



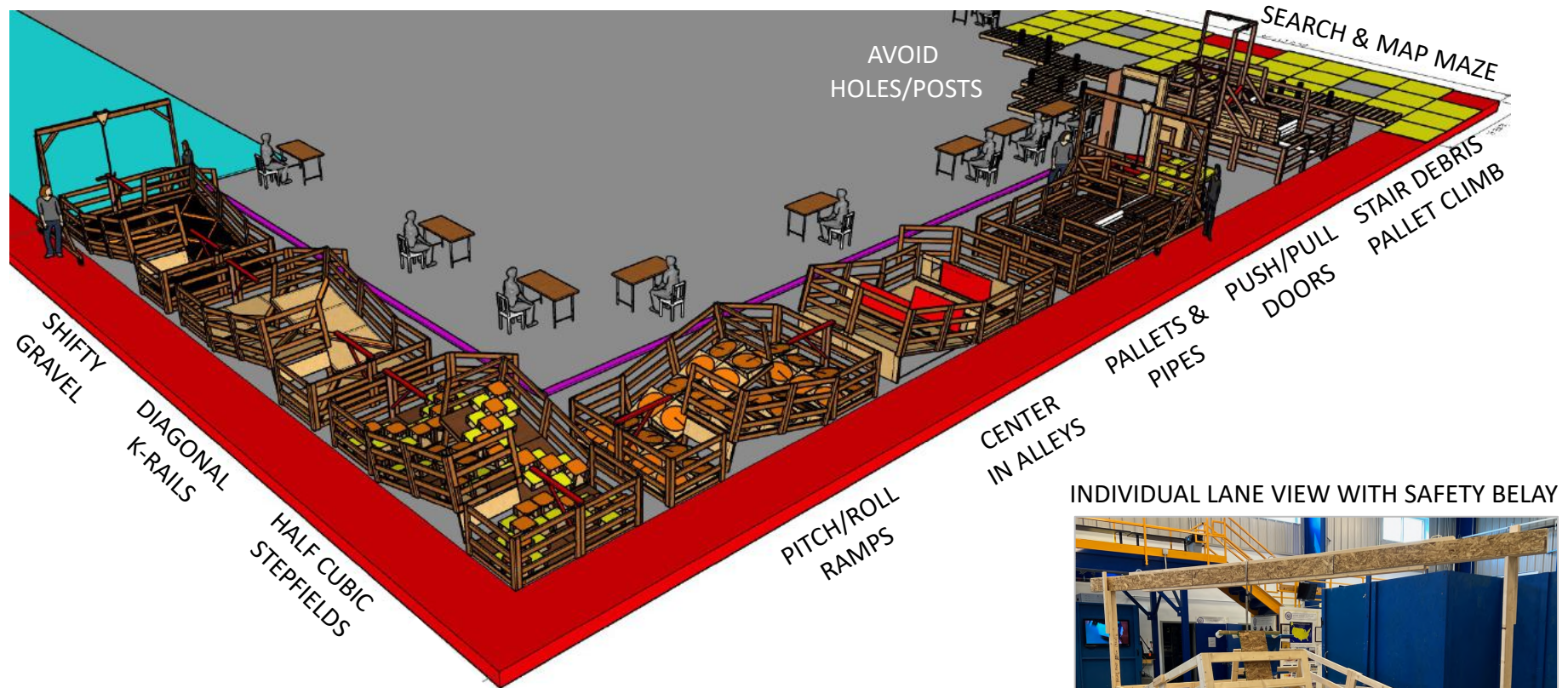
RoboCupRescue Robot League

Fabrication Guide for 2026 in Incheon, Korea



Version 2026C-Korea

Page: 1



INDIVIDUAL LANE VIEW WITH SAFETY BELAY





RoboCupRescue Robot League

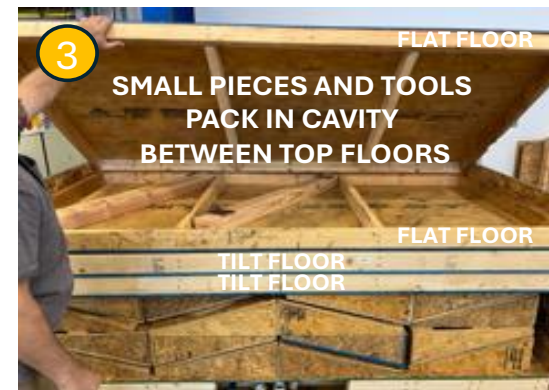


Version 2026C-Korea
Page: 2

Fabrication Guide for 2026 in Incheon, Korea

WATCH ASSEMBLY VIDEO FROM SHIPPING CRATE

https://drive.google.com/file/d/1bViGZ9UmipbqS84eM5p7LqEhJvllMW1p/view?usp=share_link



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Table of Contents



Version 2026C-Korea

Page: 3

UPDATES FOR 2026 HIGHLIGHTED

Arena Overviews	01
Table of Contents	02
Revisions to This Document.....	03
Lane Overview	04
Sequence Descriptions	07
Purchases	12
Walls/Railings (NEW)	19
Flat/Tilt Floors (12 FLAT, 12 SLOPES)	22
Shifty Gravel	25
Diagonal K-Rails	28
Half-Cubic Stepfields (STURDIER)	32
Pitch/Roll Ramps (STOWABLE).....	35
Center in Alleys.....	41
Pallets & Pipes (NEW)	44
Stair Debris & Pallet Climb (NEW).....	49
Push/Pull Doors	55
Avoid Holes/Posts	59
Search & Map Maze	62
Dexterity: Align/Inspect	67
Dexterity: Touch/Insert	76
Dexterity: E-Stops & Valves	79
Complexity: Pinch Points & Negotiate	86
Integrated Lane Belay (NEW).....	88
Rolling Gantry Belay	90
Shipping Crates	94

RoboCupRescue Championships

2026 Incheon, Korea
2025 Salvador, Brazil
2024 Eindhoven, Netherlands
2023 Bordeaux, France
2022 Bangkok, Thailand
2021 Distributed/Remote
2020 Cancelled (Pandemic)
2019 Sydney, Australia
2018 Montreal, Canada
2017 Nagoya, Japan
2016 Leipzig, Germany
2015 Hefei, China
2014 Joao Pessoa, Brazil
2013 Eindhoven, Netherlands
2012 Mexico City, Mexico
2011 Istanbul, Turkey
2010 Singapore, Singapore
2009 Graz, Austria
2008 Suzhou, China
2007 Atlanta, USA
2006 Bremen, Germany
2005 Osaka, Japan
2004 Lisbon, Portugal
2003 Padua, Italy
2002 Fukuoka, Japan
2001 Seattle, USA
2000 AAAI Conf, Austin, TX

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Revisions to this Document

RoboCupRescue Robot League



Version 2026C-Korea

Page: 4

New for 2026 (from last year in Brazil)

ESSENTIAL UPGRADES

- NEW RAILINGS/WALLS: New 90cm (36in) railings are taller and stronger to constrain bigger robots. They replace last year's 60cm(24in) tall OSB walls. (SEE PAGE 19)
- NEW FABRICATED PALLETS: Replace purchased pallets in the terrain lane at least. These are easy to fabricate, need only 8 that can flip to be smooth or complex. The flooring underneath like all other lanes enable attaching the railings. (SEE PAGE 44)

HELPFUL UPGRADES

- PITCH/ROLL RAMPS: Sets of 4 ramps are pre-assembled onto 1.2m (4ft) square backing to be easy to stow nested for transport and then place in the lane. (SEE PAGE 35)
- DIAGONAL K-RIALS: The base layer of diagonal rails should be mounted to 4 full sheets of OSB. This doubles the OSB layers for walking, and enables second and third layers to be screwed to the base layer. (SEE PAGE 28)
- CENTER IN ALLEYS: Added another floor element and adjustable doorway to make the same length lane as all other lanes – 4.8 m (16 ft) – with two coincidentally tilt-up floors as the far end zone. (SEE PAGE 41)
- STAIR DEBRIS LANE: Added a pallet stack to allow climbing 30cm (12in) PALLET & PIPE steps as an alternate route to the same elevated landing. (SEE PAGE 49)

Specific Edits to Version 2026D

1. _____ (page ##)

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Adjustable Lane Example

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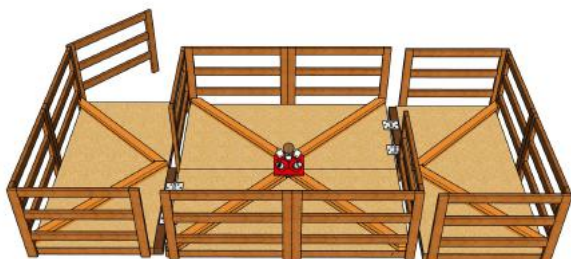


Version 2026C-Korea

Page: 5

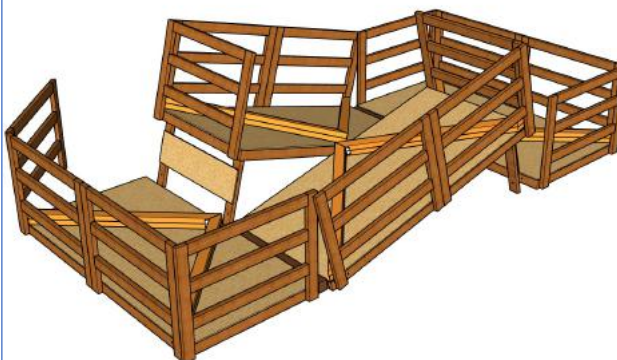
FLAT WITH 90° TURNS

Prelims



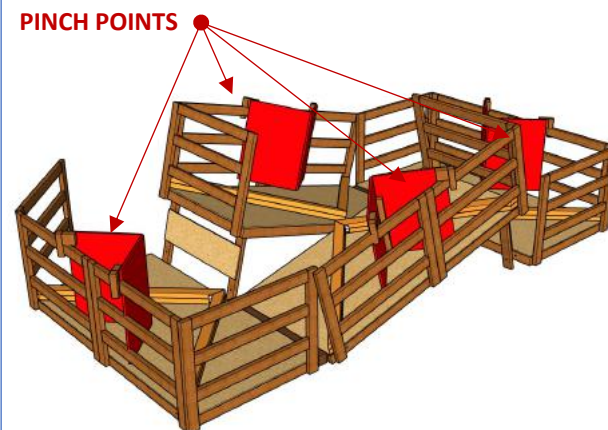
OPPOSING SLOPES (15°)

Prelims/Semis



ADDITIONAL OBSTACLES

Semis/Finals



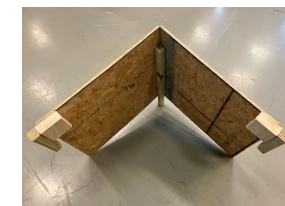
Layered K-Rail Elevations:

- K-Rail layers in 5cm (2in) increments
- Stack high enough to challenge the maximum capability of the robot.



Pinch Points:

- 60 cm (24 in) triangular panels hang on railings.
- Require precise steering in terrains and obstacles.
- Also complex approaches to dexterity tasks.





