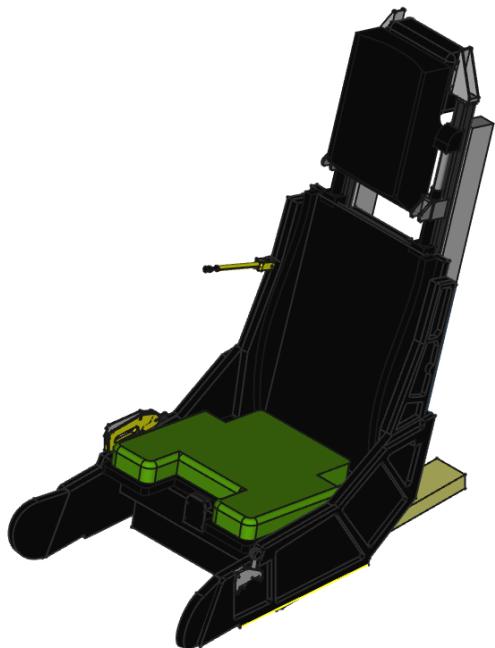


SJU-4A Ejection Seat

Construction and Assembly Manual

Revision 1.0

By Jason LeSueur Tatum



SJU-4A Ejection Seat	1
Construction and Assembly Manual	1
Revision 1.0	1
By Jason LeSueur Tatum	1
Acknowledgements:	2
Introduction	2
Features of this replica	3
Fixed, non-movable height	3
Working ejection pull handle	4
Manual seat release handle	4
Inertial Reel Release handle	4
Features not included in these plans	5
Seat height adjustment	5
Inertial Reels for shoulder straps	5
Rear parachute box shell	6
Seat back pad	6
Headrest pad	6
Materials List	6
Tools Needed	6
Wood cutting methods	7
CNC	7
Cutting by hand	8
Order of Assembly	8
Seat pan & support structure	8
Step 1: Seat Pan Support Structure	8
Step 2: Seat Pan Inner Support (Left & Right)	9
Step 3: Seat Pan Inner Side (Left & Right)	11
Step 4: Seat Pan Bottom	12
Step 5: Seat Pan Front Lower	13
Step 6: Seat Pan Front Upper	13
Step 7: Seat Pan Front Upper Inner	15
Step 8: Seat Pan Back	17
Step 9: Seat Pan Top Rear	17
Step 10: Seat Pan Top	18
Step 1: Seat Base Lower Left & Right	20
Step 2: Seat Base Inner Upper (Left & Right)	21
Step 3: Seat Base Rear Panel	22
Step 4: Seat Base Seat Back Supports (Left & Right)	23
Step 5: Seat Back Inner Panel	24
Step 6: Seat Base Lower Detail (Left & Right)	25

Step 7: Seat Base Upper Detail (Left & Right)	26
Step 8: Leg Guards (Left & Right)	26
Seat Back molding	28
Seat Rails	28
The Seat Rails are made from lengths of 3030 extruded aluminum cut into 4 pieces: (2) long lengths and (2) short lengths. These will be assembled into a simple frame using 90 degree brackets made for 3030. Once assembled, (4) holes will be drilled into the back of the assembly so that it can be attached to the Seat Rear Panel.	
	28
Step 1: Cutting the extruded aluminum	28
Step 2	29
Step 3: Attach to Seat Back	29
Headrest Box	30
Step 1: Sides and Top Plate	30
Step 2: Headrest Box Lower Plate	30
Step 3: Headrest Box Lower Rear Panel	31
Step 4: Headrest Box Upper Rear Panel	31
Step 5: attach a spacer (dimensions?) inside the box.	33
Step 6: Headrest Front Upper Styrofoam	33
Step 7: Headrest Front Lower Styrofoam	33
Step 8: Rear Styrofoam	34
Step 9: Sanding	34
Step 10: Prepping for fiberglass	34
Step 11: Fibreglassing the headrest	34
Step 11: Paint	38
Headrest Poles	39
Seat Cushion	42
Ejection Pull	50
Ejection Arming Handle	50

Acknowledgements:

- Roger Sewel
- Benjamin Morgan
- Dave Roof
- Razbam

DISCLAIMER:

This is a work-in-progress DRAFT, and is NOT finished, nor is it complete. There is no warranty, and this information is provided AS-IS and you agree to use this information at your own risk. I assume no responsibility!

Introduction

So you want to build a Harrier ejection seat? You've come to the right place if you want to build a wooden replica of the Stencil SJU-4A ejection seat, as used on the majority of the USMC AV-8B Harriers. Note that all British Harriers and a small subset of the USMC Harriers used Martin Baker seats and not the Stencil SJU-4A. However, if you are building a sim cockpit to enjoy the AV-8B N/A (Night Attack) module by Razbam for DCS (Digital Combat Simulator), then the Stencil seat is the one that you want!

These plans are the result of over a year of research, CAD modeling, and construction. I have actually built this seat in 2022, although you should know that my actual seat does differ slightly from these plans. That is because the plans have been revised to improve upon my original designs since I built my seat. Hopefully building a new seat with these plans will go relatively easy with this detailed construction and assembly guide.

Features of this replica

Fixed, non-movable height

Okay, this is not really a feature, it's a lack of a feature. The real seat contains a seat height motor that can raise and lower the seat base while the headrest box stays put. These plans do not account for such a motor and there will be no way to accomplish this without significant redesign and expensive parts. I looked into it, and it was not worth the trouble. The plans for this seat are based on the seat being in the full down position, which makes sense for me as I'm 6'6" tall. If you want the seat base to be higher up, you have 2 options.

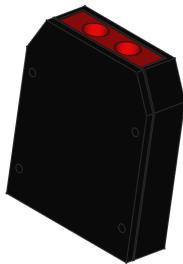
The easiest option is just to add additional material / shims under the structure support to lift the entire seat up. While this is the easiest option, it is also the most unrealistic. In the real seat, the headrest box does not move - only the lower seat base moves up and down.

The second option is to add the additional material / ships like above, but also position the headrest box lower to compensate for the seat base being raised. This could be accomplished by using shorter headrest poles or by moving the poles further down (which may require removing additional material from the rear seat back panel to accommodate the lower of the poles).

And by the way, if you didn't already know, the real seat does NOT move forward or backwards. Instead, the rudder pedals are moved aft or forward as necessary for the size of the pilot.

Working ejection pull handle

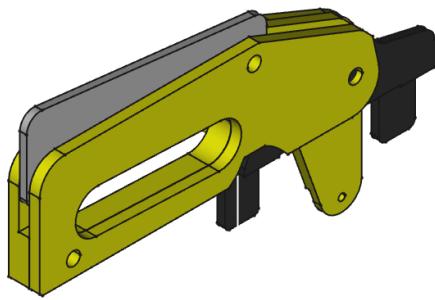
The planes allow for you to make a working ejection pull handle that can be wired into a microcontroller such as an Arduino to make the ejection pull trigger you to eject in DCS. The electronics are out-of-scope of this document, but may be included in a future revision. The STL files for the 3D printed parts required are included, however.



Manual seat release handle

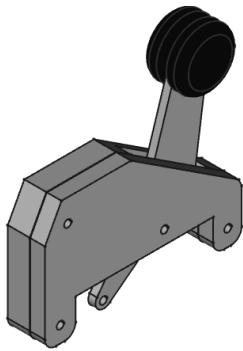
The yellow & black striped handle near your right thigh on the ride side of the seat is the manual seat release handle. This would be mechanically connected to a latching system that manually separates the pilot and seat pan from the rest of the seat in case it does not automatically separate after ejection. This handle has no function in the game, but the STL files for 3D printing this handle are provided, and the handle can be articulated. This is an optional "bolt-on"

part that you do not have to have. Note that the real handle has a spring-loaded latch that you have to squeeze down in order to allow the handle to be pulled up. I have not sufficiently designed this part to include the spring-loaded latching capability, but may do so in the future. Note that this part is primarily for aesthetics anyway and is not very strong. It may break if too much force is applied.



Inertial Reel Release handle

The Inertial Reel Release handle is on the left side of the seat. I have included the STL files for the 3D printing of this part. This would normally be connected by a cable to the inertial reel spool. Moving the handle in one direction unlocks the inertial reels which pull on the shoulder straps that connect to the parachute risers. (They pull your shoulders taught). I have yet to source an affordable inertial reel assembly, and will likely just use automotive seat belt reels on my seat at a later date. This handle is decorative, but in theory, could work as the real release handle if you were able to plumb the control cable to the inertial reel(s). Note that the real seat has 2 reels, although I'm pretty sure you could get away with having only one.



Features not included in these plans

Seat height adjustment

These plans do not allow for an automatically adjusting seat height. The real seat base moves up and down rails via a worm drive while the headrest box stays in a fixed position. The plans are designed with the seat at its lowest position. For those wishing for a higher seat position, you can accomplish this by adding additional wooden spacers under the seat supports and lowering the headrest box supports to compensate (or leave them where they are if desired - although this wouldn't be accurate).

Inertial Reels for shoulder straps

At the moment, I don't have these. In theory, you should be able to use cheap seat belt shoulder inertial reels to mimic the behavior. I plan to add this as an option to the plans sometime in the future (after I figure out how to actually pull it off). It may require the shoulder belt roller brackets to be machined out of metal instead of 3D printed.

Rear parachute box shell

This part is suspiciously missing from the Razbam Harrier. I've omitted this from the plans because you really wouldn't see it in the cockpit anyway as it would be hidden behind the seat. I may add this to the plans in the future.

Seat back pad

I have a real seat back pad, so I didn't need to make this. Since I do own the real pad, I may in the future create a fabric template for this with instructions on how to make a facsimile.

Headrest pad

I have a real headrest pad, so I didn't need to make this. Since I do own the real pad, I may in the future create a fabric template for this with instructions on how to make a facsimile.

Materials List

- (1) Sheet of $\frac{3}{4}$ " MDF or Plywood 8' x 4'
- (1) Sheet of $\frac{1}{2}$ " MDF or Plywood 4' x 4'
- (1) 2x4 in 8' length
- (2) 3/4" x 2" in 6' length premium pine board
- (1) Sheet of $\frac{1}{4}$ " MDF or Plywood 2' x 2' to use as a spacer
- (1) Box of 1 $\frac{1}{2}$ " drywall screws, fine pitch
- (1) Small box of 2 $\frac{1}{2}$ " construction wood screws
- (2) 3030 extruded aluminum bars, 5' length
- (1) Sheet polystyrofoam 4' x 4' x 1 1/2" thick
- (1) 2 yards of fiberglass cloth
- (1) Epoxy Resin
- (1) 3D Printer (or means to get parts printed)
- (2) Black steel pipe $\frac{3}{4}$ " diameter schedule 40 pipe 24" length
- (8) $\frac{3}{4}$ " conduit hangars (with attachment holes on each side)
- (4) (optional) small free castering wheels so the seat can be rolled around as needed during construction. These are temporary and should be removed before installing in your cockpit.

