ARENA ASSEMBLY GUIDE 2022

5/22/2022

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Acknowledgements

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Dozens of people have contributed to the development and validation of these test methods. They include FEMA urban search and rescue task force teams, firefighters, law enforcement, collaborating test facilities, other civilian and military organizations, and commercial manufacturers.

Disclaimer

Commercial equipment shown in this document are for illustrative purposes only. This does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the products identified are necessarily the best available for the purpose.

NOTICE

The International System of Units (SI) is used throughout this document. Conversions from SI units to U.S. Customary units are made where possible but approximate equivalents are used to specify materials which are readily available in the domestic market or to avoid excessive fabrication costs of test apparatuses while maintaining repeatability and reproducibility of the test method results

Any issues please contact:

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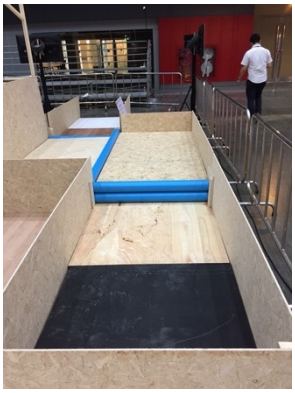
Existing arena from Mahidol to be used in 2022 RoboCup

(MAN 1) Center Between Objects

(MAN 2) Align Ground Contacts

(MAN 3) Traverse Incline

(MAN 4) Negotiate Leaning Objects

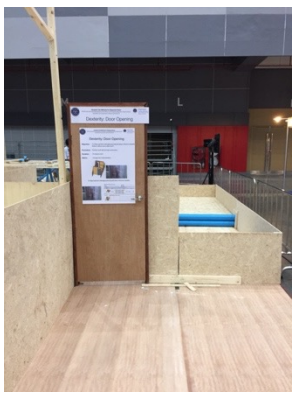


(OBS 2) Hurdles

(OBS 3) Stair with Optional Debris

(TER 1) Sand/Gravel

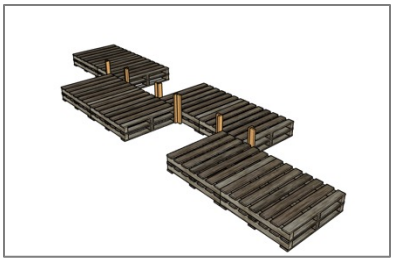
(DEX 5) Shoring



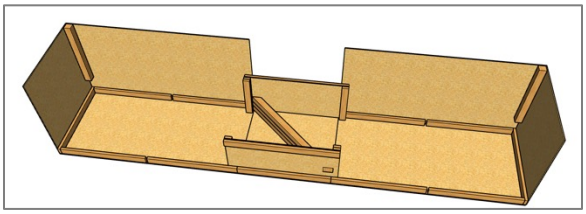
(DEX 6) Door Opening: (In-person finals only)

All task boards, omni, parallel and valve should be used.

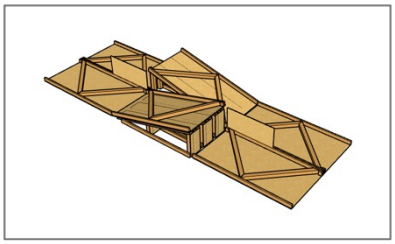
New Build for 2022 RoboCup



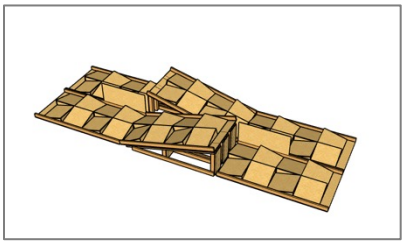
(MAN 5)
Pallet Terrain



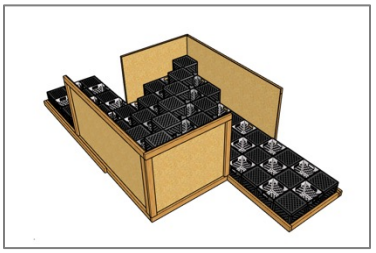
(OBS 1)
Variable Height Rails



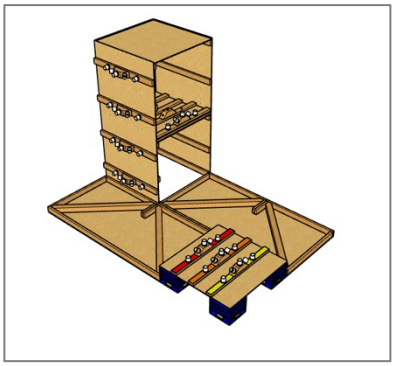
(TER 2)
K-Rails on Crossover Slope

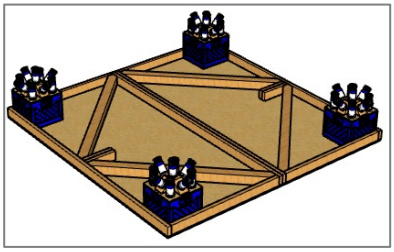


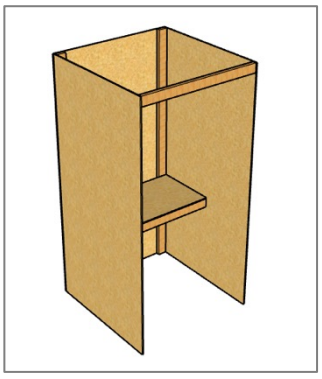
(TER 3)
Pinwheel Ramps on Crossover Slope



(TER 4)
Crate Terrain for Legged Robots







Note: We will be using most of the existing arena from Mahidol (Listed in green).

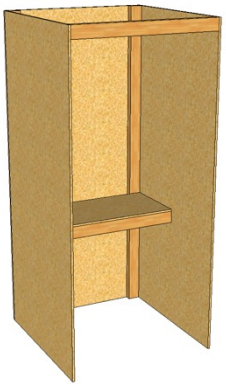
We will not have stepfields in this years design.

(MAN 1) Center Between Objects
(MAN 2) Align Ground Contacts
(MAN 3) Traverse Incline
(MAN 4) Negotiate Leaning Objects
(MAN 5) Pallet Terrain

(OBS 1) Variable Height Rails
(OBS 2) Hurdles
(OBS 3) Stair with Optional Debris
(TER 1) Sand/Gravel
(TER 2) K-Rails on Crossover Slope
(TER 3) Pinwheel Ramps on Crossover Slope
(TER 4) Crate Terrain for Legged Robots

(DEX 1) Directed Inspection
(DEX 2) Touch/Insert
(DEX 3) Extract/Place
(DEX 4) Strength Tasks in the Work Volume:
(DEX 5) Shoring
(DEX 6) Door Opening: (In-person finals only)

Operator Booth (12)



PURCHASE LIST:

- ❑ [39] 48 x 96 x 1/2 in. OSB
- ❑ [48] 2 x 4 x 96 in. post

CUT LIST:

- ❑ [12] 48 x 96 x 1/2 in. - Wall Panel (A)
- ❑ [24] 2 x 4 x 96 in. – Post (B)
- ❑ [12] 24 x 48 x 1/2 in.- Shelf (C)
- ❑ [12] 2 x 4 x 47 in. - Brace (D)
- ❑ [24] 2 x 4 x 47 in. - Shelf Support Post (E)
- ❑ [24] 2 x 4 x 21 in. - Shelf Support Post (F)

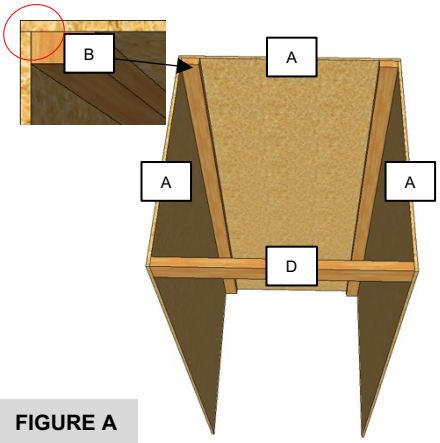


FIGURE A

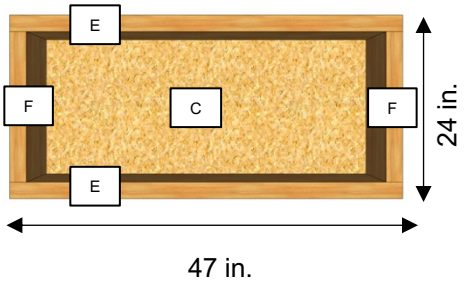


FIGURE B

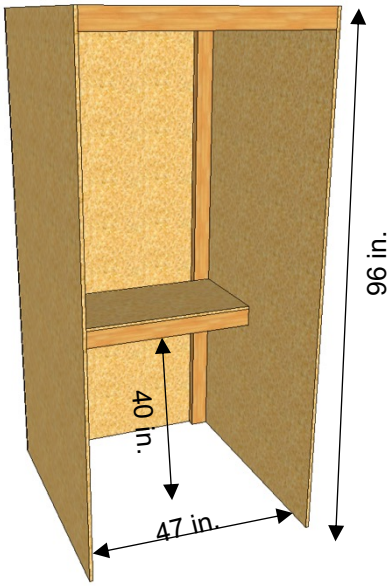
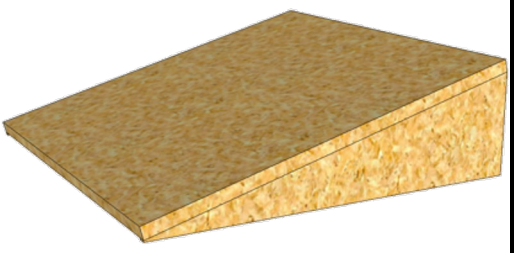


FIGURE C

Fabrication

- Attach OSB panels A shown in **Figure A.**
- Attach brace D as shown in **Figure A.**
- Lay out two shelf support post (E) 21 in. from each other such that post are on edge. Attach Shelf support (F) to (E) as shown in **Figure B**. Attach OSB panel (C) to frame.
- Install shelf unit into operator station . Shelf height is standing height for operator from floor as shown in **Figure C**.