Lane Set Up Procedure

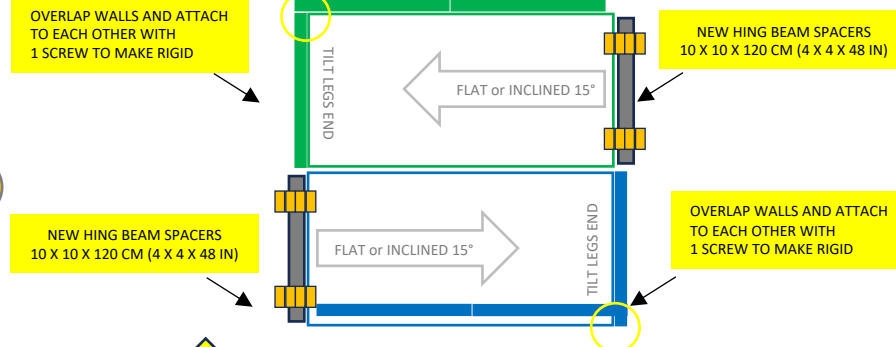


Version 2026C-Korea
Page: 6

(2) Tilt-Up Floors, (2) Flat Floors, (2) Hinge Beams, (14) Railings

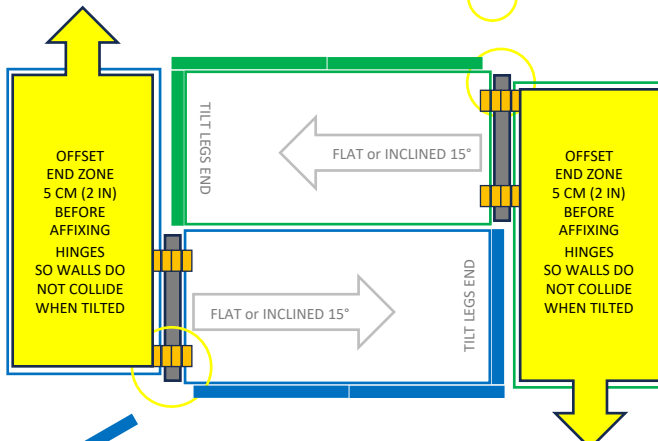
STEP

1



STEP

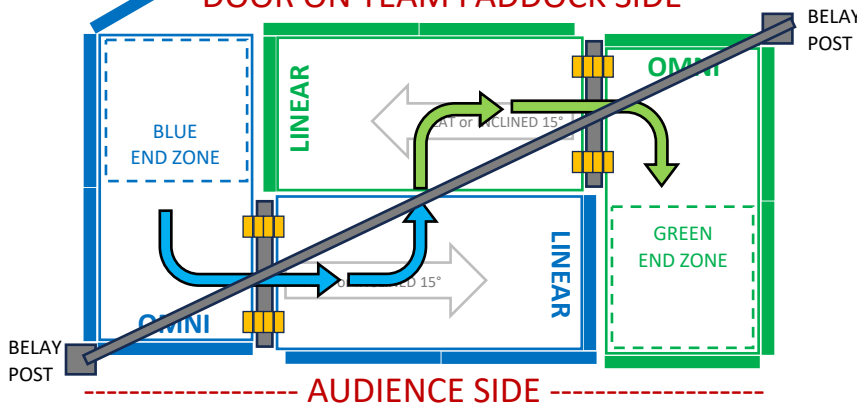
2



DOOR ON TEAM PADDOCK SIDE

STEP

3



- Every lane DOOR should always be on the TEAM PADDOCK SIDE. You need to know the intended driving path from the entry DOOR before you know where to put the legs of the TILT-UP FLOORS.
- When viewed from the audience side, the left side lanes are typically set up as shown, and the right side lanes are mirrored so that all the lane DOORS are as far as can be from the arena corner.
- Lay out (2) TILT-UP FLOORS side by side with the tilt up legs at opposite ends. Affix the HINGE BEAMS as spacers at the bottom end of the TILT-UP FLOORS. These make room for the opposite walls to fit against the end zones.
- Affix (6) RAILINGS as shown. Overlap the walls in the corners as shown and attach to each other with 1 screw near the top to make them rigid.
- Offset both FLAT FLOORS 5cm (2in) in the directions shown before affixing the hinges so the walls do not collide when tilted.
- Affix (8) RAILINGS around both FLAT FLOORS with no overlapping corners. One corner will fit the vertical belay post. The other corner RAILING will be hinged as a door.



Safety Belays



Version 2026C-Korea

Page: 7

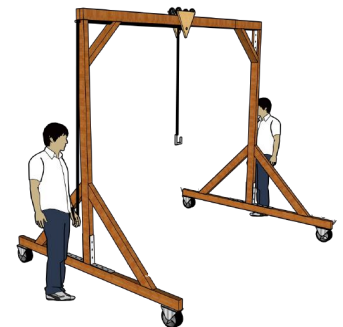
Reduce Risk in Difficult Terrains

INTEGRATED BELAY MADE OF MODULAR COMPONENTS THAT STOW IN THE BOTTOM OF EACH LANE'S SHIPPING CRATE



- Integrated safety belay over each lane enables legged and other robots try more advanced terrains and obstacles with no risk.
- Fabricated using the same wood and attaches to the railings.
- Modular box beams and connectors pack in the bottom of each lane's shipping crate.
- Purchased metal trolley and track and rope.

ALTERNATIVE ROLLING GANTRY BELAY





Standard Terrains and Obstacles



Version 2026C-Korea

Page: 8

Sequence A: Approach Country Dwelling

Shifty Gravel



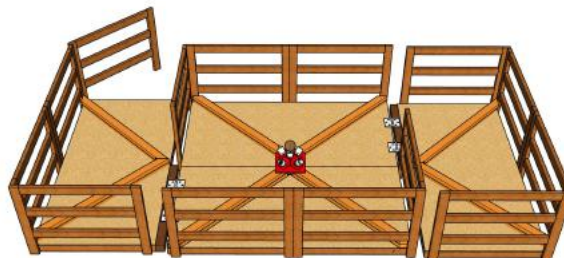
FLAT



SLOPED

Gravel larger than 2.5 cm (1 in) provides shifty terrain with potential for digging in and high centering while turning in place or climbing inclines. Diagonal X-Rails hold the gravel slopes in place.

Diagonal K-Rails



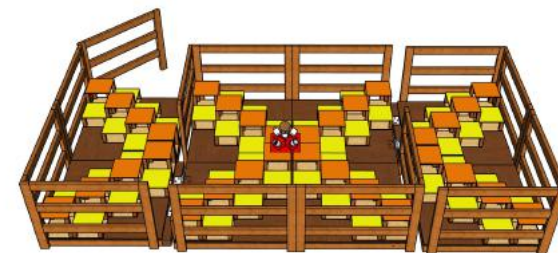
FLAT



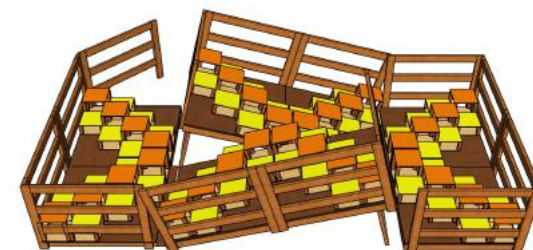
SLOPED

Smooth floors with stackable diagonal obstacles at incremental heights every 5 cm (2 in) cause roll-over issues, high-centering on the robot's chassis, and potential self-righting opportunities after falls.

Half Cubic Stepfields



FLAT



SLOPED

Three different elevations require robots to constantly deal with severe discontinuities. Each plateau is 30 cm (12 in) square with half-cubic steps of 15 cm (6 in) or full-cubic steps of 30 cm (12 in).



Standard Terrains and Obstacles

Sequence B: Approach Urban Dwelling

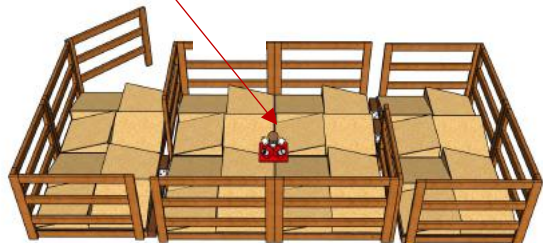


Version 2026C-Korea

Page: 9

Pitch/Roll Ramps

OMNI TASK



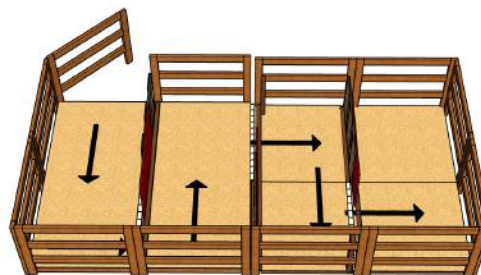
FLAT



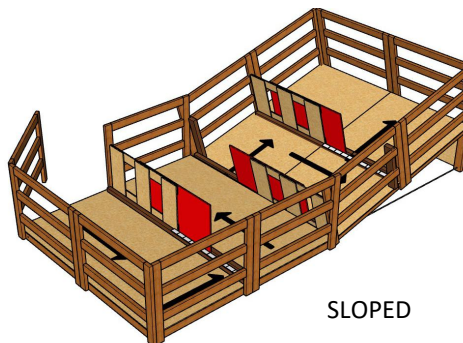
SLOPED

Discontinuous ramp terrains made of 60 cm (24 in) square ramps with 15° slopes to vary footfall orientations. Optional low-friction disks force robots to react fast enough to compensate for unexpected slips.

Center in Alleys



FLAT



SLOPED

Adjustable width alleys are set to the robot width + 10 cm (4 in) so all robots need to demonstrate similarly fine steering to center no matter their size. Flat and inclined floors vary approach angles and slipping.

Pallets & Pipes



ELEVATIONS: 20 cm (8 in)



SLOPE OPTION

Stackable pallets provide 20 cm (8 in) elevation changes with porous surfaces for feet and wheels to fall through. The rolling pipes on the leading edges eliminate friction to force climbing behaviors.



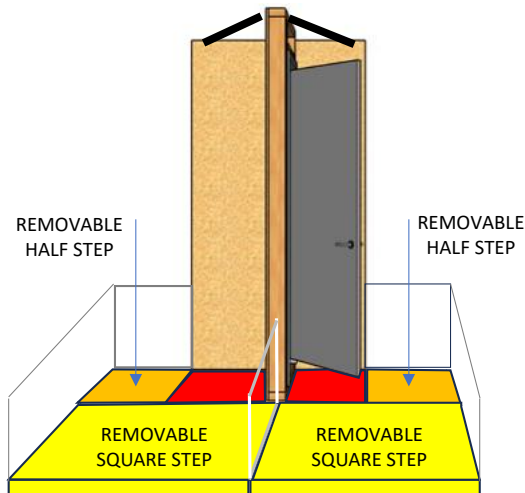
Standard Terrains and Obstacles



Version 2026C-Korea
Page: 10

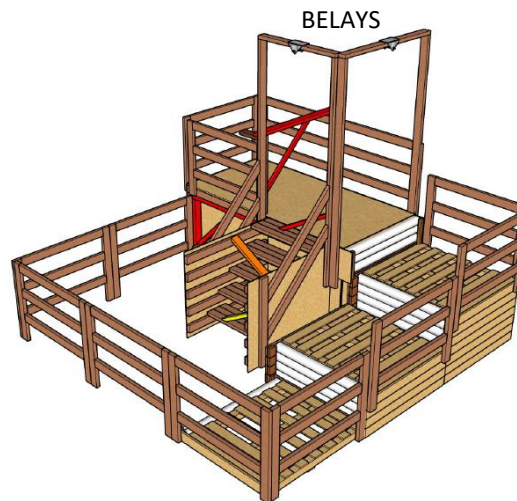
Sequence C: Access/Enter Dwelling

Push/Pull Doors



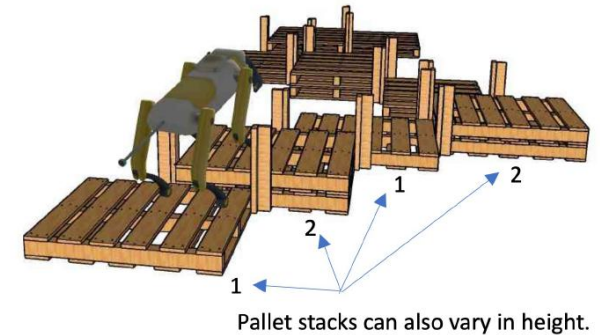
Manipulator dexterity and strength tasks with confined forward (0°) or sideward (90°) approaches. Options include a weighted mechanism to ensure positive grasping throughout and a 10 cm (4 in) stoop.

Stair Debris or Pallet Climb



Adjustable incline stairs from 30-45° with 20 cm (8 in) risers and 1, 2, or 3 angled debris rails to force steering. The Pallet & Pipe stacks provide 30 cm (12 in) plateaus to climb with rolling pipes to reduce friction.

Avoid Holes/Posts



Elevated and meandering path of 10 or more pallets requires fine steering to successfully maneuver through 5 sets of posts set 90 cm (36 in) apart. Each post knocked over causes a 10 second penalty.



