

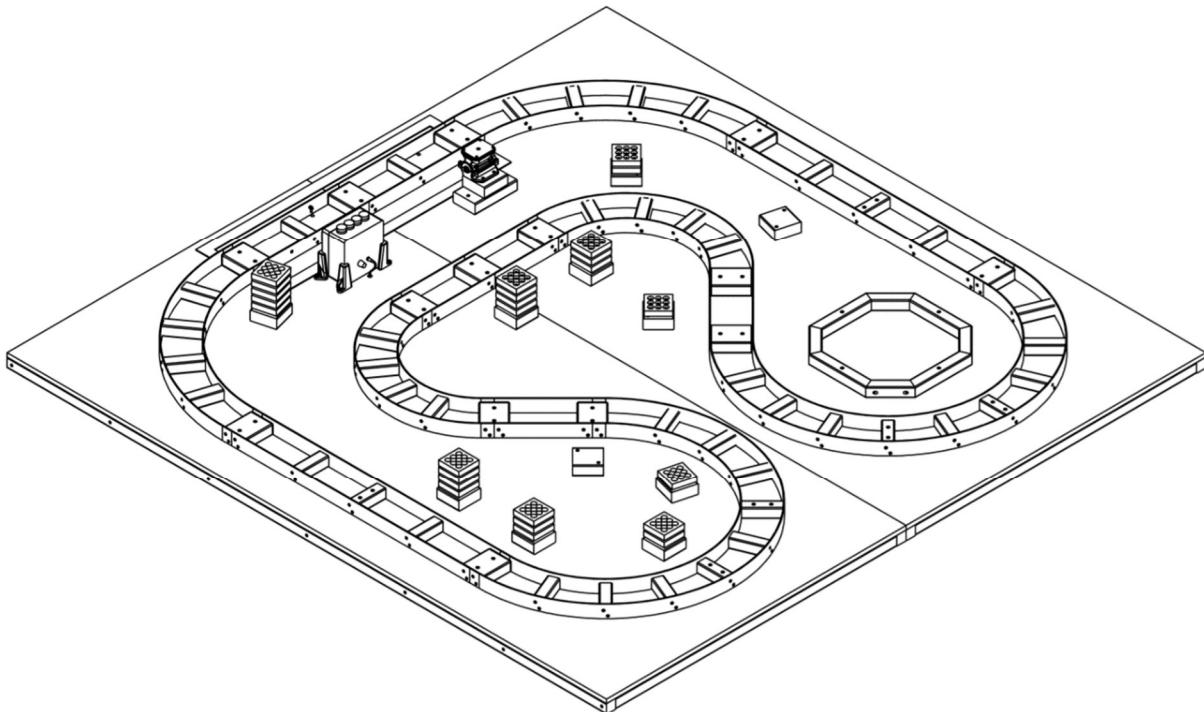


COURSE CONSTRUCTION SPECIFICATIONS

Mission
JDG2020

CLASSIFIED CLASSIFIED
CLASSIFIED TOP SECRET
CLASSIFIED

QUEBEC Engineering Games
Mission JDG 2020 : Change the world
Course construction specifications
École de Technologie Supérieure



Design, drawings and redaction by:
Alexandre Mongrain
VP Machine:
Gabriel Lévesque
With:
Pierrick Arsenault
Benjamin Fevereiro



Table of contents

1. Rails	4
1.1.BUILDING THE LINKS	4
1.2.PARTIAL ASSEMBLING.....	7
2. COURSE.....	11
2.1.BUILDING THE PLATFORM.....	11
2.2.TRACING THE POSITIONING.....	18
3. CHALLENGE COMPONENTS	21
3.1.PACKAGING STATION	21
3.2.MAKING THE TRAYS.....	23
3.3.TRAY BASES	26
3.4.DISPENSER	27
4. FINAL ASSEMBLY.....	29
4.1.INSTALLATION OF THE RAILS.....	29
4.2.INSTALLATION OF THE CHALLENGE COMPONENTS.....	32
4.3.ELECTRICAL POWER SUPPLY	34



1. Rails

1.1. Building the links

Required equipment

- (3x) spruce
2"x2"x8'
- (1x) spruce
2"x4"x8'
- Mitre saw
- 1/8" drill bit
- 3/32" drill bit
- Drill
- (4x) Provided drilling jig
- Two color Sharpie markers (Red and blue)
- Measuring tape
- Optional: Chamfer

Fabrication of the 42 2" x 2" links

- Cut the 42 lengths of 4- $\frac{3}{4}$ " with the 2"x2" on the Mitre saw.
 - The use of a stop on the Mitre saw is strongly recommended.
- Identify with an "X" a single long surface with a Sharpie (any color) on all cut pieces.
- Identify the two small surfaces of two different colours for all the pieces.
 - White jigs will be associated with the color on one side (red), and the blues will be associated with the color on the other side (blue).
- For each side, press the corresponding jig on its three bearing surfaces by pointing the arrow towards the surface identified by an "X" and drill in the holes with the 3/32" drill bit. Repeat for all pieces.
- For 6 of the 42 links, drill and chamfer (optional) two 1/8" mounting holes on the surface of the "X". (The location is not critical)

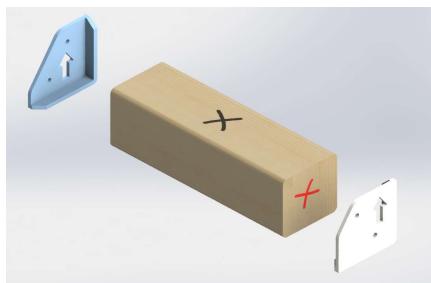


Figure 1.1 2"x2" link render with marks and jigs



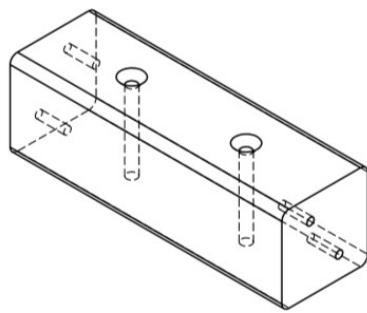


Figure 1.2 2"x2" link isometric view

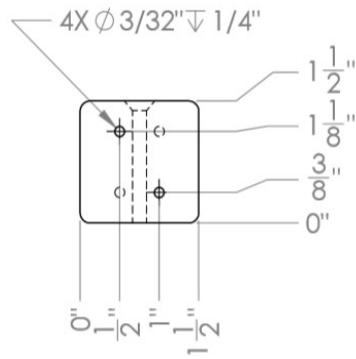


Figure 1.3 2"x2" link side view

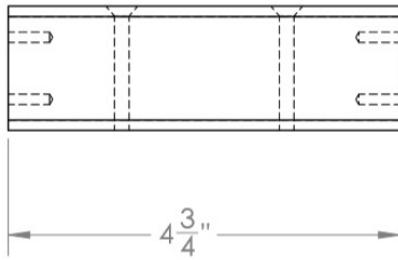


Figure 1.4 2"x2" link face view

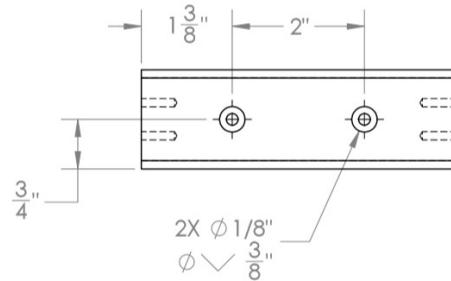


Figure 1.5 2"x2" link top view



Building the 14 2"x4" links

- Cut the 14 lengths of 4- $\frac{1}{2}$ " with the 2"x4" on the Mitre saw.
 - o The use of a stop on the Mitre saw is strongly recommended.
- Identify with an "X" a single long surface with a Sharpie (any color) on all cut pieces.
- Identify the two small surfaces of two different colours for all the pieces.
 - o White jigs will be associated with the color on one side (red), and blue jigs will be associated with the color on the other side (blue).
- For each side, press the corresponding jig on its three bearing surfaces by pointing the arrow towards the identified surface with an "X" and drill through the holes in the jig with the 3/32" drill bit. Repeat for all pieces.
- For all pieces, drill and chamfer (optional) two 1/8" fixing holes on the surface of the "X". (The location is not critical)

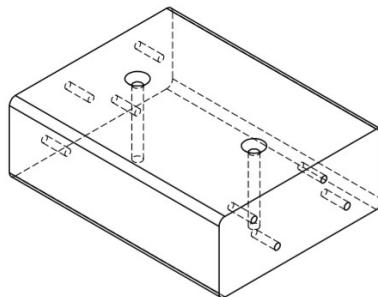


Figure 1.6 2"x4" link isometric view

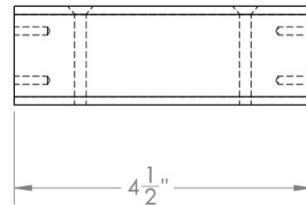


Figure 1.7 2"x4" link face view

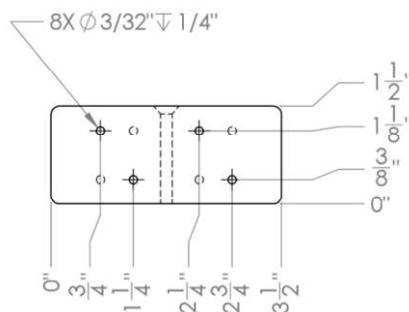


Figure 1.8 2"x4" link side view

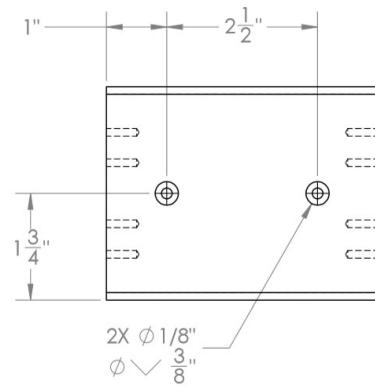


Figure 1.9 2"x4" link top view



1.2. Partial assembling

Required equipment

- (224x) 2" #8 countersunk head wood screws
- (42x) 2"x2" pre-drilled links
- (14x) 2"x4" pre-drilled links
- (28x) Continuity segments
- (4x) rails #1
- (2x) Internal rails #2
- (2x) External rails #2
- (4x) Rails #3
- (2x) Internal rails #4
- (2x) External rails #4
- (4x) rails #5
- (2x) Internal tracks #6
- (2x) External rail #6
- (4x) rail #7
- Drill
- S2 bit

Straight sections assembly

- For each pair of straight rails, assemble as below.
 - o A pair of rails #1 has additional holes to assemble the power wires, connect these two rails together.
 - o **IMPORTANT:** All "X's" must face up.
- Do not tighten the screws completely yet.

