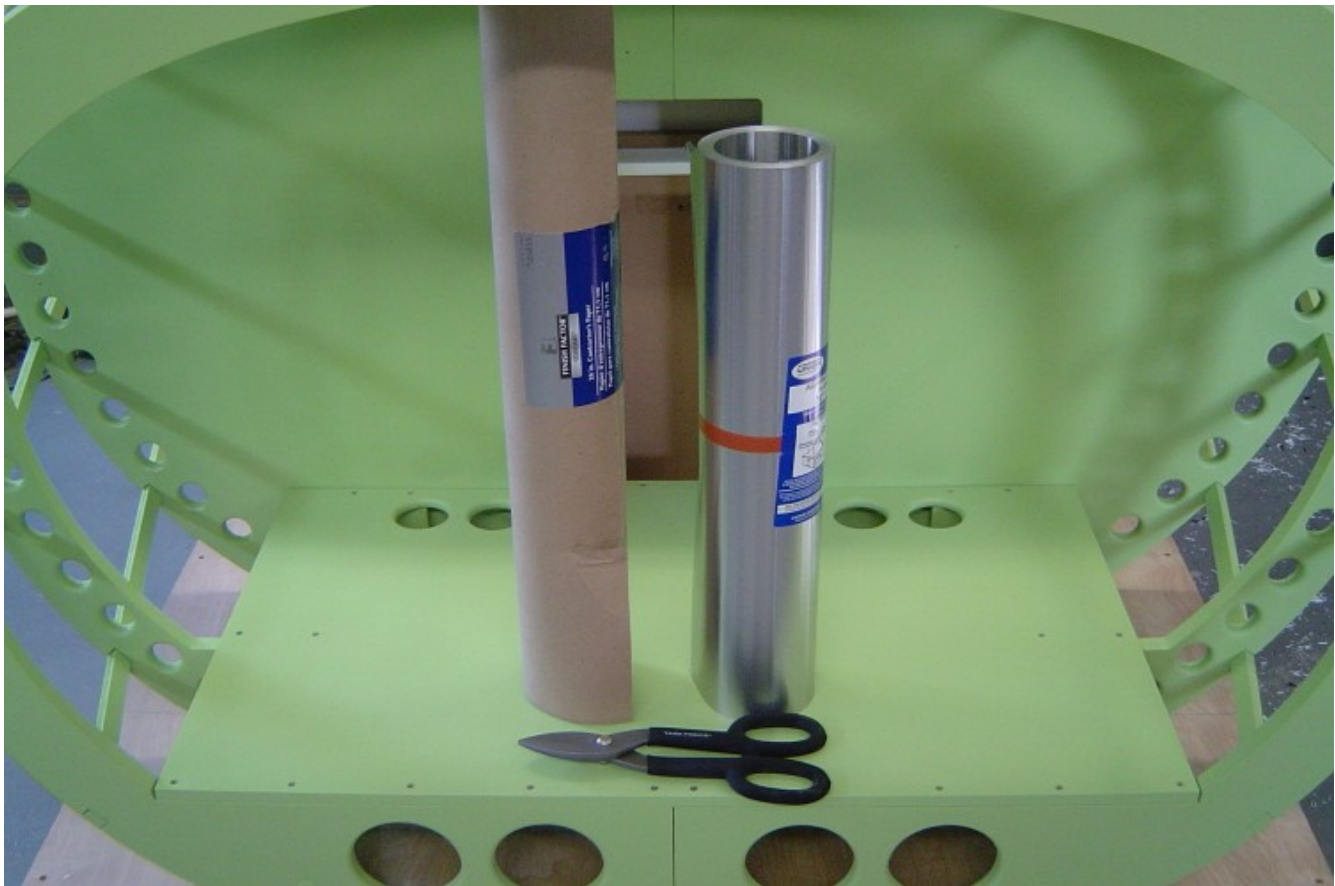
L45-SAM (Shell Assembly Manual)

Phase 6: Installing aluminum sheeting between each frame sections.

This is the last phase that you will have to worry about the frame being square and level. I will be using Aluminum Flashing used for roofing homes. You can find a roll 20 inches wide and 50 feet long which is more than enough to do both side of the shell for around \$40.00 at most hardware stores. I chose Aluminum Flashing because it is easy to cut and relatively inexpensive.

Covering the shell is the most challenging aspects of this project because of the compounds curves involved. (A compound curve occurs when an object curves in two or more directions on at least two planes. Examples would be an egg, a ball, the hull of a boat etc...) Now of course aircraft companies have all the proper tooling to stamp out, shape and bend aluminum to fit the outside of the their fuselage. We don't have that luxury, but we can still achieve the same look, inside and out! Remember, your shell does not have to be airworthy. It just needs to look good!

It took several weeks to develop this technique which I found is the least expensive and easiest way to achieve an authentic and accurate look with common garage tools. Here is a picture of the material needed for this Phase.



PROJECT45

L45-SAM (Shell Assembly Manual)

At first it seems straight forward, just cut the aluminum and screw it into place. But in fact, the aluminum needs to curve in two directions. As an example, here you can see from this paper template just how much curvature is required to get the upper Starboard aluminum sheeting to fit properly in between S6 and S7. The further forward you work, you will find the more severe the curvature is.



NOTE: Once you have ruffed in the paper template, transfer the shape to the aluminum. You will find that there will be even further trimming and fitting to get that perfect fit. If you do not get the long curve just right, you will find that the aluminum will want to bind in more than one place.

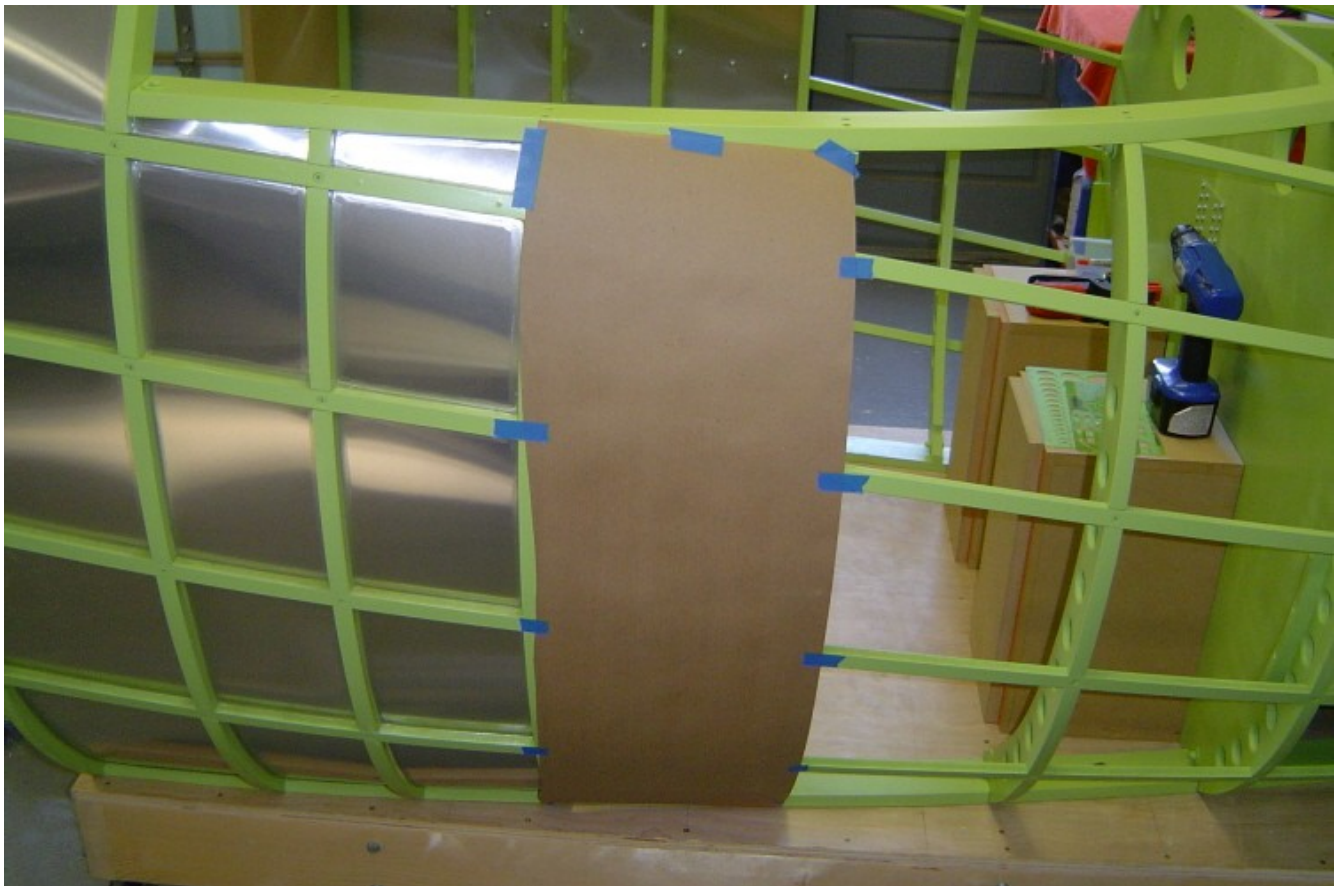
PROJECT45

PROJECT45

L45-SAM (Shell Assembly Manual)

Start at the rear, between F9 and F8. This section will need to be done in two parts, a lower and upper section due to the flat rear windscreen frame. In order to precut and fit the aluminum sheeting, I found it easy to use paper templates to do the initial fitting. Starting at the rear will help strengthen the shell and insure that everything is square. The rear of the shell is also less difficult compared to the front sections.