Standard Terrains and Obstacles



Version 2026C-Korea

Page: 11

Sequence D: Search & Map Maze

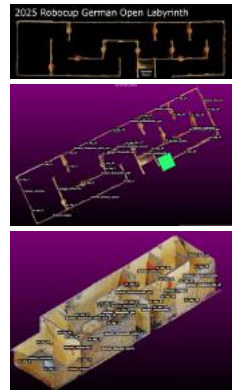
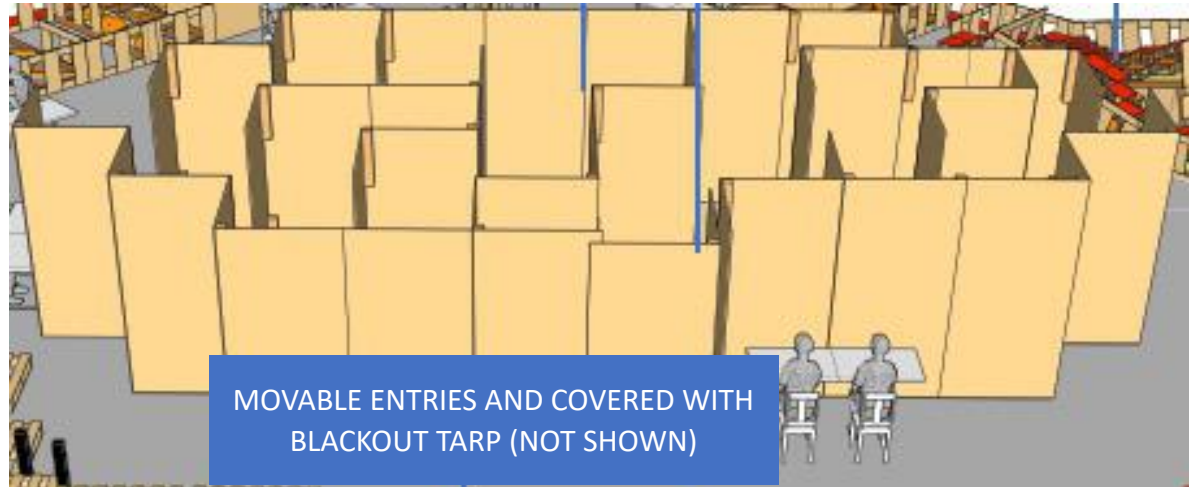
Search & Map Maze (Covered with BLACKOUT TARP)

Search the interior of the maze to produce quick and comprehensive maps (2D and 3D) of the hallways and rooms with accurate locations of each object-of-interest found and identified correctly. Some modest terrains inside ensure non-flat flooring throughout.

These maps should be suitable for emergency responders to identify the shortest route to victims, the location of potential hazards, etc.

There is a known lexicon of 2D and 3D objects of interest to find, identify, and locate on a map.

Split cylinder mapping fiducials and point cloud comparisons enable quantitative evaluation of maps and comparison of results with other teams and in other locations.





Standard Dexterity Tasks

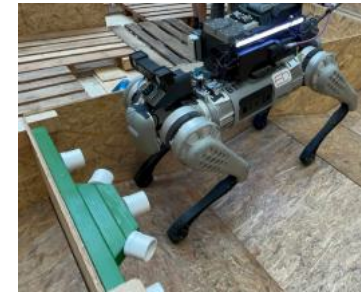


Version 2026C-Korea

Page: 12

Measure and Compare Scores

Dexterity tasks are placed throughout the terrains and obstacles to score Dexterity points. So-called Linear and Omni tasks provide increasing difficulty. Tasks are placed along the walls, on the ground, or below the ground plane. They include non-contact Align/Inspect, Touch/Insert, Press E-Stops, Turn Valves, and Push/Pull Doors. The Carry Crate tasks evaluate strength of the manipulator and stowing capabilities within complex terrains.



Align/Inspect

Touch/Insert

Press E-Stops

Turn Valves

Open Doors

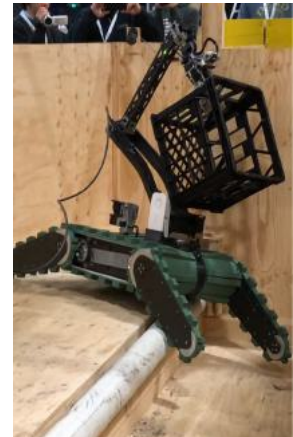
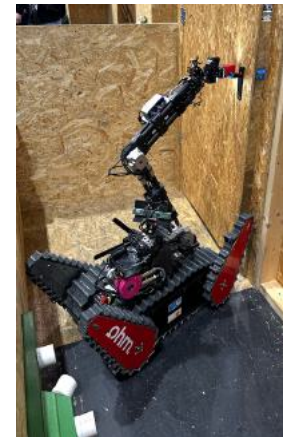
Carry Crates



Acuity & Color



Gauges to Read



QR Codes



Partial Hazmat



Version 2026C-Korea
Page: 13

Purchases

Materials and Items



Purchases (1 of 5)



Version 2026C-Korea

Page: 14

Lanes, Terrains, and Obstacles

1 USED IN SOME LANES



"2x2" LUMBER
5 x 5 cm (2 x 2 in)

2 NEED 5+ PER LANE



"THIN OSB" PANELS
11 mm (7/16 in) Thick

3 NEED 6 FOR CENTER LANE

RAMP COMPLEXITY

<https://a.co/d/0goURnY>



C CLAMPS
10 cm (4 in)

4 NEED 20 FOR AGR LANE



AGGREGATE: GRAVEL
25+ mm (1+ in)

5 NEED 50+ PER LANE



"2x4" LUMBER
5 x 10 cm (2 x 4 in)

6 USED IN SOME LANES



"THICK OSB" PANELS
18 mm (23/32 in) Thick

7 NEED 4 FOR FOAM LANE



<https://a.co/d/0hx2r0R>

SOFT FOAM
10 x 120 x 240 cm (4 x 48 x 96 in)

8 NEED 20 FOR THE MAZE



<https://a.co/d/05DFsMqb>

CONCRETE FORM TUBES
30cm diam x 60cm (12in diam x 24in)

9 USED IN SOME LANES



"4x4" LUMBER
10 x 10 cm (4 x 4 in)

10 NEED 10 FOR AVOID



PALLETS
100 x 120 cm (40 x 48 in)

11 NEED 20 FOR CLIMBING



DRAIN PIPE

LARGE PVC PIPES
10cm x 118cm (4in diam x 47in)

12 NEED 20 FOR PALLET LANE



SMALL PVC PIPES
5 cm ID x 118 cm (2 in ID x 47 in)



Purchases (2 of 5)



Version 2026C-Korea

Page: 15

Miscellaneous Parts

13 NEED 10 PER LANE

LANE ASSEMBLY

<https://a.co/d/d8rBjh0>



DOOR HINGES

7.5 cm (3 in)

14 NEED 40 FOR RAMP LANE

RAMP COMPLEXITY

<https://a.co/d/9qpx6kA>



SLIP DISKS

50 cm (20 in) Diameter

15 NEED 40 FOR RAMP LANE

RAMP COMPLEXITY

<https://a.co/d/26pAK06>



THREADED INSERTS

8mm (5/16 in) x 25 mm (1 in)

16 NEED 40 FOR RAMP LANE

RAMP COMPLEXITY

<https://a.co/d/0c9oW9QM>



HEX HEAD WASHER BOLTS

8mm (5/16 in) x 25 mm (1 in)

17 NEED 10 PER LANE

NEGOTIATE OBSTACLES

<https://a.co/d/03xzaF54>



MAGNETS with WASHERS

50 kg (110 lb) Strength

18 NEED 2 TOTAL

SAFETY BELAY ROPES

<https://a.co/d/05NCyEZ7>



SAFETY BELAY ROPE

500 kg (1100 lbs) | 30 m (100 ft)

19 NEED 1 SET PER BELAY

ROLLING BELAYS

<https://a.co/d/f4Lp85s>



CASTERS: (2) SWIVEL & (2) FIXED

15 cm (6 in) Diameter Wheels

20 NEED 20 TOTAL

PIPE HOLDERS

<https://a.co/d/71D7jzt>



HAND TIGHT STRAPS

2.5 x 120 cm (1 x 48 in)

21 NEED 4 PER LANE

BELAY JUDGING

<https://a.co/d/05D8ni80>



BELAYS: MAGNETS with EYES

50kg (100lb)

22 NEED 5 M (16 FT) PER BELAY

BELAYS – MUST MATCH

<https://a.co/d/bhYANVh>

<https://a.co/d/gzLipON>



SAFETY BELAY TRACK & TROLLEY

150 kg (300 lb) Capacity

23 NEED 2 TOTAL

GRAB HANDLES

<https://a.co/d/3aVigTE>



HEAVY LIFT ROPE

10 mm x 10 m (1/2 in x 30 ft)

24 NEED 1 PER LANE

DOOR LOCKS

<https://a.co/d/0cNTOxQx>



AUTOMATIC DOOR/GATE LATCH

Foot Flick To Unlatch



Purchases (3 of 5)



Version 2026C-Korea
Page: 16

Dexterity Tasks

25 NEED 2 TOTAL

DEX: ALIGN/INSPECT

<https://a.co/d/iGPavj2>

PLUS SPARE
IN CASE IT
BREAKS



PAPER PUNCH
5 cm (2 in) Circles

26 NEED 20 PER LANE

DEX: ALIGN/INSPECT

<https://a.co/d/06gqujRx>

<https://a.co/d/04MXYt3t>



PIPES & CAPS
5 cm ID x 5 cm (2 in ID x 2 in)

27 NEED 5 PER LANE

DEX: TOUCH/INSERT

<https://a.co/d/6NlbXev>



SANDER TOOL WITH SHAFT
6 mm (1/4 in) Diameter Shafts

28 NEED 20 PER LANE

DEX: TOUCH/INSERT

<https://a.co/d/26pAK06>

**BUY KIT
WITH
RELATED
DRILL BIT
TOO!**



THREADED INSERTS
8mm (5/16 in) x 25 mm (1 in)

29 NEED 5 PER LANE

DEX: ROTATE TASKS

<https://a.co/d/a2CrT4Z>

PACKS OF 5



90° SHUT OFF VALVES
25 mm (1 in) PEX Ball Valve

30 NEED 5 PER LANE

DEX: PRESS TASKS

<https://a.co/d/hy28aQi>



E-STOP BUTTONS
40 mm (1.5 in) Diameter Buttons

31 NEED 2 PER LANE

DEX: VICTIM BOX

<https://a.co/d/051gBwqC>

PACK OF 25



CUBIC CARDBOARD BOX
30 cm (12 in) – Double Thick is Best

32 NEED 1 PER LANE

DEX: HANDLE FOR CARRY

<https://a.co/d/05tLnfc>



SCREW ON PIPE FLANGE
TO MOUNT ON PIPE-T



WOODEN SPHERE
10cm (4in) Diameter

33 NEED 5 PER LANE

DEX: PRESS TASKS

<https://a.co/d/0ckOKxw3>

PACKS OF 5



PRESS ON/OFF LIGHTS (LED)
Battery Operated

34 NEED 1 PER LANE

DEX: DISRUPTOR/SEARCH

<https://a.co/d/046QQSip>



ADJUSTABLE FOCUS AND
LASER USED SEPARATELY

FOCUS FLASHLIGHT & LASER
Ideal as One Tool or Separate

35 NEED 1 SET PER LANE

DEX: PIPE-T HANDLE FOR CARRY TASKS



**GET EXTRA
FLANGE
FOR TOP
TO MOUNT
SPHERE
HANDLE**

12 mm (1/2 in) PIPE-T HANDLE
1 Pipe, 2 Flanges, 1 Tee, 2 Nipples

36 NEED 2 PER PLATES LANE

DEX: PIPE-T WEIGHTS

<https://a.co/d/03hMyu1z>



PLATE WEIGHTS
2.4 cm (1 in) holes for PIPE-T HANDLE



Purchases (4 of 5)



Version 2026C-Korea
Page: 17

Dexterity Tasks

37 NEED 1 FOR DEMO LANE

DEX: FIREHOSE DRAG

<https://a.co/d/0ceTRVkz>



FIRE HOSE REEL
Wall Mount

38 NEED 1 FOR DEMO LANE

DEX: FIREHOSE DRAG

<https://a.co/d/05BFTiHt>



FIRE HOSE
3.8 cm x 15 m (1.5 in x 50 ft)

39 NEED 1 FOR DEMO LANE

DEX: FIREHOSE DRAG

<https://a.co/d/0iwuvdmn>



SPIGOT TO CONNECT FIRE HOSE
Matching Fire Hose Purchased

40 NEED 1 FOR DEMO LANE

DEX: 2 HAND HORIZONTAL

<https://a.co/d/09hLqRr>



SOLD FOR DOGS!
WE'LL MODIFY IT

METAL FIRE HYDRANT PROP
60 cm (24 in) Tall

41 NEED 1 FOR DEMO LANE

DEX: 2 HAND HORIZONTAL

<https://a.co/d/01uraUOj>



FIRE HYDRANT WRENCH
Adjustable

42 NEED 1 FOR DEMO LANE

DEX: 2 HAND VERTICAL

<https://a.co/d/0hnxLbNN>

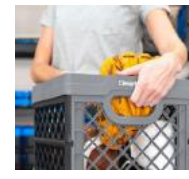


HANDWHEEL & HANDLE
30 cm (12in) Diam.