Table 1.1 Straight rails assembly bill of materials

No	Description	Qty.
1	Rail #1	4
2	Rail #3	4
3	Rail #5	4
4	Rail #7	4
5	Continuity segment	16
6	2"x4" pre-drilled link	8
7	2"x2" pre-drilled link	6
8	2"x2" pre-drilled link with fixation holes	2
9	2" countersunk head wood screws	64



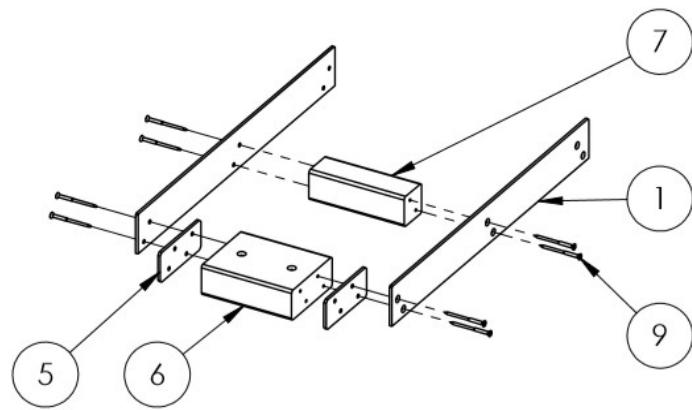


Figure 1.10 section assembly #1

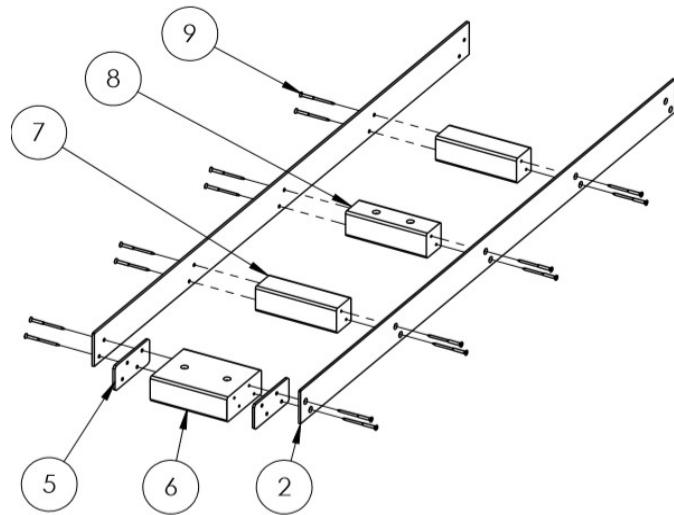


Figure 1.11 section assembly #3

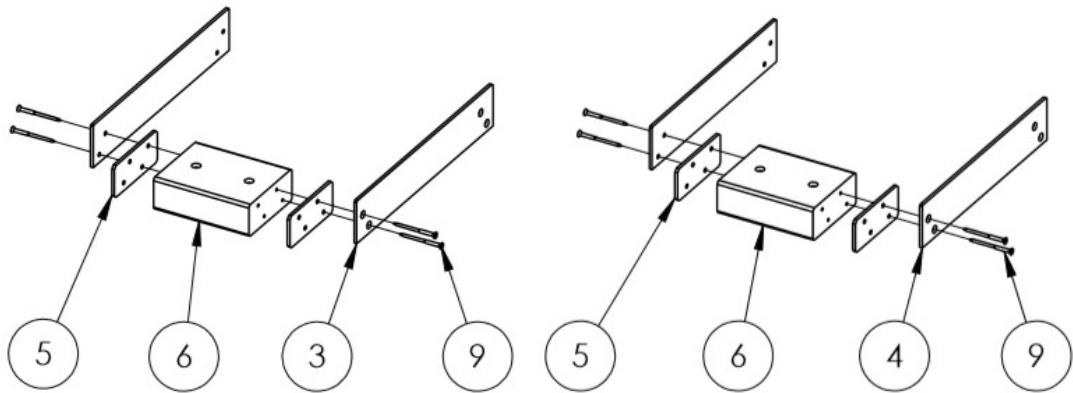


Figure 1.12 section assembly #5

Figure 1.13 section assembly #7



Curved sections assembly

- For each pair of curved rails, assemble as below.
 - o **IMPORTANT :** All "X's" must face up.
- Do not tighten the screws completely yet.

Table 1.2 Curved rails assembly bill of materials

No	Description	Qty.
1	Internal rail #2	2
2	External rail #3	2
3	Internal rail #4	2
4	External rail #4	2
5	Internal rail #6	2
6	External rail #6	2
7	Continuity segment	12
8	2"x2" pre-drilled link	30
9	2"x2" pre-drilled link with fixation holes	4
10	2"x4" pre-drilled link	6
11	2" #8 countersunk head wood screws	80