Step 1: (I choose the section between S5 and S6 for illustration proposes. This method applies to the entire shell with the only exception being the overhead forward sections.) Tape up a section of paper on the outside of the shell. This will give you an excellent idea of what this piece is going to look like. Remember, the aluminum will be attached to the inside so there may be slight deviation in the shape.



NOTE: Although the shell is perfectly straight and the distance between the frame sections is equal and constant, you will be surprised how much curvature is required to get this method to work properly. The further forward you move in this Phase, the more the aluminum will need to be curved in order to fit the shell due to its compound curves.

***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 2: Once you are happy with the fit of the paper template, trace it out from the inside of the shell., screw it in place from the inside using size 6, half inch sheet metal screws, (not included). The aluminum will attach to the numerous lateral strips which were installed in Phase 3.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 3: Once the trace lines are in place on the template, remove it from the outer shell. Cut the template out slightly on the inside of the trace lines. It's OK if it is a little too small, the caulking will take call of that in Phase 7. If it is too big, on the other hand, the template will bind.



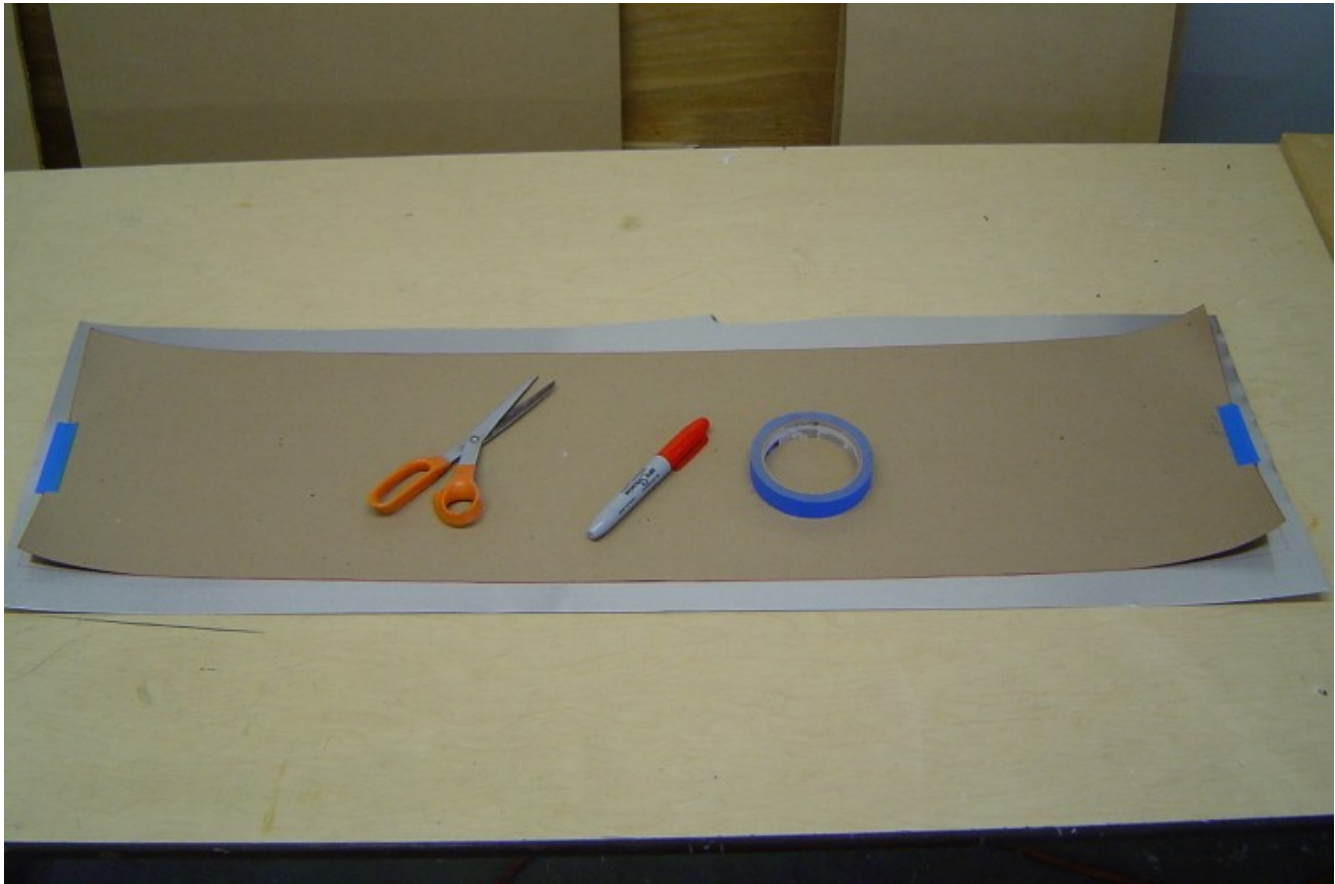
NOTE: Use three or four clamps to hold the paper template in place. You may find that there will be some trial and error fitting with all of the pieces during this Phase. Do not worry too much about how perfect your cutting is. The goal here is to get the aluminum as close to the Frame sections as possible without binding. Later in Phase 7, the caulking will hide any imperfections and hold the edges and corners in place.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 4: Now that you have the template as close as your going to get it, tape it down to a piece of aluminum. Make sure that the aluminum and the template both want to coil up in the same direction. It's much easier when the aluminum naturally wants to wrap around the shell. I used a red sharpie marker to transfer the cut lines to the aluminum. Also, mark the top of the part so that you know which end is which. If not, you might find yourself trying to "put a square peg in a round hole."



If you plan on painting the inside of the aluminum as stated in Phase 7, I highly recommend sanding off the coating now prior to installing it in the shell. I found that the paint will not stick to the coating on the aluminum and can easily be scratched off. Sanding the aluminum after it is installed is a pain. (I know)

NOTE: I actually found it easier to cut the thin aluminum flashing with a pair of standard scissors rather than with the heavy duty metal cutters. I had more control with the scissors and my cut lines were accurate.

PROJECT45

L45-SAM (Shell Assembly Manual)

Step 5: Place the aluminum in its intended area. It may slide right in, or it might need a little help. Be careful not to force it into place! If you do, you will find that it is too big and needs to be taken out and trimmed. (Good luck getting it out without binding it.)



NOTE: Here again I am using clamps to hold the aluminum in place for proper alignment. I also use the “blue painters” tape to help hold the top and bottom of each piece in place.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 6: With a small spacer, mark the screw hole one inch from the edge of each frame section where the lateral strips fall. The screws closest to the rear wall are 1 $\frac{3}{4}$ inches away due to the $\frac{3}{4}$ inch Polly strip. With the screw holes close to the frame section, finding the lateral strip and figuring out where to drill the pilot holes comes easy. Be careful not to drill all the way through the lateral strip, although it's not a huge issue if you do.



NOTE: I made a small aluminum spacer to easily find the one inch marks for the pilot holes, (not shown here).



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 7: Use size 6 screws (1/2 inch long) with a large Phillips head to attach the aluminum sheeting to the inside of the shell. The oversize head will help hold the thin aluminum in place.



NOTE: You can see here that I am using a longer tool to reach past the angle of the ribs. The further forward you work, the more of an issue this becomes.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 8: Caulk in all of your recent aluminum work from the outside. It may take two or more passes to achieve the correct strength. You may also need to use clamps and blue painters tape to help hold the aluminum in place until the caulking dries.



NOTE: Again, I recommend using a “Clear General Use Caulk” to seal the aluminum sheeting in between the frame sections. When looking for caulk, there are two things to remember:

1. Permanently flexible
2. Paintable

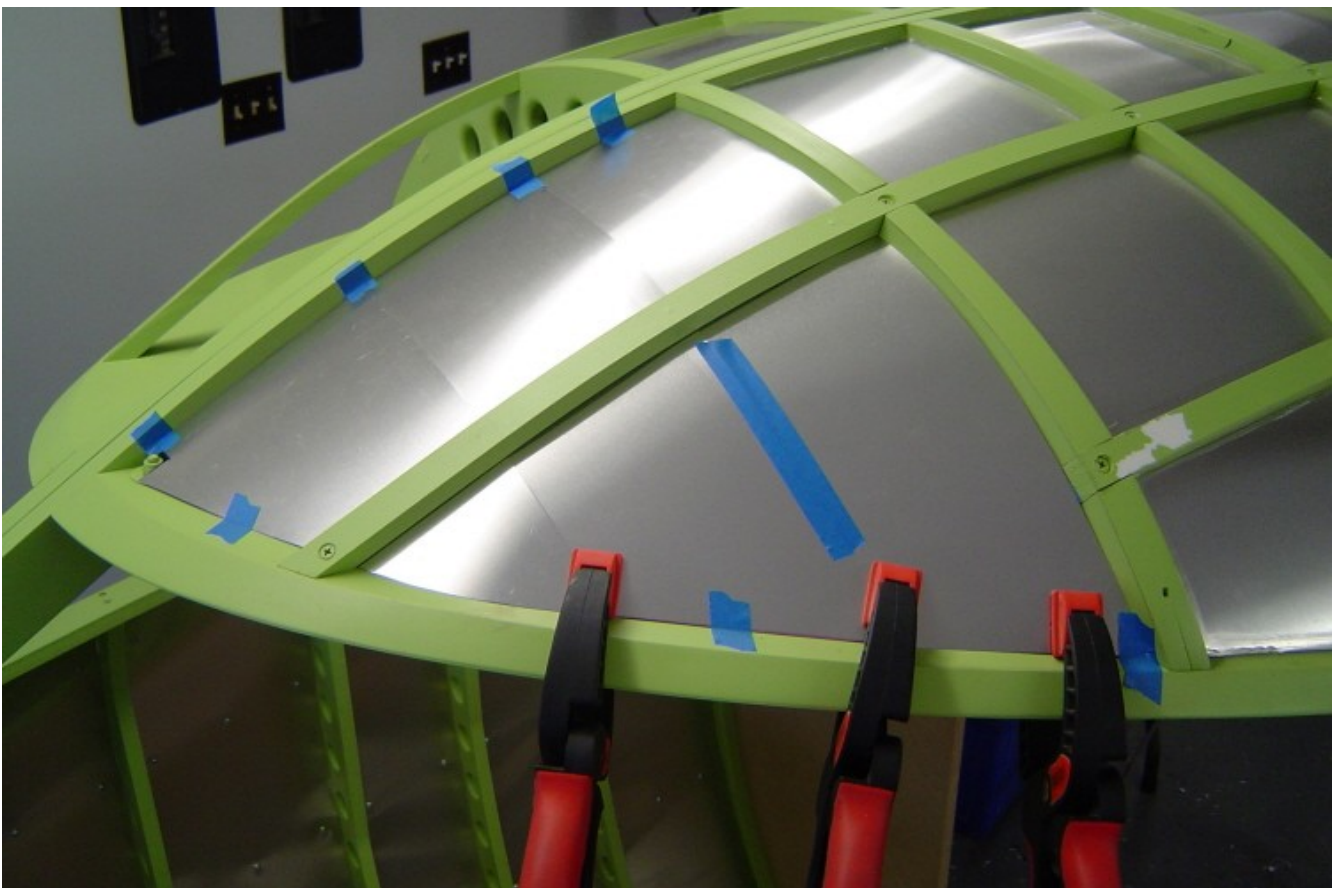


PROJECT45

L45-SAM (Shell Assembly Manual)

Step 9: There are a few ways to approach the front two upper corners of the overhead shell. If you have the funds, a metal shop can use an “English Wheel” to roll the aluminum into the convex shape needed to fit this section. If you're looking for absolute perfection and a professional look, this is the way to go.

On the other hand, the goal and purpose of this assembly manual is to show home builders that the cockpit shell of their dreams can be achieved with common hand tools around the garage or workshop. I used three separate pieces of aluminum on each side in this area to reduce the binding effect. Even with three pieces there is slight binding but not enough to notice.



NOTE: If you do experience some binding, try to limit it to the outside of the shell. The foam will cover this in Phase 8.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 10: These pieces overlap by approximately a half inch. There are only three screws holding these pieces in place. Two screws are visible in this photo, the third is hidden by P6 upper.



NOTE: It may take two or more applications of caulking and moving the clamps around to secure these aluminum parts in place. Once the caulking dries, all of the tape and clamps can be removed.



PROJECT45

L45-SAM (Shell Assembly Manual)

Another Phase complete and in the books! The shell is really starting to look like an aircraft fuselage now. At this point there is little, if any, lateral movement of the shell even without the foam and fiberglass installed. There is no doubt that this design will be able to hold up to the demands of a full motion base platform.



WARNING: Your friends or family might confuse your work with a capsule from the Gemini or Mercury space programs during the 1960's. My wife did!
(I guess I need to go ahead and fill her in on what I am building.)



PROJECT45

L45-SAM (Shell Assembly Manual)

Phase 7: Caulking and painting the aluminum inside the frame.

Now that the shell, for the most part, is boxed in and is really starting to look like something, it's time to caulk all of the aluminum to eliminate any imperfections (AKA screw ups) to date. This will also add more strength to the frame, help insulate, and again reduce squeaking from base system vibrations or motion base movements.

Step 1: Hopefully, you are finished with caulking in the aluminum on the outside of the shell. If not, finish up with that task.



NOTE: Don't be afraid to lay the caulking down thick. This not only seals the frame but gives it additional strength.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 2: If you did not sand off the coating on the aluminum prior to installing it in the shell, do so now. It is a little more time consuming after the aluminum is installed but **MUST** be done. The paint will **NOT** stick to the coating and can easily be scratched off. With the coating removed, the paint bonds to the aluminum.

Step 3: Now for the caulking on the inside. It's going to feel like forever caulking the inside because it's being done all at once. This could end up being a six hour project by the time you are finished, not to mention the creation of yet another nickname to add to the list, "The caulkpit." But in the end, your shell will be strong and quite. You will also notice that there is zero lateral movement of the shell.



NOTE: In this illustration, there are four stages of caulking visible. F9 has already dried clear. F8 and F7 have the caulking applied and spread evenly. F6 has only had the caulking applied, and F5 has not yet been caulked.

***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 4: Back to the paint booth, (or spray cans). It's only important to spray the inside of the shell because very shortly, in phase 8, the foam will be added to the outside covering most of your outside work to date.



NOTE: Pictured above is my full scale model of a frame section simulating F6 and F7 that I built in early 2008 while conducting the shell construction research.



PROJECT45

L45-SAM (Shell Assembly Manual)

Phase 8: Installing and shaping the foam on the outer shell.

CAUTION: If you are planning to fiberglass your shell as I am, be sure to use “sandable” foam that **WILL** bond with the fiberglass resin. Some foam will **MELT** when it comes in contact with the resin! (This will upset you.)

I tested “Great Stuff”, (foam in a can used to insulate and seal cracks) and found that it will work. You can find “Great Stuff” at your local hardware store for around \$5.00 per can. I applied fiberglass resin to the foam and the outcome was promising! The fiberglass did not melt or shrink the foam.

Step 1: Obtain 22 cans of Great Stuff “Gap & Cracks” to fill in all the sections on the outside of the shell. This is the sandable version that can also be trimmed and cures hard. Beware that there are at least two other versions of Great Stuff for window frames that stays soft after it cures and can not be sanded.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 2: Split the shell with the exception of two bolts holding it together at the center windscreen. This phase will require that the shell be split down the middle because each half will need to be flat on its side in order to apply the foam on the lower sections.

Step 3: Follow the directions on the can and apply the foam in a back and forth motion. It will take you a few sections to get the hang of it. The good news is that it really doesn't matter what it looks like because it's going to get sanded down.

DO NOT OVER APPLY THE FOAM! The foam will slowly expand, filling in all the voids and then expand 10 times over that.



WARNING: Always wear safety goggles when applying the foam. The last thing that you need is the foam back spraying and getting into your eyes.

CAUTION: Do not cut or sand the foam within 72 hours after applying it to the shell. Premature cutting or sanding will cause the foam to constricted, possibly to the point that more foam would need to be applied!

PROJECT45

L45-SAM (Shell Assembly Manual)

Step 4: Fill in all the sections on both sides of the shell down to the lateral strip shown in this picture below. As you can see, it took me a few sections to get the process down, but it will still serve its purpose.



NOTE: Let the foam set for a few hours or until it forms a hard outer shell prior to removing the two remaining bolts and laying each half down on its side.

CAUTION: WAIT AT LEAST 72 HOURS BEFORE PROCEEDING TO STEP 8. THE FOAM NEEDS TIME TO CURE PROPERLY!

(After the foam is sprayed on the shell it will look like there is not enough to fill the sections entirely. The next day, it will have swelled 10 times over. On the third day, it will have collapsed down half its size. This is why you should just leave the foam alone until it runs the course of curing!)

PROJECT45

L45-SAM (Shell Assembly Manual)

Step 5: Lay each half of the shell down on its side. Be careful not to damage the sharp corners on the frame. You will also need to stack up a few items to support the lower end of F9 so that it is not under stress. (Not shown in this picture)



NOTE: I used a few old shop rugs under the shell to prevent damage to the shell.

CAUTION: WAIT AT LEAST 72 HOURS BEFORE PROCEEDING TO STEP 8. THE FOAM NEEDS TIME TO CURE PROPERLY!



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 6: Fill in the sides of the shell. You can clearly see that I have gotten better with time during this process!



CAUTION: WAIT AT LEAST 72 HOURS BEFORE PROCEEDING TO STEP 8. THE FOAM NEEDS TIME TO CURE PROPERLY!



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 7: After about 24 hours, trim the extra foam off of the bottom of the shell so that it can be turned back up on its base. Be careful not to take too much off because the foam will shrink.



CAUTION: WAIT AT LEAST 72 HOURS BEFORE PROCEEDING TO STEP 8. THE FOAM NEEDS TIME TO CURE PROPERLY!



