When Your First Arrive

1. SIGN IN.

2. READ MATERIALS
   Look over this set of instructions we are using today. Read Ground Rules and Key Locations especially carefully.

3. YOUR MATERIALS
   What you will do today: Make a stool from ½” and ¾” plywood.
   - You will get a quarter sheet of ½” plywood. A quarter sheet is roughly 24” x 48”. ½” plywood is actually on 15/32” inches thick. The nominal thickness is ½”, the actual thickness is 15/32”.
   - You will have a partial sheet of ¾” plywood. ¾” plywood is actually 23/32” inches thick.
   - You will also get a few feet of a 2x2. A 2x2 is NOT 2” x 2” - that is only the nominal size. Its actual dimensions are 1.5” x 1.5”.

4. CALCULATE KEY DIMENSIONS
   To make the stool you will need to cut out 5 pieces of plywood, one forming the top and the other four forming the sides. The bottom will be open. You will also be using 4 pieces of 2x2 to help join the five sides.
   - What dimensions should the 5 pieces of plywood be cut to? We’ll give you one thing: the seat is one size and the four sides are another size. Use the space here to calculate what the sizes necessary to make the stool.”

<table>
<thead>
<tr>
<th>Overall Height “z” (inches)</th>
<th>Top Dimension “x” (inches)</th>
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<tbody>
<tr>
<td>Tall</td>
<td>23</td>
</tr>
<tr>
<td>Medium</td>
<td>20</td>
</tr>
<tr>
<td>Short</td>
<td>17</td>
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NOTE: ALL PHOTOS IN THIS PACKET ARE SHOWN FOR A “STOOL” OF HEIGHT 10” AND TOP DIMENSION 10”.
Your stool: SHORT  MEDIUM  TALL

Dimensions of pieced used for top: ______in. x ______in.

Dimensions of sides: ______in. x ______in.  (height x width)

2x2 length: _______ in.
Use this page for calculations - you are encouraged to work this out by hand (don’t just do it all in your calculator!)

After getting your answers, make sure everyone in your group is coming to the same answers and hold tight - we'll be over soon!
Ground Rules of the Shop

• ONLY USE THE SHOP WHEN AN INSTRUCTOR/TA IS HERE

• ONLY USE TOOLS THAT YOU ARE COMFORTABLE USING AND HAVE EXPERIENCE WITH
  Get help if you need it!

• PUT THINGS BACK THE WAY YOU FOUND THEM

• IF YOU BREAK SOMETHING, YOU AREN’T IN TROUBLE → TELL US
  We want to replace whatever it is that is broken... so we need to know about it.

• IF YOU GET HURT, TELL AN INSTRUCTOR/TA IMMEDIATELY
  Wear safety glasses when sawing,
  Wear hearing protection when using the table saw.
  Wear dust masks when sanding.
  First Aid Kit is on wall in FIRST Robotics shop by entrance to room with power tools

• CLEAN UP YOUR MESS
  No sawing, sanding, drilling in the TLP lab space. (use the TLP space for computers and sensor work)
  Including trash, small wood pieces you don’t need, sawdust, etc.

• DO NOT MOVE ANY OF THE FIRST ROBOTICS ROBOTS or MATERIALS
  We are their guests...

Key Locations of Stuff

• In a kit for each team (one/team)
  Drill bits, screwdriver bits for drill, countersinking bit, wood glue, safety glasses (2x), sawdust/sanding masks,
  carpenter’s square, triangle square, tape measurer, pencil, Philips head screwdriver

• In TLP cabinet (right)
  Clamps, sandpaper, wood putty and putty knife, screws, Carpenter’s L, angle iron to use as fence for circular
  saw, Velcro, extension cords, shop cloths

• In TLP cabinet (left)
  Power tools (4 drills, 3 sanders, 1 jigsaw, 2 circular saws, 1 router)

• In TLP “wood storage” area
  Plywood, 2x2s, 2x4s, scraps

• In FIRST Robotics shop
  Tablesaw, workbenches
The main point of today is for you to become familiar with the shop and to learn some basics of woodwork - in particular focusing on measuring, cutting, and joining.