43 NEED 1 FOR DEMO LANE

DEX: 2 HAND CARRY

<https://a.co/d/034DObHy>



DEXTERITY: TWO HAND CARRY
30 cm (12 in) Cubic

44 NEED 1 FOR DOOR LANE

TWO GRIP OPTIONS



PRE-HUNG DOOR, KNOB & HANDLE
80 cm (32 in) Wide

45 NEED 5 FOR DEMO LANE

DEX: INSERT KEYS

<https://a.co/d/0fOeUE82>



SINGLE CYLINDER LOCKS
Entire Set Similarly Keyed

46 NEED 5 FOR DEMO LANE

DEX: HOOK TASKS

<https://a.co/d/0c6Mo5xV>



SET OF 10



SQUARE U-BOLTS
5 x 10 cm (2 x 4 in)

47 NEED 6 EACH COLOR

LINEAR/OMNI TASKS



SAFETY GREEN

SAFETY BLU

SAFETY RED

MATTE BLACK

SPRAY PAINT (6 each)
Green | Blue | Red | Black

48 NEED 40+ EACH SIZE

SEVERAL USES

<https://a.co/d/053OK3AN>

<https://a.co/d/0bpZ4svu>



AA and AAA BATTERIES
48 counts shown



Purchases (5 of 5)



Version 2026C-Korea
Page: 18

Tools

Cordless Drills, Spare Batteries, Chargers



Miter Saw with Cut Guides



Panel Saw For OSB



Hole Saw 10cm (4in) To Make "Handles" in OSB



<https://a.co/d/0a3sDDNZ>



Purchases (5 of 5)



Version 2026C-Korea
Page: 19

Different Types of Screws to Use

Pre-Fabrication of Lumber Components Use any Torx Screws

- Use any TORX SCREWS when burying the head into lumber is okay because it is never coming out.
- For fabrication of elements that will never come apart.

TORX GENERAL DECKING SCREWS

[800] 5mm x 40 mm (#10in x 1-1/2 in)
[300] 5mm x 65 mm (#10in x 2-1/2 in)
[100] 5mm x 75 mm (#10in x 3 in)

TYPICAL FLAT-HEAD
TORX SCREWS



OR

SPAX WAFER-HEAD
TORX SCREWS



Pre-Fabrication of OSB Panel Components Use Washer-Head Torx

- Use WASHER-HEAD TORX SCREWS or WAFER-HEAD SPAX SCREWS to prevent penetration into the OSB.
- For assembly of OSB panels to any lumber.

SPAX WAFER HEAD SCREWS

[800] 5mm x 40 mm (#10in x 1-1/2 in)
[300] 5mm x 65 mm (#10in x 2-1/2 in)
[100] 5mm x 75 mm (#10in x 3 in)

SCREWS: <https://a.co/d/2So1bOh>
BITS: <https://a.co/d/aG4VE6l>



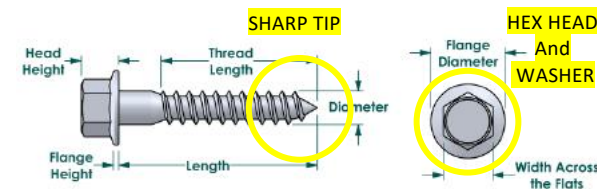
Set-Up/Tear-Down Use Only Hex Head Screws with Magnetized Bits

- Use #10 ROOFING SCREWS with WASHERS, HEX HEADS, and MAGNETIZED SOCKET BITS for one-handed tool use.
- NEED TO BE EASY TO FIND AND REMOVE. Cannot be buried by novice tool users at the venue. The different tool can't be used to disassembly any pre-fabricated components.

HEX HEAD ROOFING SCREWS

[800] 5mm x 40 mm (#10in x 1-1/2 in)
[300] 5mm x 65 mm (#10in x 2-1/2 in)
[100] 5mm x 75 mm (#10in x 3 in)

EXAMPLE: <https://a.co/d/51dEgnJ>
BITS: <https://a.co/d/0g1KPAb>





Version 2026C-Korea
Page: 20

Walls/Railings

Fabrication



Lane Railings



Version 2026C-Korea
Page: 22

Taller/Sturdier Lumber

QUANTITY: [100] RAILINGS = [14] RAILINGS PER LANE x [7] LANES (GRAVEL, K-RAILS, RAMPS, STEPFIELDS, CENTER, PALLETS, STAIRS)

PURCHASE LIST:

- [245] "2x4" LUMBER
240 cm (96 in)
- [1,176] WASHER HEAD TORX SCREWS
10 cm (4 in) long
<https://a.co/d/0aNWH1dZ>

CUT LIST:

- A** [196] "2x4" VERTICALS
90 cm (36 in) Long
- B** [294] "2x4" HORIZONTALS
100 cm (41 in) Long
OVERALL WIDTH WHEN
ASSEMBLED MUST BE NO
LARGER THAN 120 cm (48 in)
TO FIT INTO SHIPPING CRATE

FABRICATION TIPS:

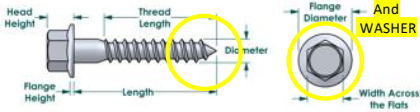
- C** Recess screws using oversized paddle bit marked with tape to shoulder depth of the 10 cm ((4 in) screws used.



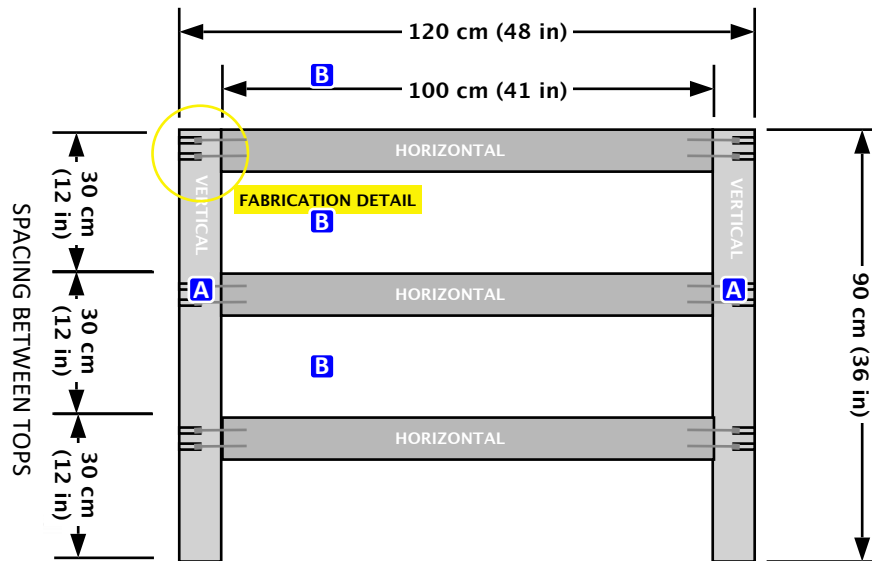
Final assembly at the venue use washer head HEX SCREWS with MAGNET BITS

SHARP TIP

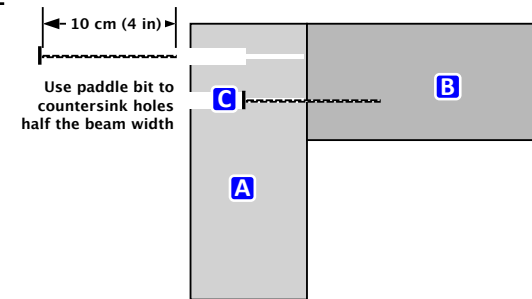
HEX HEAD
And
WASHER



RAILING ASSEMBLY



FABRICATION DETAIL



14 RAILINGS PER LANE

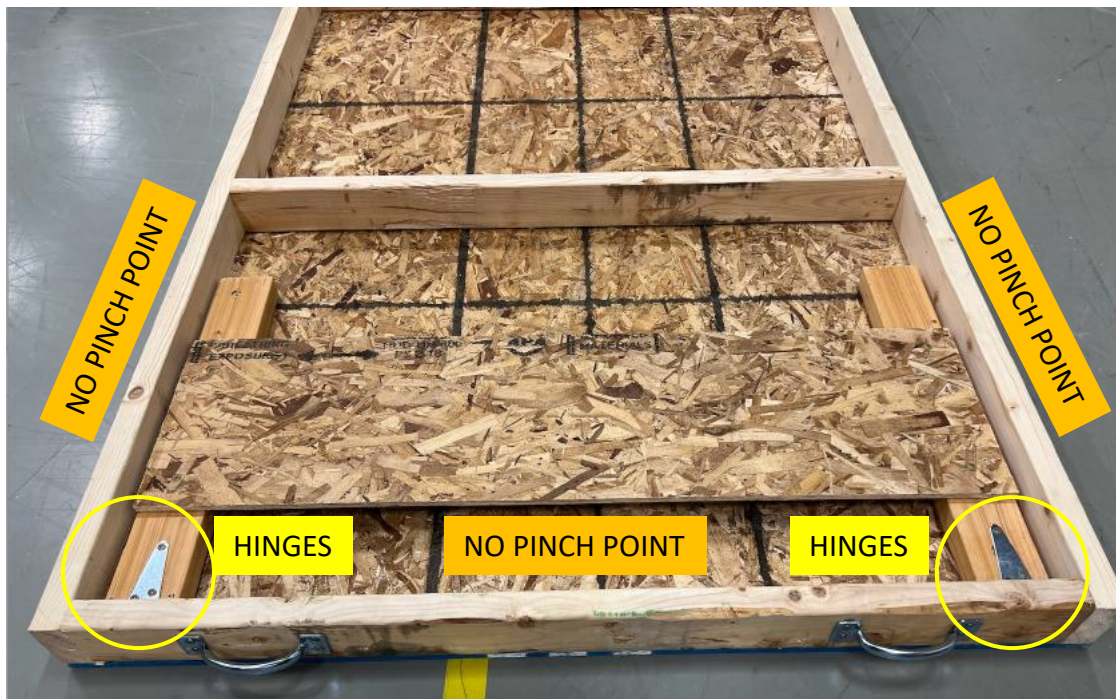


RECESSED 10 CM (4 IN) SCREWS

NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.