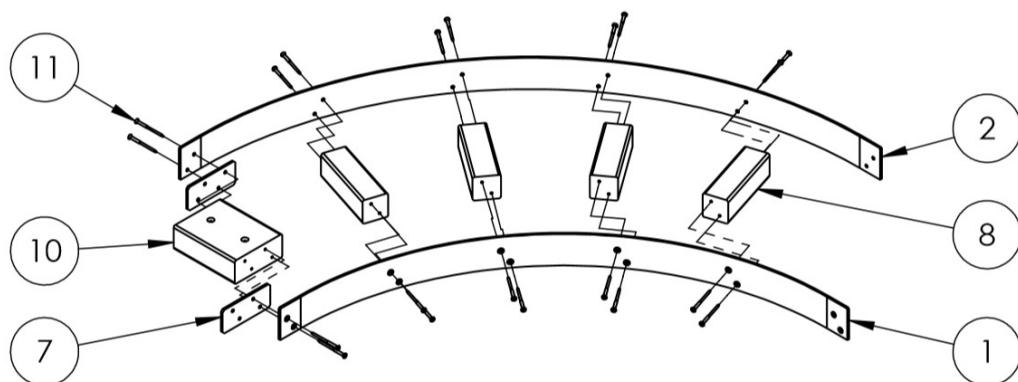


Figure 1.14 Section assembly #2



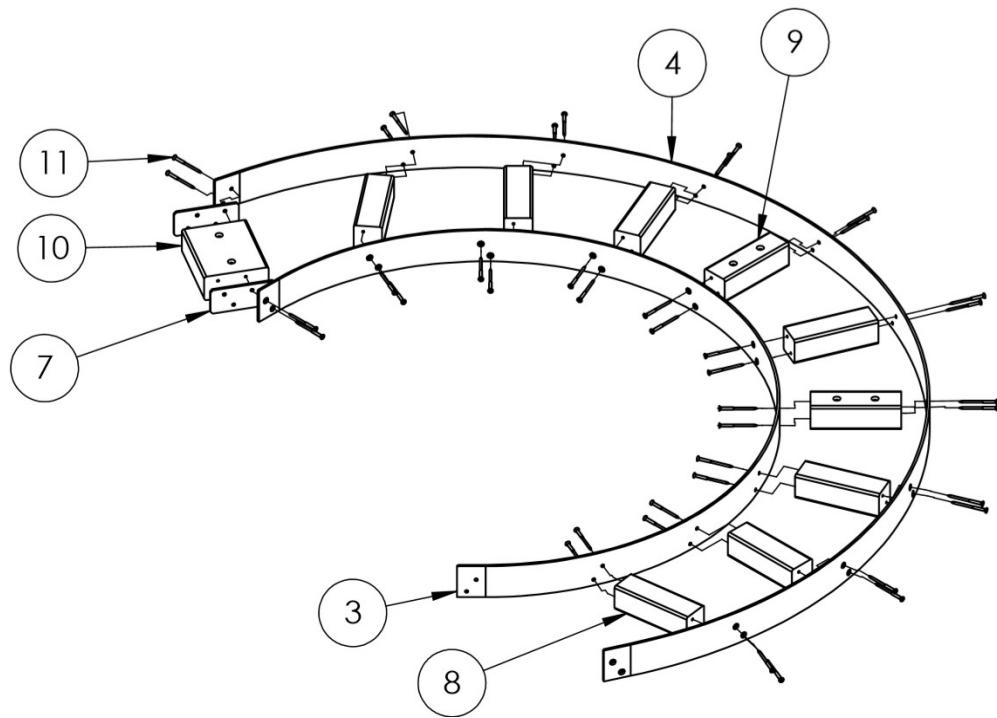


Figure 1.15 section assembly #4

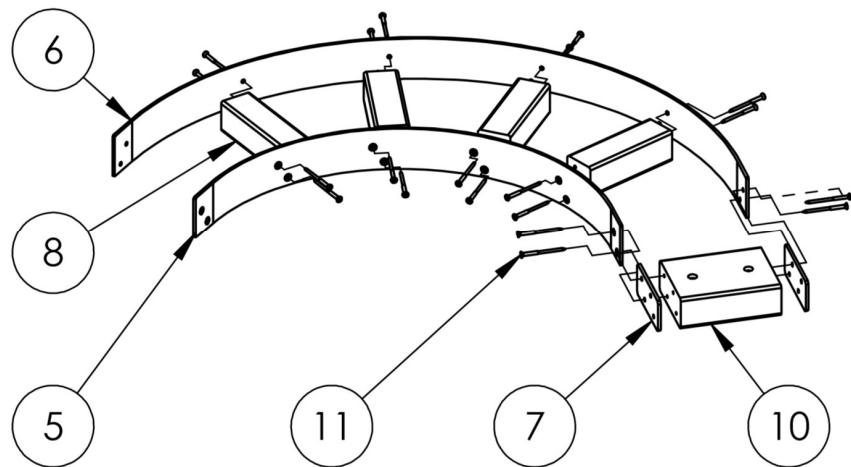


Figure 1.16 section assembly #6



2. Course

2.1. Building the platform

Required equipment

- (3x) 3-1/2" 1/4-20 hex head screw
- (3x) 1/4-20 nut
- (6x) 1/4-20 washer
- (28x) 3" #8 countersunk head wood screws
- Drill
- (52x) 2" #8 countersunk head wood screws
- (2x) 3/4"x4'x8' plywood
- (11x) 2"x2"x8' spruce
- Mitre saw
- 5/32" drill bit
- 5/16" drill bit
- 1/2" drill bit
- 7/16" wrench
- Pencil
- Measuring tape
- S2 bit

Frame cutouts

- Select the 4 straightest 2 "x2 "x8' solid lengths and set them aside.
- Among the rest, cut with a mitre saw 14 lengths of 2 "x2" of 48" less the thickness of two of the 2"x2" of 8' (nearly 45").

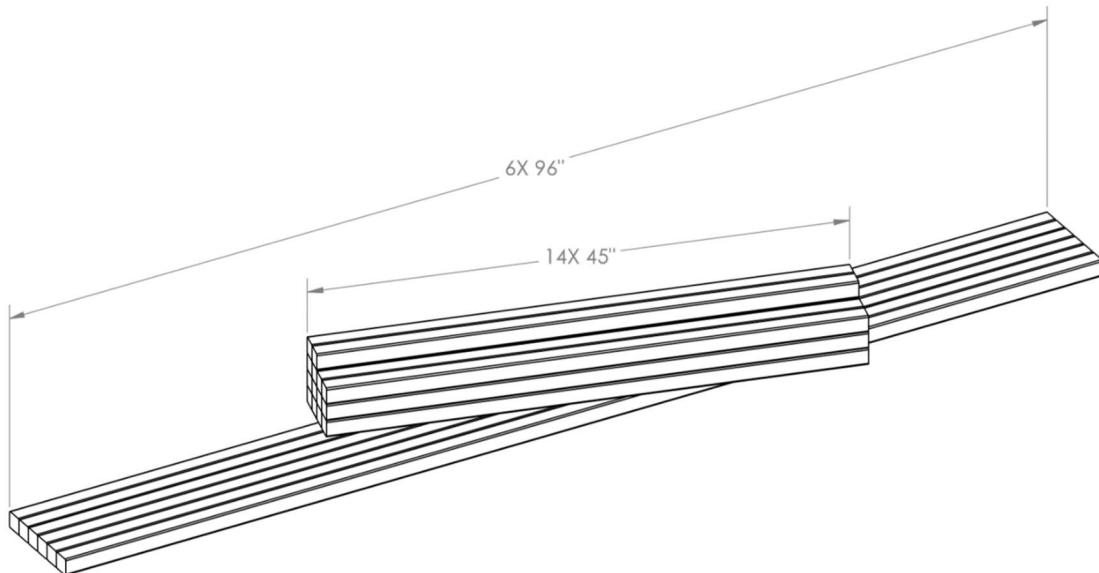


Figure 2.1 Cut lengths for the frame



Frame assembly

- On one of the surfaces of the 8' lengths, draw 7 marks every $15\frac{3}{4}$ " starting at $\frac{3}{4}$ ".

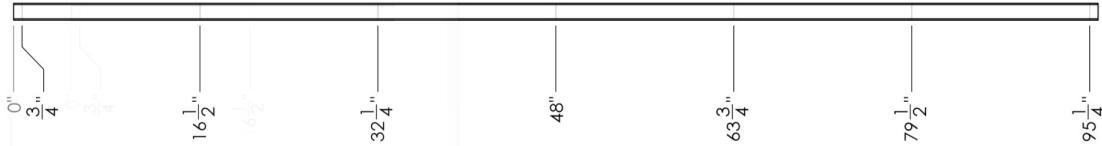


Figure 2.2 Markings on 8' 2"x2"

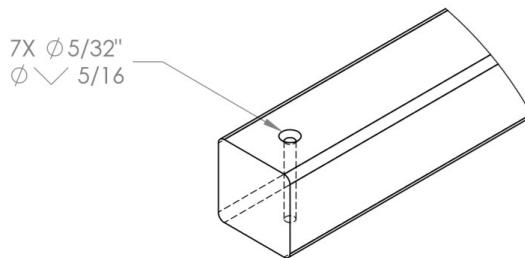


Figure 2.3 8' 2"x2" drilling

- Drill with a 5/32" drill bit in 8' lengths vis-a-vis the center of the marks.
 - o Optionally use a drill bit with integrated chamfering cutter.
- On the opposite side of the drilling chamfer, draw 6 marks at every $15\frac{3}{4}$ " starting at $15\frac{3}{4}$ ".
- Form a frame with 2 lengths of 8' and 2 lengths of 45".
- Evaluate perpendicularity with the distance from opposite corners. A difference of $\frac{1}{2}$ " between the two measures is acceptable.
- Screw the frame with 3" screws.
 - o If necessary, use clamps to keep the pieces flat on a work surface.



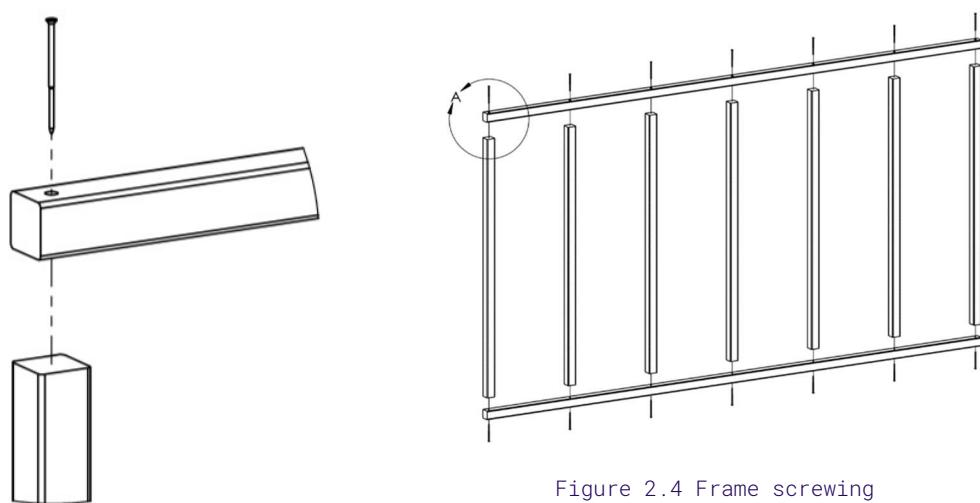


Figure 2.4 Frame screwing

DETAIL A

Figure 2.5 Detail view of frame screwing

- Screw the 5 reinforcements with 3" screws using the previously made marks.
- Repeat a second time in order to have a second identical frame.
 - o **Warning:** the frame is fragile and should only withstand slight effort.



Union bolts assembly and drilling of wires clearance holes

- Place the two frames side by side in the direction of the 8'. Make sure that the two adjacent 2"x2" are well supported and at the same height.
- At about 8" from each end and 45" near the center, drill 5/16" holes through the two 2"x2".

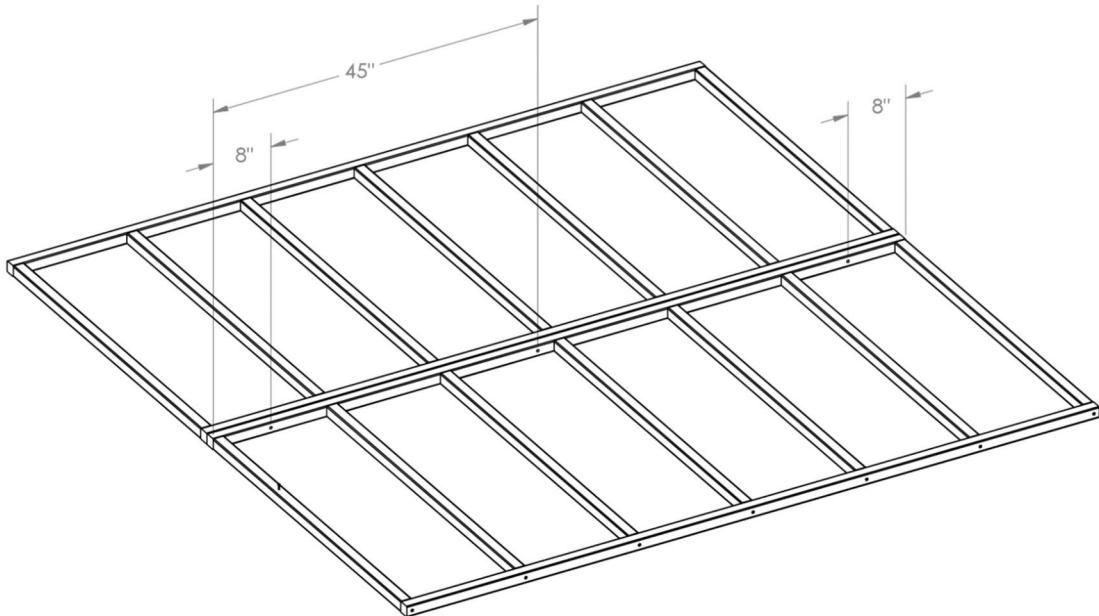


Figure 2.6 Union bolts holes drilling

- Assemble and tighten the $\frac{1}{4}$ "-20 bolts as shown below.