Tools Needed

- Jigsaw (if not cutting the parts out via CNC)
- Circular saw (if not cutting the parts out via CNC)
- (optional) Miter saw (if not cutting the parts out via CNC)
- Square
- Bar clamps (at least 2)
- Cordless drill
- 5/64" drill bit (for pilot holes)
- Countersink bit
- Fiberglass rolling tools
- Scissors (for cutting fiberglass sheets)
- Work gloves (so you don't get fiberglass stuck in your fingers, it hurts!)
- Stanley Surform Shaver (or other curved shaver / rasp) - used for shaping the styrofoam

Wood cutting methods

CNC

Lucky you, if you happen to have access to a CNC machine that can cut the parts you need to build this seat. This will by far give you a better result than cutting these parts by hand using conventional tooling. I know, because I cut all my parts by hand! Assuming you have a full-bed CNC that can handle a full 4' x 8' sheet MDF or plywood, you should be able to knock out most of the wooden parts quickly. I have provided Autocad DXF 2D files for the $\frac{3}{4}$ " sheet and the $\frac{1}{2}$ " sheet with all of the parts already laid out. In theory, you should be able to create profile cutting jobs using these relatively easily. There should be enough spacing between parts. Additionally, I have provided individual Autocad DXF 2D files that you can use to cut out each part one by one or to use to arrange any way you see fit. Please note that I have not provided drilling of pilot holes at this time. That may come in a future revision. All holes would be 5/64" in diameter, and it does not take long to drill these by hand during assembly where you think you will need them.

Cutting by hand

Unfortunately, you may not have access to a CNC, and may have to cut everything by hand. Ouch. You're in for a long haul, because this is going to take some serious time. I know, because this is what I did. My seat was cut entirely by hand using nothing but a jigsaw and a circular saw. I recommend a good jigsaw with a good Bosch jigsaw blade. I used Bosch T101B 4" blades.

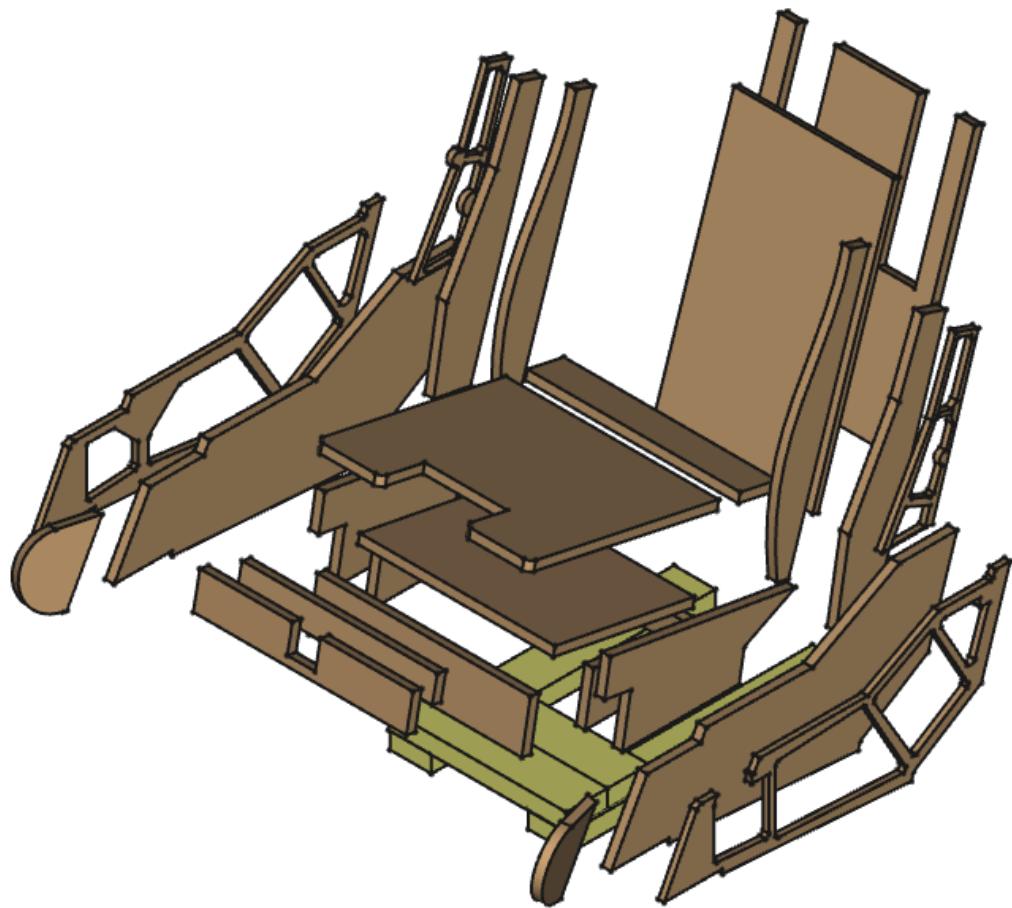
For straighter cuts, I recommend the use of guides that can be clamped down to the work surface using bar clamps. I didn't always do this, and it shows.

When cutting with a jigsaw, do not apply too much forward pressure to the jigsaw. Take it slow and let it do the cutting. If you push the jigsaw, the blade will not be straight and you'll get warped cuts (plus, you'll wear out the blade faster!)

You'll also have to deal with either printing out templates and attaching them to the pieces, or getting the measurements of the piece and transferring the measurements to the stock. I did both methods. Since I do not have access to a large plotter, I ended up using FreeCAD to produce tech drawings of the parts I needed, and I would have to use an A4 template and export the technical drawing multiple times with the part moved around to get different sections of it. Then I would painstakingly tape the sheets of paper together to make one big template. Ideally, you will want to use some spray adhesive to attach the template to the stock. I ran out of spray adhesive so I just taped it down around the edges. I don't recommend the tape method, because it will become a problem as you are cutting with the jigsaw. The paper will drag, curl up under the blade, etc. It's way better to use spray adhesive if you can.

There are some parts that you need 2 of. It's okay to stack and clamp 2 pieces of stock together so that you cut both pieces at the same time. You need to be even slower with the

jigsaw if you do this. And be careful. If you mess up, you're messing up 2 pieces at the same time! That may or may not have happened to me a few times. Just saying.

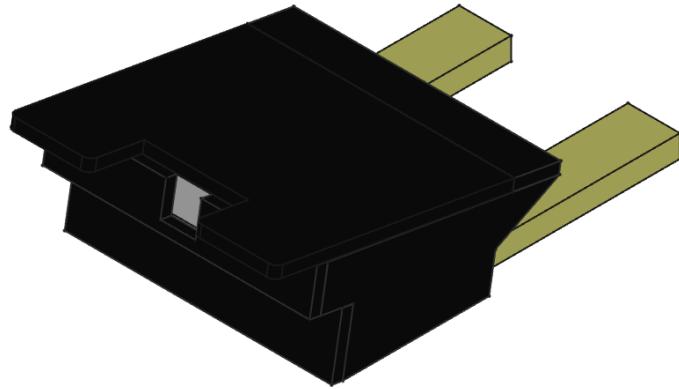


Exploded view of the seat base and seat pan

Order of Assembly

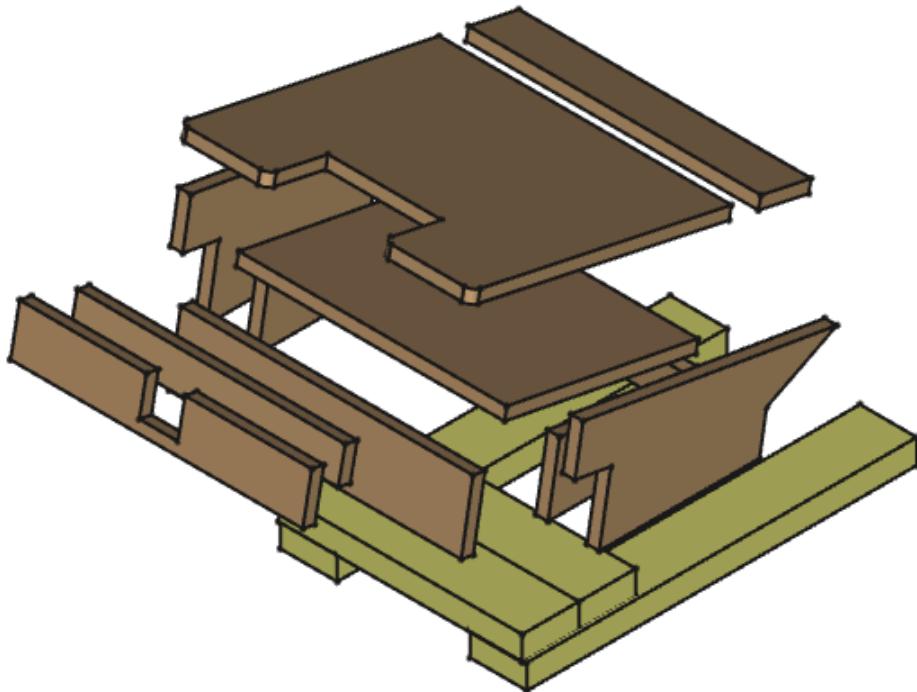
1. Seat pan / support structure
2. Seat base
3. Seat support rails
4. Headrest / Parachute box (front half only)
5. 3D printed parts
6. Seat Cushion
7. Seat Back Pad
8. Headrest Pad

Seat pan & support structure



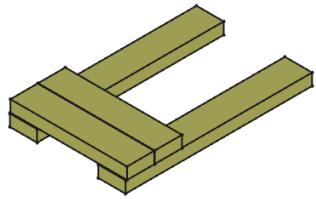
Completed Seat pan assembly

This is what the finished seat pan & support structure will look like when completed. It consists of 2 sections of (2) sections of 2"x4" that are 2' in length and (2) sections of 2"x4" that are 1'3" in length, plus 10 parts cut from $\frac{3}{4}$ " MDF or plywood.