Ramps - 220

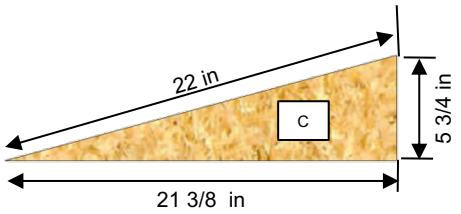


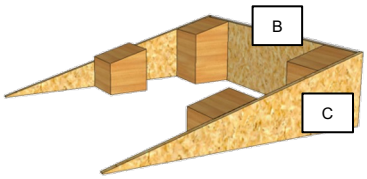
PURCHASE LIST:

- ❑ [62] 48 x 96 in. OSB
- ❑ [46] 4 x 4 x 96 in. post

CUT LIST:

- ❑ [220] 22 x 22 5/8 x 5/8 in. OSB (top) (A)
- ❑ [220] 5 3/4 x 22 x 7/16 in. OSB (back) (B)
- ❑ [440] 5 3/4 x 22 x 21 3/8 x 7/16 in. OSB triangle (sides) (C)
- ❑ [440] 4 x 4 x 5 3/4 in. Post **15º Mitre cut sq. to long point** (back legs) (D)
- ❑ [440] 4 x 4 x 2 3/4 in. Post **15º Mitre cut sq. to long point** (front legs) (E)





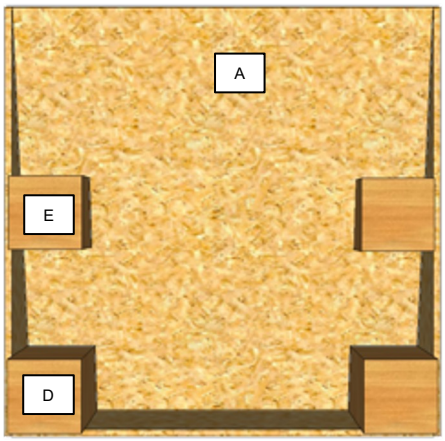
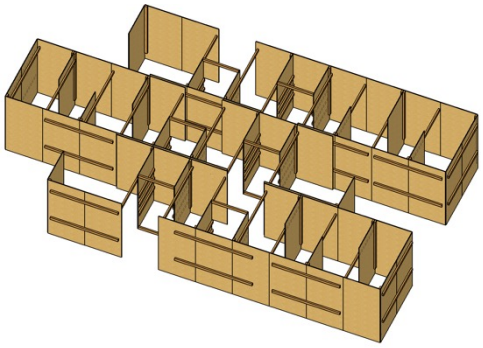


FIGURE A

Ramp Fabrication

- Place triangles (C) flatly on the floor. Attach one top post (E) to support triangle (C) and repeat for additional **side as shown in Figure A.** Note: Posts will be flush with the top of support triangle (C).
- Attach Front Leg (E) as shown in **Figure A.**
- Attach ramp surface (A) to support triangles (C). Note: **Use rougher side up as the ramp surface if there is a difference in surface texture**.
- Attach back plate (B) to high side of ramp as shown in **Figure A.**

Maze Wood



PURCHASE LIST:

- ❑ [80] 48 x 96 x 1/2 in. OSB
- ❑ [100] 2 x 4 x 96 in. post

Ramps are fabricated on page: 9

Will be built in place. Similar design.

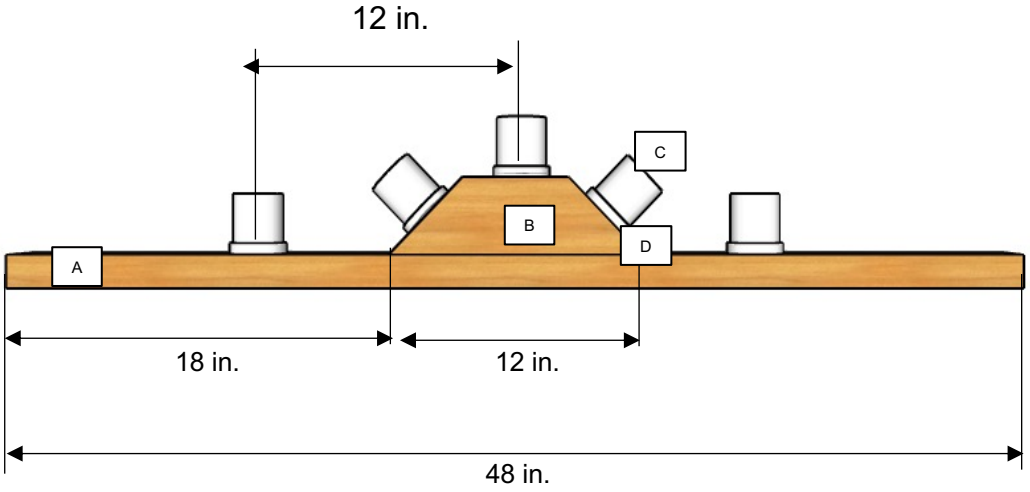
Search Rails for Maze

PURCHASE LIST:

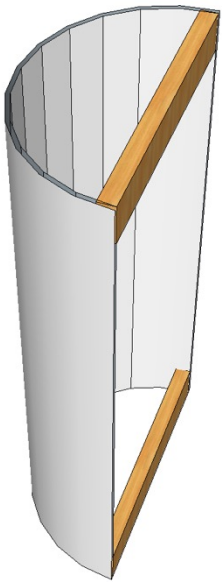
- ❑ [10] 2 x 4 x 96 in. post
- ❑ [3] 4 x 4 x 96 in post

CUT LIST:

- ❑ [20] 2 x 4 x 48 in. post (A)
- ❑ [20] 4 x 4 x 12 in post (B) cut on a **45 º**
- ❑ [100] 2 ID in x 2 in. - Pipe (C)
- ❑ [100] 2 in. – Caps (D)



Victim Fidcials (40 halves)

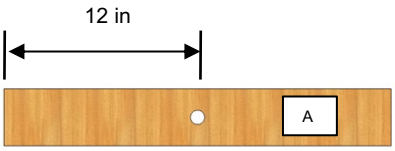


PURCHASE LIST:

- ❑ [20] 48 x 96 in. post
- ❑ [20] 24 ID x 48 in. Concrete Form

CUT LIST:

- ❑ [80] 2 x 4 x 24 in. Post (A)
- ❑ [20] 24 ID x 48 in. Concrete Form (B)



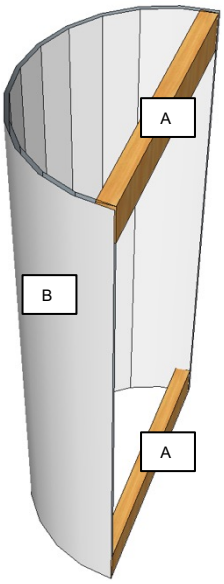


FIGURE A

Fabrication

FABRICATION INSTRUCTIONS – Barrels

- Cut concrete form in half lengthwise

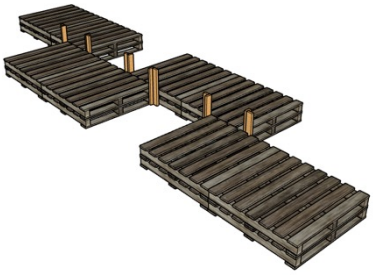
FABRICATION INSTRUCTIONS – Barrel Braces

- Drill 1/4 in thru hole centered in barrel braces as shown in Figure A. Repeat for additional 39.

FABRICATION INSTRUCTIONS – Barrel halves

- Attach braces as shown in Figure B. Repeat for additional 39 halves.

Pallet Terrain



PURCHASE LIST:

- ❑ [16] ~48 x ~48 in. pallets
- ❑ [3] 2 x 4 x 96 in. post
- ❑ [1] 48 x 96 x 1/2 in. OSB

CUT LIST:

- ❑ [12] 2 x 4 x 24 in. – Post (A)
- ❑ [3] 12 x 96 x 1/2 in OSB Panel (B)
- ❑ [2] 12 x 60 x 1/2 in. OSB Panel (C)

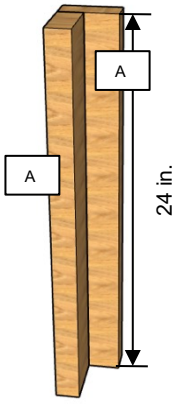


FIGURE A

- Attach Post A to Post A shown in **Figure A**.
- Layout pallets as show in **Figure B**.
- Attach Posts and panels as shown in **Figure B**.

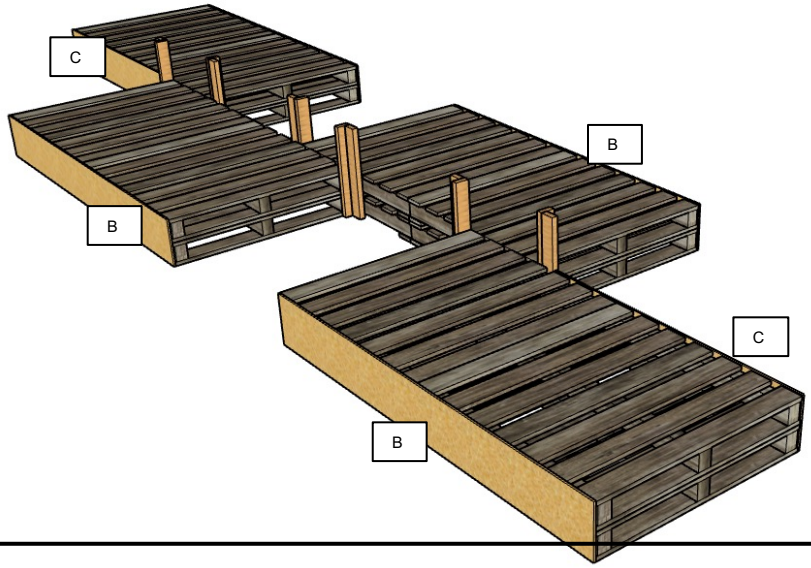
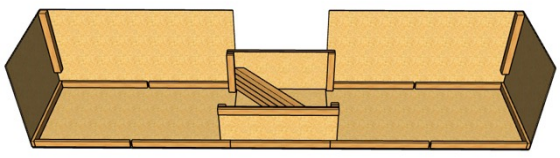


FIGURE B

Variable Height Rails



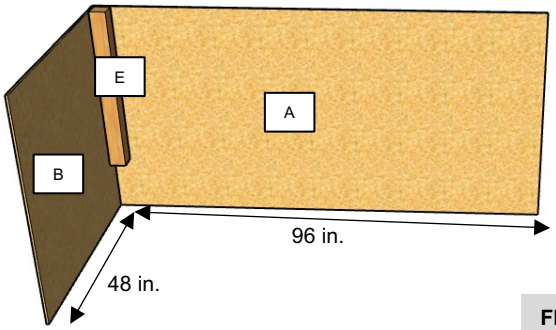


FIGURE A

PURCHASE LIST:

- ❑ [6] 48 x 96 x 1/2 in. OSB
- ❑ [5] 4 x 4 x 96 in Post
- ❑ [10] 2 x 4 x 96 in. Post

CUT LIST:

- ❑ [4] 48 x 96 x 1/2 in. OSB (A)
- ❑ [3] 48 x 48 x 1/2 in. OSB (B)
- ❑ [2] 24 x 56 x 1/2 in. OSB (C)
- ❑ [4] 4 x 4 x ~ 65 in. Post **(NOTE: 45 º Mitre cut)** (D)
- ❑ [2] 4 x 4 x 12 in. Post (E)
- ❑ [2] 2 x 4 x 56 in. Post (F)
- ❑ [4] 2 x 4 x 48 in. Post (G)
- ❑ [4] 2 x 4 x 47 in. Post (H)
- ❑ [4] 2 x 4 x 46 in. Post (I)
- ❑ [6] 2 x 4 x 24 in. Post (J)

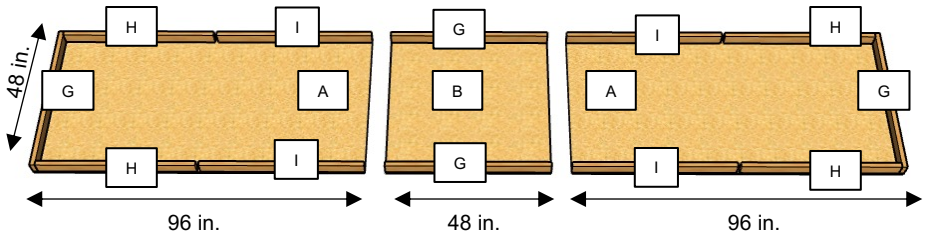


FIGURE B

- Attach Post E to panels A and B as shown in **Figure A**. Repeat for additional panel.
- Attach posts G, H an dI to Panels A and B as shown in **Figure B**. **Note there is a 1 in. gap between H and I .**
- Attach Post F and J to Panel C. Repeat for additional panel. **Note: There are double post J on opposite corners.**
- Cut post to length shown in **Figure D**. **This should be cut to fit.**

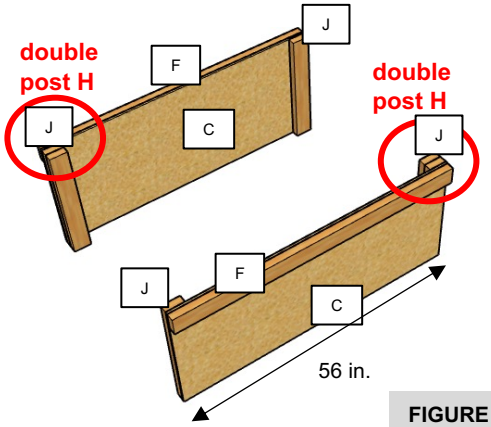


FIGURE C

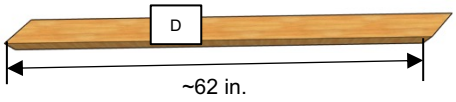
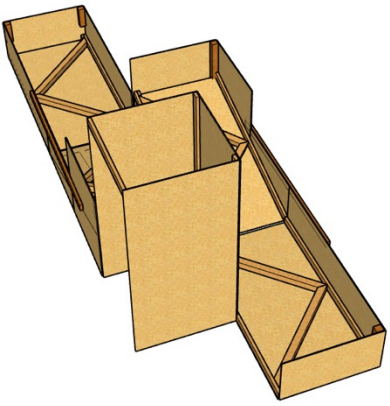


FIGURE D

K-Rails on Crossover Slope



PURCHASE LIST:
[8] 48 X 96 X 5/8 in. OSB
[5] 48 X 96 X 1/2 in. OSB
[40] 2 X 4 X 96 in. Post
[15] 4 x 4 x 96 in. Post

CUT LIST:
Terrain
- ❑ [4] 48 x 96 x 5/8 in. OSB (A)
- ❑ [8] 2 x 4 x 96 in. Post (B)
- ❑ [8] 2 x 4 x 45 in. Post (C)
- ❑ [8] 2 x 4 x 12 in. Post (D)
- ❑ [8] 4 x 4 x 63 5/8 in. **(NOTE: cut to fit) arrow head on both ends**. Post (E)

CUT LIST:
Incline
- ❑ [6] 12 x 90 x 5/8 in. OSB (F)
- ❑ [6] 12 x 23 3/8 x 5/8 in. OSB (G)
- ❑ [6] 12 x 10 15/16 x 5/8 in. OSB (H)
- ❑ [12] 2 x 4 x 90 in. Post (I)
- ❑ [12] 2 x 4 x 80 in. Post (J)
- ❑ [12] 4 x 4 x 23 3/8 in. (**15º cut**) Post (K)
- ❑ [12] 4 x 4 x 10 15/16 in. (**15º cut**) Post (L)

Frame
- ❑ [3] 24 x 96 x 1/2 in. OSB (M)
- ❑ [4] 24 x 48 x 1/2 in. OSB (N)
- ❑ [4] 48 x 48 x 1/2 in. OSB (O)
- ❑ [2] 24 x 48 x 48 x 1/2 in OSB (P)
- ❑ [2] 2 x 4 x 96 in. Post (Q)
- ❑ [5] 4 x 4 x 12 in. Post (R)

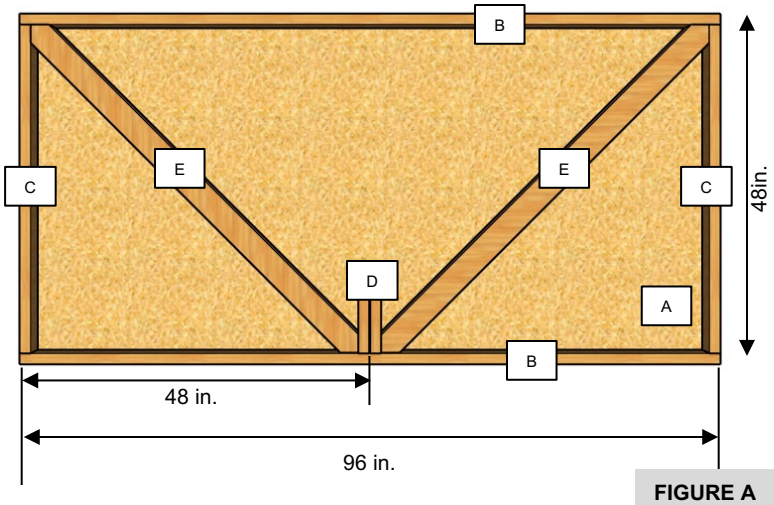


FIGURE A

Terrain Fabrication

- Attach Posts B and C to OSB panel A as shown in **Figure A.**
- Attach Post D centered as shown in **Figure A.**
- Cut to fit **Post E** and insert into frame**. Repeat for additional 3 terrain panels.**

Incline Fabrication

- Attach Posts K to OSB panel G as shown in **Figure B**
- Attach Posts L to OSB panel H as shown in **Figure C.**
- Attach Post I and J as shown in **Figure D.**
- Attach panel F as shown in **Figure D. Repeat steps 1-3 for 5 additional inclines**

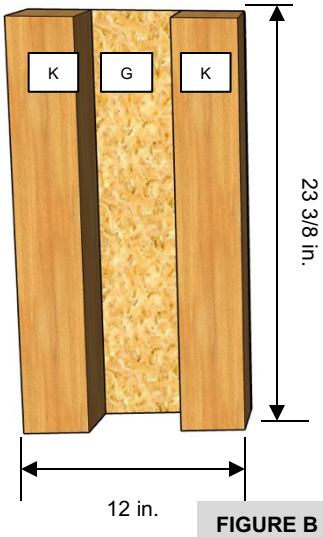


FIGURE B

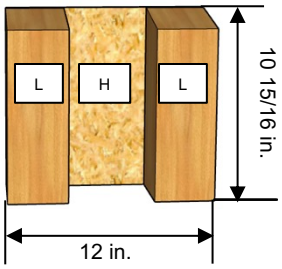


FIGURE C

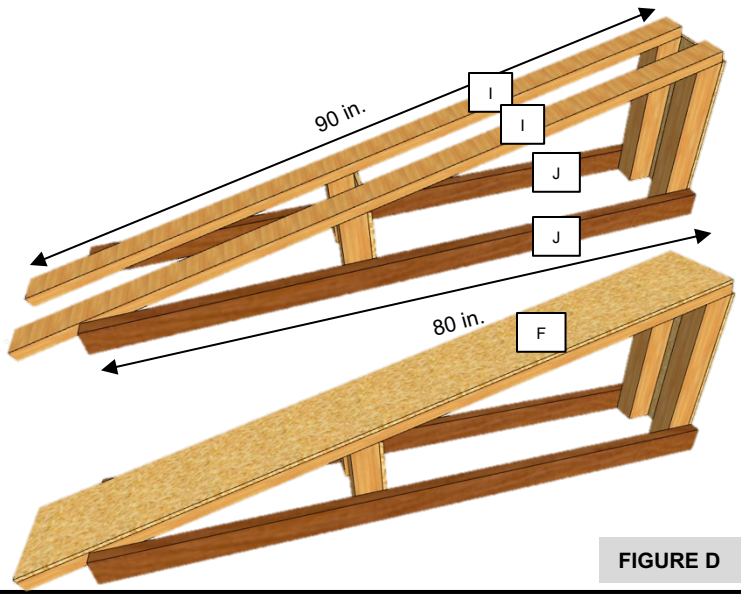


FIGURE D

K-Rails on Crossover Slope

Frame

- ❑ [3] 24 x 96 x 1/2 in. OSB (M)
- ❑ [4] 24 x 48 x 1/2 in. OSB (N)
- ❑ [4] 48 x 48 x 1/2 in. OSB (O)
- ❑ [2] 24 x 48 x 48 x 1/2 in OSB (P)
- ❑ [2] 2 x 4 x 96 in. Post (Q)
- ❑ [5] 4 x 4 x 12 in. Post (R)

Frame Fabrication

- Cut out triangle as shown in **Figure A. Repeat for additional triangle.**
- Install terrain panels and incline as shown in **Figure B.**
- Install containment panels around terrain as shown in **Figure C.**
- **Place operator booth as shown.**