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 8: After waiting 72 hours, trim off the extreme high points of the foam with a tool similar to the one pictured below. Just about any cutting tool will work as long as it has a sharp edge. (Anyone have an electric carving knife?) Try to leave approximately a half inch of extra material incase of shrinkage. You don't want the foam shrinking down lower than the shell frame.



NOTE: When you do the initial trimming, be sure to leave at least a half inch of extra foam on the shell!! This Great Stuff is not intended for this type of project and sometimes has a mind of its own. It expands one day and constricts the next.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 9: After the high points have been removed, again, let the foam set for at least 24 hours incase the foam wants to constrict or (suck in). It's much easier and cheaper to be patient.



NOTE: After waiting another 24 hours, the foam will be ready for sanding with a six inch orbital disc sander. Sixty grit sandpaper will take the foam down fast!



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 10: It's time to start shaving and shaping. Remove thicker pieces of foam with a razor blade or a hacksaw blade. A six inch orbital disc sander with 60 grit sandpaper cuts right through the foam. The larger the sanding tool, the better results you will be able to achieve over the side areas of the shell. This is a great time to use "line integration" to find the complex compound curves of the outer shell. Imagine shaping a giant egg with a window view!



NOTE: You do not want to take too much off too fast. The last thing you want to do at this point is have to add more foam to your shell!



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 11: You will need to move the shell out to the edge of the base platform in order to use the orbital sander at the bottom.



***PROJECT*45**

***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 12: You may need to go back and fill some of the larger air pocket holes. Another thing to look for is areas where the foam did not attach to the aluminum fully. This will cause the surface of the foam to “float” back and forth from its intended position. You can see in this picture a large section just behind the Port Windscreen Frame where I needed to reapply a nice size section.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 13: Let the shell settle for another 72 hours. After this period of time passes, you will find that the foam has expanded very slightly in some areas. Sand the shell one final time using line integration in an attempt to get everything as perfect as possible. It is much easier to work with the foam verses fiberglass when dealing with larger issues and areas.



CAUTION: Most “sandable” foams do not take a lot of effort to get it down to where you want it, so be careful. Just a few light passes should do it!

Another Phase Complete!

I think it is safe to say that this phase is a bit time consuming but not because it is labor intensive. The hardest part about this phase is being patient and leaving the foam alone until it has cured properly. I actually enjoyed watching the shell take shape during this phase and I hope you do too.



PROJECT45

L45-SAM (Shell Assembly Manual)

Phase 9: Cover the shell with your choice of material.

I will be covering my shell with fiberglass because of it's strength. A fiberglass finish is very hard, smooth and impact resistant, (to a point). It's only downside is that it can be messy to work with and heavier than other possible methods to skin the shell. If you are planning on a motion base simulator, the overall weight could be a factor.

If you are not familiar with fiberglass, this is not the project to start learning unless you have a friend with experience. In this phase, I do not intend to teach you how to work with fiberglass, but only to share some techniques and tricks that I found worked well.

Polyester resins are styrene based products used in all types of composite construction. Commonly referred to as fiberglass resin or boat resin, it's an economical alternative to using epoxy resins.

New Vinyl Ester resins are becoming more popular as an alternative to epoxies as well. Epoxy resins are a two-part resin system used when high strength, low shrinkage and low brittleness are required. Epoxy resins outperform most polyester (orthophthalic) resins in general but for this project, I found Polyester resins work just fine.

NOTE: Using wax paper to slide between the frame and the base will keep the fiberglass from bonding the two together. Also, line the edges of the shell with painters tape to form a nice edge for the fiberglass to build up against.

Other thoughts or possibilities to cover your shell that my suite you are:

Cloth.....

Monocot....

Aluminum.....

Or just leave the frame sections exposed!

Each of these other alternatives has many pros and cons. You will have to determine which method best suites your personal needs and budget.

WARNING: If you choose to cover your shell with fiberglass, always use protective gloves while working with the resin in a well ventilated area.

WARNING: Be sure to wear a mask that will catch the small fiberglass particles when sanding when you get to that point!

PROJECT45

L45-SAM (Shell Assembly Manual)

Step 1: It may sound a bit strange to start working on the windscreen in this phase of construction, but you will soon understand why. The design of the shell calls for the finished outer skin and the Plexiglas windscreen to be flush with each other. We need to build templates for the windscreen and the best material I found to accomplish this is 1/8 inch door skins. They are very flexible and easy to work with. You can find door skins at the larger home improvement stores. Just ask one of the associates where the L45 windscreen templates are kept.



NOTE: You can see in this illustration the flexibility of the door skins as they are leaned up against the shell.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 2: Using the paper template included in the kit, create two duplicate windscreens from the door frame material. You will also find that all of the holes are marked for you around the perimeter of the Windscreen template. If you took the time to count and measure these holes, you will find that they match up with those on the real Lear45!



NOTE: Hopefully you will have no issues here, however, you may notice that when fitting the windscreens that they are not a perfect fit. If so, that's OK. The important part of a proper fit is to make sure that the Windscreen is perfectly aligned with the center line of the shell. This is where a noticeable flaw will show up. If for some reason the fit of the paper template is too far off to your liking, draw out another one based on what you have learned with the trial fit. Remember, the paper template is a copy of the windscreens on L45-002. I included it in the kit to hopefully help create your templates!



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 3: Line up the template you are working with so that the center line and lower edges are perfect and then clamp it into place. Carefully determine if any material needs to be removed from the top and rear of the template. The goal here is to cover only the windscreen frame to the edges.

Step 4: Once you are happy with the fit and shape of the templates, we can start drilling holes for the 80 screws that hold the windscreen in place. Start with the 18 holes up the center line. There are 36 along the bottom between the lower rear mark hole and the last marked hole in bottom row of 18 on the center windscreen. There are 25 marked holes between the lower rear and the top mark in the row of 18 on the center windscreen. I dare you to check and see if I am correct with the hole count and placement!

Step 5: With all the screw holes marked on the windscreen template, clamp it into place and start drilling the holes. Be sure not to let the windscreen bunch up or bind while you are completing this step. Skip several holes at a time to insure that there is no binding occurring like pictured below.



NOTE: You can see here in this picture how the fiberglass will build up to 1/8th inch thick equal to the Windscreen template. This will ensure a smooth transition from the outside skin of the shell to the Windscreen.

PROJECT45

L45-SAM (Shell Assembly Manual)

Step 6: Finish securing the first windscreen template to the shell. There are 80 outer screws holding the windscreen to the aircraft. Repeating on the other side is easier said than done for two reasons. First, make sure that the two windscreens match up perfectly down the center line. The other thing that makes the second windscreen a little bit tougher to install is the fact that you will not be able to use the clamps down the center post like seen in the above pictures.



NOTE: Hopefully you have studied your arsenal of Lear45 photographs. You will find that there are **actually** two rows of Phillips head screws that are counter sunk into an aluminum frame, one on each side. The screws pictured here represent the outer row of screws . The inside row will come in Phase 10, the Windscreen!



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

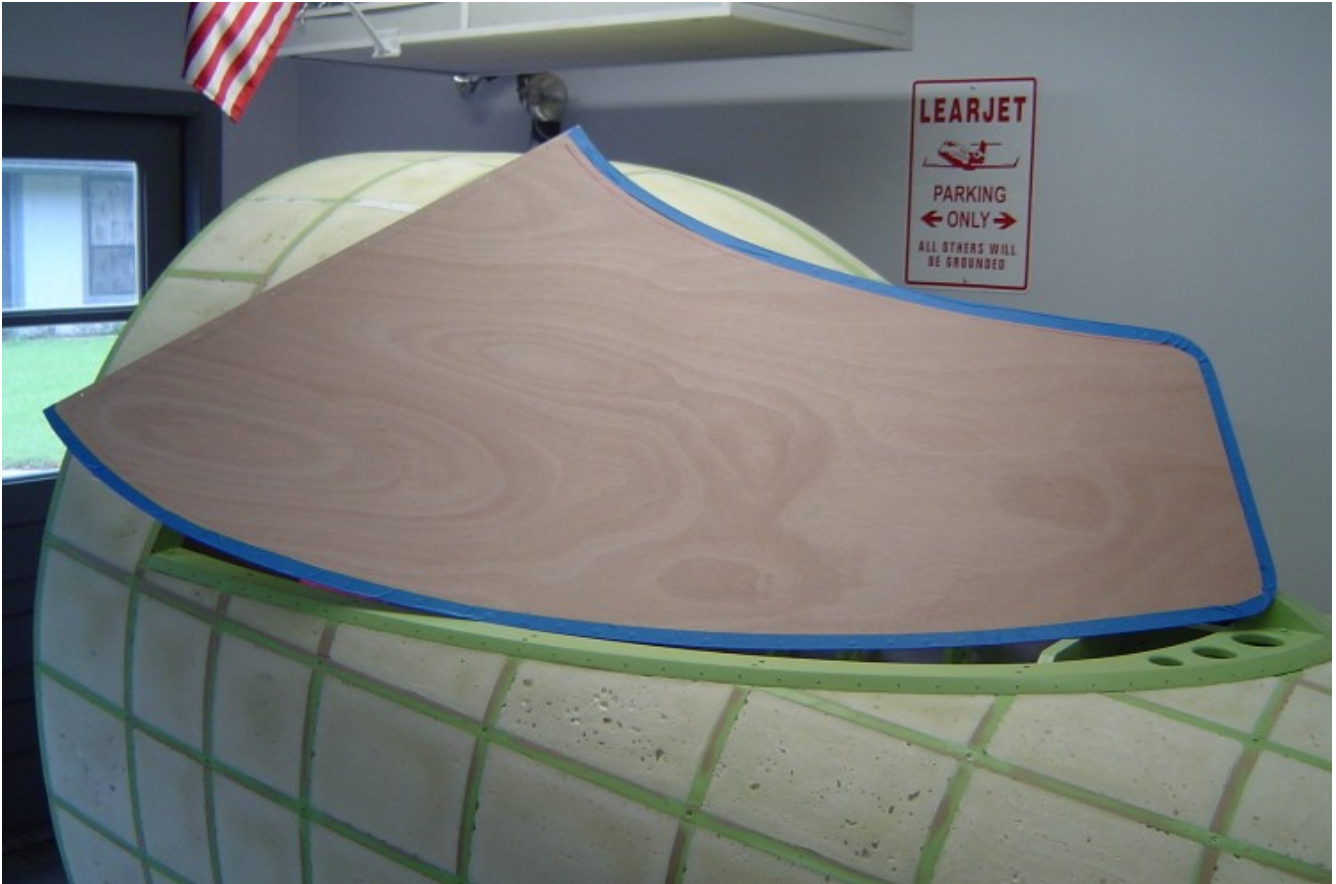
Step 7: You may need to split the shell and slide on half forward like I had to do and sand the edge of the temporary windscreen. I used the blue painter's tape to prevent sanding away at the center windscreen.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 8: Now that you have both sides of the windscreen templates set and in place, take them off. The edges of the windscreens need to be wrapped with blue painter's tape to prevent the fiberglass from bonding it to the template. **THIS IS VERY IMPORTANT!**