Exploded view of the seat pan with the seat supports

Step 1: Seat Pan Support Structure

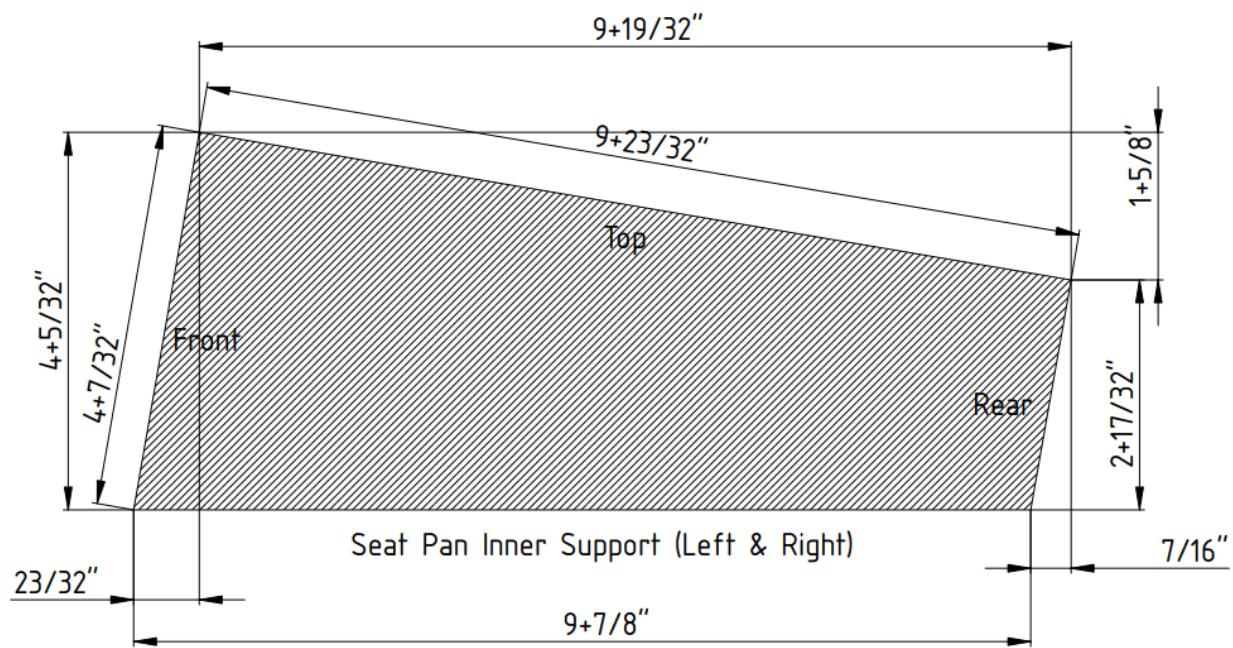
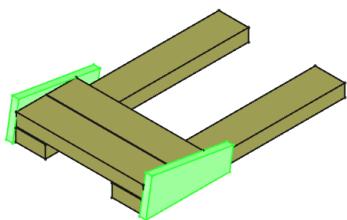


Cut the following lengths of 2"x4":

- (2) 2'
- (2) 1'3"

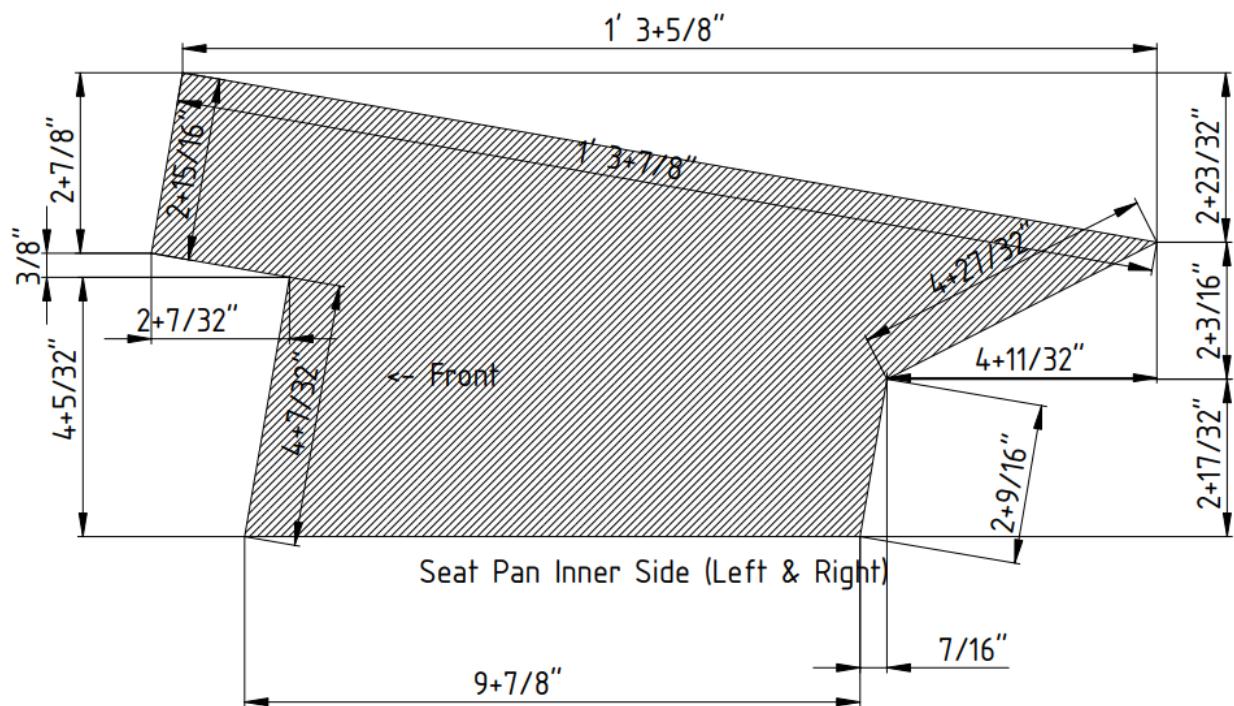
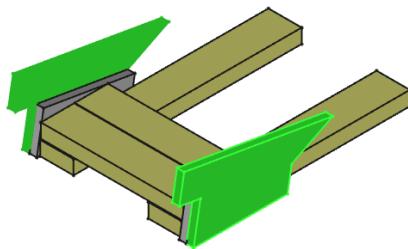
Attach the 2 smaller sections on top of the 2 longer sections as shown with 2 ½" wood construction screws by driving the screws from the top. Ensure that small pieces are flush with the front of the longer pieces and are square.

Step 2: Seat Pan Inner Support (Left & Right)



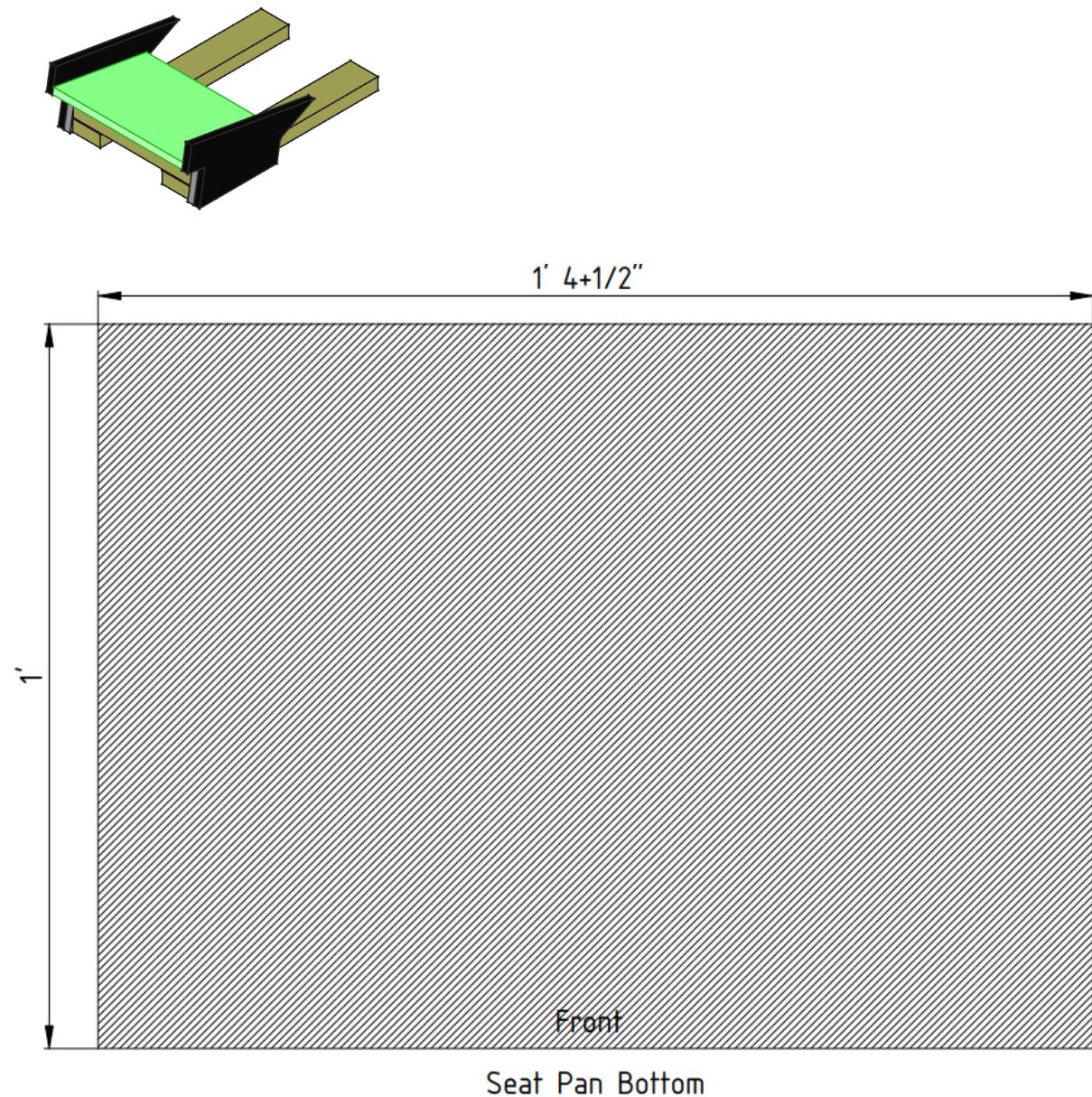
Attach the two $\frac{3}{4}$ " thick **Seat Pan Inner Supports** to the 2x4's as shown. Make sure that the leading front edge is taller than the rear edge, and make sure that the front and rear edges are sloped to the rear of the seat near the top. If not, then they are upside down. Also make sure that the bottom edge is flush with the ground. Use $1\frac{1}{2}$ " drywall screws from the sides. Make sure you pre-drill the holes using a $5/64$ " drill bit.