Make sure those that are less experienced gets lots of opportunities to do the work. For those of you who are really good with woodworking, demonstrate the work/coach the others... but don’t do all of the work for them!

Introduction (if we have two instructors, we’ll do this)

• Finish and check calculations.
• Review Ground Rules
• Get your team’s tools, a quarter sheet of plywood, and a 2x2
• Tour of TLP stuff
• Tour of FIRST Robotics space

Step One: Use Tablesaw to Cut 5 Sides of Stool (next 30 minutes)

A. Set up the tablesaw to cut the seat of your stool. Use ⅜” thick plywood
   A.1. Set the fence to be the right distance (x) away from the blade. Check the actual distance after you set the fence. Adjust as necessary.
   A.2. Cut the wood lengthwise first → it will be helpful to have someone on the other side of the tablesaw to hold the two pieces after they are cut.
   A.3. One of your two pieces you just cut is x inches wide. Rotate that piece and cut it again so that you make an x inch square. You will want to use the pusher on the tablesaw... before doing so, make sure it is perpendicular to the fence!
B. Now, let’s cut out the other four pieces... which should all be the same size. Use the dimensions you calculated earlier. Use ½” plywood.
   B.1. Cut the quarter sheet of plywood lengthwise first. Use the dimension for height that you calculated earlier.
   Change position of fence - rechecking the actual distance after setting the fence.
   B.2. Now, reset the fence to the width dimension and cut 4 pieces out of the wood piece you just cut.
   B.3. You should end up with four pieces of ½” plywood that are all height x width in size.
C. If there are any splinters on any sides or edges, run some coarse sand paper over wood to smooth them out.
D. Sweep up the sawdust.

Step Two: Use a Hand Saw to Cut 4 2x2 pieces (next 20 minutes)

A. I’d recommend cutting your 2x2 about 1/32” shorter than the calculated value from the prior step - being too long is worse than too short for these pieces.
   A.1. Mark a 2x2.
   A.2. Cut with handsaw.
   A.3. Repeat (mark, cut) three more times. I’d recommend checking the length with your plywood pieces by setting up the stool once you have 2 of them cut - just to make sure the length you are cutting is correct.
B. Sweep up any sawdust.

Step Three: Assemble 2x2 pieces onto seat

A. Your main job now is to get the seat attached to the four sides. We will use the 2x2s to help do this. Before proceeding, think about other ways could we get the four sides attached to each other and the seat so as to make a stool.
B. Make a DRY ASSEMBLY. Layout out your wood (as shown to the right). Assemble the stool. Try to match up pieces in a way that “makes the best stool” that has tight joints that line up correctly.

Once you have the pieces in the best layout, number each side (1, 2, 3, 4), put a corresponding number on the seat on the appropriate side ... and also on the 2x2. This makes sure you can reassemble them in precisely the same way as you just determined to be best.

C. The hardest task involved with this assembly is figuring out how to get the 2x2s into their correct location before securing them to the underside of the seat. We’ll use screws to attach the 2x2s to the seat. Some ways to consider aligning the 2x2’s prior to assembly are shown below.

<table>
<thead>
<tr>
<th>You could measure the location and mark it... then clamp the 2x2 into place and drill the pilot holes of the screws.</th>
<th>You could have a team member hold up two sides in position on the seat... and then place the 2x2 snug up against the two sides and drill the pilot holes while everyone holds their pieces in position.</th>
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<tr>
<td>You could lay a side on the table and hold the seat upright - thus making sure the side is at the very edge of the seat... then clamp the sides in place, put 2x2 snug up against sides, and then drill pilot holes.</td>
<td>Same as above, but use a square to make sure sides are at edge of seat and then clamp in sides in position prior to drilling.</td>
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Any of these ideas could work - plus probably some others. BUT, the bottom two ideas are going to assure alignment the best. Just measuring and marking the location is NOT a good idea... as each piece of wood is slightly different and the measurements would end up being just a bit off. I prefer the bottom left technique as it really makes sure the seat and sides are flush.
D. I decided to lay a side on the table and align with the seat in a vertical position (the bottom left option from the preceding table). I then clamped the pieces together and placed two 2x2s in place so that I would know the right location for the 2x2s. You can see what this looked like in the figure to the right. In the photo, I am getting ready to attach the horizontal 2x2 to the seat.