NOTE: The fiberglass will need to be approximately 1/8th inch thick, which is the same thickness as the temporary windscreen. Once the fiberglass is in place, the temporary windscreen will be removed and replaced with 1/8th inch Plexiglas.

CAUTION: It is worth repeating, make sure you wrap the edges of the template with the painter's tape.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 9: Reattach the temporary windscreens back to the shell. You can just see the edge of the blue painter's tape around the windscreen. At this point, you are just about ready for the fiberglass. I found that two layers of fiberglass matting with six gallons of resin will cover the shell and build it up to 1/8th inch. A third layer of fiberglass matting may be required around the windscreen in order to build it up to the 1/8th inch height. If so, be sure to taper it in over at least a six inch area.



NOTE: The shell will require approximately 140 square feet of fiberglass matting to cover the shell two full times and then some.

DO NOT PURCHASE THE MATTING FROM YOUR LOCAL HARDWARE STORE OR RETAIL STORE!

I found that you can save up to 80% by purchasing the matting from an online wholesaler like "James Town Distributors" in bulk. I purchased 5 rolls of matting that was cut 38" X 3 yards.

***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 10: Either slide wax paper between the shell at the nose and over head section or split the shell and use the blue painter's tape. Place the tape on the front edge of the nose and the rear wall so that the fiberglass will build up against it and not drip down the sides. I created a paper template for the first layer of the nose section because of the complex curves.



NOTE: I am in no way an expert on working with fiberglass, but I have stayed in a Holiday Inn Express! So if you are a “Glass Guy” do what you know is best.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 11: If you created paper templates, transfer the shapes over to the fiberglass matting. Precut the matting for the nose and the overhead sections. The idea is to only work the fiberglass on the top sections of the shell to prevent excess running of the resin. Make sure everything is prepared and ready to go. If possible, have a second set of hands to help lay the fiberglass and work out most of the air bubbles.



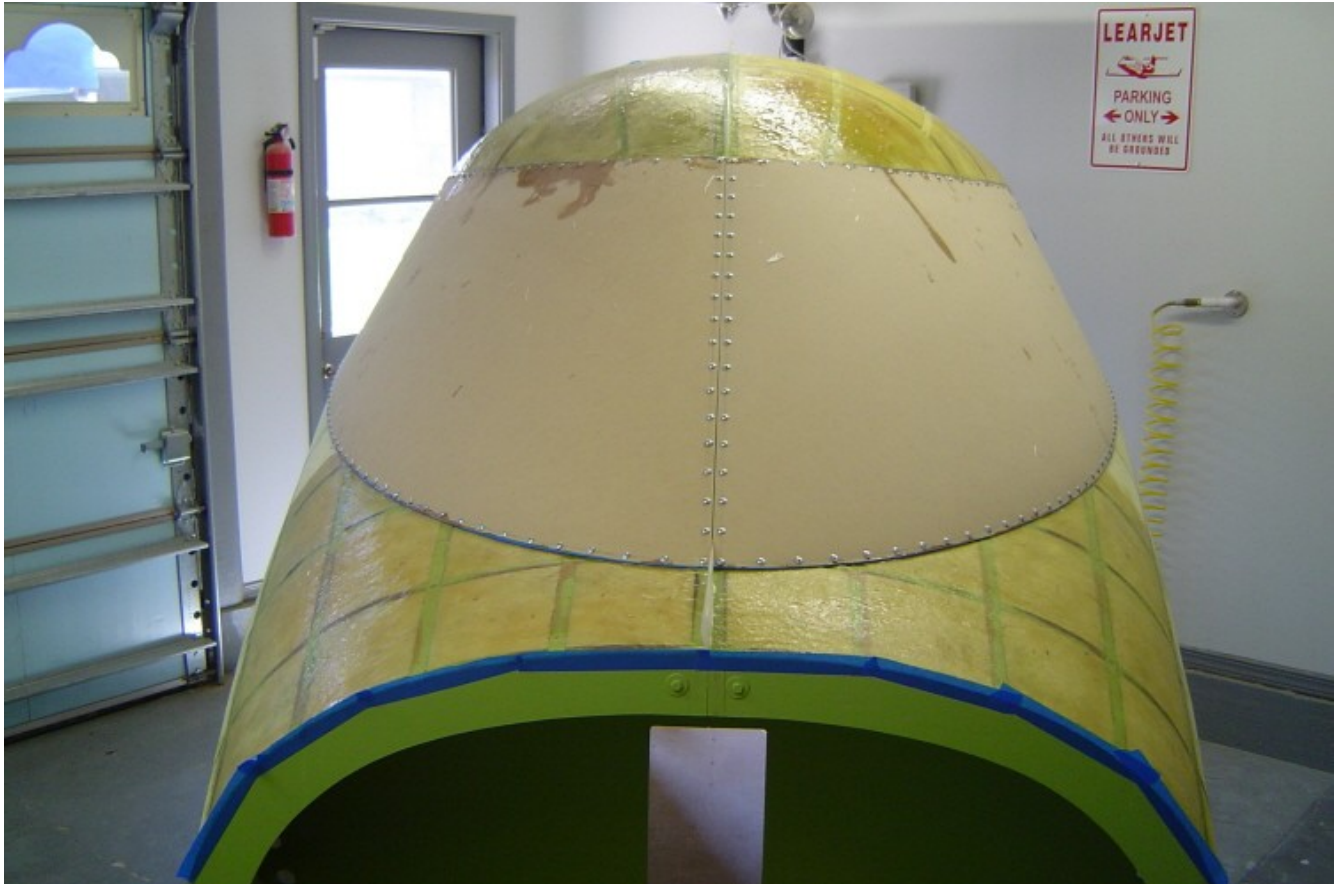
NOTE: DO NOT use the cheap foam brushes to apply the resin. Use a cheap 1.5" to 2.5" "throw away" horse hair brush. The foam brushes fill up with resin and then fall apart within minutes! A delay at this critical step is the last thing you need when working the fiberglass. You do not want the resin to start prematurely setting up on you before you have the matting right where you want it.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