Step 3: Seat Pan Inner Side (Left & Right)



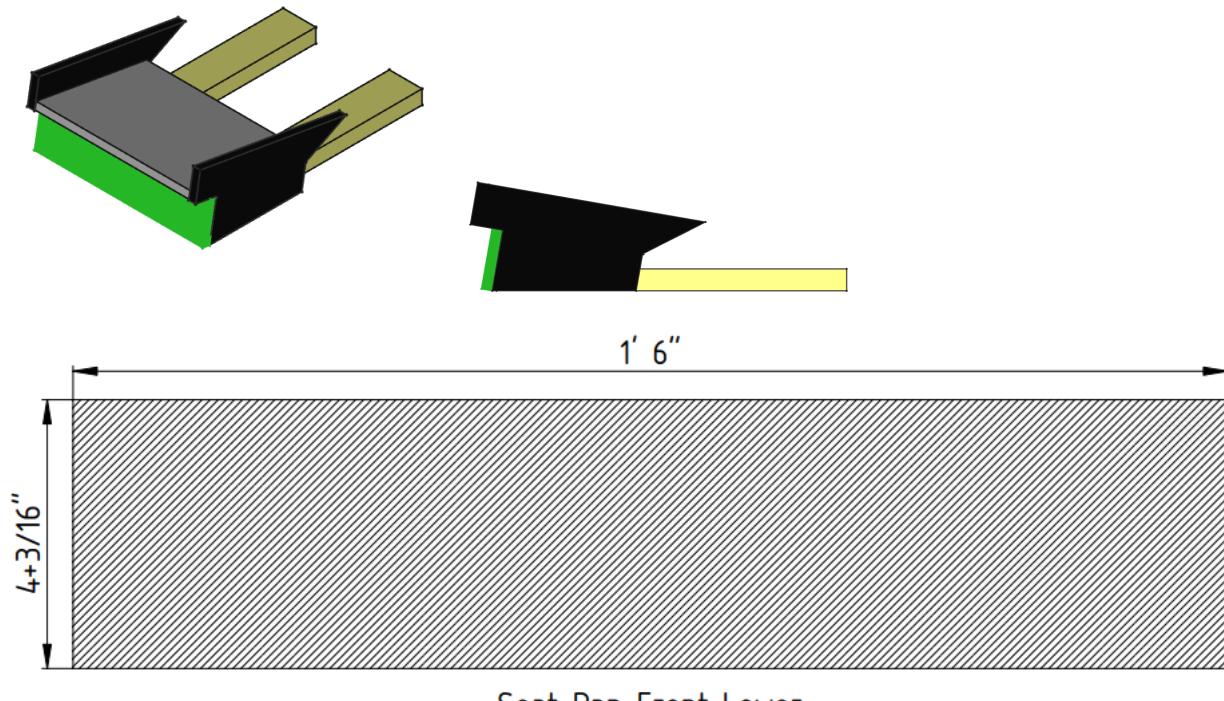
Attach the $\frac{3}{4}$ " thick **Seat Pan Inner Side Left** and $\frac{3}{4}$ " thick **Seat Pan Inner Side Right** to the Seat Pan Inner Supports from the previous step. Ensure that the front leading edge is flush with the Seat Pan Inner Supports. Use $1\frac{1}{2}$ " drywall screws and pre-dill and countersink the holes using a $5/64$ " drill bit.

Step 4: Seat Pan Bottom



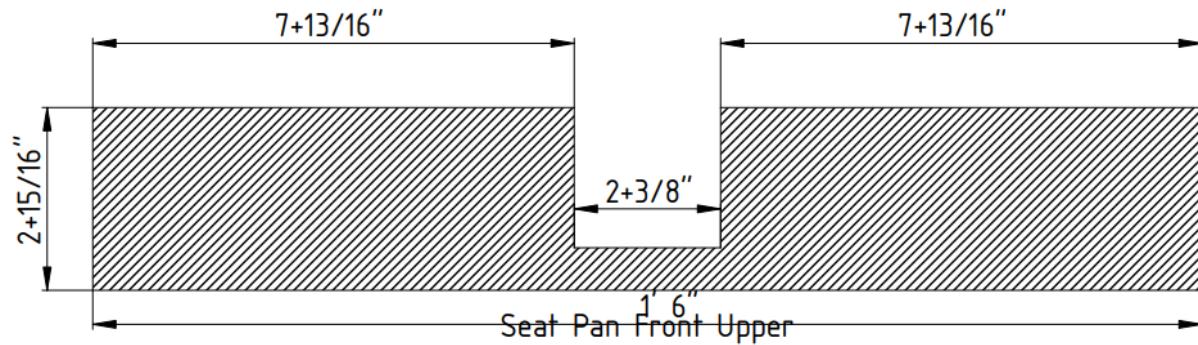
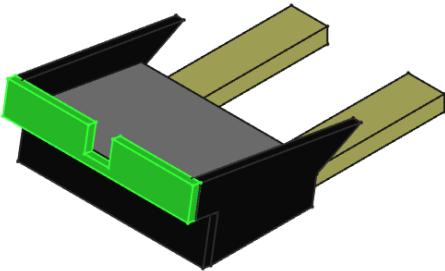
Attach the $\frac{3}{4}$ " thick **Seat Pan Bottom** on top of the Seat Pan Inner Supports (Left & Right) using $1\frac{1}{2}$ " drywall screws drive from the top, pre-drilled with a $5/64$ " drill bit.

Step 5: Seat Pan Front Lower



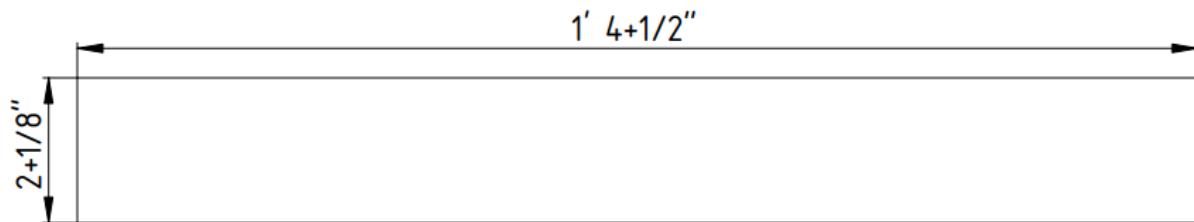
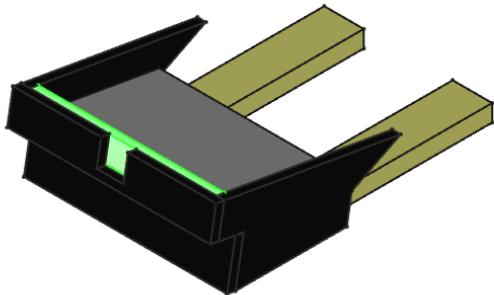
Attach the **Seat Pan Front Lower** to the front bottom of the seat pan assembly using 1 $\frac{1}{2}$ " drywall screws with pre-drilled holes using a 5/64" drill bit. Note that the front bottom edge will be tilted up slightly and will not be flush with the ground.

Step 6: Seat Pan Front Upper



Attach the Seat Pan Front Upper to the upper leading edges of the Seat Pan Inner Sides (Left & Right) and the Seat Pan Bottom with $1\frac{1}{2}$ " drywall screws. Make sure the slot cutout is facing up, as this is where the ejection seat pull handle will go. Pre-drill holes with a $5/64$ " drill bit and countersink these holes so that the screw heads are slightly below the surface. Use (2) screws on the front face of each side driving into the Seat Pan Inner Sides behind it and drive (2) screws along the bottom of the front face into the Seat Pan Bottom.

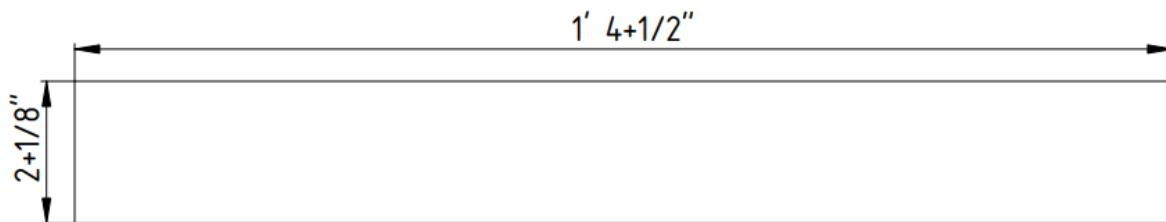
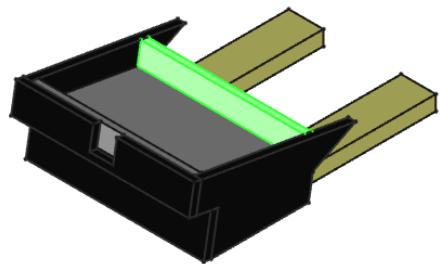
Step 7: Seat Pan Front Upper Inner



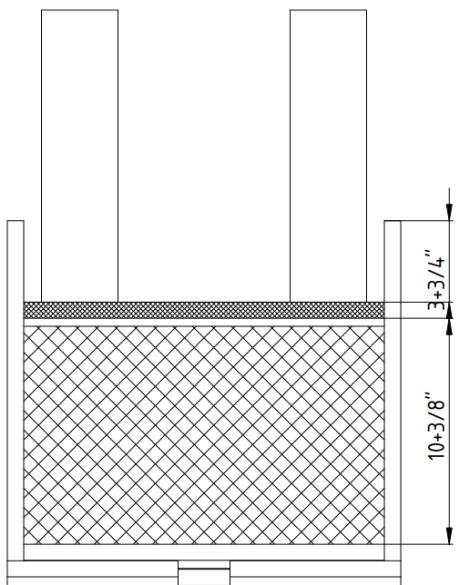
Seat Pan Front Upper Inner

Attach the **Seat Pan Front Upper Inner** piece to the insides of the Seat Pan Inner Sides (Left & Right) flush up against the Seat Pan Front Upper and the Seat Pan Bottom. Drive (4) $1\frac{1}{2}''$ drywall screws from rear of the Seat Pan Front Upper Inner into the Seat Pan Front Upper. Pre-drill the holes with a $5/64''$ drill bit. You do not need to countersink these holes.