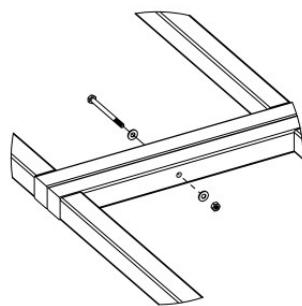


Figure 2.7 Union bolts assembly



- Drill the holes as shown below with a drill bit $\frac{1}{2}$ ".

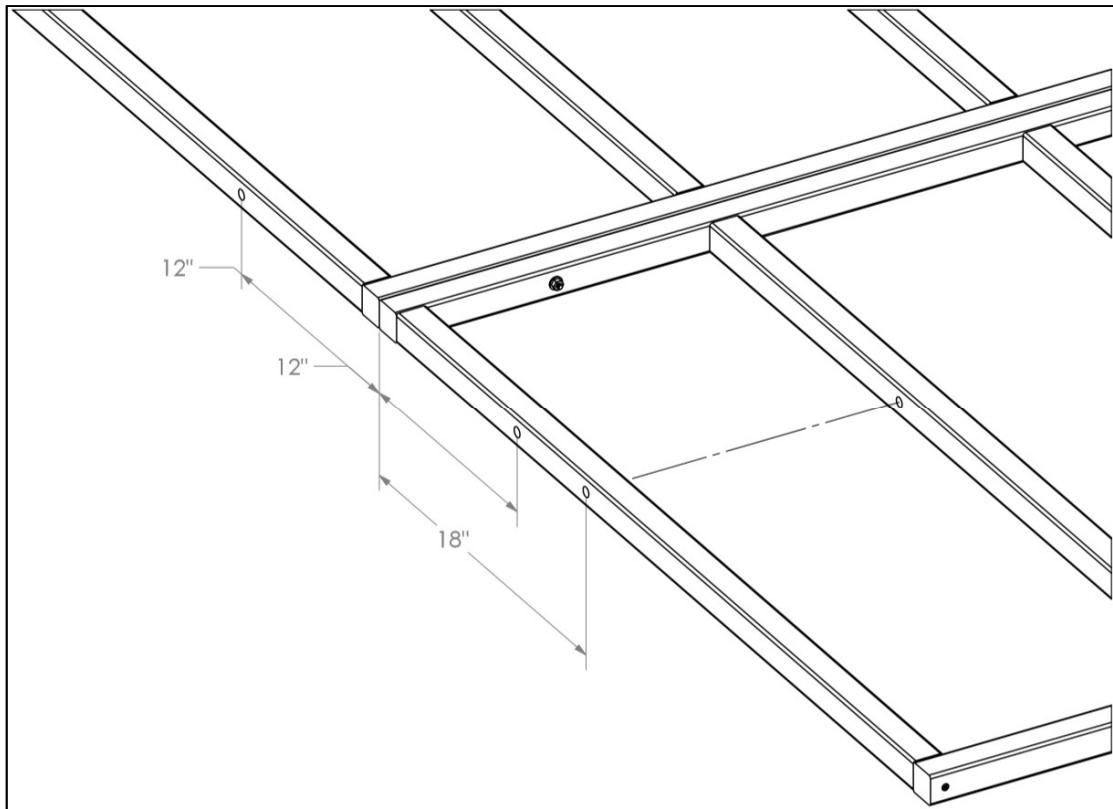
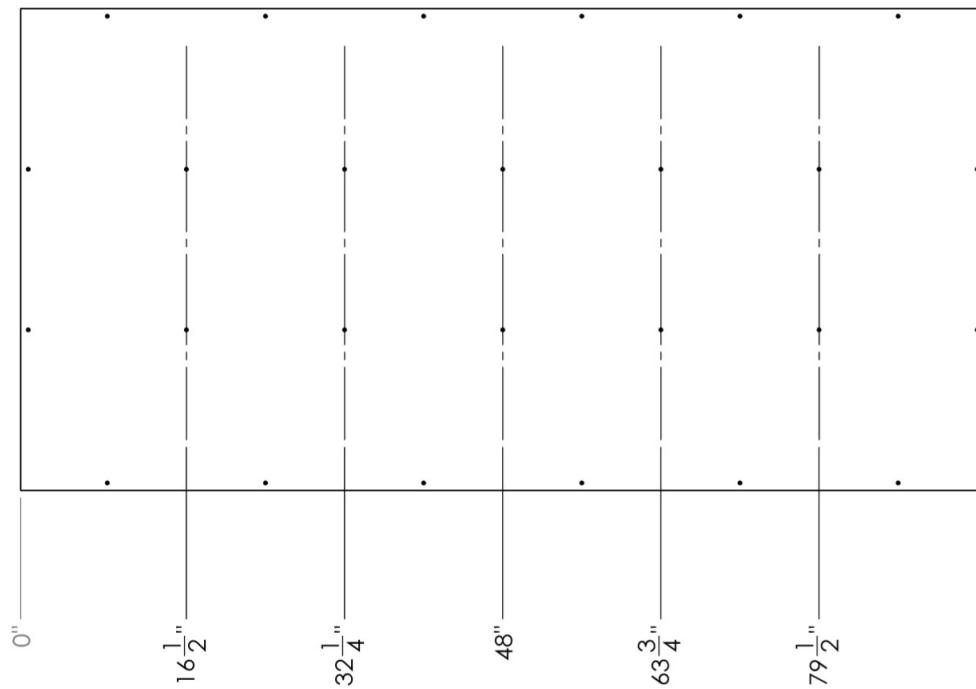


Figure 2.8 Drilling of wires clearance holes



Plywood screwing

- Draw 5 lines at each $15\frac{3}{4}$ " starting from $\frac{3}{4}$ " on the plywood to locate the frame reinforcements.



Marking of the position of frame reinforcement

- Lay both frames flat on the ground and place the two sheets of plywood on top, with marks facing upwards. Press the two sheets of plywood together firmly to minimize the crack.
- Screw the plywood onto the frame as shown.
 - o Straighten the frame by screwing it in so that it takes the shape of the plywood.



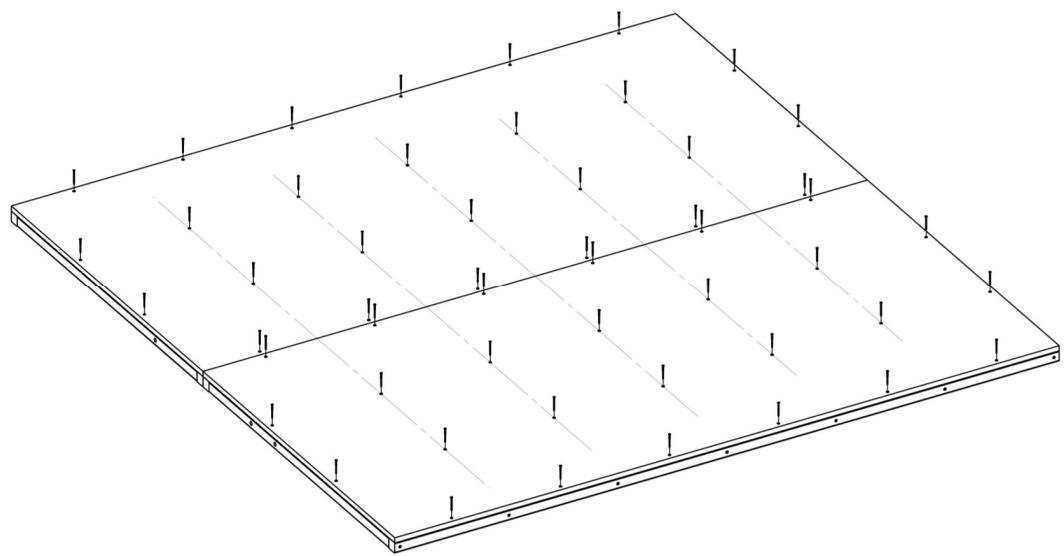


Figure 2.9 Screwing of the plywood onto the frame



2.2. Tracing the positioning

Required equipment

- Pencil
- Measuring tape

Marking

- Delete existing lines on the plywood.
- On the assembled platform, draw the lines shown on the following drawings.
 - For more accuracy, draw two marks at the ends and connect them with a straight ruler.
 - An accuracy of $\pm 1/16"$ on the marking is sufficient.