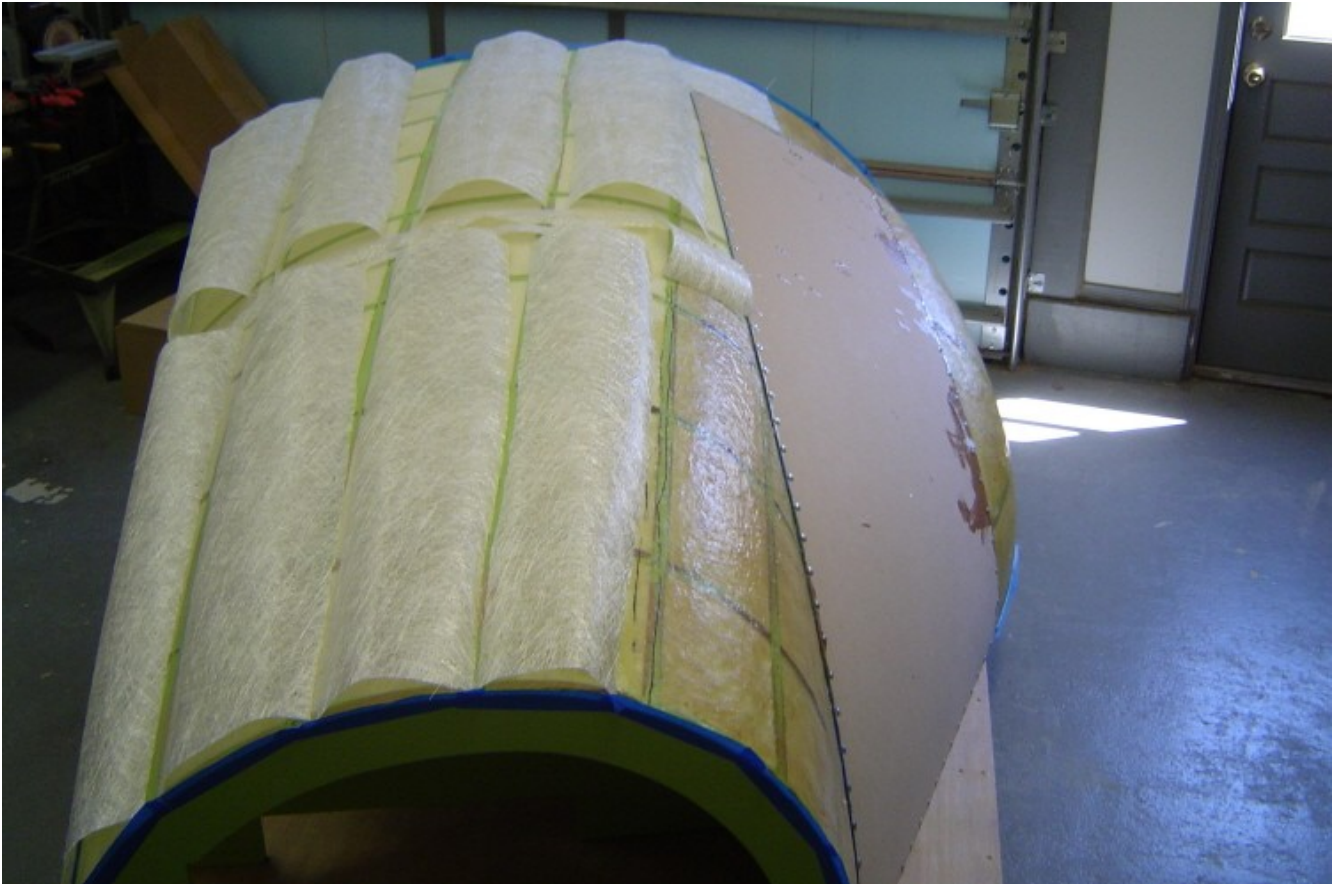
Step 12: Like I said earlier in this phase, I do not intend to teach anyone how to work with fiberglass. As a matter of fact, I could use a lesson or two! I do know that by the time I have this project completed, I will know more about fiberglass than I knew before. Here is a photo of the first layer of matting on the top of the shell.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 13: Split the shell and set one half off to the side and out of the way. Precut the matting for the side you are going to work on. Be sure not to cut the pieces any bigger than you can manage, especially if you are tackling this by yourself.



CAUTION: Now that there is some fiberglass on the shell, it is starting to **GAIN WEIGHT!** Your shell sides will soon be too heavy to simply sit straight up on their own. Either lean it up against a wall or lay it down, (center line down).



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 14: Apply the fiberglass matting and resin to this section while it is laying on it's side. It is much easier to manage the resin and prevent it from running down the side when it is in this position.



NOTE: Again you can see the blue painter's tape around the perimeter of the shell to help keep the fiberglass resin in play and not running down the edges.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 15: After the fiberglass cures completely, which can be as soon as just a few hours, take the high lumps and bumps down quickly with a 60 grit disk sands. Be care to only take the high stuff down. The orbital sander will smooth it out nicely later.



NOTE: You may have to go back and add some fiberglass matting and resin to some of the extreme low spots on your shell. You may also need to add a third layer of fiberglass matting around the Windscreen area to build it to the 1/8th inch height.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 16: Take care of the edges at the front, rear and bottom of the shell. You should have had some blue painters tape along these edges to help keep the resin from running wild and off the shell. You will be surprised at how easy the tape is pulled off and removed from the shell.



NOTE: You can see in this picture that I have not yet hit the edges with the sanders. It doesn't look bad and clearly the tape has done it's job!



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 17: Once the extreme high points have been knocked down and any low points have been built up, it's time to move up to 80 grit sand paper with the pneumatic orbital sander. I found this step a bit fun believe it or not. This is one of those steps that is time consuming and can not be rushed so you might as well enjoy it!



NOTE: You can see where I had to come back and fill some more areas in with Bondo. The really cool thing about the orbital sander is it seeks out the high points. You can tell when you have found one because it is hard to keep it on that spot. When you first begin, the orbital sander will be bouncing all over the place! After a couple of hours, not so much. It becomes very sensitive and does the hard work for you.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 18: Now it is time to take care of the areas around the Windscreens. Again, you might find that you need to build up these areas a little here and there. You will notice in this picture below that I had to fit in a few extra pieces of matting and resin to build it up to the proper height.



NOTE: I had to remove the screws around the Windscreen so that the orbital sander would have a smooth transition from the Fiberglass to and over the Windscreen template. Take care not to sand away the wooden template as this will become an issue when it comes time to fit in the Plexiglas Windscreens. You need to try and maintain the 1/8th inch thickness of the fiberglass.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 19: Once you are, for the most part, happy with the fiberglass work, apply your first coat of primer paint to your shell. After about an hour, you can go back and find the thousands of tiny pin holes that need to be filled in with spotting or glazing putty.



NOTE: It may be easier to work one side of the shell at a time or work with them in various stages. As a matter of fact, I was still working the fiberglass on the Port side when this picture was taken.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 20: After removing all of the screws around the wooden Windscreen template, gently push on it and remove it from the shell. Again, you will be pleasantly surprised at how well the painter's tape worked to keep the fiberglass from sticking to the template.



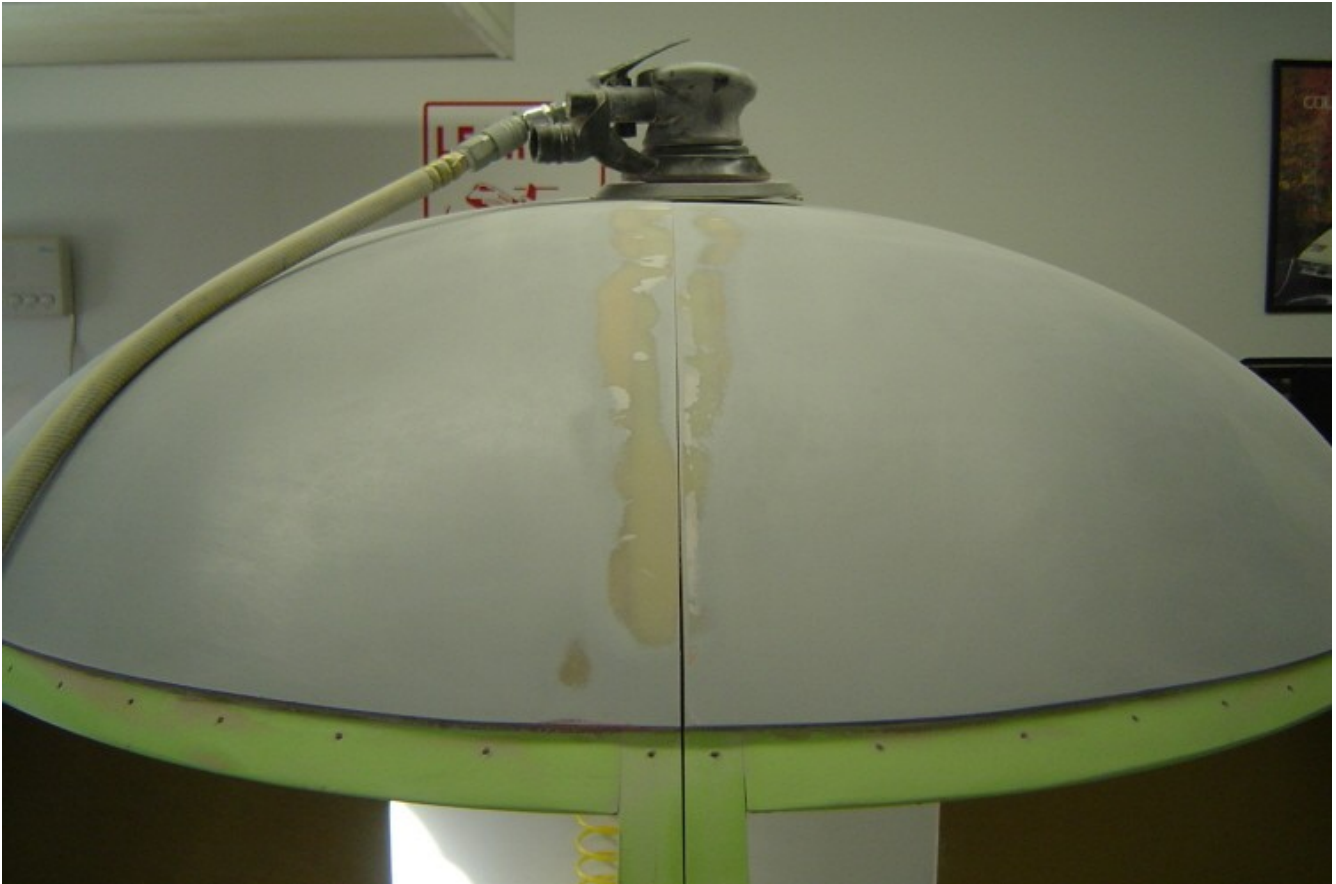
NOTE: You may need to go back and do some light sanding with a Dremel tool to remove the fiberglass that leaked behind the templates. I had minor issues to deal with on L45-002.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 21: By now you should have two perfectly shaped and painted halves of the shell. The only problem is what do they look like when they are pushed together? In other words, we need to sand and shape the two halves to make them look like they belong together.