Step 8: Seat Pan Back



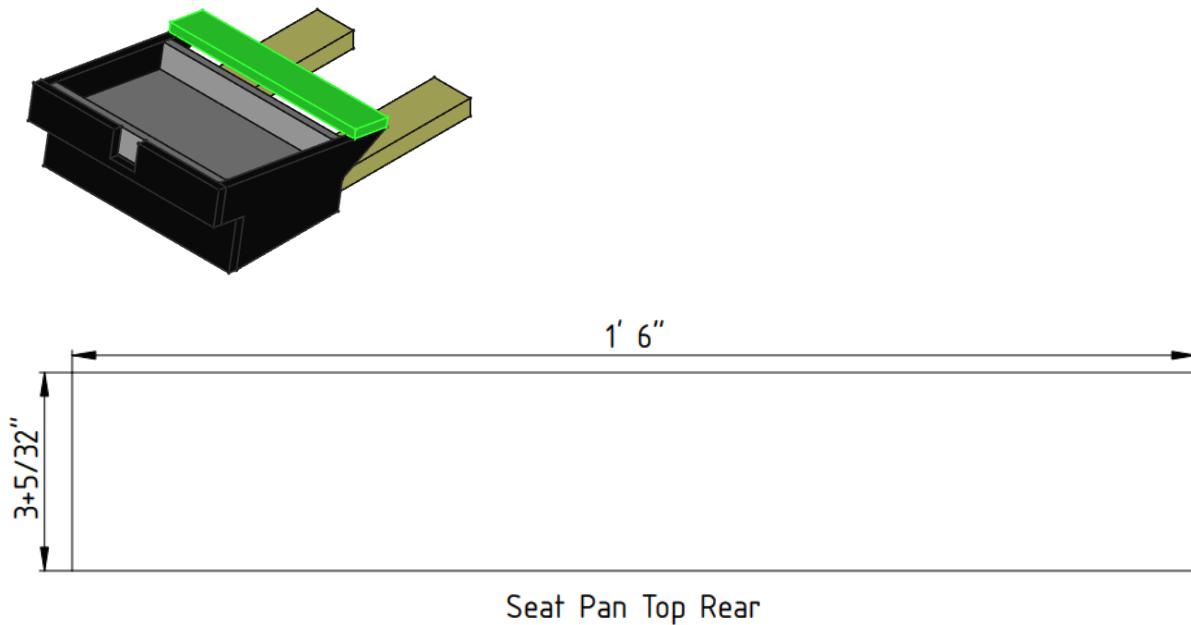
Seat Pan Back



Seat Pan Top View

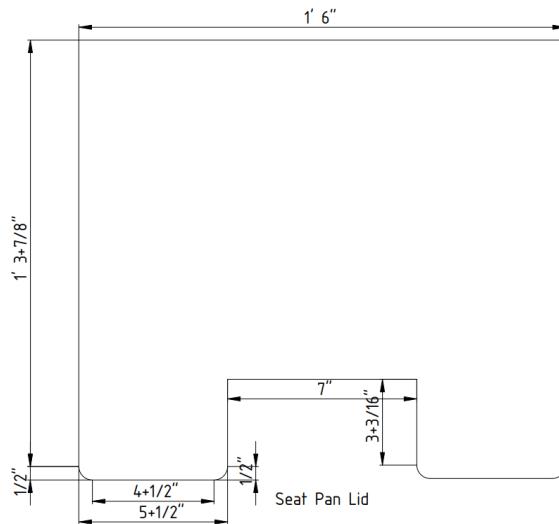
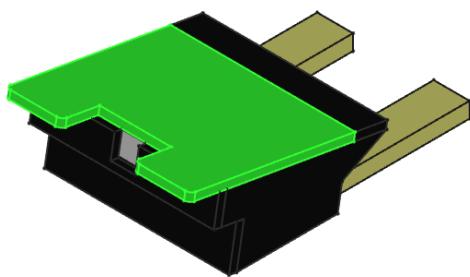
Attach the Seat Pan Back inside of the Seat Pan Inner Sides (Left & Right) $10\frac{3}{8}''$ inches from the back side of the Seat Pan Front Inner panel or $3\frac{3}{4}''$ from the rear of the Seat Pan Inner Sides (Left & Right). Attach using $1\frac{1}{2}''$ drywall screws from the sides of the Seat Pan Inner Sides. Pre-drill holes with $5/64''$ drill bit. Countersinking is not required.

Step 9: Seat Pan Top Rear



Attach the Seat Pan Top Rear to the top of the Seat Pan Inner Sides (Left & Right) flush with the ends of those pieces. The front edge of the Seat Pan Rear Lid will not be flush with the Seat Pan Back. Use 1 ½" drywall screws and pre-drill holes with 5/64" drill bit. Countersink the holes if desired.

Step 10: Seat Pan Top



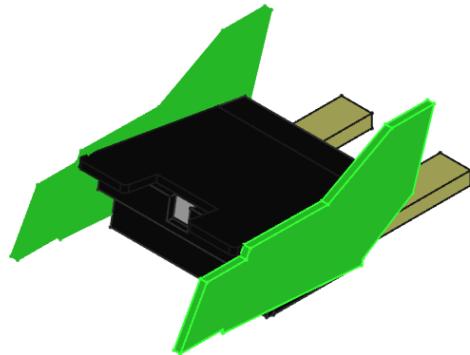
Attach the Seat Pan Lid to the top of the seat pan. The rear of the Seat Pan Lid should be up against the Seat Pan Rear Lid. Use (4) 1 1/2" drywall screws and pre-drill holes using a 5/64" drill bit. Use (2) of the screws on the sides and drive (2) of the screws into the the Seat Pan Upper Front. It is recommended to countersink these screws so that they don't snag the seat cushion.



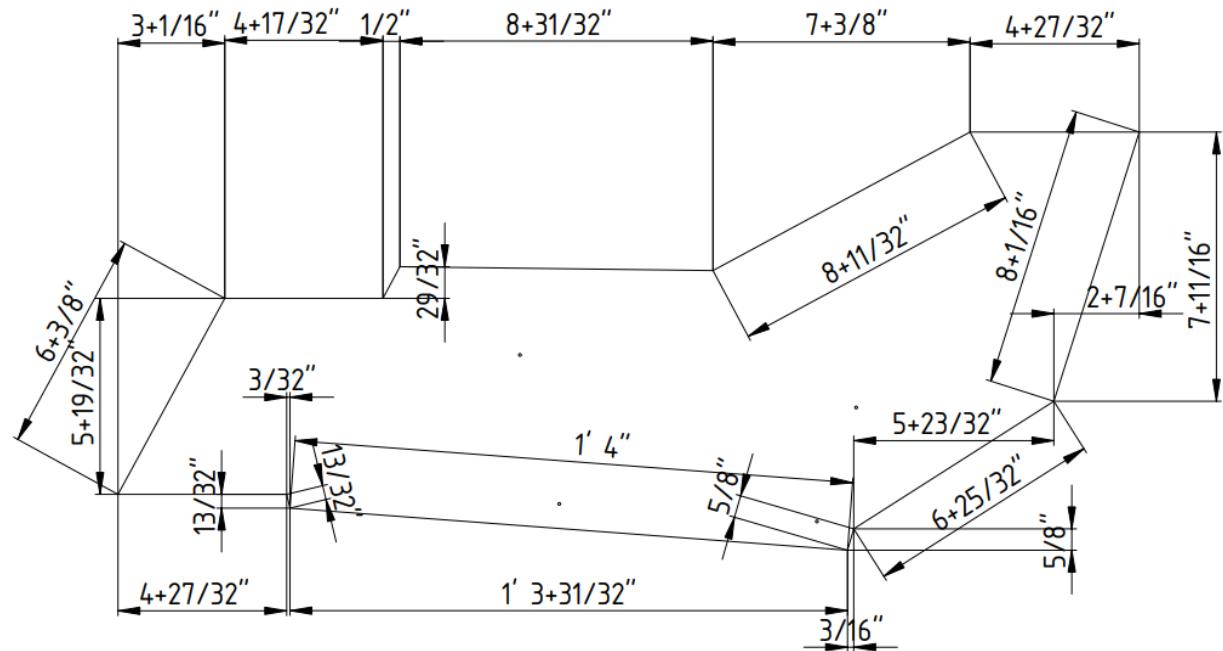
Location of screw holes shown. (Note this is an earlier revision of the seat that does not have the Rear Seat Pan Lid and the slot is not yet cut out of the Seat Pan Front Upper. This completes the basic assembly of the Seat Pan Box. When ready, move on to completing the Seat Base.

Seat Base

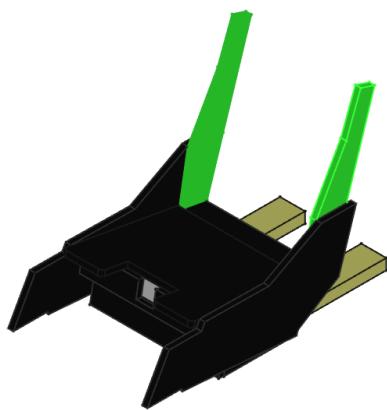
Step 1: Seat Base Lower Left & Right



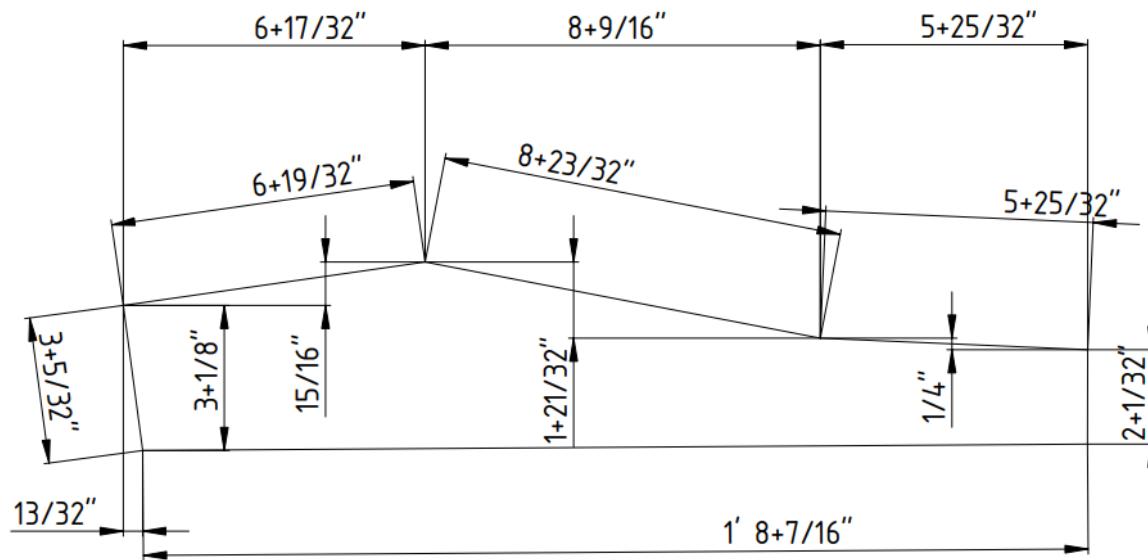
Attach the Seat Base Lower Left & Seat Base Lower right panels to the Seat Pan Inner Sides using (4) 1 1/2" drywall screws. Pre-drill all holes with a 5/64" drill bit and countersink the holes. Alignment of these panels is crucial. It is recommended that you measure and scribe lines as shown in the diagram to ensure proper placement. Failure to get this step right may lead to misalignment of other parts.