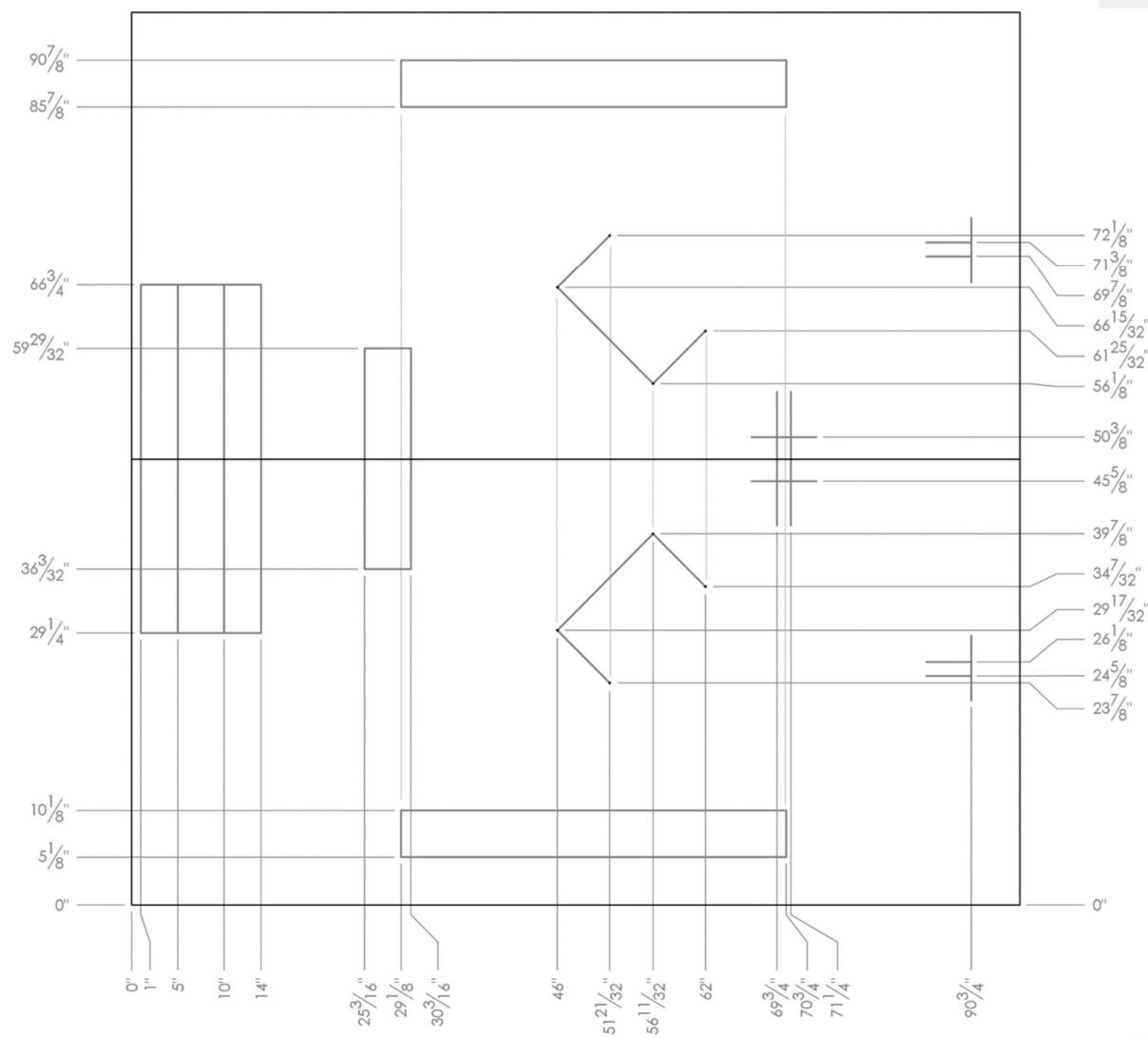


Figure 2.10 Marking of the tracks position



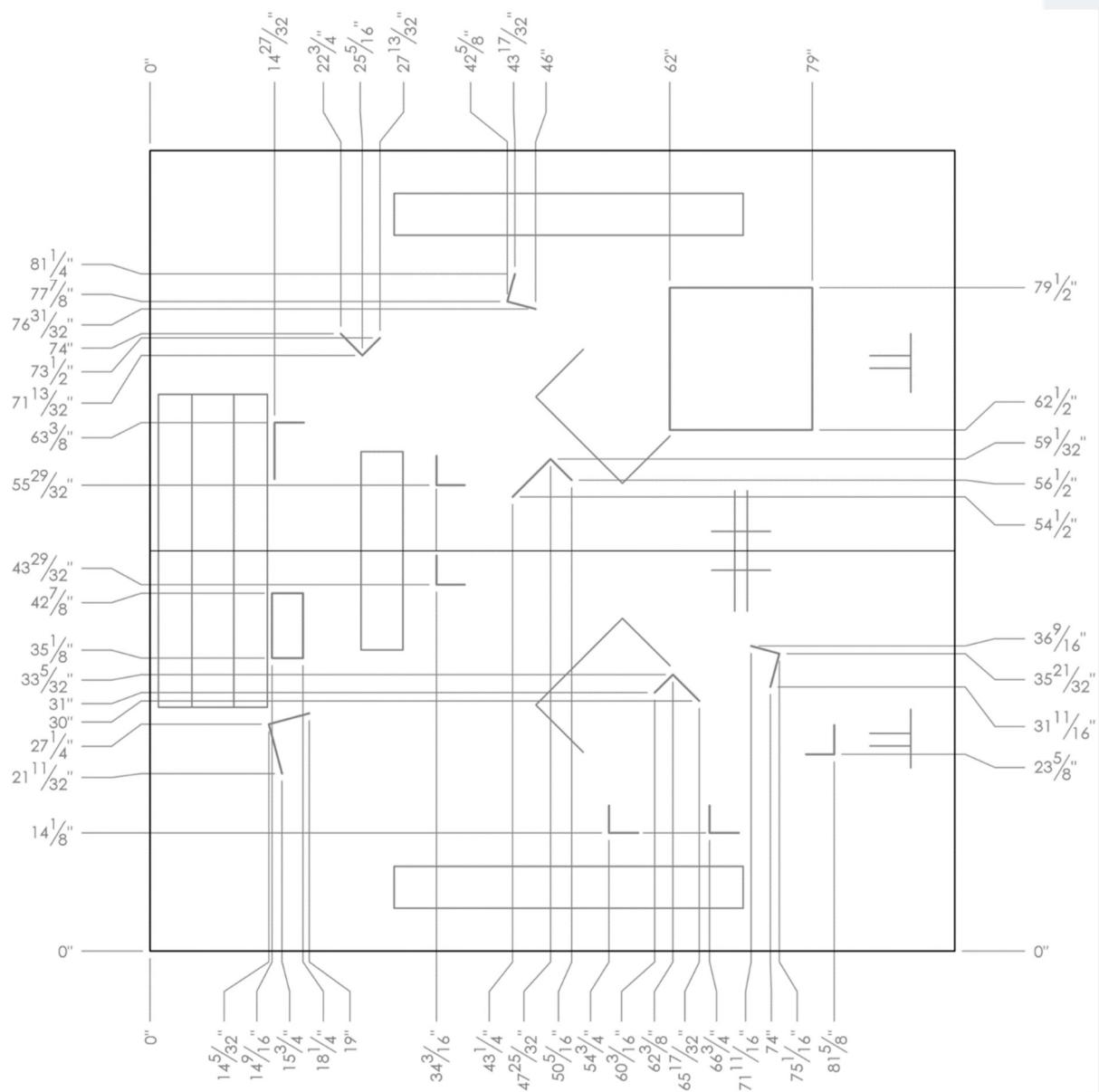


Figure 2.11 Marking of the challenge elements positions



Challenge components

2.3. Packaging station

Required equipment

- **(8x)** 3" #8 countersunk head wood screws
- **(1x)** spruce 2"x2"x8'
- Drill
- Mitre saw
- S2 bit
- 1/8" drill bit
- Measuring tape
- Optional: Chamfer bit

Cutting

- Cut 4 pieces for each drawing below.

Assembly

- Pre-drill angle holes on the small pieces.
- Assemble the 8 pieces with the 3" screws.
 - If necessary, use clamps to keep the pieces flat on a work surface.