NOTE: Be sure to sand the lower nose section between F1 and F2 in this same manor.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Another Phase just about completed of this construction project. It really feels like there is an aircraft nose section sitting in the “hangar”!



You are now ready for paint! There are a few things to keep in mind when picking a color for your shell. The most popular color for a Lear jet is high gloss white. But a high gloss will show any imperfections that may be in the skin of your shell. A semi gloss may be a better alternative for you.

We also need to keep in mind the light being generated from the overhead projectors may be an issue with reflections. There are some Sim builders who say this is not an issue and others that say it is. Just be mindful of it. I personally found that proper positioning of the projectors so that they do not hit the top of the shell results in no glare or visual anomalies.

PROJECT45

L45-SAM (Shell Assembly Manual)

Finishing your shell with paint can be as simple as picking up several cans of Krylon spray paint at \$2.97 a can. As most of us know, a good paint job is always in the preparation and the finishing work, not the actual painting itself. I am not going to teach you how to paint but I will cover a few pointers and some lesson learned the hard way to help you get through the process easier than I did.

Step 22: Reinstalled your windscreen templates, (if removed) to effectively “mask” off the windscreen areas. I put the majority of the screws back in to make sure that the windscreen was seated properly to insure that the edges would be covered with paint.



I did not bother to mask the front or the rear off because I painted these areas at an angle. Very little over spray reached these areas.

NOTE: Do not try to cover the shell all at one time when painting. Apply a very light tack coat and let it set for a few minutes. If you try to cover too much, the paint will slide off the surface creating runs.

PROJECT45

L45-SAM (Shell Assembly Manual)

Step 23: If you choose to go with a multicolor paint scheme like I did, if possible, start with the largest and lightest colored area first. You do not have to mask off the area that you will be painting another color. Once you are happy with the amount of paint applied to this first section, take at least a 12 hour break to give the paint a chance to cure. If you try to mask off the area by putting painters tape on top of the freshly painted area, you will be disappointed at the results when you pull the tape up. (I had an issue or two to overcome.)

Step 24: After waiting at least 12 hours, go back and wet sand the areas near the second layer of painting is going to be applied next. Use 1000 grit wet sandpaper to knock down any trash and over spray. Now you are free and clear to continue with your creative works in design and color.



NOTE: You may find it easier to either split the shell at this point to lay the two sides down or raise the shell onto a platform. This will be necessary in order to reach the lowest parts of the sides of the shell.

***PROJECT*45**

L45-SAM (Shell Assembly Manual)

CAUTION: Do not sand too hard or too long in one spot. If you are spraying with cans, the paint is not that thick and you will easily find yourself sanding through the paint and down to the primer. If you do this; you will need to repaint that section setting you back at least 12 hours!



NOTE: To save yourself from double work, don't bother wet sanding the entire first layer until all of the layers of paint are applied. Even with the best masking off jobs, over spray will find its way onto the shell which means you will need to wet sand a second time.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 25: Plan your curing times accordingly. After all of the paint has been successfully applied, it's now safe to wet sand the entire shell. Again, use 1000 grit sanding paper to knock off the trash that got caught in the paint and the over spray. Be careful not to sand too hard or too long in one area or you risk sanding through the paint to the primer!



Step 26: A good rubbing compound is the next step. Be sure to use a new cotton cloth for each paint color you are rubbing out. If not, you will end up blinding colors and rubbing one color into the next.

Step 27: At this point, the paint has been applied, the trash and over spray has been removed and all the fine scratches created from the sanding process have been buffed away. Now it is time to polish the shine back into that paint job! I used New Finish for cars. I looked all over for Learjet wax but it could not be found!

Hopefully at this point your paint job sparkles and shines. I am not a paint expert, but I thought I would share with you how L45-002 got it's top coat for less than \$40. I hope yours turns out as well!

PROJECT45

L45-SAM (Shell Assembly Manual)

Phase 10: Installing the Windscreens!

The windscreen is the key to the completed look of the Lear45 airframe that sets it apart from all other small business jets in my opinion. When I was studying this airframe and determined that it can be modeled AND made to look as close to the real thing as possible, the decision was made to build the L45!

Many people are not aware that the windscreens in the real L45 are approximately an inch thick! They have to be in order to separate the pilots and passengers from the harsh environment. At .81 MACH and 51,000 feet of altitude, the outside air temperature is well below -30 degrees F. Another neat to know piece of information is that the windscreens are not complex compounded curves or in other words, they are not concave. They are flat but bent around the frame of the fuselage the same way you would wrap a piece of paper around a cone. It is because of this that makes it possible for us to model the L45 with relative ease!

With that said, the Port and Starboard Windscreens can be achieved fairly easily by using 3" X 6" sheets of 1/8th Plexiglas found at your local hardware store. It will be held in place with screws every two inches around the inside of the Windscreen Frame. This is so the Windscreen rest flush with the outer fiberglass shell. The Plexiglas is flexible enough to contour to the shell without cracking. You can try Lexan to which I have heard is harder to scratch but is still bendable.

NOTE: I recommend leaving the protective film on the Plexiglas until 99% of your planned heavy hardware is in place to help prevent inadvertent damage or scratches. You will also find that an Antistatic Plexiglas cleaning formula such as Plaskolite, will work wonders in keeping the lense and dust off of the Windscreens.

The windscreen Phase is the last section in this SAM, but certainly not the last to be said about the project as a whole. Again, the windscreen templates are the key to your success with how well they will turn out. If you tried to take a shortcut with the fiberglass phase by not creating your own set of windscreen jigs..... I don't know what to tell you. The cool thing is if anything ever happens to one of your windscreens, you will have templates to produce replacements in the future.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 1: Trace out the shape of the windscreen onto the Plexiglas sheet. Make sure to leave the protective plastic on both sides until they are both completed and ready to be installed into your shell.

Step 2: With a fine tooth jigsaw blade, cut out the windscreen shape. Leave about $\frac{3}{4}$ of an inch more in case as you are going along, the blade skips and causes a stress crack in the Plexiglas. If you want to take this process a step further to avoid unnecessary cracking, sandwich the Plexiglas between two pieces of plywood and clamp them all together. This will also allow you to get closer to the cut line without worrying about stress cracks.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 3: Attach the template to the rough cut windscreen by using 3/8th inch Philips pan head screws. All the holes will eventually need to be drilled but start with the inner row of 69 screws per windscreen.

Step 4: With a router and a half inch bit, trim the excess material off of the windscreen using the edge of the template as a guide. This method will insure that the fit of the windscreen will be identical to the template which will guarantee a perfect fit.



PROJECT45

L45-SAM (Shell Assembly Manual)

Step 5: After the windscreen has been properly trimmed, one at a time, start drilling the 80 outside holes and transferring over the screws. In all, you will have drilled 298 holes into both windscreens!

Step 6: Now use the windscreen template as a guide while you are taping off the outer aluminum frame. This area will be painted with aluminum paint on the outside of the windscreen.