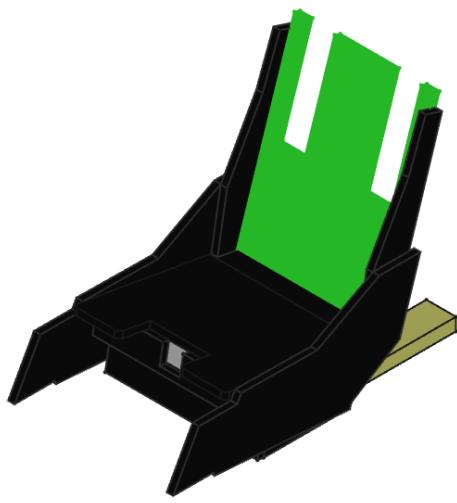
Step 2: Seat Base Inner Upper (Left & Right)



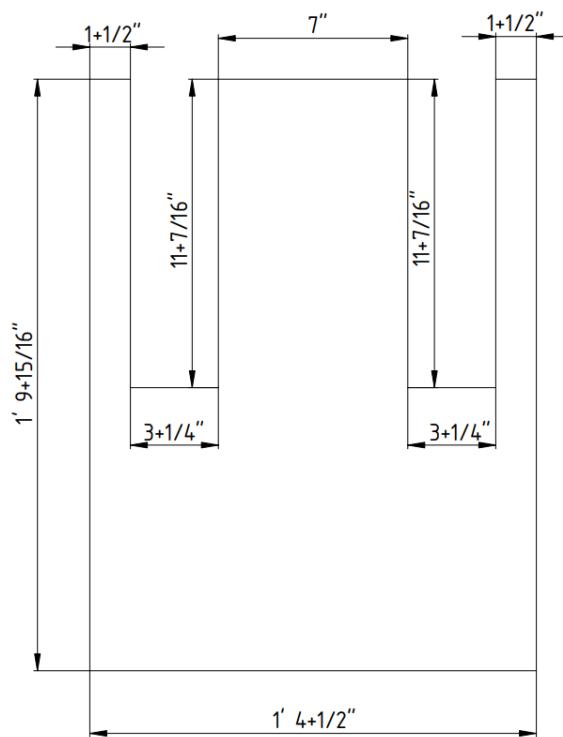
Attach the Seat Base Inner Upper (Left & Right) panels to the insides of the Seat Base Inner Lower pieces. The base of these pieces should sit flush to the Seat Pan Lid Rear. The rear edge of these panels should be inset from. The rear edge of the Seat Base Inner Lower pieces as shown. Drive (4) 1 1/2" drywall screws into each panel from the inside of the seat into the Seat Base Lower Inner pieces. Pre-drill holes with a 5/64" drill bit and countersink the holes.



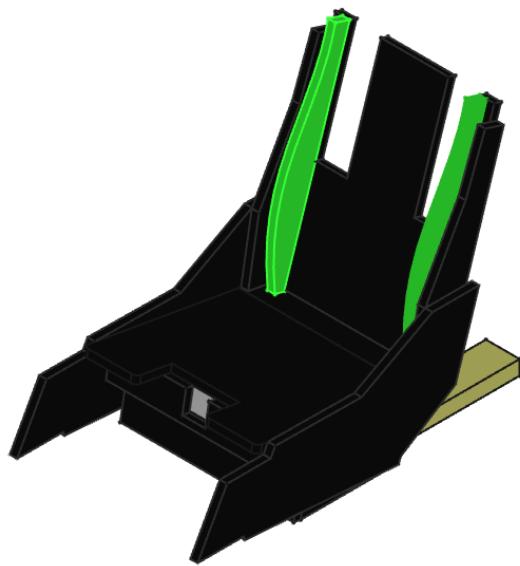
Step 3: Seat Base Rear Panel



Attach the Seat Base Rear Panel to the insides of the Seat Base Inner Upper (Left & Right) and align with the rear edges of these panels. Drive (3) 1 ½" drywall screws from the sides of each of the Seat Base Inner Upper Panels and drive (2) more at an angle from the bottom of the Seat Pan Rear Lid into the Seat Base Rear. Proper alignment is critical. Use of bar clamps is recommended to hold the pieces together while drilling holes and attaching screws. Pre-drill holes with a 5/64" bit and countersink all but bottom screws.

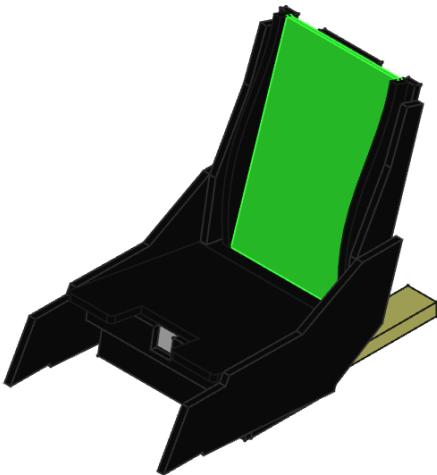


Step 4: Seat Base Seat Back Supports (Left & Right)



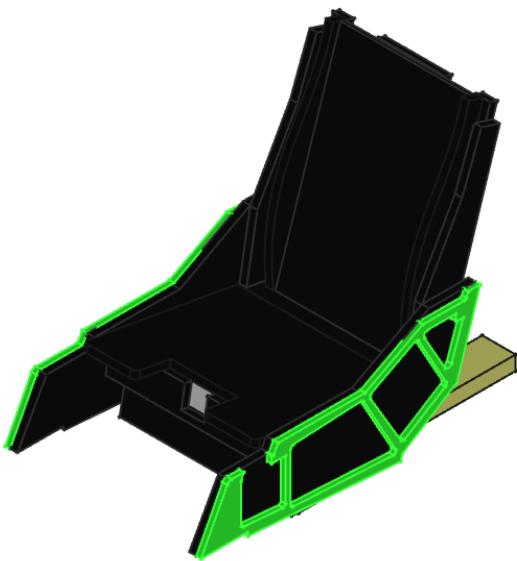
In order to attach these parts, you need to first cut a 2" x 8" spacer from $\frac{3}{4}$ " wood or MDF. Screw these spacers into the Seat Pan Inner Upper Sides using (2) 1 $\frac{1}{2}$ " drywall screws for each. These spacers should be flush against the Seat Base Rear panel. After these spacers are installed, attach (3) 1 $\frac{1}{2}$ " drywall screws through the Seat Supports from the inside face into the spacers. Pre-drill all holes with a 5/64" bit and countersink.

Step 5: Seat Back Inner Panel



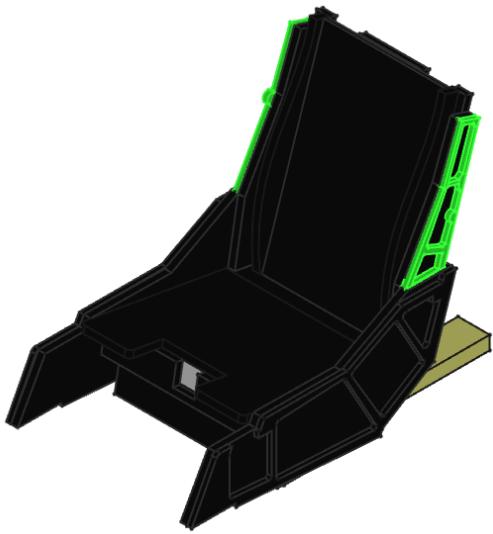
Before installing the Seat Back Inner panel, you must cut a $\frac{1}{4}$ " spacer from plywood or MDF to separate the Seat Back Inner panel from the Seat Back Rear panel. This is necessary to create the correct amount of space for the headrest poles which will be added later. You can clamp the spacer and the Seat Back Inner Panel to the Seat Back Rear panel using bar clamps and then drive Screws into the 3 pieces. Alternatively, you can glue the spacers to either board. The Seat Back Inner Panel should fit between the two seat back supports from the previous step. Pre-drill all holes with a $\frac{5}{64}$ " drill bit and countersink.

Step 6: Seat Base Lower Detail (Left & Right)



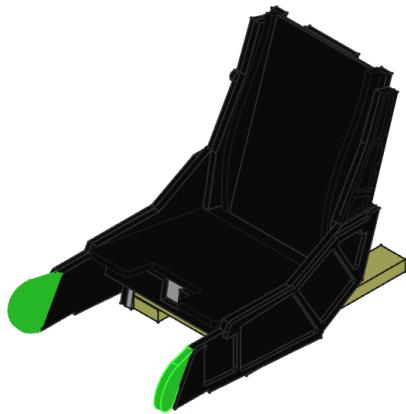
Attach the **Seat Base Lower Detail Left** and **Seat Base Lower Detail Right** panels to the Seat Base Lower Inner panels via 1 ½" drywall screws. Pre-drill all holes with a 5/64" drill bit and countersink. Take care to install the correct pieces on the correct sides. The left detail has a cutout near the front edge and the right does not.

Step 7: Seat Base Upper Detail (Left & Right)



Attach the **Seat Base Upper Side Detail (Left & Right)** to the inner panels using 1 ½" drywall screws. Make sure that you install the correct panels on the correct side as they are not identical. The right panel has a rounded protrusion where the Ejection Seat Arming handle assembly will be installed later. Pre-drill all holes with a 5/64" drill bit.

Step 8: Leg Guards (Left & Right)



These pieces require some additional prep work before they can be installed. A 12 degree slant must be cut into the trailing edge using a miter saw and a jig to hold the board in the proper position while cutting. TODO: PROVIDE DETAILS!