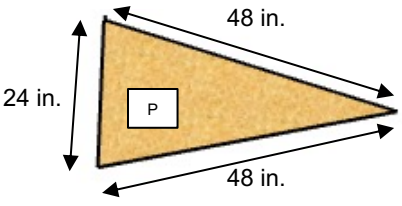


FIGURE A

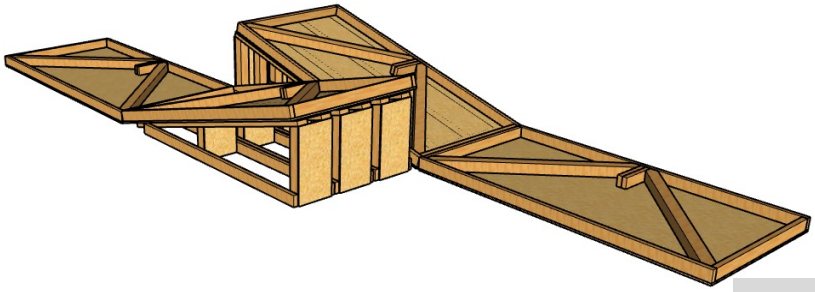


FIGURE B

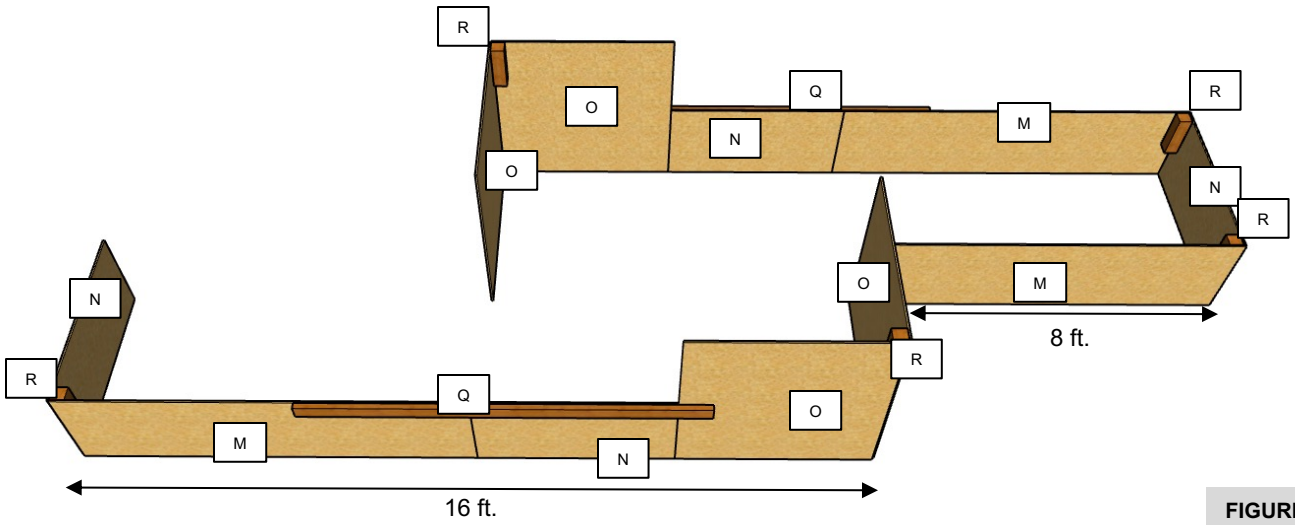


FIGURE C

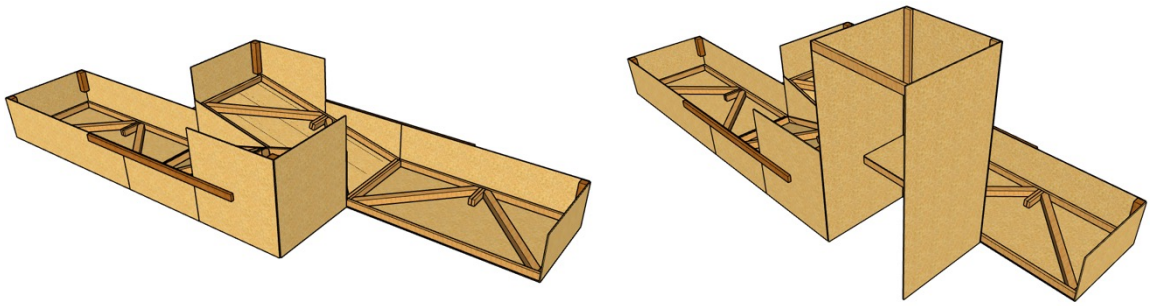
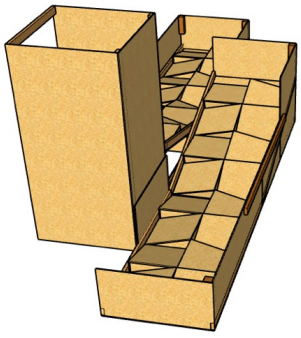


FIGURE D

Pinwheel Ramps on Crossover Slope



PURCHASE LIST:
[8] 48 X 96 X 5/8 in. OSB
[5] 48 X 96 X 1/2 in. OSB
[40] 2 X 4 X 96 in. Post
[7] 4 x 4 x 96 in. Post

CUT LIST:
Terrain Tray
- ❑ [4] 48 x 96 x 5/8 in. OSB (A)
- ❑ [8] 2 x 4 x 96 in. Post (B)
- ❑ [8] 2 x 4 x 45 in. Post (C)

Ramps are fabricated on page: 9

CUT LIST:
Incline
- ❑ [6] 12 x 90 x 5/8 in. OSB (F)
- ❑ [6] 12 x 23 3/8 x 5/8 in. OSB (G)
- ❑ [6] 12 x 10 15/16 x 5/8 in. OSB (H)
- ❑ [12] 2 x 4 x 90 in. Post (I)
- ❑ [12] 2 x 4 x 80 in. Post (J)
- ❑ [12] 4 x 4 x 23 3/8 in. (**15º cut**) Post (K)
- ❑ [12] 4 x 4 x 10 15/16 in. (**15º cut**) Post (L)

Frame
- ❑ [3] 24 x 96 x 1/2 in. OSB (M)
- ❑ [4] 24 x 48 x 1/2 in. OSB (N)
- ❑ [4] 48 x 48 x 1/2 in. OSB (O)
- ❑ [2] 24 x 48 x 48 x 1/2 in OSB (P)
- ❑ [2] 2 x 4 x 96 in. Post (Q)
- ❑ [5] 4 x 4 x 12 in. Post (R)

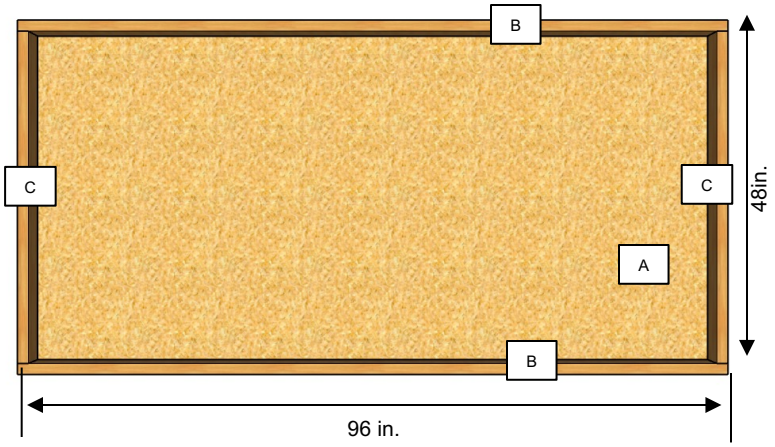


FIGURE A

Terrain Tray Fabrication

- Attach Posts B and C to OSB panel A as shown in **Figure A. Repeat for additional 3 terrain panels.**

Incline Fabrication

- Attach Posts K to OSB panel G as shown in **Figure B**
- Attach Posts L to OSB panel H as shown in **Figure C.**
- Attach Post I and J as shown in **Figure D.**
- Attach panel F as shown in **Figure D. Repeat steps 1-3 for 5 additional inclines**

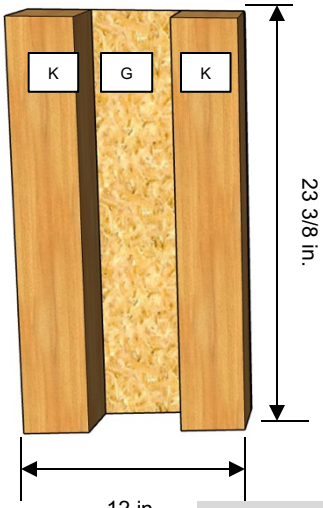


FIGURE B

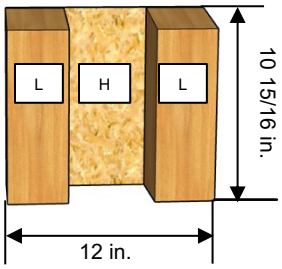


FIGURE C

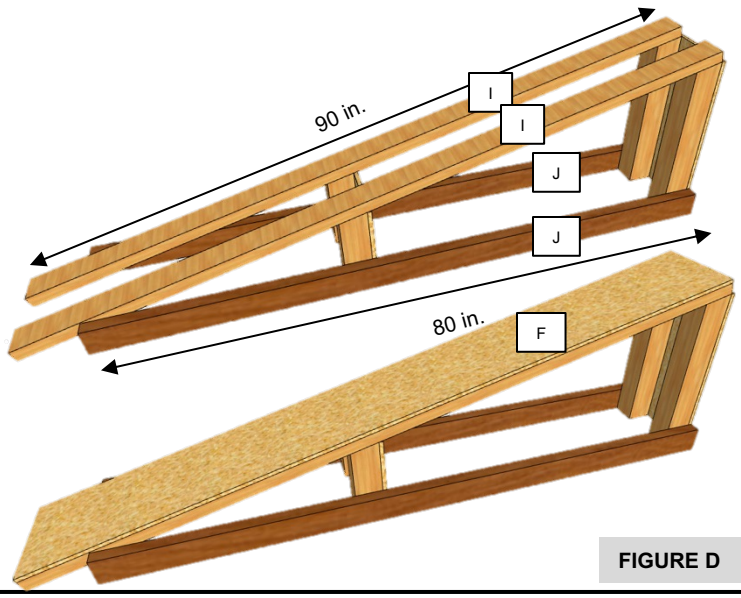


FIGURE D

Pinwheel Ramps on Crossover Slope

Frame

- ❑ [3] 24 x 96 x 1/2 in. OSB (M)
- ❑ [4] 24 x 48 x 1/2 in. OSB (N)
- ❑ [4] 48 x 48 x 1/2 in. OSB (O)
- ❑ [2] 24 x 48 x 48 x 1/2 in OSB (P)
- ❑ [2] 2 x 4 x 96 in. Post (Q)
- ❑ [5] 4 x 4 x 12 in. Post (R)

Frame Fabrication

- Cut out triangle as shown in **Figure A. Repeat for additional triangle.**
- Install ramps and incline as shown in **Figure B.**
- Install containment panels around terrain as shown in **Figure C.**
- **Place operator booth as shown.**