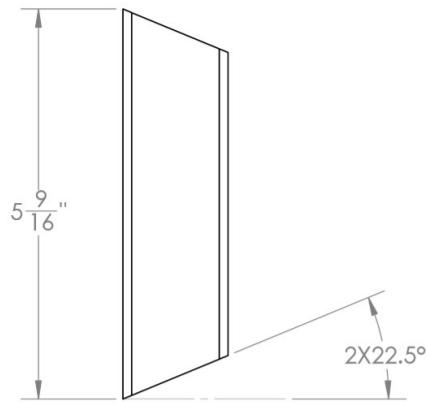


Figure 0.1 Small piece top view

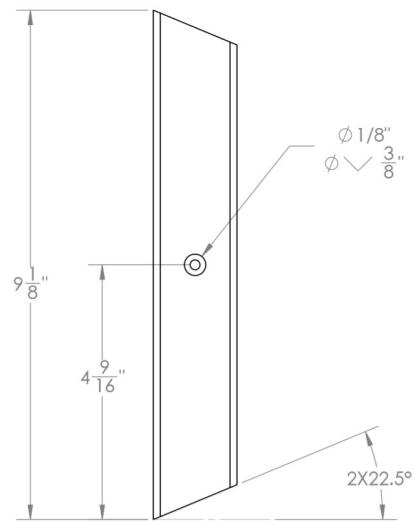


Figure 0.2 Big piece top view

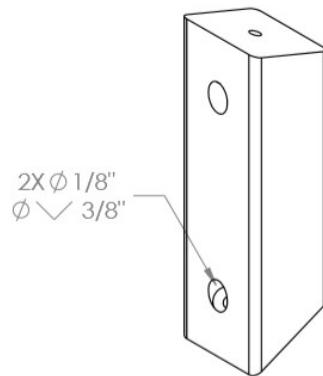


Figure 0.3 Small piece isometric view

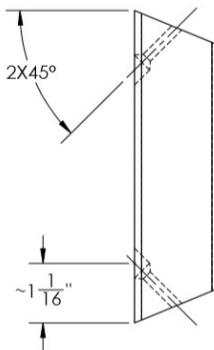


Figure 0.4 Small piece drilling location

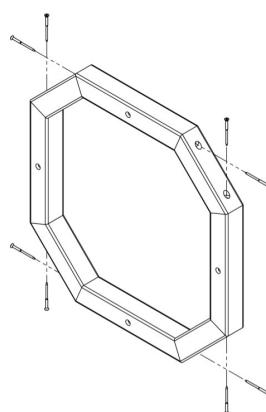


Figure 0.5 Assembly isometric view



2.4. Making the trays

Required equipment

- (1x) 2'x4'x $\frac{3}{4}$ " MDF
- (1x) 2'x4'x $\frac{1}{4}$ " MDF
- Carpenter glue
- Clamps
- Pencil
- Press drill
- Mitre saw
- Banc de scie
- 1/8" drill bit
- Measuring tape
- 11/16" drill bit OR
5/8" drill bit
(Forstner bit or
Spade drill bit)

Cutting

- Cut 2 strips of 3 $\frac{1}{4}$ " the MDF sheet $\frac{3}{4}$ " on its long side.
 - o Optionally, without a saw bench, cut 5 times in the short side, on two opposite cuts (normally a miter saw is able to cover a little more than 1' per cut).
- On the mitre saw, cut the MDF strips $\frac{3}{4}$ " into pieces of 3 $\frac{1}{4}$ " to have 25 pieces.
- Cut 2 strips of 2 $\frac{1}{2}$ " the MDF sheet $\frac{1}{4}$ " on its long side.
 - o Optionally, without saw bench, cut 4 times in the short side, on two opposite cuts
- On the mitre saw, cut the MDF strips $\frac{1}{4}$ " into pieces of 2 $\frac{1}{2}$ " to have 25 pieces.

Drilling

- On the 25 pieces of MDF $\frac{3}{4}$ ", draw the center of the holes.
- Pre-drill on the marks using a 1/8" drill bit on the column drill.
- Drill in the guide holes with an 11/16" drill bit.
 - o You can use a 5/8" drill bit for an almost equivalent result.



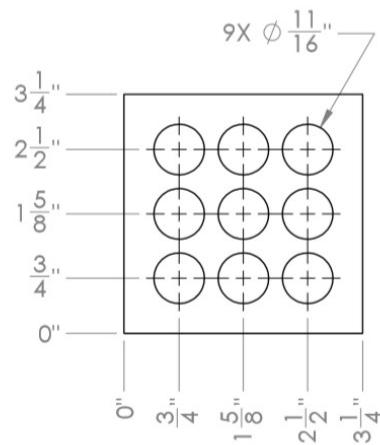


Figure 0.6 ¾" MDF drawing

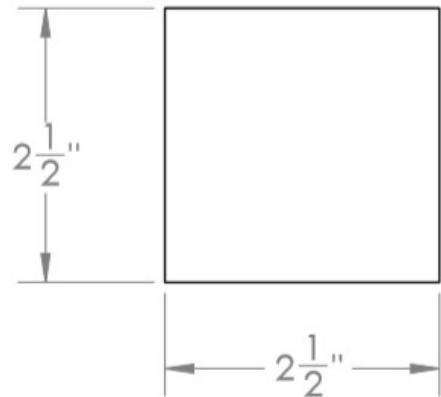


Figure 0.7 ¼" MDF drawing

Glueing

- Spread glue on one of the two surfaces of a piece of MDF ¼".
- Position a piece of MDF ¼" to cover one end of the holes as shown below.
- Tighten the two parts together with a clamp and leave them to stand for eight hours.
- Repeat for the other 24 pairs of pieces.



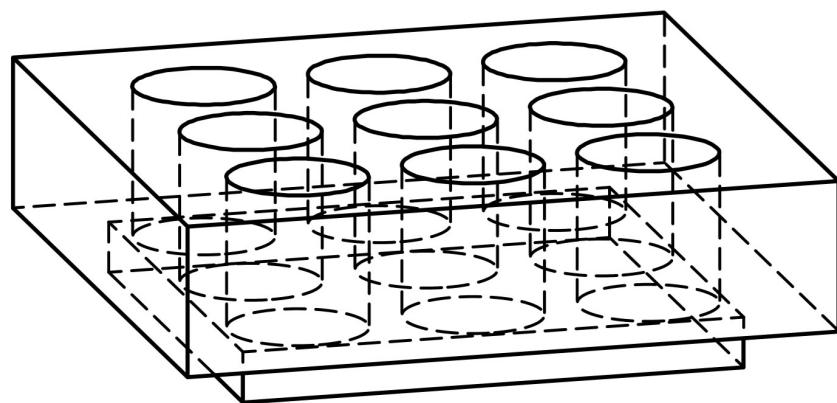


Figure 0.8 Tray isometric view

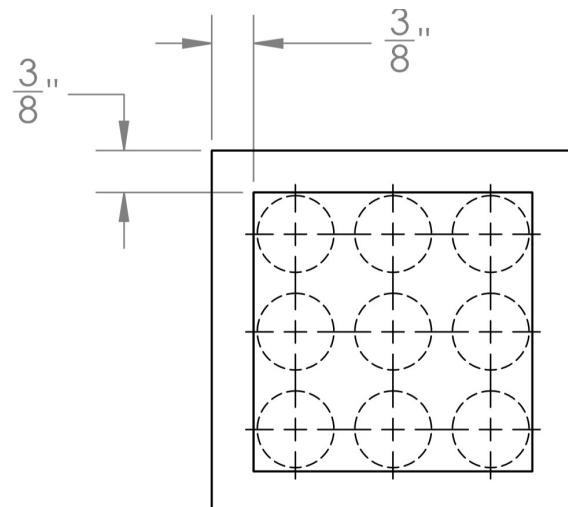


Figure 0.9 Relative position of each parts



2.5. Tray bases

Required equipment

- (1x) 2"x4"x8' spruce (39" required)
- Mitre saw
- 1/8" drill bit
- Measuring tape
- Optional: Chamfer bit

Fabrication

- Cut 11 pieces of $3\frac{1}{2}$ " out of the 2"x4".
- Drill and chamfer (optional) two 1/8" holes for mounting as shown in the drawing below. Location is not important.

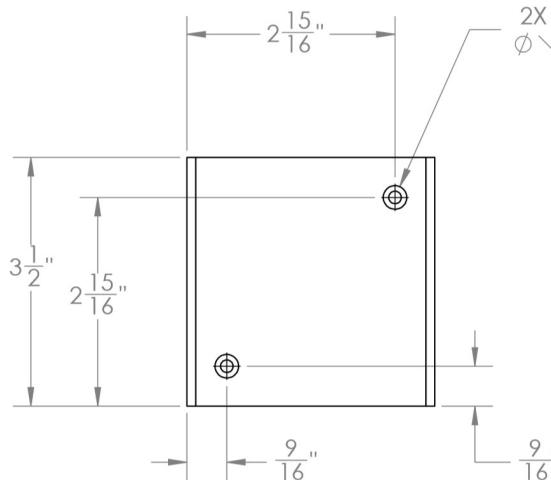


Figure 0.10 Holes position on the base

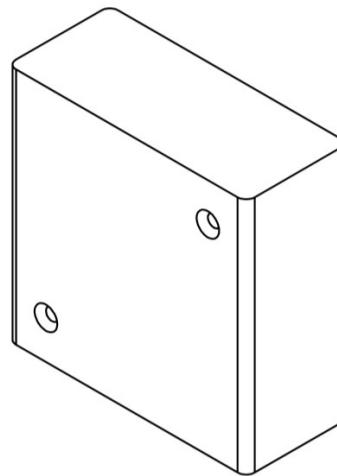


Figure 0.11 Base isometric view



2.6. Dispenser

Required equipment

- (4x) 2" #8 countersunk head wood screws
- (1x) 2"x4"x8' spruce (10½" required)
- Mitre saw
- 1/8" drill bit
- 3/32" drill bit
- Drill
- S2 bit
- Measuring tape
- Optional: Chamfer bit

Fabrication

- Cut 1 piece of 6¾" out of the 2"x4".
- Cut 1 piece of 3¾" out of the 2"x4".
- Drill the 1/8" holes as shown below.
 - o Location is not important.
 - o Chamfers are optional.
- Screw the small piece onto the large one. Tightly tighten the screw to prevent the head from protruding.
- Pre-drill the 3/32" holes with the dispenser in place.
- Screw on the dispenser.