Additionally, pocket holes must be predrilled into surface of these pieces at a very steep angle. TODO: I have yet to find out the best way to do this. I probably need to cut a jig piece to aid in the drilling of these parts or possibly use a store-bought jig tool. TBD

Seat Back molding

The seat back molding is made from 2 blocks of 2" thick dense construction styrofoam that are glued together using a construction adhesive such as Liquid Nail, and then carved and shaped to match the seat back covering of the real seat. First, a few reference pictures of the real seat back to understand that this is a complex, compound shape:





Seat Rails

The Seat Rails are made from lengths of 3030 extruded aluminum cut into 4 pieces: (2) long lengths and (2) short lengths. These will be assembled into a simple frame using 90 degree brackets made for 3030. Once assembled, (4) holes will be drilled into the back of the assembly so that it can be attached to the Seat Rear Panel.

Step 1: Cutting the extruded aluminum

Cut the extruded aluminum into the following lengths:

- (2) Length 1 (TBD)
- (2) Length 2 (TBD)



Step 2

Using 90 degree corner brackets, assemble the frame as shown. TODO : Provide dimensions for where these parts go.



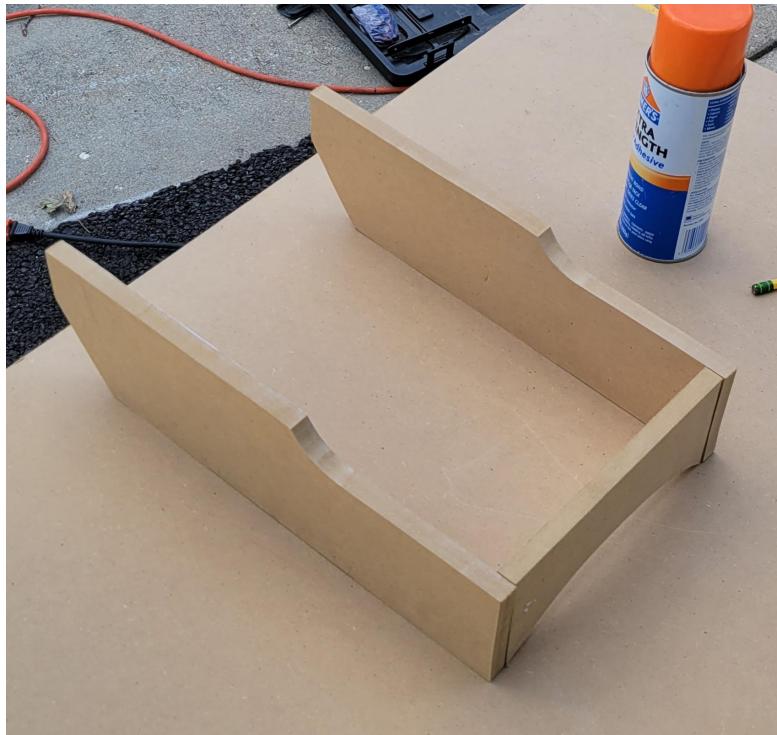
Step 3: Attach to Seat Back

Drill holes through the extruded aluminum at the locations shown (TODO) and then clamp the frame to the back of the seat with bar clamps. Make sure the shorter arms are facing down and resting on the 2x4 supports and is centered horizontally with the back of the seat. Now, using a 5/64" drill bit, carefully pre-drill holes into the seat back, being careful to not go all the way through the front of the seat.



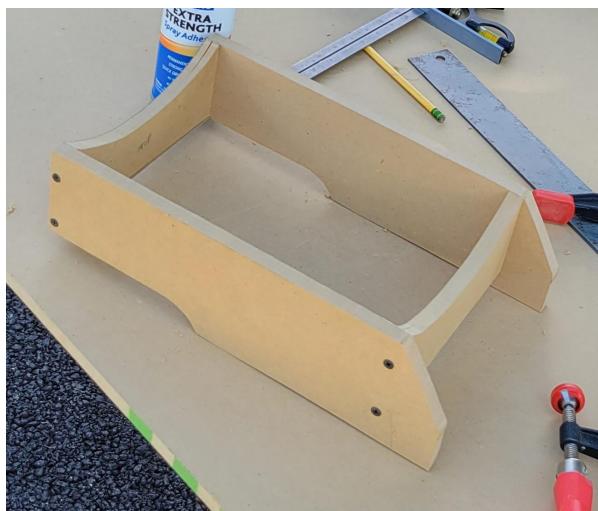
Headrest Box

Step 1: Sides and Top Plate



Attach the two sides of the headrest to the top plate piece, ensuring that the curved part of the top plate faces the front and that the thin part of the sides faces up. Attach the side plates with 1" drywall screws and pre-drill all holes with a 5/64" drill bit.

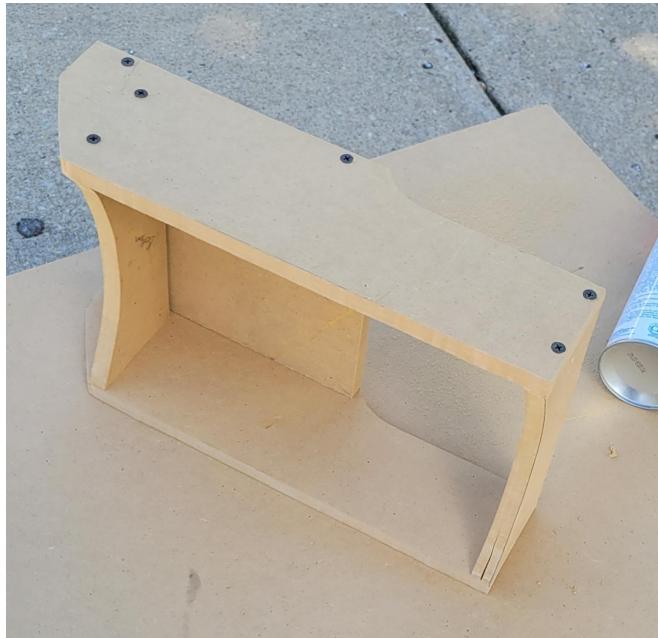
Step 2: Headrest Box Lower Plate



Attach the Lower Plate between the two sides and align the bottom of the plate with the start of the 45 degree angle of the sides. Make sure that the curve of the Lower Plate faces forward.

Attach with (2) 1" drywall screws on each side and use a 5/64" drill bit to pre-drill all holes and countersink.

Step 3: Headrest Box Lower Rear Panel



Attach the **Lower Rear Panel** to the back of the headrest box between the sides and flush with the bottom of the headrest with (4) 1" drywall screws. Pre-drill all holes with a 5/64" drill bit and countersink.

Step 4: Headrest Box Upper Rear Panel

(DIAGRAM MISSING)

Attach the Upper Rear Panel to the back of the headrest box between the sides and flush with the top of the headrest with (4) 1" drywall screws. Pre-drill all holes with a 5/64" drill bit and countersink.

(PHOTO MISSING)

Step 5: attach a spacer (dimensions?) inside the box.

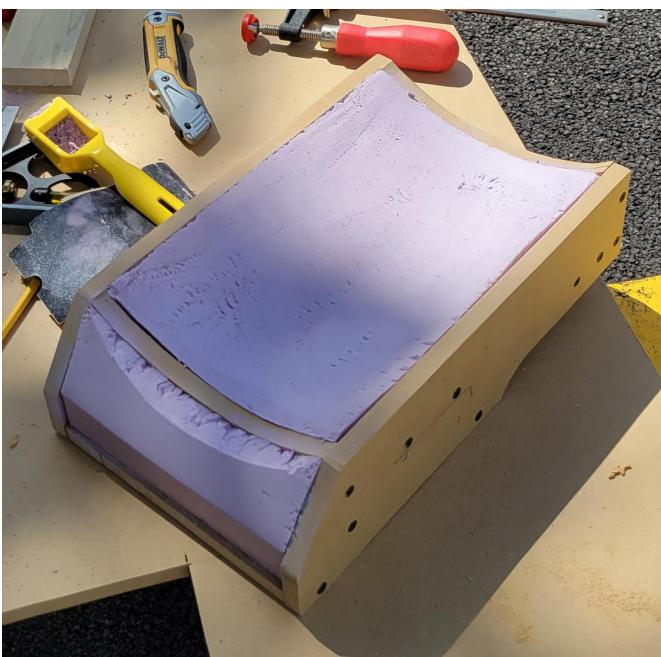
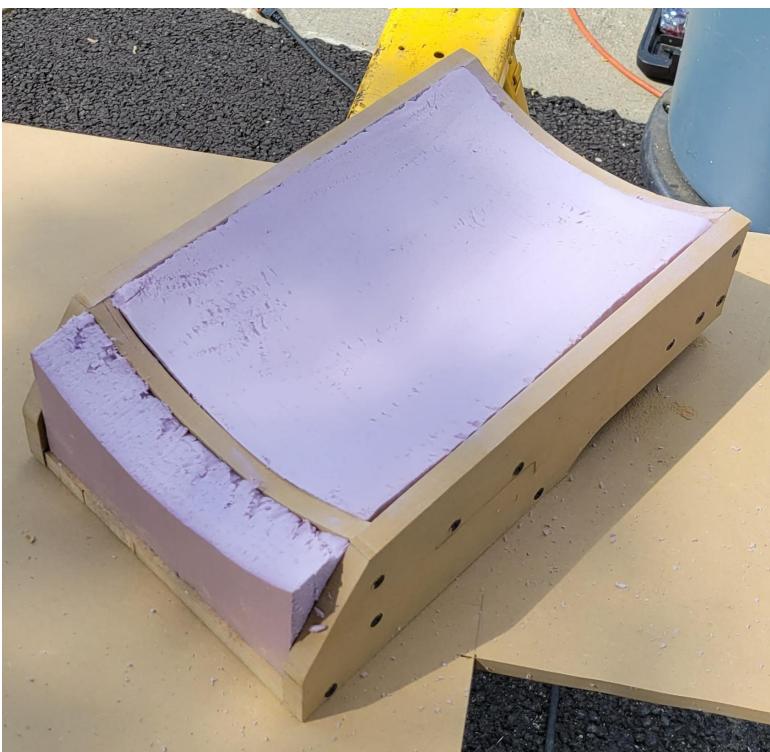
Step 6: Headrest Front Upper Styrofoam

Cut a piece of 2" Styrofoam to fit inside the top front opening of the headrest box.