Flat/Tilt Floors

Fabrication





Floors



Version 2026C-Korea

Page: 24

Fabricate All Floors Similarly

QUANTITY: [24] FLOORS = [4] PER LANE x [6] LANES (GRAVEL, K-RAILS, STEPFIELDS, RAMPS, CENTER, PALLETS)

PURCHASE LIST:

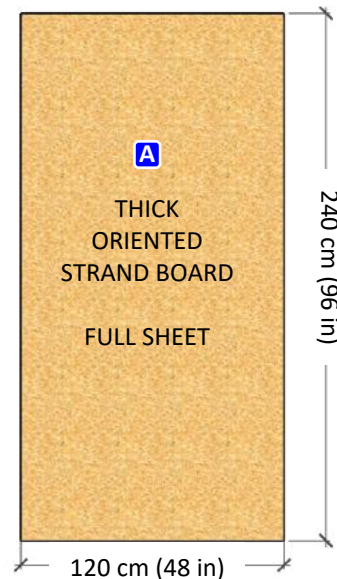
[24] "THIN OSB" PANELS
120 x 240 cm (48 x 96 in)

[96] "2x4" LUMBER
240 cm (96 in) long

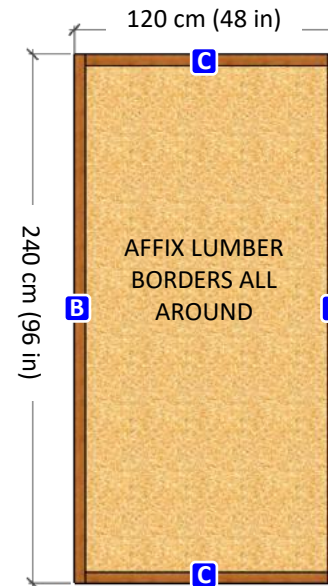
CUT LIST:

- A** [24] "THIN OSB" FULL PANELS
NO CUTS
- B** [48] "2x4" LONG BORDERS
240 cm (96 in)
SHOULD BE SAME AS OSB PANEL
- C** [96] "2x4" SHORT BORDERS/JOISTS
110 cm (45 in)
CUT TO FIT BETWEEN LONG BORDERS

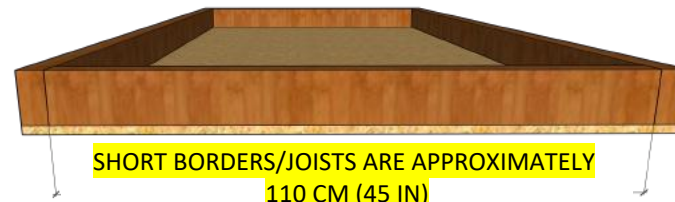
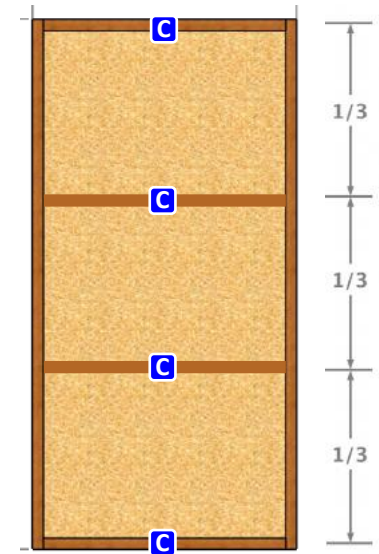
START WITH
FULL OSB PANEL



ADD LONG AND
SHORT BORDERS



ADD SHORT
INTERIOR JOISTS



SHORT BORDERS/JOISTS ARE APPROXIMATELY
110 CM (45 IN)
BASED ON YOUR LONG BORDER LUMBER WIDTH

NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Tilt-Up Legs (15°)



Version 2026C-Korea
Page: 25

Add to Half the Floors Fabricated

QUANTITY: [12] TILT-UP LEGS AND [12] HINGE BEAM SPACERS GET ADDED TO HALF THE FLOORS FABRICATED

PURCHASE LIST:

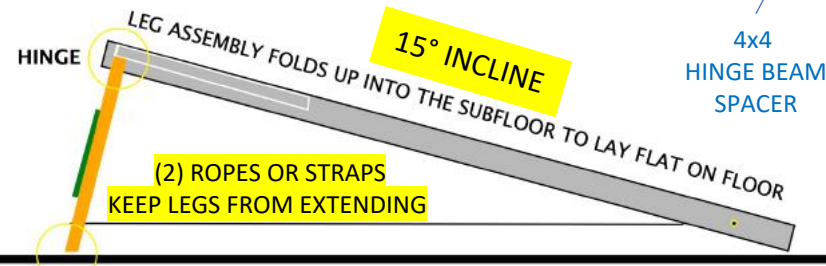
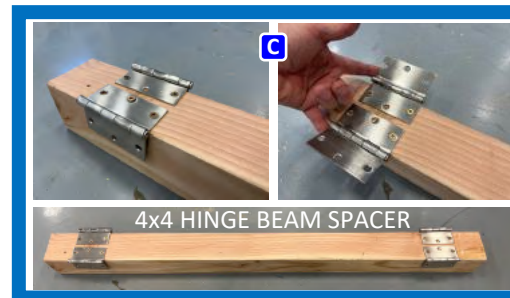
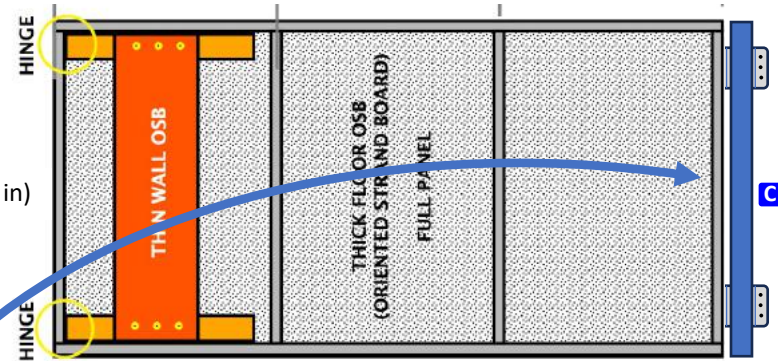
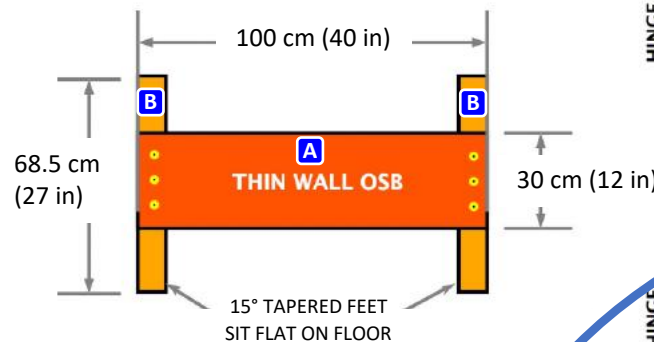
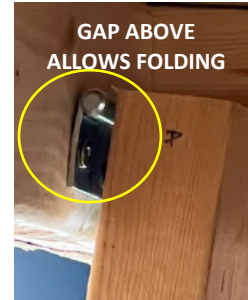
- [1] "THIN OSB" PANELS
120 cm x 240 cm (48 in x 96 in)
- [16] "2x4" LUMBER
240 cm (96 in)
- [5] "4x4" LUMBER
240 cm (96 in)
- [40] DOOR HINGES
7.5 cm (3 in) or similar
- [60m] ROPE or STRAPS
500 kg (1100 lbs) or 12 mm (1/2 in)

CUT LIST:

- A** [10] "THIN OSB" PANELS
30 x 100 cm (12 x 40 in)
- B** [20] "2x4" LEGS
68.5 cm (27 in) long with 15° tapered feet on one end – cut tall on saw
SHOULD MAKE 15° INCLINE WHEN ASSEMBLED WITH THE HINGE
- C** [10] "4x4" HINGE BEAM SPACERS
120 cm (48 in) long attach to bottom of tilt-up floors with hinges on top.

FABRICATION TIPS:

- Be certain the folded legs completely recess up into the frame of the floor. So be careful how the hinge is attached.
- Make one assembly and measure the resulting angle before making more. The incline should be 15°.



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.c

Shifty Gravel

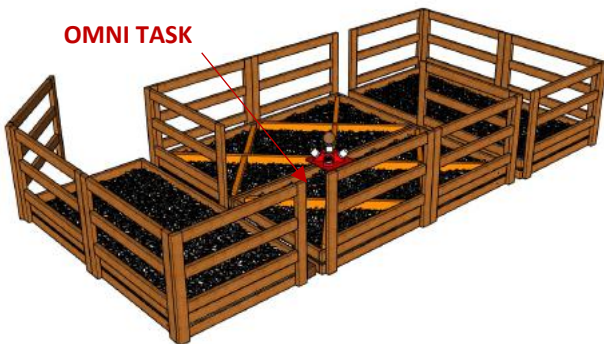
Fabrication



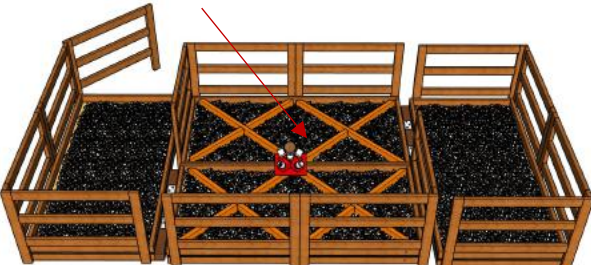
CONFINED FLAT

Prelims

OMNI TASK



OMNI TASK



OPPOSING SLOPES (15°)

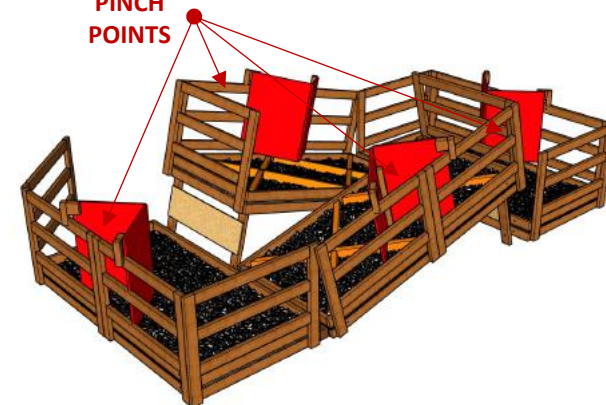
Prelims/Semis



ADDITIONAL OBSTACLES

Semis/Finals

PINCH
POINTS



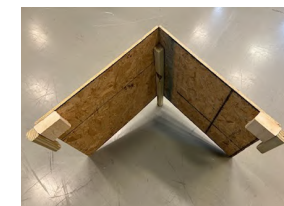
Shifty Aggregates:

- Robot feet to sink up to 10 cm (4 in) below the perceived ground plane.
- Traction and digging in become a problem.



Pinch Points:

- 60 cm (24 in) triangular panels hang on railings.
- Require precise steering in terrains and obstacles.
- Also complex approaches to dexterity tasks.





Shifty Aggregates

Fabrication



Version 2026C-Korea
Page: 28

QTY: [4] BORDERS, [4] X-RAILS

PURCHASE LIST:

[20] "2x4" LUMBER
240 cm (96 in)

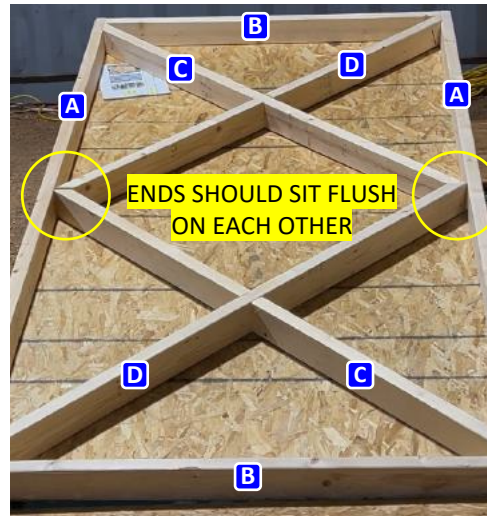
CUT LIST:

- A** [8] "2x4" LONG BORDERS
240 cm (96 in)
SHOULD BE SAME AS OSB PANEL
- B** [8] "2x4" SHORT BORDERS
110 cm (45 in)
CUT TO FIT BETWEEN LONG BEAMS
- C** [4] "2x4" X-RAIL TOP NOTCH
169 cm CORNER TO BORDER CENTER
67.5 in CORNER TO BORDER CENTER
45° BOTH ENDS – CUT TALL OPPOSING
- D** [4] "2x4" X-RAIL BOTTOM NOTCH
169 cm CORNER TO BORDER CENTER
67.5 in CORNER TO BORDER CENTER
45° BOTH ENDS – CUT TALL OPPOSING

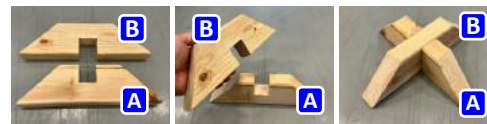
FABRICATION TIPS:

- Attach border frames together and to pre-fabricated SUBFLOORS with angled screws.
- Measure the diagonals that fit from a corner to the center of a long border.
- Notch the exact CENTER of each rail a bit wider than the beam's width, so the two notches can intersect easily.
- Screw the X-Rails to the SUBFLOOR from the underside to support the OSB.