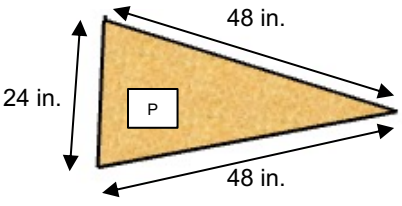


FIGURE A

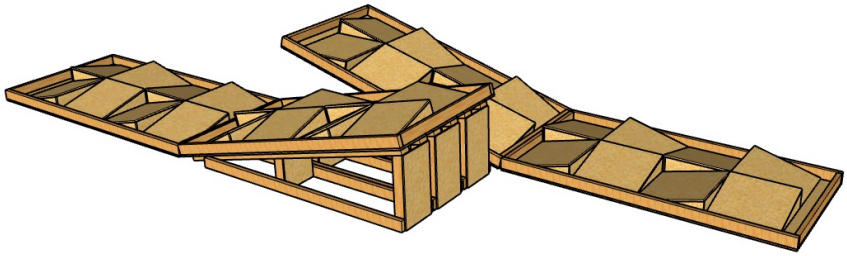


FIGURE B

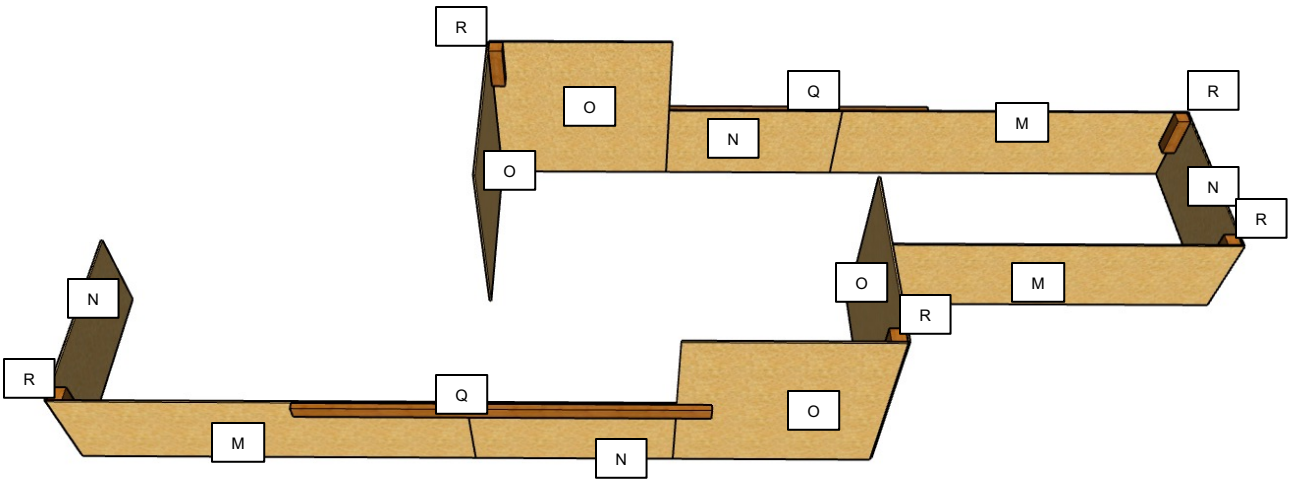


FIGURE C

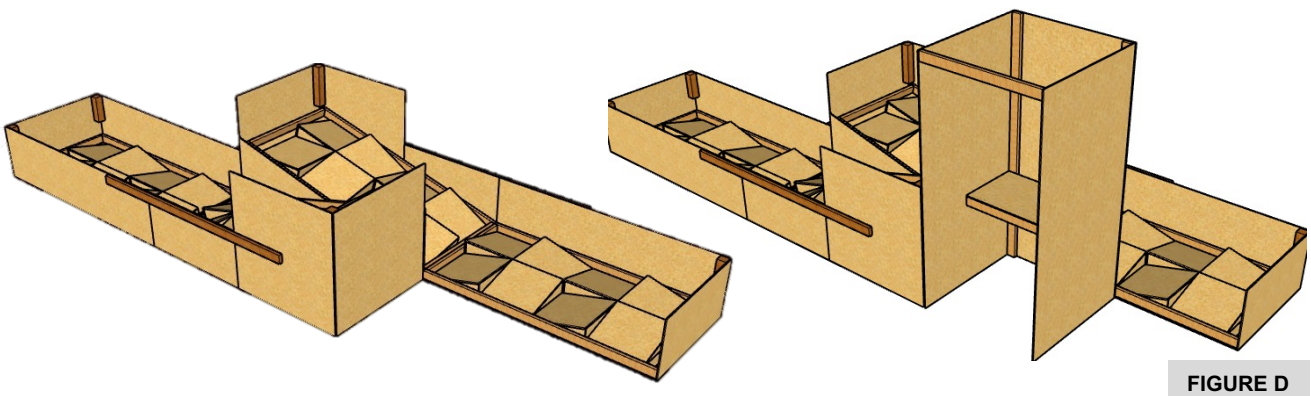
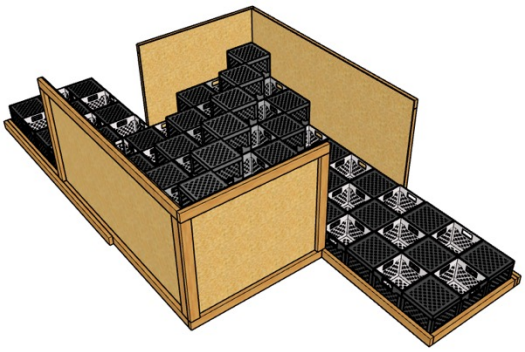


FIGURE D

Crate Terrain for Legged Robots



PURCHASE LIST:

- ❑ [3] 48 x 96 x 1/2 in. OSB
- ❑ [18] 2 x 4 x 96 in. Post
- ❑ [110] 12 x 12 x 10 1⁄2 in crate (https://www.uline.com/Product/ProductDetailRootItem?modelNumber=S-16317)
- ❑ [250] 12 in. cable ties.

CUT LIST:

- ❑ [2] 48 x 96 x 1/2 in. OSB (A)
- ❑ [2] 48 x 52 x 1/2 in. OSB (B)
- ❑ [6] 2 x 4 x 96 in. Post (C)
- ❑ [6] 2 x 4 x 52 in. Post (D)
- ❑ [2] 2 x 4 x 48 in. Post (E)
- ❑ [8] 2 x 4 x 45 in. Post (F)
- ❑ [2] 2 x 4 x 44 in. Post (G)

Put 7 crates side by side all touching to see the ACTUAL DIMENSION for containment. D, E, F, G dimensions is noted for imperial lumber, using uline crates.

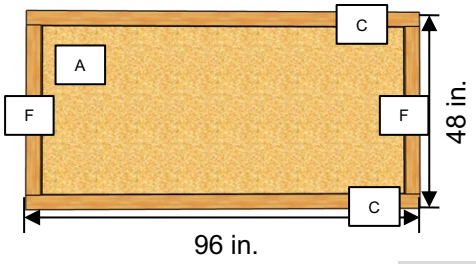


FIGURE A

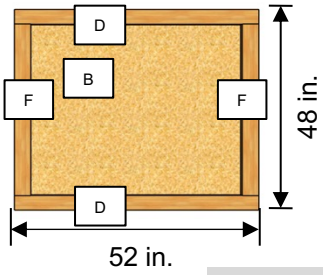


FIGURE B

Wall Fabrication

- Attach OSB panel and Posts as A shown in **Figure A**. Repeat for additional panel.
- Attach OSB panel and Posts as A shown in **Figure B**. Repeat for additional panel.
- Attach walls together as shown in **Figure C**.

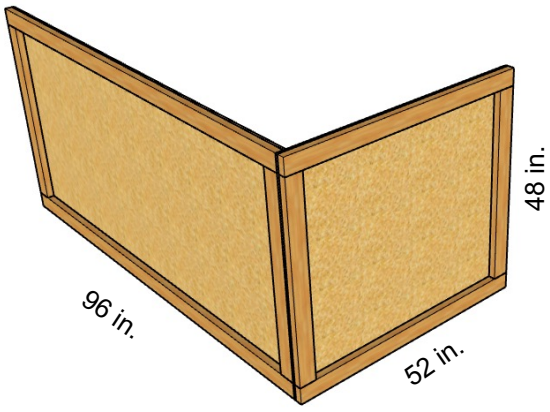


FIGURE C

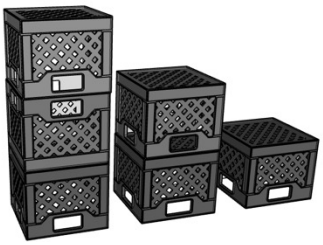
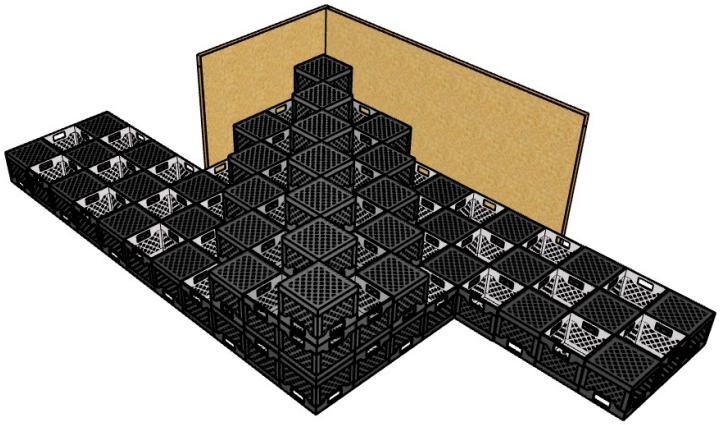