Using shaping tools, carve & sand a uniform curve between the top plate and bottom plate.

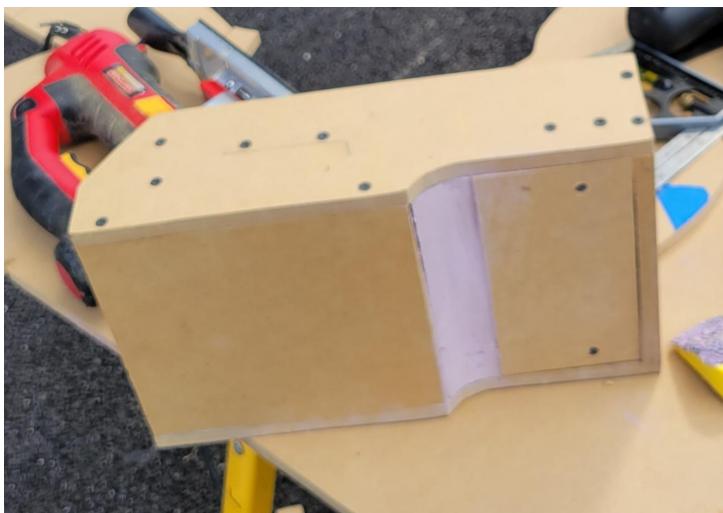
Step 7: Headrest Front Lower Styrofoam

Insert a 2" block of Styrofoam into the lower front section of the headrest. First, carve and sand the same profile as in step 6. The carve and sand off a 45 degree angle to match the angle of the sides.



Step 8: Rear Styrofoam

Flip the headrest over and insert a 3rd piece of Styrofoam and carve and sand in inside curve as shown:



Step 9: Sanding

Sand a $\frac{1}{4}$ " bevel into all of the outside edges of the front of the headrest. Do not sand any of the inside edges. Ignore placement of the conduit hangers in this picture as those are not accurate locations.



Step 10: Prepping for fiberglass

Apply either wood putty, caulk, or bondo to all seams and cracks and holes. Lightly sand to ensure a smooth finish. Blow off any dust.



Step 11: Fibreglassing the headrest

Okay, so I do not have a huge amount of experience with fiberglass. Here's what I learned. When you mix the 2 part fiberglass resin and hardener together, it will generate heat for quite a while. That heat will eat Styrofoam and can deform the shape you are trying to keep. This happened a bit to me. There are a few solutions. The first solution is to use epoxy instead of

traditional fiberglass resin. Epoxy does not generate heat. The downside is epoxy is a lot more expensive! Another option is to seal and coat the Styrofoam completely with another material first to protect it. For example, coating with drywall compound might work. Epoxy may be the better choice as you won't have to do the extra work to protect the Styrofoam.

At any rate, if you will want to buy some cheap fiberglass roller tools. I got a set from Amazon for about \$9 US. Also you will need acetone to clean these tools after use. If you don't clean them, they will be ruined and unusable a second time.

I recommend watching a few fibreglassing videos to understand how to do it. It's not hard, but proper techniques will give you less frustration and better results. That how-to is beyond the scope of this document. I highly recommend wearing clean work gloves when working with fiberglass cloth. Tiny glass strands can get stuck in your skin and it will hurt like a son-of-a-\$@#! It's like getting a wooden splinter, only worse because it is tiny and hard to see. Plus it can break off in your skin while trying to get it out with your crappy tweasers and sausage fingers. Don't ask me how I know this, just trust me on this one.

Make sure you allow plenty of time for curing of the resin or epoxy. It will help if you can leave the piece in the sun. Cold weather will also increase curing time, so be aware of that.



I chose to not do the sides, but that's up to you. Also, you may want to do a second fiberglass layer if you want it even stronger. I also did not do that because I got impatient and/or lazy.

When the fiberglass is fully cured, you will need to sand it. You **must** wear a face mask and eye protection for this. You do not want fiberglass dust in your lungs. That can be seriously dangerous to your health.

Step 11: Paint

You will first want to paint the surface with a primer or evenly apply Shilac to the entire surface and let dry. This is because MDF is very porous and will soak up a huge amount of paint (especially on the cut edges) and not look great when painted. Some people will go to the trouble to seal all edges and gaps with wood filler and sand everything smooth. That will indeed give you the best results but will take a lot of time. I used Shilac. I also accidentally knocked over my can of Shilac on my driveway, and now a section of my driveway is permanently sealed in Shilac.



Brush this stuff on and make sure it is evenly coated. Some say to sand it and apply a second coat but I did not bother.

Once the Shilac was dry, I painted the surfaces with a semi-gloss black spray paint. I did 2 coats. In the picture below you can see that I did not fill the screw holes. I plan to do this later and repaint, but you should do this before you paint. And yes, I didn't fiberglass the back piece. I plan to try Bondo here instead.



Headrest Poles



The headrest poles are made from 2' sections of $\frac{3}{4}$ " black pipe. These were readily available at Home Depot with threads on either end. You don't need the threads, but it does not hurt anything. Don't drop these on your toes, because that will definitely hurt. You will also need (8) $\frac{3}{4}$ " conduit hangars.

Step 1

Using a barclamp to hold the pipe, place it in the recessed area on the back of the seat. It should be centered with the 3030 extruded rails that are behind it, and there should be about a $\frac{1}{4}$ " gap between the pipe and the extruded aluminum. After ensuring the pipe is straight, hold a $\frac{3}{4}$ " conduit hangar over the pipe near the top and mark the holes for the hangar. Do the same near the bottom. So this for both sides (pipes). Temporarily remove the 3030 extruded aluminum. Pre-drill the holes for the hangars using a 5/64" drill bit. Attach the (2) conduit hangars over the pipe and screw them down so that the pipe does not move. Note that the pipes should be all the way down, touching the bottom of the recessed area of the back of the seat. Reattach the 3030 rails to the back of the seat and ensure that the pipes are aligned and centered with each rail.

Cut (2) sections of X diameter PVC pipe in X" length so that X inches of pipe will project above the seat back. Slide these over the tops of the pipes.

Step 2

Cut the 8 wooden spacers as shown and glue them to the sides and back of the headrest as shown with wood glue and allow to dry. Pre-drill the holes on the sides and back of the spacers into the headrest as shown. Using pliers or a vice, bend one end of (4) $\frac{3}{4}$ " conduit hangars as shown. Attach the (4) modified conduit holders to the headrest using 1" drywall screws but allow them to be really loose. Slide the headrest onto the poles. Align the top conduit holders with the tops of the pipes and screw the conduit hangars down tight. Tighten the bottom conduit holder screws as well. Ensure that the headrest is secure and does not move on the poles.

Step X

3D print the shoulder harness runner brackets and the upper headrest brackets. Slide the shoulder harness runner brackets over the pipes (remove headrest first). Using a 3030 slot thingy,

Seat Cushion

The seat cushion is made much like a conventional seat cushion with fabric, cushion foam, and a zipper, albeit with a few extra inside and outside corners.

You will need a 2" or 3" thick dense block of cushion foam, 24"x24". I ended up using 3". It may be more realistic to use 2".



Start by measuring out the shape of the cushion over the seat pan. The cushion sides should be about $\frac{1}{2}$ " inset from the sides of the seat pan and front of the seat pan. The notch in the front of the cushion should be 1 or 2" inset to allow unrestricted access to the ejection pull handle. I actually need to redo mine because my notch is not deep enough. Use a sharpie and a straight edge to draw out the lines you will cut from the foam.



I recommend using a large serrated bread knife to cut the foam. Try to keep the blade straight up and down (90 degrees from the top surface and try to cut as straight as a line as you can. It should look like the following picture when cut:



Note that my front notch is not deep enough.

For fabric, you have to find something "close enough". I could not find the real fabric used in the seat cushion. I ended up going with some outdoor fabric known as sail cloth. I bought 2 yards of fabric.

You will need a sewing machine or God-like hand sewing skills.

Start by laying the foam cushion on the bottom side of the material (not the finished side) and trace around an outline around the cushion using a fabric marking pencil or pen. Then, using a ruler, mark out lines that are 1" away from the cushion outline.



Repeat this for the other face of the cushion.

Now, trace an outline of the sides. You want a single piece that will cover both sides, the front, and the front notch. Leave a few extra inches. Then mark a 1" border away from that outline as before. You will need one more piece to cover the back and rear notches.



You need $\frac{1}{2}$ " cushion padding. You will mark the shapes you need to cover every side. You need to mark this $\frac{1}{2}$ " larger on each side.



Then you will start stapling the seams together like so:



Although you can use a fabric stapler, I found that an ordinary paper stapler worked fine for this. When done, the cushion should be completely wrapped in this foam. It should look something like this:



Why did we do this? This is the secret to making the fabric taunt. It helps push out the corners, giving you the desired shape when you push the cushion into the fabric cover.

Now, on to sewing. I would start with the back piece. Unfortunately, I didn't take pictures of this part. But what you are going to need to do is cut a slit down the length of it for your zipper. You may want to watch some videos on how to do this. It is not hard. After the zipper is sewed on (making sure you sew it to the inside fabric of the cushion - not the outside), you will begin sewing the top plate to the back piece. Make sure you center the back piece with the back of the top plate. Once this is done, you will begin sewing the main side piece around the top plate. Make sure you pin the edges together and that you are sewing as if the cover is inside-out. The inner line on both pieces of fabric should be meeting up. You will have cut angles on some of the seams of the side fabric to aid it bending around the corners. When the top plate is sewn, repeat the process for bottom plate.

When done, turn the cover out.



Now, carefully stuff the cushion in, pushing it into all the corners.



Inertial Reel Release

Ejection Pull

Manual Seat Separation Handle

Ejection Arming Handle

My first draft:



A real one



The ejection seat arming handle was originally made from a $\frac{3}{4}$ " block of MDF that I cut with a jigsaw and beveled with sanding paper. I drilled a hole in the end so that a piece of $\frac{1}{2}$ " PVC would fit in the hole to make up the shaft. Then a hole was carefully drilled through the side of the block for a bolt to act as a pivot point. I used a bolt and some washers and a nut to hold the assembly together.



However, I intend to redo this part. On the real seat, there is an spring-loaded inner shaft (painted black) that acts as a locking mechanism. You must pull the inner shaft outward (releasing locking pin) in order to get the handle to move. The shaft locks into the upward (unarmed) and downward (armed) position. I intend to design 3D printed parts to replicate this action. There also needs to be a bracket on the inner side that will be used to actuate a limit switch to tie into the simulator.