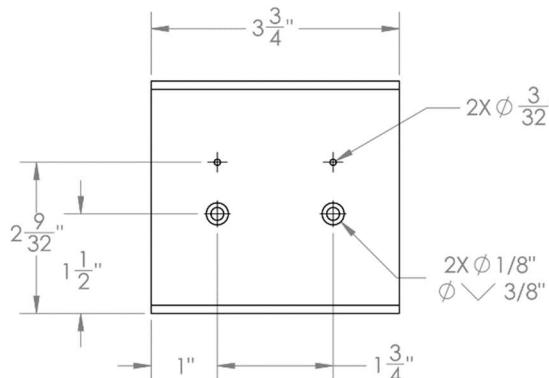


Figure 0.12 Assembly isometric view

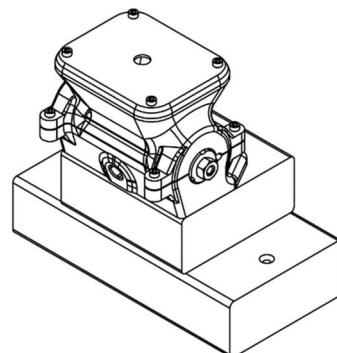


Figure 0.13 Assembly isometric view



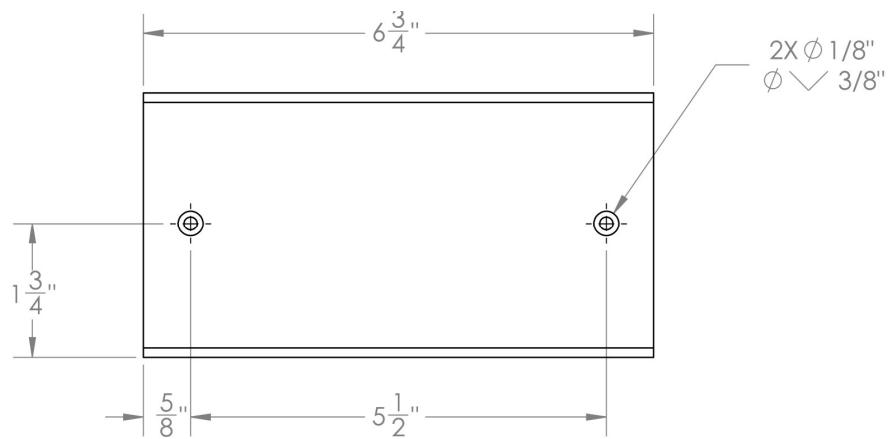


Figure 0.14 Big piece drilling

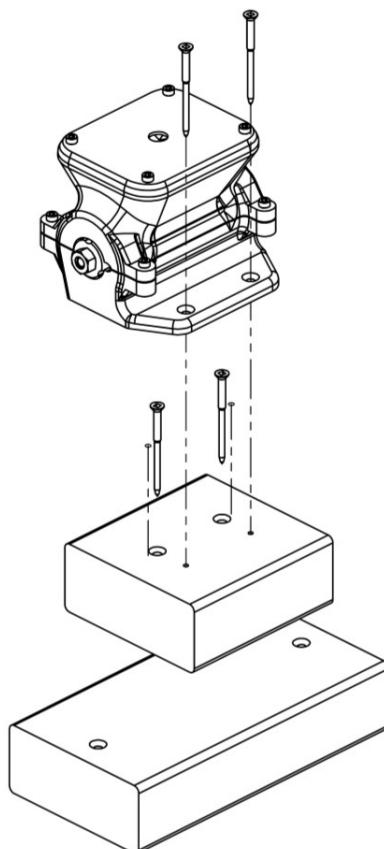


Figure 0.15 Assembly exploded view



3. Final assembly

3.1. Installation of the rails

Required equipment

- **(92x)** 2" #8 countersunk head wood screws
- **(2x)** Preassembled sections #1
- **(2x)** Preassembled sections #2
- **(2x)** Preassembled sections #3
- **(2x)** Preassembled sections #4
- **(2x)** Preassembled sections #5
- **(2x)** Preassembled sections #6
- **(2x)** Preassembled sections #7
- Assembled course
- Drill
- S2 bit

Assembly

- Flat on the ground, pre-assemble all sections together, without tightening the screws.

Table 3.1 Track assembly bill of materials

No	Description	Qty.
1	Preassembled section #1	2
2	Preassembled section #2	2
3	Preassembled section #3	2
4	Preassembled section #4	2
5	Preassembled section #5	2
6	Preassembled section #6	2
7	Preassembled section #7	2
8	2" #8 countersunk head wood screws	56



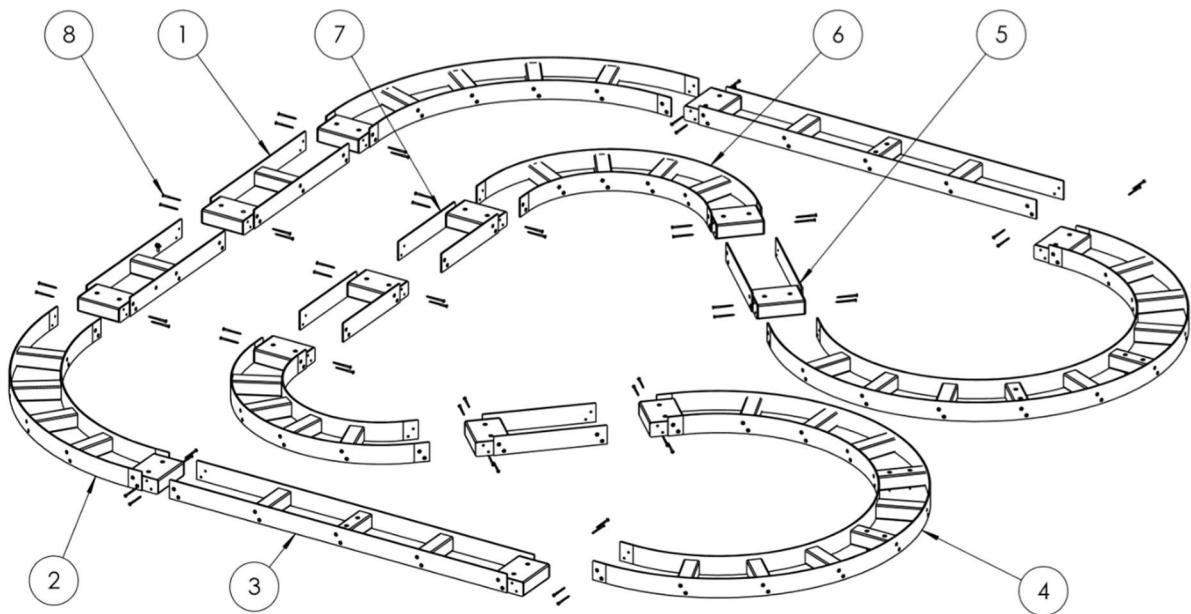


Figure 3.1 Tracks assembly exploded view

- Position the flexible assembly by section No. 1 using the course marks.
- Screw in the sections No. 1.
- Repeat for sections No. 7, 3, 4 and 5 in this order.
 - o For the last sections, it is possible that it is necessary to apply a little pressure.
- Gradually tighten all link screws starting from section No. 1.
 - o **IMPORTANT :** Tighten **gradually** to avoid deforming the rails.



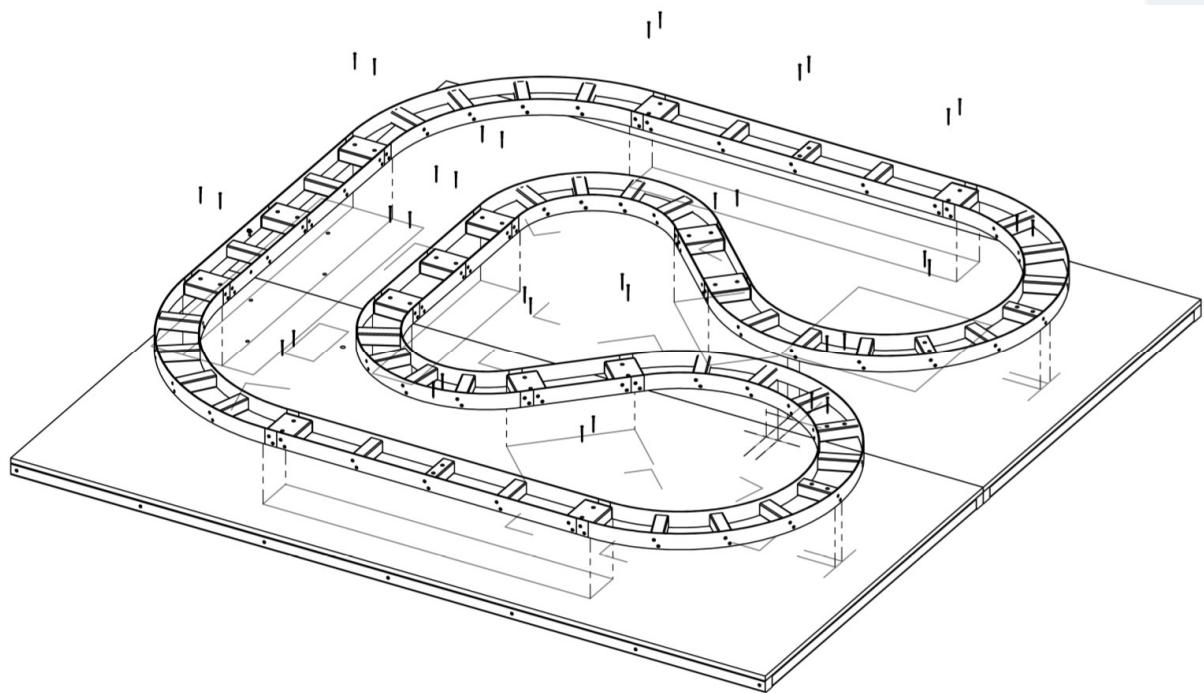


Figure 3.2 Track position on the terrain



3.2. Installation of the challenge components

Required equipment

- (32x) 2" #8 countersunk head wood screws
- Assembled distributor
- Drill
- (11x) Tray base
- Generator
- (4x) Generator support
- (1x) Packaging station
- Assembled course with tracks
- S2 bit

Assembly

- Screw the elements to the marks in the course as shown in the drawings below.