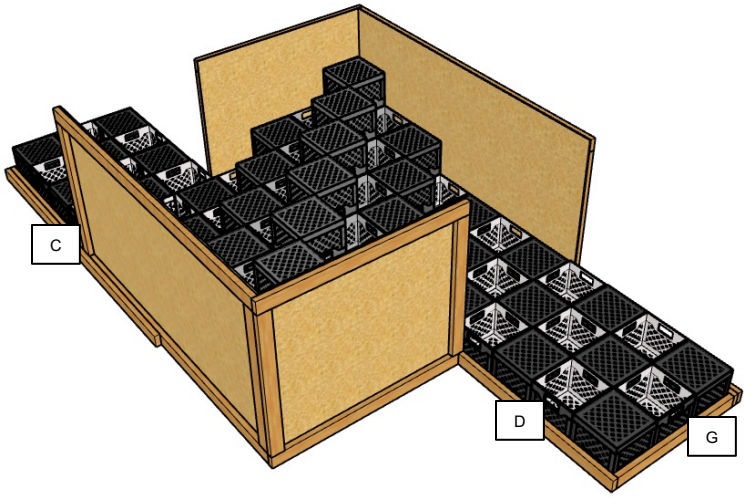
FIGURE D

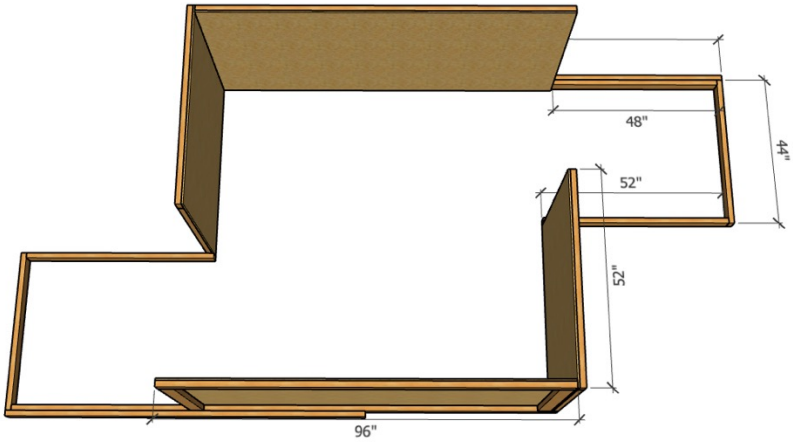
Crate Fabrication

- Attach crates together using 12” cable ties on opposite as shown in **Figure D:**
  - 7 vertical stacks of 3 crates
  - 24 vertical stacks of 2 crates
  - Remaining crates are singles

Crate Terrain for Legged Robots



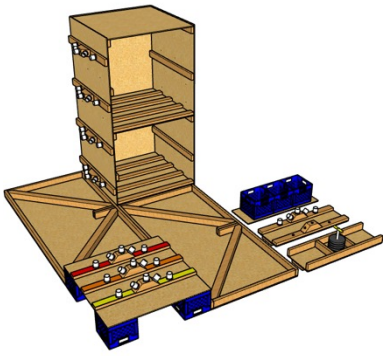




Layout

- Start in one corner with pattern.

Dexterity



PURCHASE LIST:

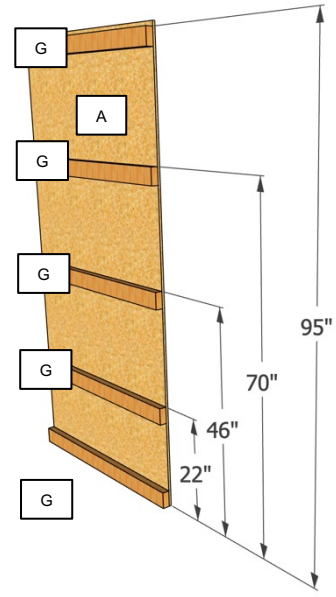
- ❑ [7] 48 x 96 x 1/2 in. OSB
- ❑ [5] 4 x 4 96 in Post
- ❑ [25] 2 x 4 x 96 in. Post
- ❑ [8] 12 x 12 x 10 1⁄2 in crate
  (https://www.uline.com/Product/ProductDetailRootItem?modelnumber=S-16317)
- ❑ 25lbs of weights
- ❑ [10] T-Nuts 8 mm (5/16 in) threaded
  https://www.amazon.com/gp/product/B06XCK35C1/
- ❑ **Galvanize Pipe**
  [2] ¾ nipples
  [1] Tee
  [1] ¾" X 6" Threaded pipe
  [1] ¾ " flange
- ❑ [30] 2 ID in x 2 in. - Pipe (C)
- ❑ [30] 2 in. – Caps (D)

CUT LIST FOR ENCLOSURE

- ❑ [3] 48 x 96 x 1/2 in. OSB (A)
- ❑ [1] 48 x 48 x 1/2 in. OSB (F)
- ❑ [10] 2 x 4 x 48 in. Post (G)

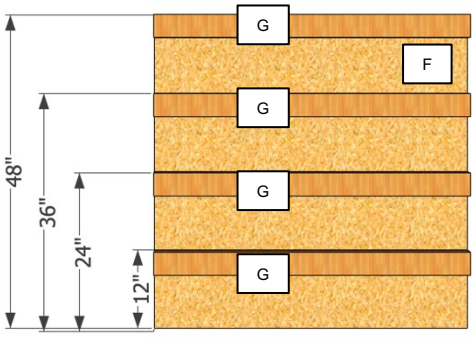
CUT LIST FOR SHELVES

- ❑ [3] 48 x 48 x 1/2 in. OSB (F)
- ❑ [3] 16 x 48 x 1/2 in. OSB (H)
- ❑ [2] 2 x 4 x 48 in. Post (I)
- ❑ [2] 2 x 4 x 13 in. Post (J)
- ❑ [6] 2 x 4 x 8 in. Post (K)



side panel

FIGURE A



shelf panel

FIGURE B

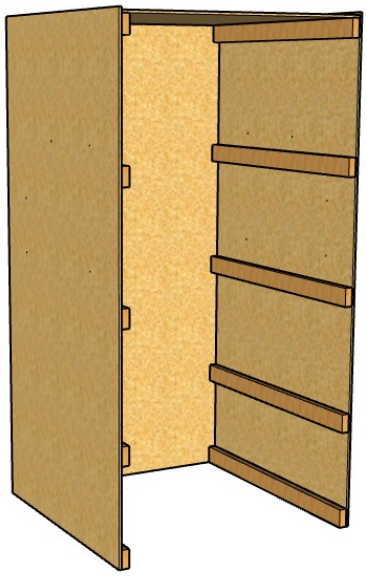


FIGURE C

Enclosure and Shelf Fabrication

- Attach Posts G to Panel A as shown in **Figure A. Repeat for second panel.**
- Attach Posts G to Panel F as shown in **Figure B. Repeat for second panel.**
- Assemble side panels with back panel as shown in **Figure C.** **NOTE: Interior dimension must be 48 in. , so shelf unit slides in easily.**

Dexterity

CUT LIST FOR THE TERRAIN:

- ❑ [2] 48 x 96 x 1/2 in. OSB (A)
- ❑ [4] 4 x 4 x ~63 5/8 in. Post **(NOTE: cut to fit) arrow head on both ends**. (B)
- ❑ [4] 2 x 4 x 96 in. Post (C)
- ❑ [4] 2 x 4 x 45 in. Post (D)
- ❑ [4] 2 x 4 x 12 in. Post (E)

CUT LIST FOR RAILS:

- ❑ [7] 2 x 4 x 48 in. post (I)
- ❑ [7] 4 x 4 x 12 in post (L) cut on a **45 °**
- ❑ [30] 2 ID in x 2 in. - Pipe (M)
- ❑ [30] 2 in. – Caps (N)

CUT LIST FOR SHELVES

- ❑ [3] 16 x 48 x 1/2 in. OSB (H)
- ❑ [2] 2 x 4 x 48 in. Post (I)
- ❑ [2] 2 x 4 x 13 in. Post (J)
- ❑ [6] 2 x 4 x 8 in. Post (K)

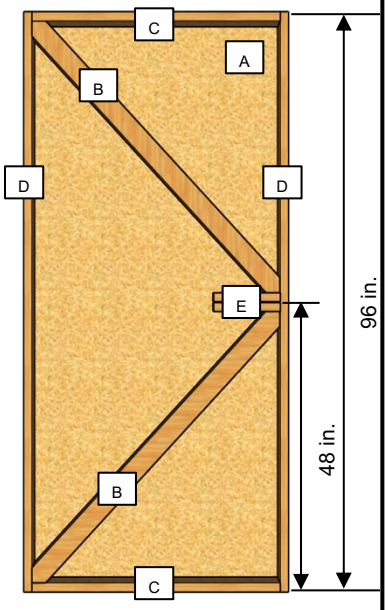


FIGURE D

FIGURE E

Terrain Fabrication

- Attach Posts C and D to OSB panel A as shown in **Figure A.**
- Attach Post E centered as shown in **Figure D.**
- Cut to fit **Post B** and insert into frame**.**

Weight T Fabrication

- Assemble as shown in **Figure E**.

Linear Rail Fabrication

- Assemble as shown in **Figure F. repeat for 4 additional rails.**
- Assemble ONE linear rail with t- nut inserts as shown in **Figure F**

Small Shelf Fabrication

- Assemble as shown in **Figure G. repeat for 1 additional shelf**
- **Second Shelf insert posts as shown in Figure H**

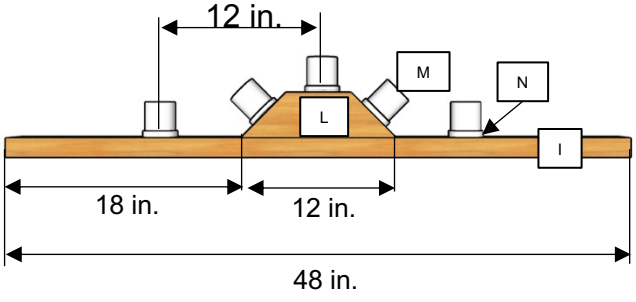


FIGURE F

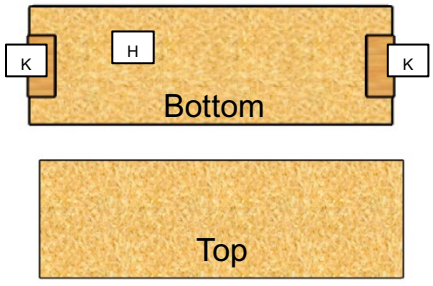


FIGURE G

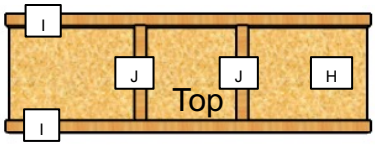
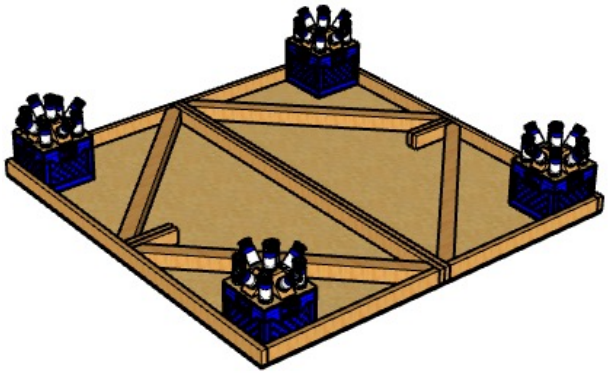


FIGURE H

Dexterity



PURCHASE LIST:

- ❑ [2] 48 x 96 x 1/2 in. OSB
- ❑ [4] 4 x 4 96 in Post
- ❑ [7] 2 x 4 x 96 in. Post
- ❑ [8] 12 x 12 x 10 1⁄2 in crate
  (https://www.uline.com/Product/ProductDetailRootItem?modelnumber=S-16317)