TALL "2x4" X-RAILS CONTAIN GRAVEL
ON SLOPED CETER ROOM

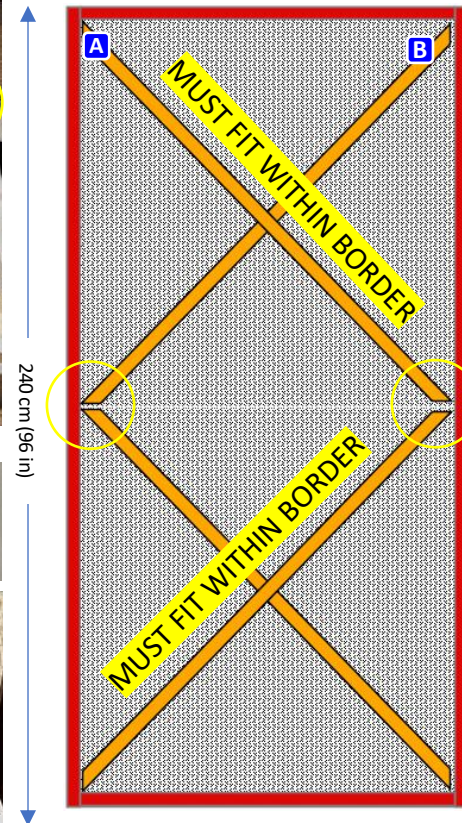


CENTER NOTCHES INTERSECT LIKE OMNIS



SINGLE SLOPED SUBFLOOR

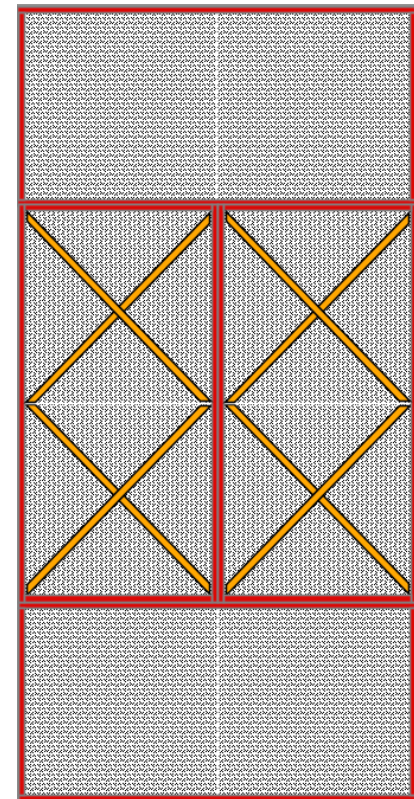
DIAGONAL TALL "2x4s"
45° ENDS OPPOSING
CENTER NOTCHES TO INTERSECT



SCREW X-RAILS TO SUBFLOOR
FROM UNDERSIDE TO STIFFEN OSB

ENTIRE LANE

PATTERN OF [8]
PREFABRICATED OSB PANELS
WITH AFFIXED DIAGONALS

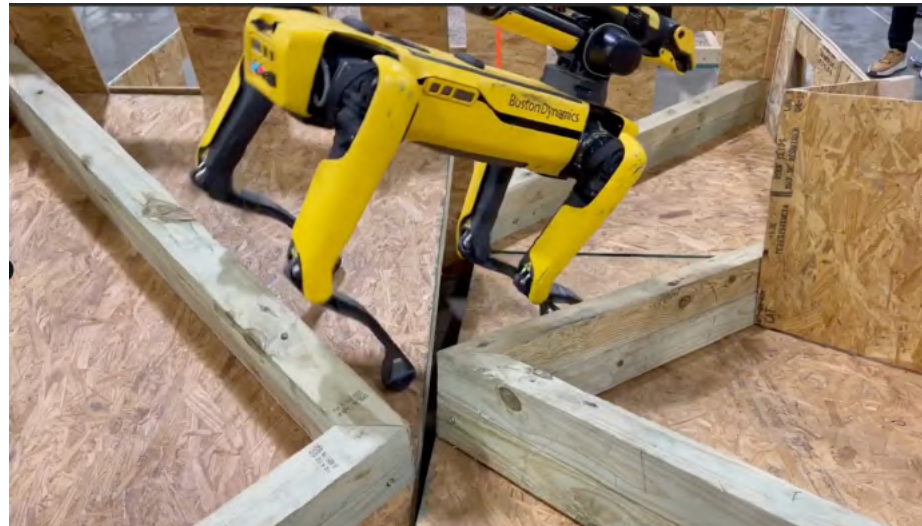


ENTER

NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.

Diagonal K-Rails

Fabrication





Diagonal K-Rails

Difficulty Levels

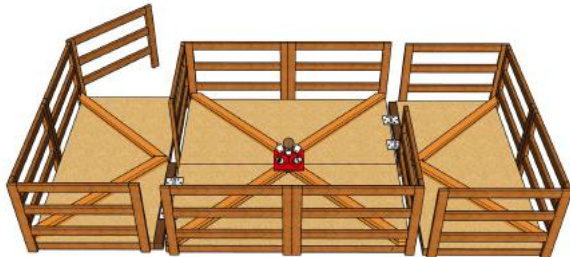


Version 2026C-Korea

Page: 30

FLAT WITH 90° TURNS

Prelims



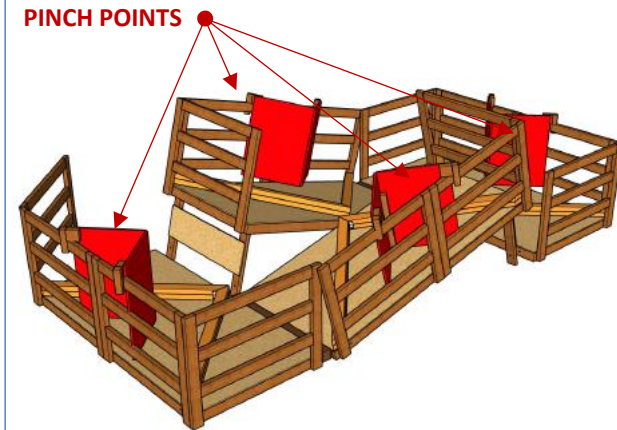
OPPOSING SLOPES (15°)

Prelims/Semis



ADDITIONAL OBSTACLES

Semis/Finals



Layered K-Rail Elevations:

- K-Rail layers in 5cm (2in) increments
- Stack high enough to challenge the maximum capability of the robot.



Pinch Points:

- 60 cm (24 in) triangular panels hang on railings.
- Require precise steering in terrains and obstacles.
- Also complex approaches to dexterity tasks.





Diagonal K-Rails

Fabrication



Version 2026C-Korea

Page: 31

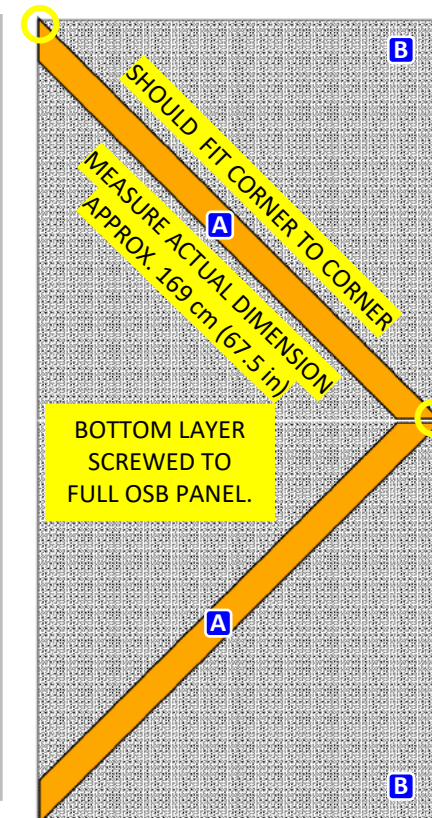
Screw the bottom layer 10 x 10 cm rails to a full OSB sheet for easy stowing and deployment. So [8] terrain panels fills the lane.

EASY STOWING AND LAYOUT OF [8] TERRAIN ELEMENTS
(EVEN IF ONLY ON A FLAT FLOOR FOR PRACTICE)

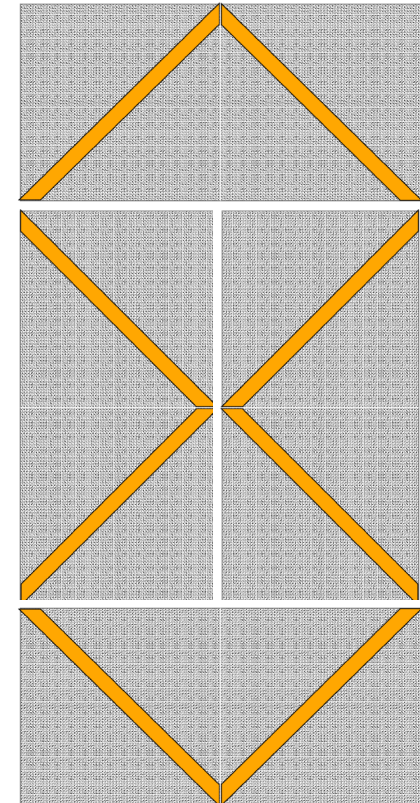
INSERT PICTURE OF FULL
PANEL BEING CARRIED

PLUS PICTURE OF SECOND
LAYER BEING SCREWED
DOWN THROUGH PADDLE
BIT HOLE

DIAGONAL "4x4" WITH
BOTH ENDS CUT 45° OPPOSING
TO FORM A TRAPEZOID



PATTERN OF [8]
PREFABRICATED OSB PANELS
WITH AFFIXED DIAGONALS



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Diagonal K-Rails

Fabrication



Version 2026C-Korea

Page: 32

QUANTITY: [32] DIAGONALS MAKE UP TO [4] LAYERS OF FLAT “2x4s”. SCREW THE FIRST DIAGONAL LAYER TO [8] SQUARE OSB PANELS.

PURCHASE LIST:

- [16] “4x4” LUMBER
240 cm (96 in)
- [4] “THIN OSB” PANELS
120 x 240 cm (48 x 96 in)

CUT LIST:

- A** [32] “4x4” DIAGONALS
169 cm (67.5 in) – 45° BOTH ENDS
MUST FIT CORNER TO WALL
CUT FLAT, BOTH ENDS OPPOSING
- B** [8] “THIN OSB” SQUARE PANELS
120 x 120 cm (48 x 48 in)
SCREW FIRST LAYER OF DIAGONALS
TO THESE FOR STOWING IN CRATE

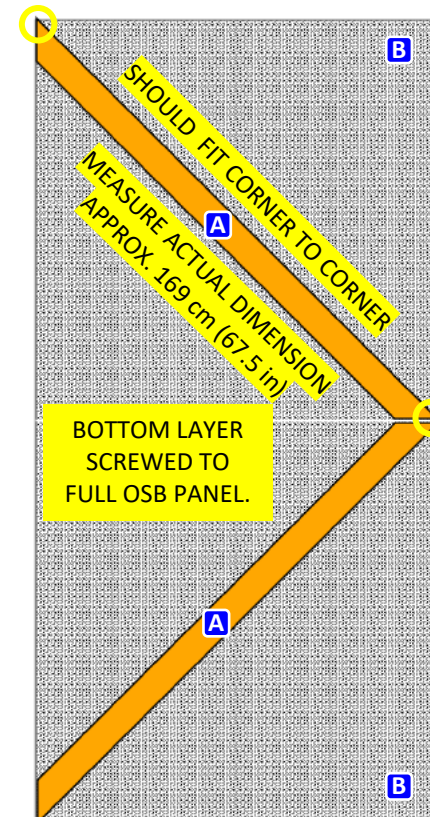
FABRICATION TIPS:

- Screw the BASE DIAGONAL “4x4” to a SQUARE OSB PANEL as a way to keep the terrain from moving in the lane and to stow easily. So make 8 square elements for the entire lane. The double layer of OSB also helps strengthen for walking on.
- ADD A SPACER under the “4x4” if necessary to make the obstacle 10cm (4in) tall (USA lumber or others).
- To add a second “4x4” layer by screwing to the base layer through recessed holes, or add dowel holes in similar locations on ALL DIAGONALS, then drop a long bolt into the coincident holes.