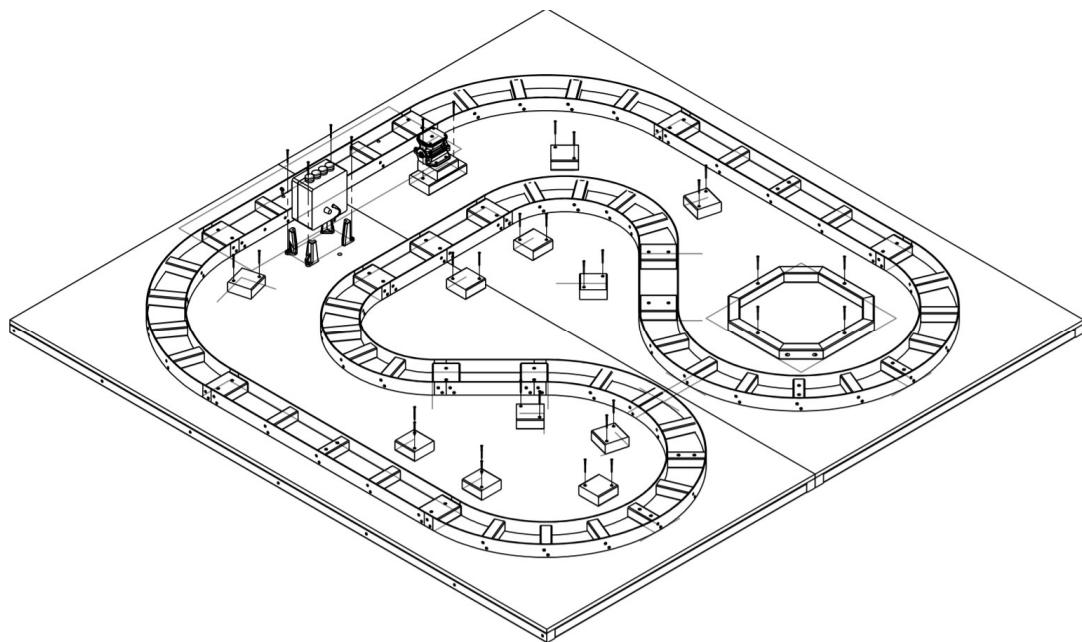


Figure 3.3 Challenge components position on the terrain



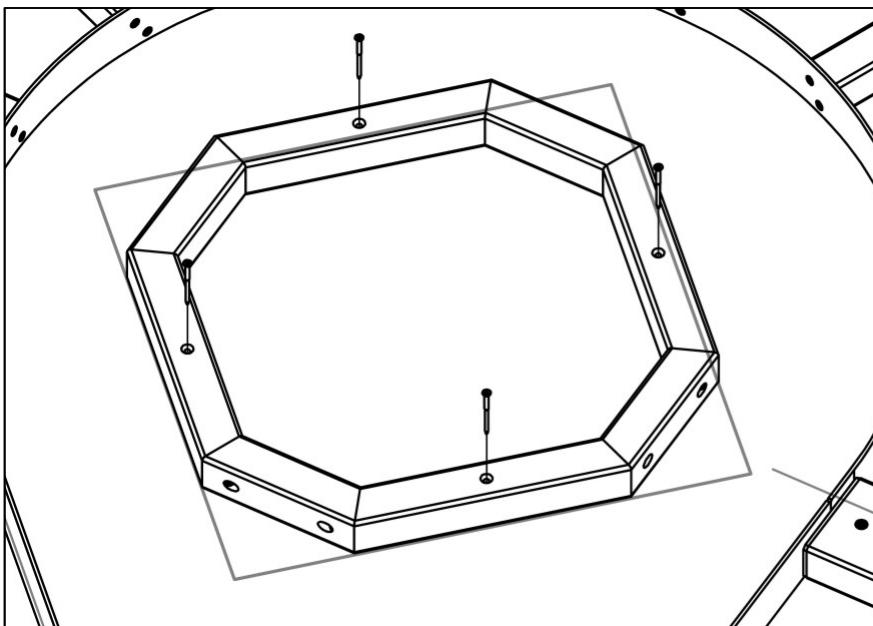


Figure 3.4 Packaging station assembly on its marks

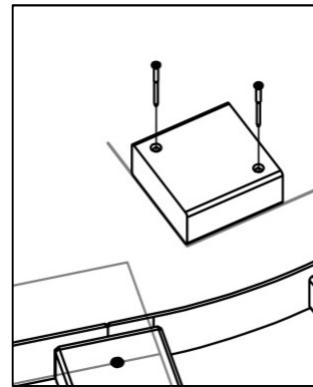


Figure 3.5 Tray station assembly on its marks

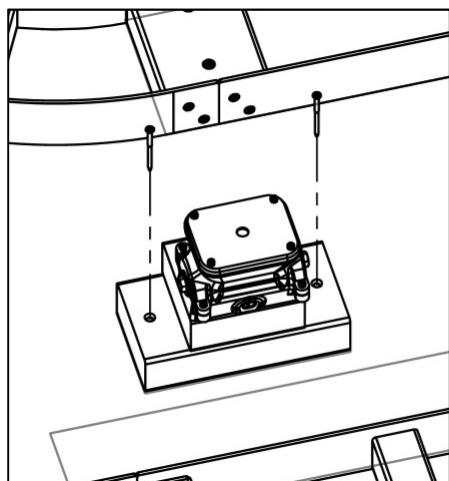


Figure 3.6 Distributor assembly on its marks

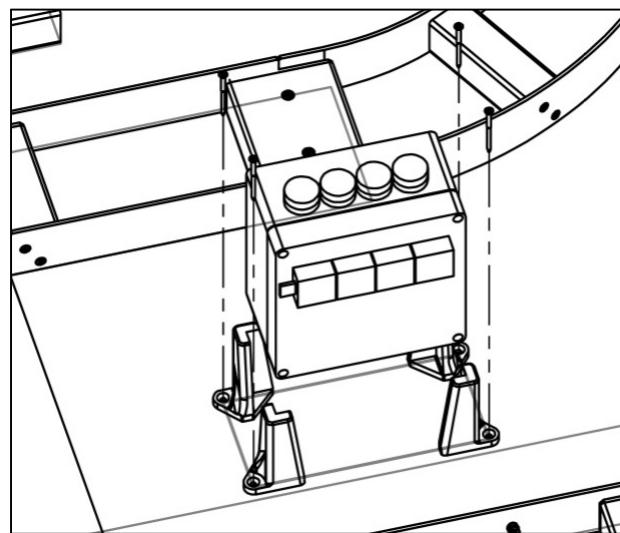


Figure 3.7 Generator assembly on its marks



3.3. Electrical power supply

Required equipment

- (2x) #8 countersunk head screw
- (4x) #8 nut
- (2x) #8 washer
- Drill
- $\frac{1}{2}$ " drill bit
- 11/32" wrench
- S2 bit screwdriver

Drilling for wire clearance holes

- With respect to the holes of the No. 1 rail connectors, drill a hole of $\frac{1}{2}$ " in the inside of the rails.
- Behind the generator, facing its power connector, drill a hole of $\frac{1}{2}$ " as close to the generator as possible. If necessary, mark the position and remove the generator before drilling.

Connector assembly

- Assemble the connector as shown below.

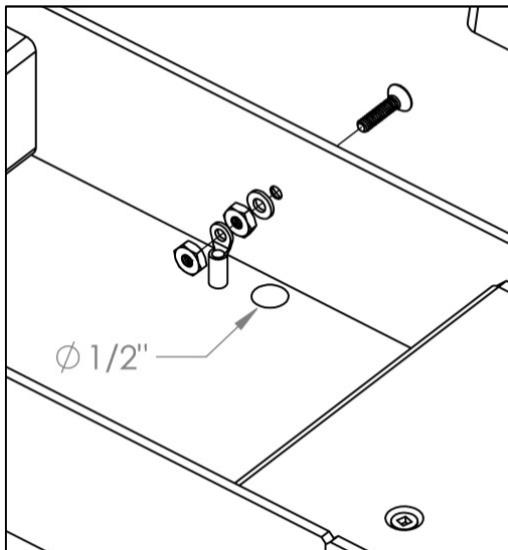


Figure 3.8 Connector assembly and tracks power supply wire holes

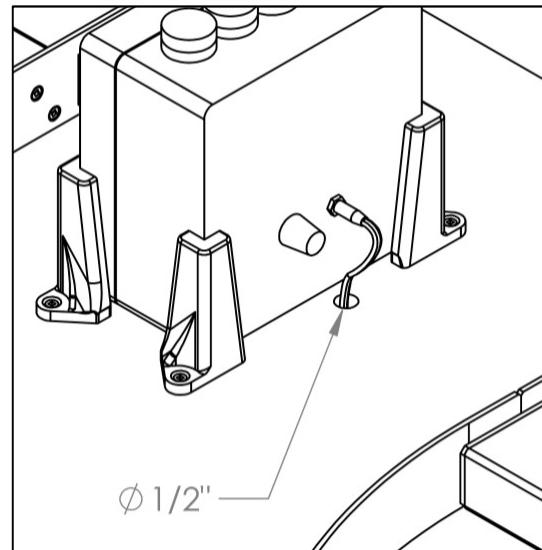


Figure 3.9 Generator power supply wire hole