CUT LIST:

- ❑ [2] 48 x 96 x 1/2 in. OSB (A)
- ❑ [4] 4 x 4 x ~63 5/8 in. Post **(NOTE: cut to fit) arrow head on both ends.** (B)
- ❑ [4] 2 x 4 x 96 in. Post (C)
- ❑ [4] 2 x 4 x 45 in. Post (D)
- ❑ [4] 2 x 4 x 12 in. Post (E)

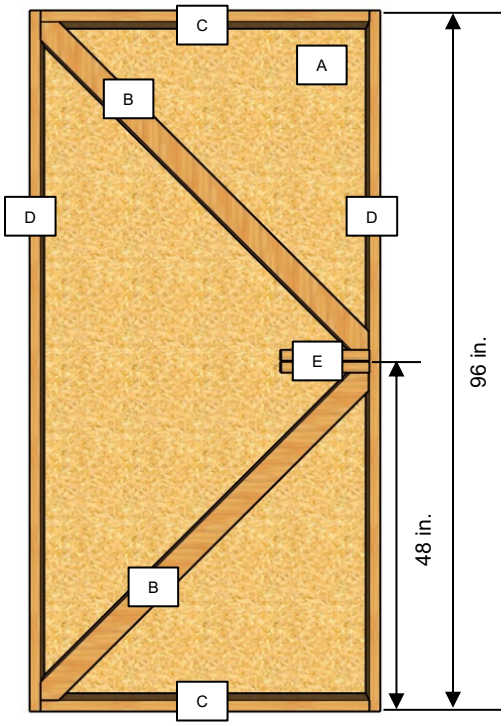
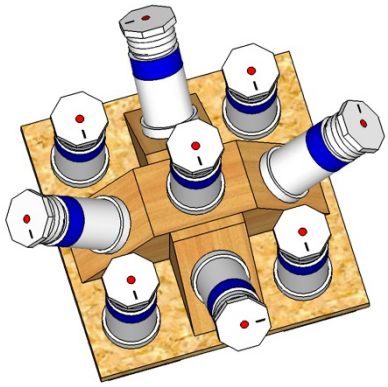


FIGURE A

Terrain Fabrication

- Attach Posts C and D to OSB panel A as shown in **Figure A.**
- Attach Post E centered as shown in **Figure A.**
- Cut to fit **Post B** and insert into frame**.**

Task Panel (10)



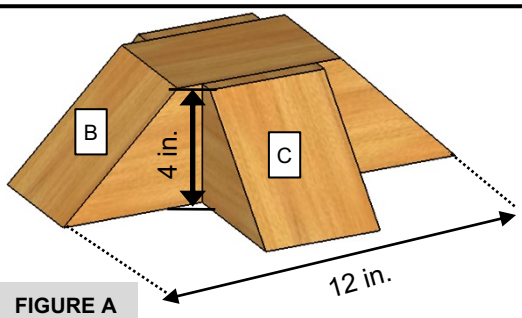


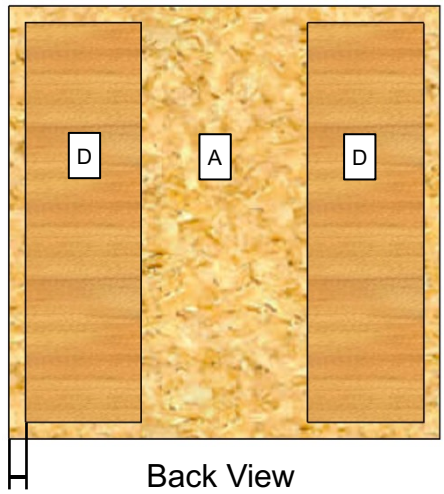
FIGURE A

PURCHASE LIST:

- ❑ [2] 48 x 96 x 1/2 in. OSB
- ❑ [2] 2 x 4 x 96 in. post
- ❑ [3] 4 x 4 x 96 in. post
- ❑ [6] 2 ID in. x 96 in. PVC Pipe
- ❑ [6] 1.5 ID in. x 96 in. PVC Pipe
- ❑ [90] 2 in. PVC Caps (https://www.ferguson.com/product/proflo-dwv-heavy-duty-high-pressure-pvc-cap-pftc/_/A-ProdFamily-115673)
- ❑ [90] 2 in Threaded Plug (http://www.grainger.com/product/LASCO-Threaded-Plug-22FK11?functionCode=P2IDP2PCP)
- ❑ [1] Blue duct tape
- ❑ [1] Velcro
- ❑ [1] Red/Black Markers

CUT LIST:

- ❑ [10] 13 x 13 x 1/2 in. – OSB (A)
- ❑ [10] 4 x 4 x 12 in. Post **45º Mitre cut long to long point** (B)
- ❑ [20] 4 x 4 x 4 in. Post **45º Mitre cut sq. to long point** (C)
- ❑ [20] 2 x 4 x 12 in. Post (D)
- ❑ [90] 2 ID in x 4 in PVC Pipe
- ❑ [90] 1.5 ID in x 3 in PVC Pipe



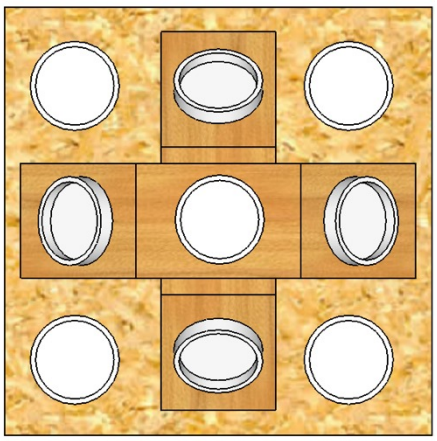


FIGURE B

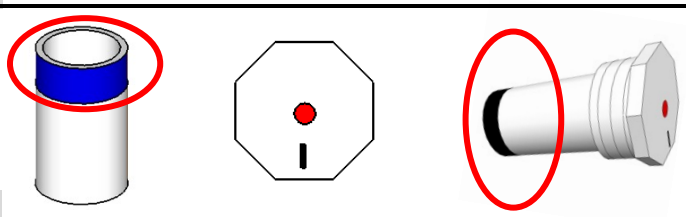
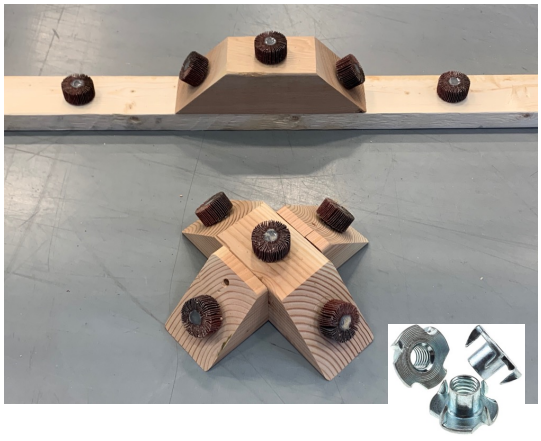


FIGURE C

Fabrication

- Attach angled posts (B and C) together as shown in **Figure A**.
- Attach caps as shown in **Figure B**.
- Attach post (D) to backside of OSB Panel (A) as shown in **Figure B**. **Note: the 1/2 in. offset from edge.**
- Attach pipes to caps.
- Wrap top of 50 mm pipe with blue tape as shown in **Figure** C
- Mark top of treaded plug as shown in **Figure C**.
- Insert 1 1/2 in. pipe into the threaded plug. Wrap 1/4 in. Velcro at the end of the pipe as shown in **Figure C**.

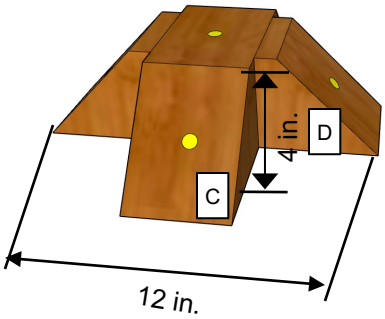


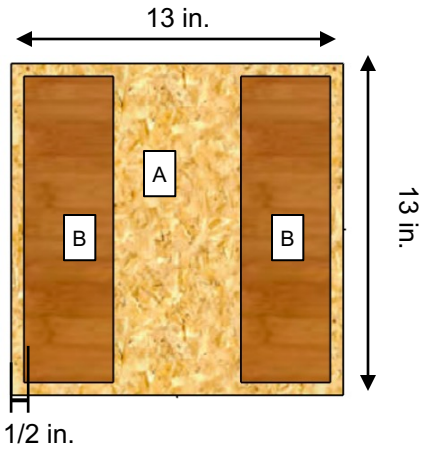
PURCHASE LIST:

- ❑ [1] 48 x 96 x 1/2 in. OSB
- ❑ [3] 2 x 4 x 96 in. post
- ❑ [2] 4 x 4 x 96 in. post
- ❑ [25] Small Round Abrasive Flap Wheel Sanders 1 in. diam high friction cylinder Shaft: .25 in. diameter, at least 1 in. long https://www.amazon.com/dp/B07ZRQ9YL3/
- ❑ [25] Large Round Abrasive Flap Wheel Sanders 2 in. diam high friction cylinder Shaft: 0.25 in. diameter, at least 1 in. long. https://www.amazon.com/gp/product/B0821B4RZN/
- ❑ [50] T-Nuts 5/16 in. threaded https://www.amazon.com/gp/product/B06XCK35C1/

CUT LIST:

- ❑ [5] 13 x 13 x 1/2 in. OSB (A)
- ❑ [10] 2 x 4 x 12 in. Post (B)
- ❑ [10] 4 x 4 x 12 in. Post **45º Mitre cut long to long point** (C)
- ❑ [10] 4 x 4 x 4 in. Post **45º Mitre cut sq. to long point** (D)
- ❑ [5] 2 x 4 x 48 in. Post (E)





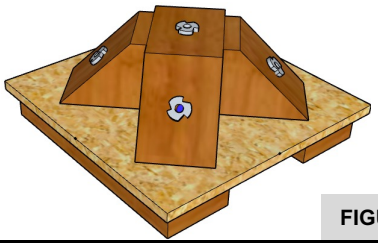


FIGURE A

Omni (5)

- Attach angled posts (C and D) together as shown in **Figure A**.
- Drill 5/16 in. holes as shown in **Figure A. Insert T-Nuts into holes**
- Attach post (B) to backside of OSB Panel (A) as shown in **Figure A**. **Note: the 1/2 in. offset from edge.**

Linear (5)

- Attach post C to post E as shown in **Figure B.**
- Drill 5/16 in. holes as shown in **Figure A. Insert T-Nuts into holes**