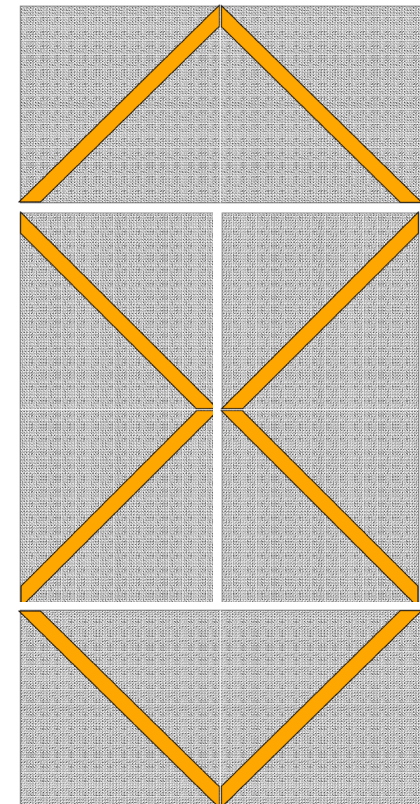
ADD DIAGONAL K-RAIL LAYERS
INCREMENTALLY EVERY 5 CM (2 IN).
ADD THIN OSB SPACERS AS NEEDED.



DIAGONAL “4x4” WITH
BOTH ENDS CUT 45° OPPOSING
TO FORM A TRAPEZOID



PATTERN OF [8]
PREFABRICATED OSB PANELS
WITH AFFIXED DIAGONALS

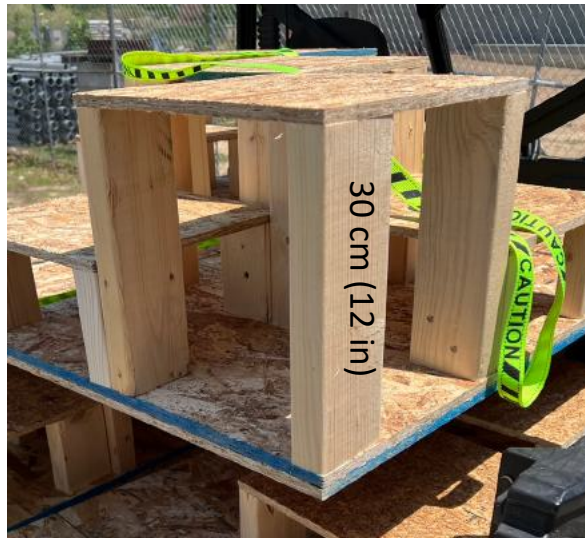


NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.

Half-Cubic Stepfields

Fabrication

A QUAD-STEP made from
5x10 cm (2x4 in) posts
cascading around in every direction.
Add 2 screws on top.



Two QUAD-STEPs on 60 cm (24 in) OSB panels form diagonal hills.
SINGLE-STEPs on separate 60 cm (24 in) OSB bases fill in corners.



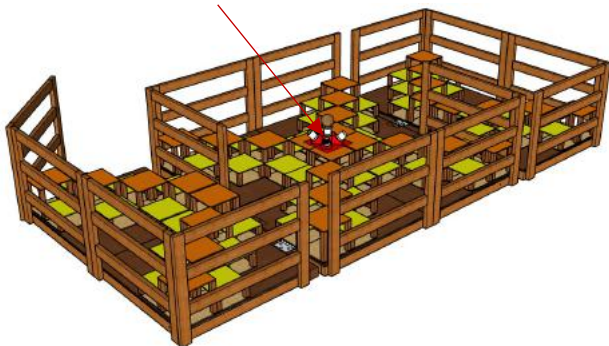
An entire lane of elements
stacks well to stow and ship.
(16) QUAD-STEPs
(16) SINGLE-STEPs



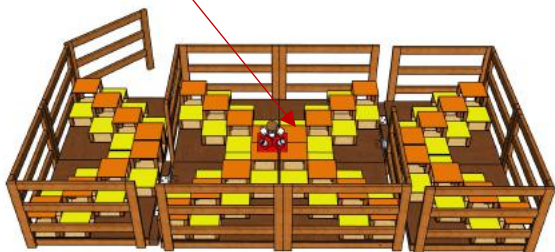
FLAT WITH 90° TURNS

Prelims

OMNI TASK

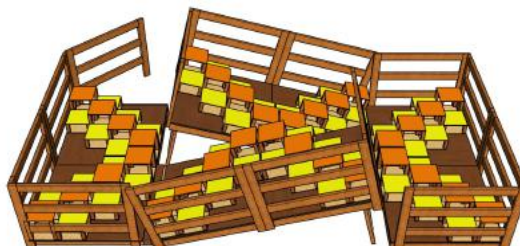


OMNI TASK



OPPOSING SLOPES (15°)

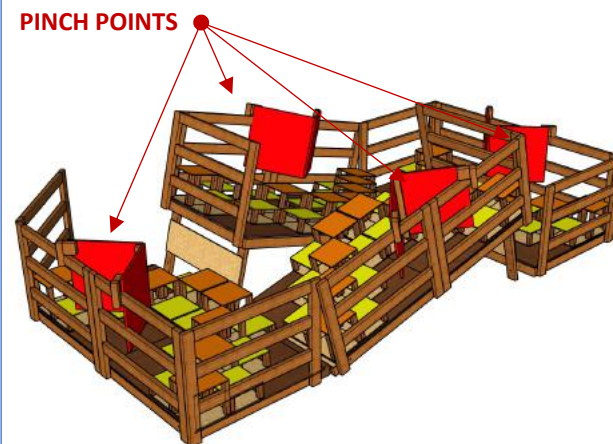
Prelims/Semis



ADDITIONAL OBSTACLES

Semis/Finals

PINCH POINTS



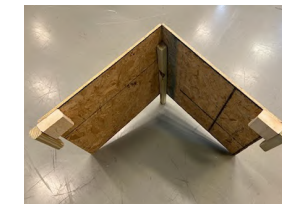
Three Terrain Elevations:

- Ensure contact points are always on three different elevations.
- 30 cm (12 in) square plateaus with 15 cm (6 in) elevation changes.



Pinch Points:

- 60 cm (24 in) triangular panels hang on railings.
- Require precise steering in terrains and obstacles.
- Also complex approaches to dexterity tasks.





Half-Cubic Stepfields

Stronger Fabrication



Version 2026C-Korea
Page: 35

QTY: [16] QUADS, [16] SINGLES

NOTE: CAN USE SHELVING WOOD BOARDS IF WIDTH IS JUST UNDER 30cm (12in) SO THEY FIT 4 ACROSS FLOOR WIDTH.

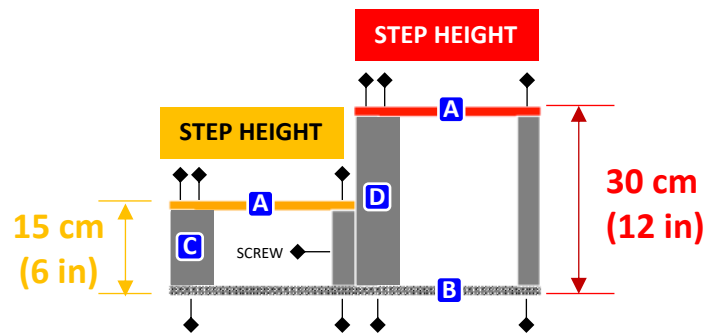
PURCHASE LIST:

- [4] "THICK FLOOR OSB" PANELS
120 cm x 240 cm (48 in x 96 in)
- [4] "THIN OSB" PANELS
120 cm x 240 cm (48 in x 96 in)
- [25] "2x4" LUMBER
240 cm (96 in)

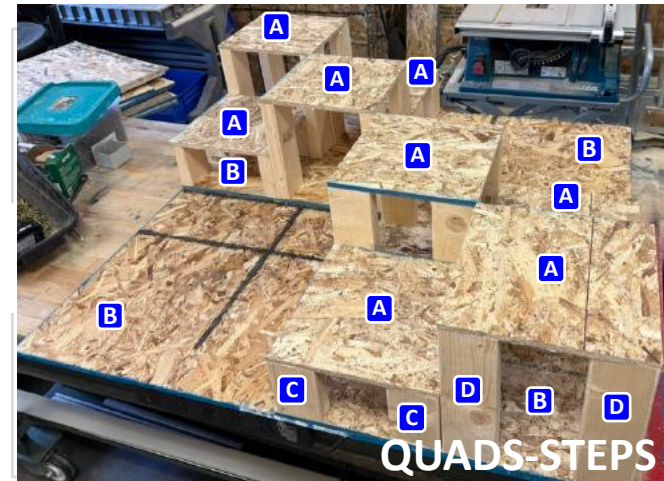
CUT LIST:

- A** [80] "THICK FLOOR OSB" STEPS
MUST FIT 4 ACROSS FLOOR WIDTH
WIDTH: 297 mm (11-7/8 in)
LENGTH: 297 mm (11-7/8 in)
- B** [32] "THIN OSB" QUAD BASES
MUST FIT 4 SQUARE WIDTH
WIDTH: 594 mm (23-3/4 in)
LENGTH: 594 mm (23-3/4 in)
- C** [200] "2x4" SHORT LEGS
HALF THE LONG LEGS
15 cm (6 in)
- D** [130] "2x4" LONG LEGS
DOUBLE THE SHORT LEGS
30 cm (12 in)

QUAD STEP ASSEMBLY



WASHER/WAFER HEADTORX SCREWS



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.

Pitch/Roll Ramps

Fabrication





Pitch/Roll Ramps (15°)



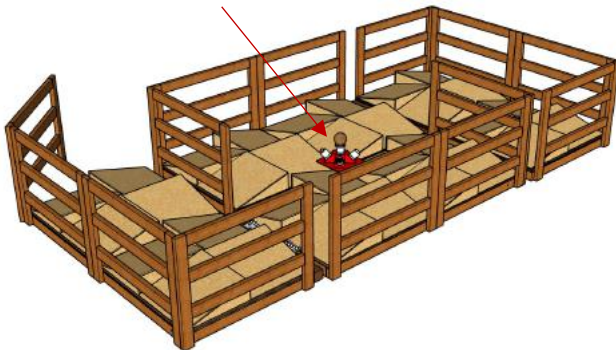
Version 2026C-Korea
Page: 37

Lane Difficulty Settings

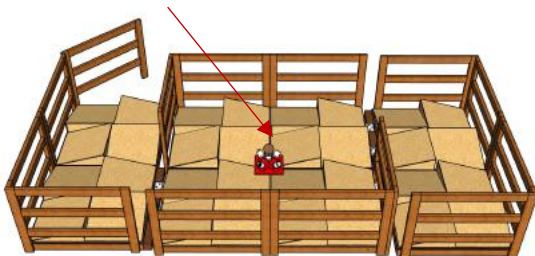
CONFINED FLAT

Prelims

OMNI TASK



OMNI TASK



OPPOSING SLOPES (15°)

Prelims/Semis



ADDITIONAL OBSTACLES

Semis/Finals

PINCH POINTS



Rotating Slip Disks:

- Thin wood disks 50 cm (20 in) diameter rotate unexpectedly.
- Require quick reactions or changes of contact points when slipping.



Pinch Points:

- 60 cm (24 in) triangular panels hang on railings.
- Require precise steering in terrains and obstacles.
- Also complex approaches to dexterity tasks.