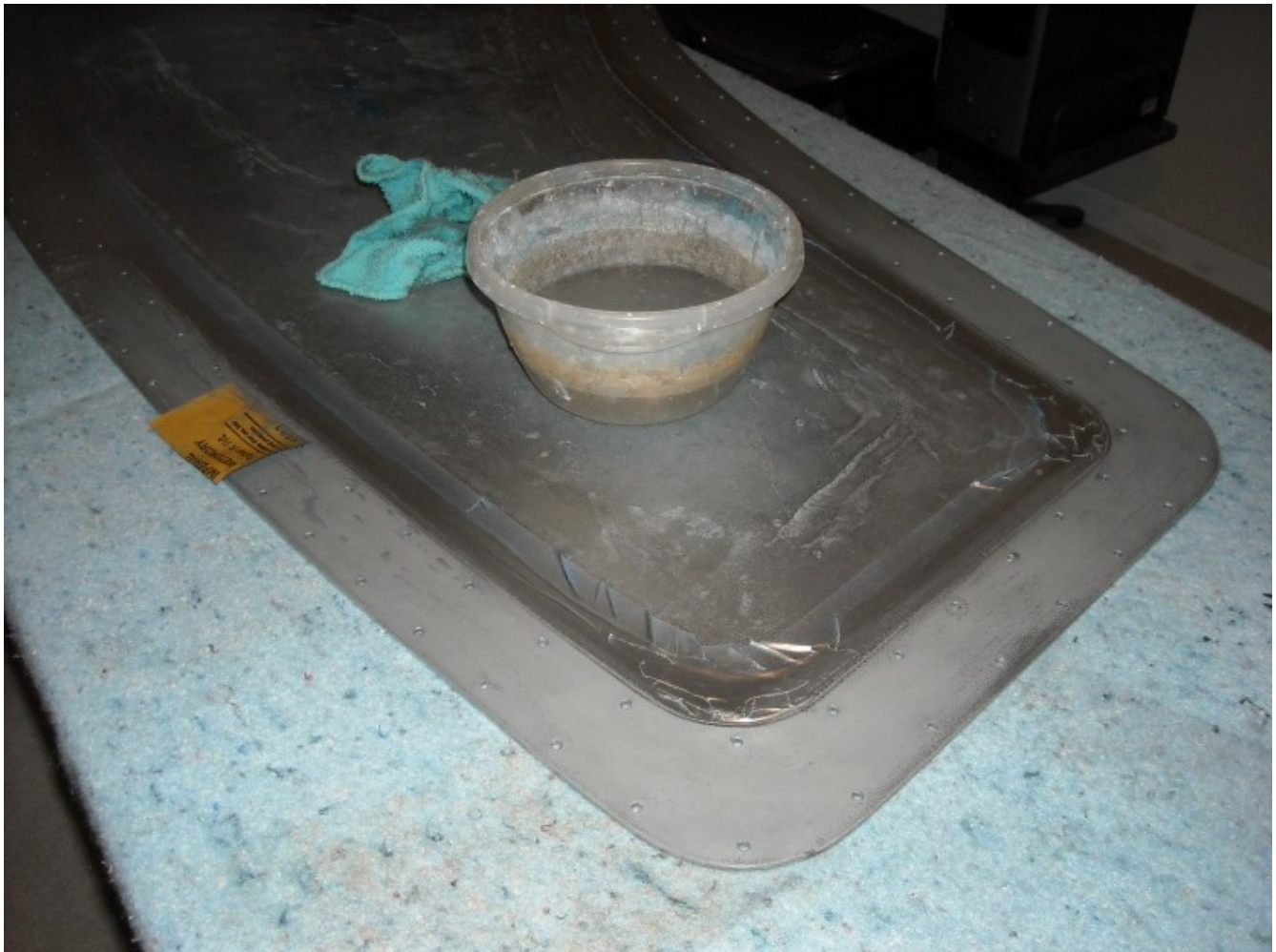


PROJECT45

L45-SAM (Shell Assembly Manual)

Step 7: Prior to painting the outside windscreen the aluminum, mask off the inside for the black trim work. I offset my trim work from the painted aluminum frame by a half inch. This will give a great visual effect from both the inside of the cockpit and the outside.

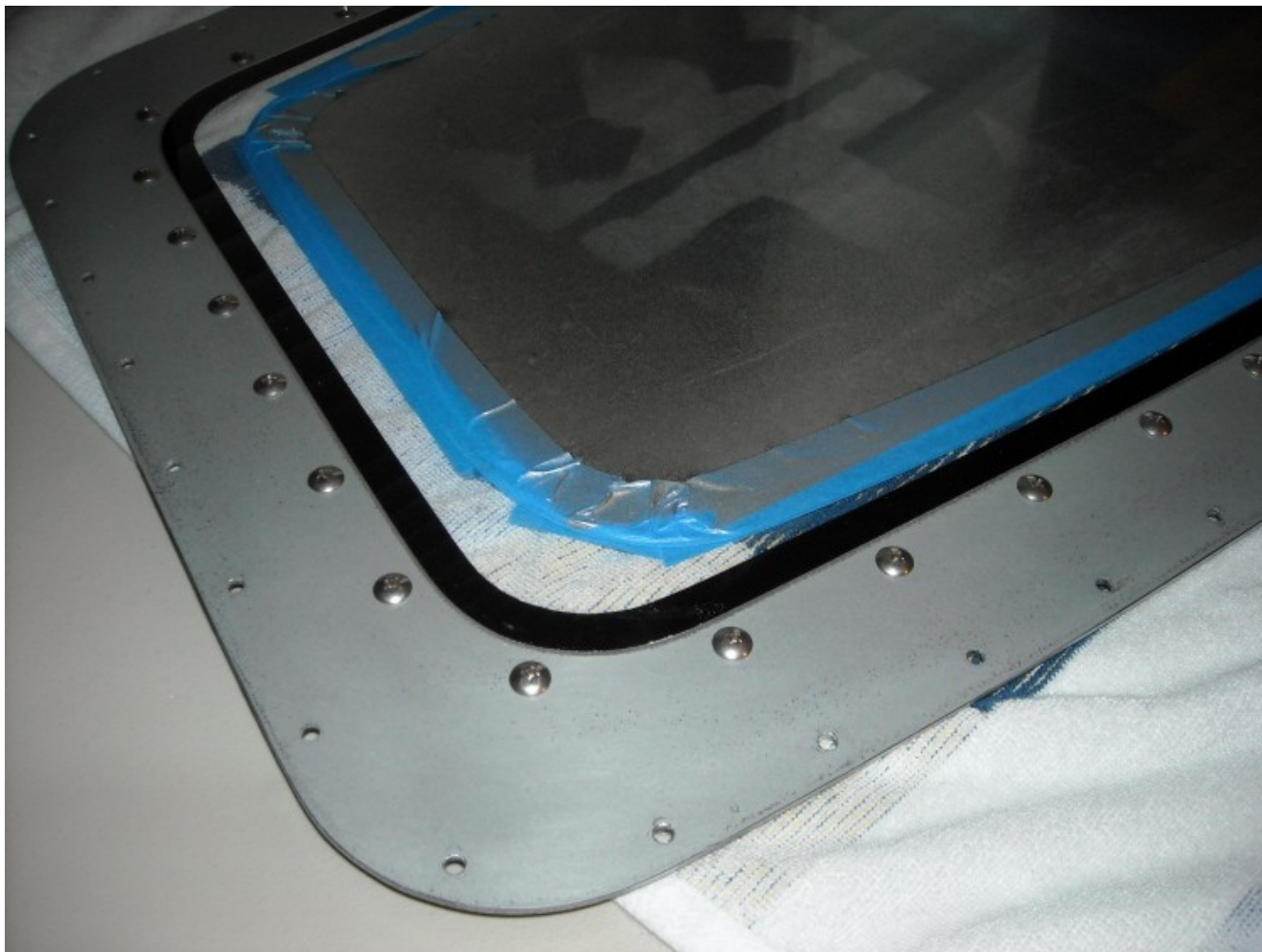
Step 8: Lay the windscreen on a flat surface in a well ventilated area and start by painting the inside first black. Wait approximately an hour before you turn it over and then paint the outside aluminum. Wait at least 24 hours before wet sanding both the inside and the outside frames.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 9: Save yourself a ton of headaches by moving forward and installing the inside row of screws and nuts. Remember, the inside row of screws are nothing more than just replicas.



***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Step 10: You are ready to install the freshly cut and painted windscreens into the shell! This should be one of those crowning moments for you with the overall project. Take a look at the finished detail of the windscreen as it is seated into the shell.



Congratulations!!!

This completes the assembly of your L45 shell!

***PROJECT*45**

L45-SAM (Shell Assembly Manual)

Visit www.project45.us for all of the latest news and updates related to the L45 shell and other products. As I advance my own project, (L45-002) I will be posting updates, tutorials and pictures on this site as well as Hangar45 .



Visit www.hangar45.net to see what other L45 builders are creating for their personal projects. You will find a forum there that covers everything from dimensional information to the latest software developments! If you are building your own version of the L45, we welcome you to join the hangar as one of our primer Club Members.



Again, please respect the L45 design by NOT coping, duplicating or sharing these plans with others. It should be noted that over 1,000 hours have been invested in the research and development of this shell to perfect the design to its current state.

Thank you for your interest in this L45 shell kit. Please do not hesitate to contact me via phone (904)349-5944 or email ronjonrollo@yahoo.com if you have questions or comments.

Designer and creator,
Ron Rollo

PROJECT 45

L45-SAM (Shell Assembly Manual)

L45 PARTS CHECK LIST

Main parts:	Port Check	Starboard Check
Center Windscreen Frame	_____	_____
Upper Windscreen Frame	_____	_____
Lower Windscreen Frame	_____	_____
Deck Pate	_____	_____
F1	_____	_____
F2	_____	_____
F3 (Forward Bulkhead)	_____	_____
F4	_____	_____
F5	_____	_____
F6 Lower	_____	_____
F6 Upper	_____	_____
F7 Lower	_____	_____
F7 Upper	_____	_____
F8	_____	_____
F9 (Rear Wall)	_____	_____
Pedal Assembly Floor	_____	_____
3 Piece Pedal Frame	_____	_____

Other Parts:	Check
10 7' Lateral MDF Strips	_____
8 42" White Lateral Polly Strips	_____
1 Nose Avionics Bay Floor	_____
2 Nose Avionics Bay Supports	_____
4 Frame Plates	_____
2 "L" Brackets	_____
108 Frame Screws (+5)	_____
70 Nuts and (50 1¼" & 20 2" Bolts)	_____
140 Washers	_____
82 Frame Plate Screws (+5)	_____
34 Small Stainless Screws (+2)	_____
16 Large Stainless Screws (+1)	_____
252 Lateral strip screws (+10)	_____
1 Windscreen Paper Template	_____
1 Assembly Manual (CD)	_____

***PROJECT*45**

L45-SAM (Shell Assembly Manual)

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