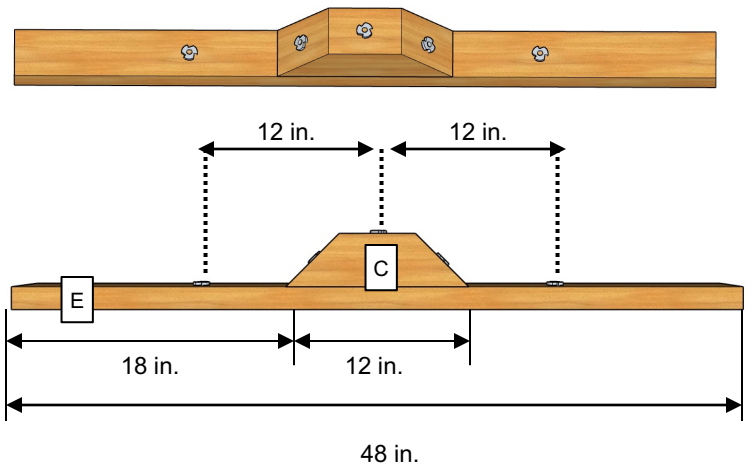
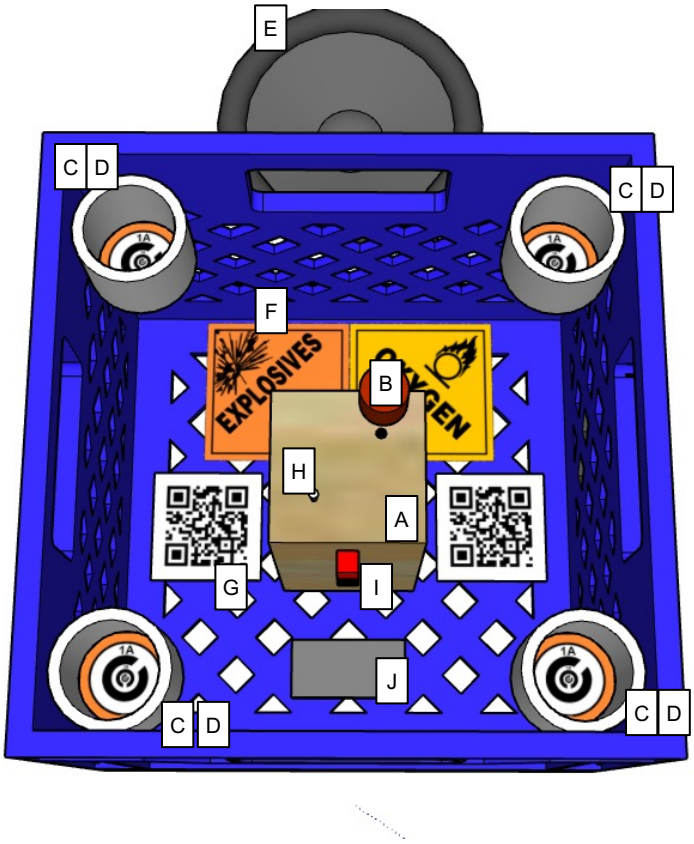
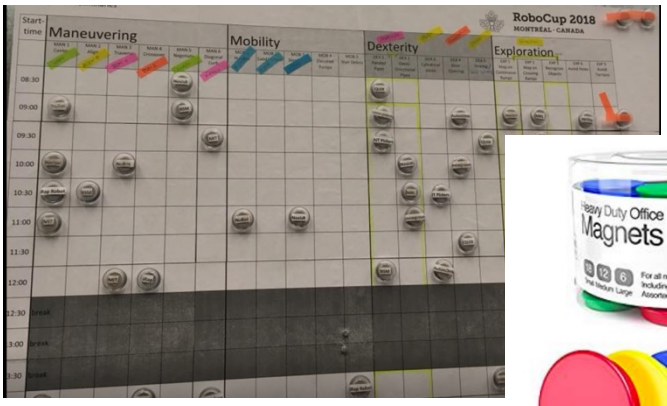


FIGURE B



- ❑ [12] 12 x 12 x 10 1⁄2 in crate (https://www.uline.com/Product/ProductDetailRootItem?modelnumber=S-16317)
- ❑ [12] 4 x 4 x 10 in. post (A)
- ❑ [12] Large Round Abrasive Flap Wheel Sanders 2 in. diam high friction cylinder Shaft: 0.25 in. diameter, at least 1 in. long. (B) https://www.amazon.com/gp/product/B0821B4RZN/
- ❑ [12] T-Nuts 5/16 in. threaded https://www.amazon.com/gp/product/B06XCK35C1/
- ❑ [48] 2 ID in. x 2 in. PVC Pipe (C)
- ❑ [48] 2 in. PVC Caps (D) (https://www.ferguson.com/product/proflo-dwv-heavy-duty-high-pressure-pvc-cap-pftc/_/A-ProdFamily-115673)
- ❑ [12] Battery operated speaker (E)
- ❑ [24] 4 in. Hazmat Stickers (F)
- ❑ [24] QR code (G)
- ❑ [12] 1 in screw (H)
- ❑ [12] 2 in. Magnet (I)
- ❑ [500] Hand Warmers (J) https://www.amazon.com/HotHands-Hand-Warmers-Odorless-Activated/dp/B0007ZF4OA

Tools and Admin Section



- ❑ (1) – Dispatch board
- ❑ (100+) - Magnets

- ❑ (1) HDMI Computer Monitor >21 in

- ❑ (20) Clipboards

- ❑ (30) -Gloves
- ❑ (5) Safety Glasses
- ❑ (2) Ear Muff
- ❑ (10) Clip on nail pouch
- ❑ (1) First Aid Kit

- Fire extinguishers/sand buckets/ etc… should be stationed at the operator stations, team paddock and battery charging stations.

- (1) Shipping Scale 440 LB/200 KG Capacity

- (5) Torx T25 Shaft 5/16 in. (it must fit into the t-nuts

- ❑ Cordless drills and accessories
  - ❑ [4] Cordless drills
  - ❑ [6] Battery chargers
  - ❑ [12] Total batteries

- ❑ [2] Corded drill

- ❑ [1] Circular Saw
- ❑ [1] Miter Saw

- ❑ Drill sets
  - ❑ Typical size drill bits
  - ❑ Nut drivers
  - ❑ Torx/Star bit sets
  - ❑ Screw Driver bits

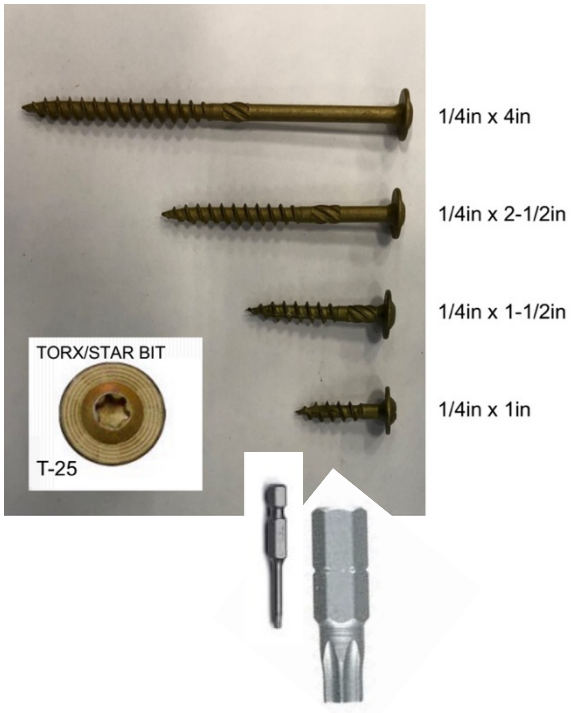
- ❑ Paddle Bit Set
  - ❑ [3] 1- 4cm (1/2 - 1.5 in)

- ❑ Hole saw
  - ❑ [3] 15 cm (6 in) diameter
  - ❑ [3] 5 cm (2 in) diameter

- ❑ Tape Measure
  - ❑ [2] 30m/100ft tape measure
  - ❑ [4] 8m/25ft tape measure

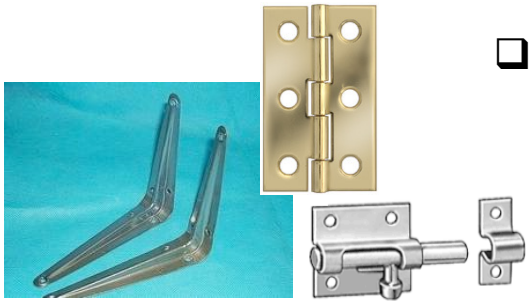
- ❑ Cable Ties
  - ❑ [200] Various sizes
  - ❑ [5] Cable tie cutters

- ❑ Duct tape
  - ❑ [5] Rolls of Safety Yellow duct tape
  - ❑ [5] Rolls of Safety Orange duct tape
  - ❑ [5] Rolls of Safety Red duct tape
  - ❑ [5] Rolls of Blue duct tape
  - ❑ [5] Rolls of Black /Yellow diagonal stripe tape



Star/Torx bit screws with washer heads

- ❑ [500] 12 mm (1 in) long
- ❑ [1000] 40 mm (1 1/2 in) long
- ❑ [2000] 60 mm (2 ½ in) long
- ❑ [500] 120 mm (4 in) long
- ❑ [50] Matching star/torx bits for each size



- ❑ Hardware
  - ❑ [8] Hinges 100 mm (4 in)
  - ❑ [200] washers 25 mm (1 in)

- ❑ [10] Power cords
- ❑ [30] Power Strips

- ❑ Color printer and copier with supplies
  - ❑ [1] Color inkjet printer/copier
  - ❑ **<u>USB and power cables</u>**
  - ❑ Printer driver software
  - ❑ [4] Spare paper packs
  - ❑ [4] Spare ink colors and black

- ❑ Briefing/planning/task list support
  - ❑ [3] Dry erase whiteboards
  - ❑ [3] Sets of markers/erasers

- ❑ Office supplies
  - ❑ [2] Stapler, staples
  - ❑ **<u>[4] scissors</u>**
  - ❑ [1] Scotch (clear) tape
  - ❑ [50] Pencils
  - ❑ [100] paper clips
  - ❑ [10] Black permanent Sharpie Markers-large
  - ❑ Various sizes binder clips

- AV equipment
  - [3] Large LCD display
  - [2-3] Pan Security Camera with cable
  - Ability to switch between the cameras
  - PA system

Additional Materials Needed

Additional lumber:

[5] sheets of 5/8 in. OSB plywood
[10] sheets of 1/2 in. OSB plywood
[20] 2 x 4 x 96 in. post
[10] 4 x 4 x 96 in. post

[300] 6 in concrete block