E. You will attach the 2x2 to the seat with two 2” screws. Before screwing the screws in, though, you need to drill pilot holes in the wood with a drill bit whose diameter is slightly smaller than the diameter of your screws. I used a 3/32” drill bit. BUT, before, you drill, you need to mark the locations of the pilot holes. Refer back to the Plan View of the Seat for locations of the screws (and, consequently, the pilot holes). The figure below on the left shows two pilot holes drilled and their locations.

F. After drilling the pilot holes, screw in the screws. Check your work - does it look good? Are the edges of the sides aligned well with the seat?

G. Guess what → now you get to the same thing 3 more times for the 3 other 2x2s. After finished, your seat should look as shown below.

**Step Four: Attaching the Sides to the 2x2s**

It would be GREAT if the outside of your stool did not have any screws that were visible (it would look a lot nicer to not have screws showing). And, if our stool were a bit bigger, we could do this. In addition, one point of this workshop is to show you several ways of joining wood. So, we’ll connect two sides with screwheads not showing on the outside of the stool and two with screwheads showing on the outside of the stool.
A. To align a side prior to drilling pilot holes, you generally have the same options as when attaching the 2x2s to the seat. Do this however you think is best, but end up with a side clamped to the seat... somewhat like what is shown in the following figure (in which “Side 1” is clamped in position to the seat)

B. Mark locations for pilot holes on the 2x2- making sure they are not going to hit the screws attaching the 2x2s to the seat. You can pick a good location (it is not specified on the drawing).

C. After drilling pilot holes, put glue on all surfaces of Side 1 that will connect with another piece of wood.

D. Attach Side 1 with screws. Wipe off any excess glue with a shop cloth.

E. Repeat for Side 2.

F. Sides 3 and 4 must be attached with screws from the outside of the stool – there is no room to attach from the inside. For each one, mark the locations of the screws on the side. I put the screws 2.5 inches from the outer edge of the stool and 1.5 inches down from the top of the stool (as shown on the Overall Isometric View drawing).

G. After marking the locations, you should use a countersinking drill bit for Sides 3 and 4 because these screws are on the outside of the stool. Call over an instructor to show you the countersinking bit once your holes are marked and you are ready to drill. As with the prior sides, glue and screw Sides 3 and 4 to the seat.

**Step Five: Attaching Sides to Each Other**

A. To attach the sides to each other, you'll use a new type of joint: directly screwing into the end of the plywood. This method does not work well for thin pieces of wood... but this 15/32” plywood is thick enough.

B. Mark the locations of the holes on each corner. As shown on the Overall Isometric View drawing, put three screws on each corner, one 4 inches from the top, one halfway, and the other 2 inches from the bottom.

C. Drill countersunk holes for the pilot holes. Be careful to push the drill straight in - the end grain that you are drilling into is narrow!

D. Once all countersunk pilot holes are finished, screw in 9 screws. You can use shorter screws for this if you want to, but a 2” screw is fine.

E. Sweep up your workspace from any sawdust resulting from drilling.

**Step Six: Finishing the Stool**

A. You should sand all sides of the stool with a random orbital sander. Do this outside and wear a dust mask while sanding. Work up from coarser paper to finer paper.

B. If you want, you can use a jigsaw to form handles on the stool... or perhaps router the edges of the seat to give them a bevel or radius ... or put some wood putty in cracks to improve how your stool looks.

C. Clean up... put away tools.