Pitch/Roll Ramps (15°)

Fabrication



Version 2026C-Korea

Page: 38

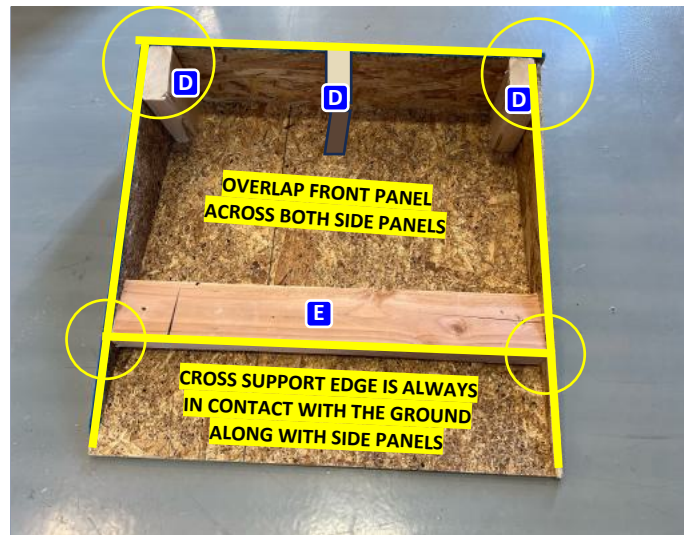
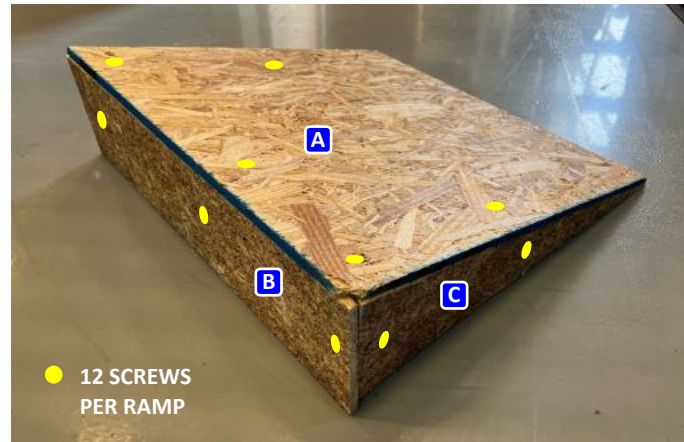
QUANTITY: [40] RAMPS MOUNTED [4] PER SQUARE OSB PANEL BACKING FORM [5] PEAKS AND [5] VALLEYS AS SHOWN TO STACK IN PAIRS

PURCHASE LIST:

- [5] "THICK OSB" PANELS
120 x 240 cm (48 in x 96 in)
- [5] "THIN OSB" PANELS
120 x 240 cm (48 in x 96 in)
- [10] "2x4" LUMBER
240 cm (96 in)

CUT LIST:

- A** [40] TOPS "THICK OSB"
594 mm (23-3/4 in) SQUARE
MUST BE LESS THAN HALF YOUR
FLOOR WIDTH TO FIT 2 ACROSS
- B** [40] FRONTS OF "THIN OSB"
15 cm (6 in) TALL
MATCH SQUARE TOP DIMENSION
SUPPORTS THE ENTIRE TOP EDGE
- C** [80] SIDES OF "THIN OSB"
MATCH SQUARE TOP DIMENSION
15 cm (6 in) TALL
TAPERS AT 15°
SUPPORTS THE ENTIRE TOP EDGE
- D** [120] "2x4" LEGS
15 cm (6 in) – 15° CUT ONE END
CUT FLAT ON SAW
- E** [40] "2x4" CROSS SUPPORTS
CUT TO WIDTH BETWEEN WALLS
LESS THAN TOP BECAUSE SIDES ARE
RECESSED UNDER THE TOP



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.

Four Square Mounting for Pairs of "Valleys" and "Peaks"

Four ramps are screwed to a half OSB panel to make [8] terrain elements that fill a lane and stow compactly in nested pairs.





Pitch/Roll Ramps (15°)



Version 2026C-Korea

Page: 40

Rotating Slip Disks

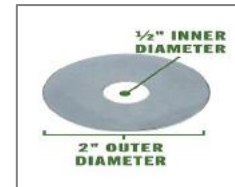
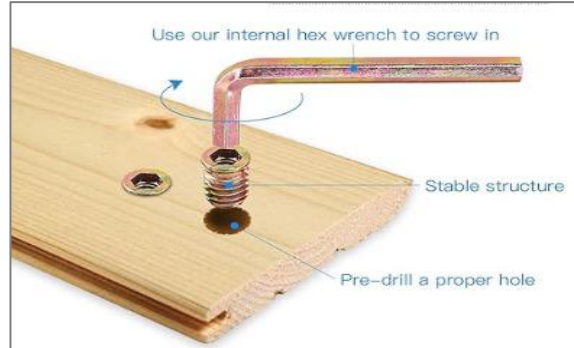
QUANTITY: [40] SLIP DISKS CENTERED ON EACH RAMP AND LOOSE ENOUGH TO ROTATE. BOLD LINES SHOW ROTATIONS WHEN SLIPPING.

PURCHASE LIST:

- [40] THIN ROUND DISKS**
3 mm thick x 50 cm diameter
(0.12 in thick x 20 in diameter)
Example: <https://a.co/d/bZNhpLu>
- [40] THREADED INSERTS**
8 mm thread x 25 mm long
(5/16 in thread x 1 in long)
Example: <https://a.co/d/3lhbJ5J>
- [40] HEX BOLTS**
8 mm thread x 40 mm long
(5/16 in thread x 1-1/2 in long)
Example: <https://a.co/d/at3Zsu3>
- [40] FENDER WASHERS**
8 mm thread x 40 mm diameter
5/16 in bolt x 1-1/2 in diameter
Example: <https://a.co/d/0V6FOMf>
- [1] THICK MARKER**
Magnum black marker
Example: <https://a.co/d/9YNsxQu>

FABRICATION TIPS:

- Find the center of each ramp by drawing straight lines from corner to corner. Drill in center using a bit specifically sized for the threaded insert being used.
- Find the center of the disks by measuring inward from the edges at multiple angles.
- Clamp 10 disks together to drill the center holes in batches.



THIN ROUND DISKS

- Any thin disk with big enough diameter may do. It doesn't need to be wood.
- Could also be plastic or even metal (pizza pan liners)
- Need to drill oversized center holes for the hex bolts.

THREADED INSERTS

- Placed in the **CENTER** of each RAMP.
- Be sure to drill the correct size hole for the the external threads to bite.

HEX BOLTS

- Must match the threaded inserts internal thread and be at least 25mm (1in) long.
- Thread in by hand and stays loose so the disk rotates freely.
- Add a FENDER WASHER to protect the holes in the THIN ROUND DISKS

FENDER WASHERS

- Match the Big enough to fully cover holes in disks.
- Any large outer diameter should work.

THICK MARKER

- Straight lines from the center out shows when the ROUND DISK is rotated by the robot's actions.

NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Pitch/Roll Ramps (15°)



Version 2026C-Korea

Page: 41

Rotating Slip Disks

QUANTITY: [40] SLIP DISKS CENTERED ON EACH RAMP AND LOOSE ENOUGH TO ROTATE. BOLD LINES SHOW ROTATIONS WHEN SLIPPING.

PURCHASE LIST:

[40] THIN ROUND DISKS

3 mm thick x 50 cm diameter
(0.12 in thick x 20 in diameter)

Example: <https://a.co/d/bZNhpLu>

[40] THREADED INSERTS

8 mm thread x 25 mm long
(5/16 in thread x 1 in long)

Example: <https://a.co/d/3lhbJ5J>

[40] HEX BOLTS

8 mm thread x 40 mm long
(5/16 in thread x 1-1/2 in long)

Example: <https://a.co/d/at3Zsu3>

[40] FENDER WASHERS

8 mm thread x 40 mm diameter
5/16 in bolt x 1-1/2 in diameter

Example: <https://a.co/d/0V6FOMf>

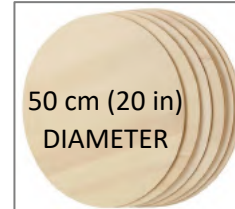
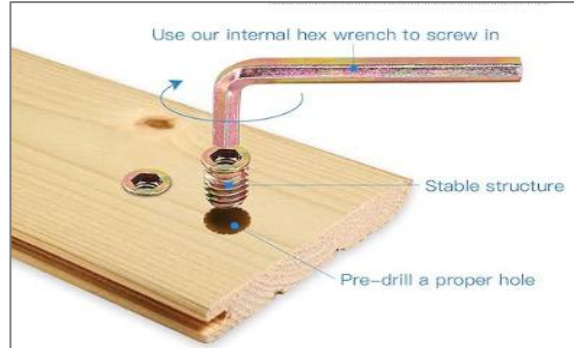
[1] THICK MARKER

Magnum black marker

Example: <https://a.co/d/9YNsxQu>

FABRICATION TIPS:

- Find the center of each ramp by drawing straight lines from corner to corner. Drill in center using a bit specifically sized for the threaded insert being used.
- Find the center of the disks by measuring inward from the edges at multiple angles.
- Clamp 10 disks together to drill the center holes in batches.



THIN ROUND DISKS

- Any thin disk with big enough diameter may do. It doesn't need to be wood.
- Could also be plastic or even metal (pizza pan liners)
- Need to drill oversized center holes for the hex bolts.

THREADED INSERTS

- Placed in the CENTER of each RAMP.
- Be sure to drill the correct size hole for the the external threads to bite.

HEX BOLTS

- Must match the threaded inserts internal thread and be at least 25mm (1in) long.
- Thread in by hand and stays loose so the disk rotates freely.
- Add a FENDER WASHER to protect the holes in the THIN ROUND DISKS

FENDER WASHERS

- Match the Big enough to fully cover holes in disks.
- Any large outer diameter should work.

THICK MARKER

- Straight lines from the center out shows when the ROUND DISK is rotated by the robot's actions.

NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Version 2026C-Korea
Page: 42

Center in Alleys

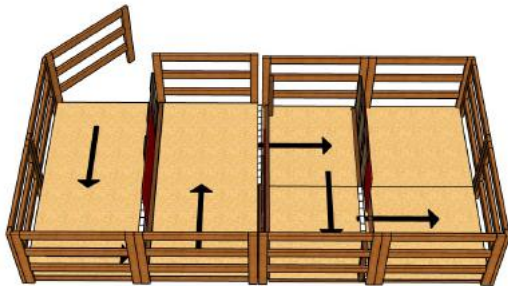
Fabrication

Adjustable Doorways, Adjustable Incline

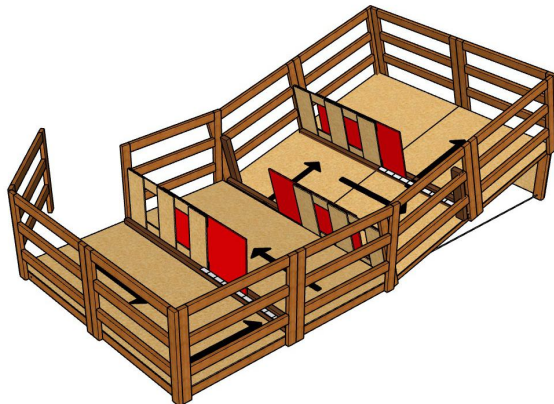
Square Room Dimensions

Flat or Sloped

FLAT



SLOPED 15°



Sliding OSB Panels

Challenge All Robots Similarly

SLIDING OSB PANELS ARE C-CLAMPED
TO LEAVE PASSAGES MEASURING
ROBOT WIDTH + 10 cm (4 in)



Flooring Complexity Options

Positioning Uncertainty

ADD SLIP DISKS FOR PERIODIC
FRICTIONLESS COMPLEXITY



CENTER IN ALLEYS:

- Adjustable width doorways are set 10cm (2in) wider than robot.
- Flat and inclined floors vary approach angles and slipping.



Pinch Points:

- 60 cm (24 in) triangular panels hang on railings.
- Require precise steering in terrains and obstacles.
- Also complex approaches to dexterity tasks.





Center Fabrication



Version 2026C-Korea
Page: 44

QTY: [3] SLIDING OSB PANELS WITH [2] C-CLAMPS EACH.

PURCHASE LIST:

NOTE: USE ALREADY FABRICATED ELEMENTS

[2] SLOPED FLOORS

[14] RAILINGS

- [1] "THIN OSB"
120 x 240 cm (48 x 96 in)
- [3] "2x4" LUMBER
120 cm (48 in)
- [6] "C CLAMPS"
HOLD THE SLIDING PANEL ALONG THE
TOP OF THE WALL FOR ADJUSTMENT.

CUT LIST:

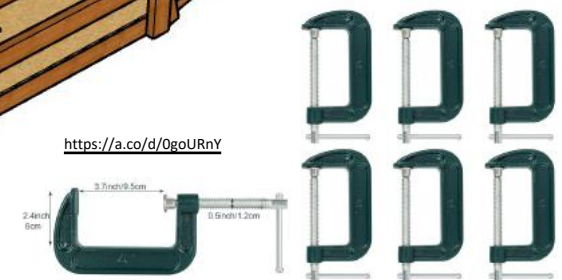
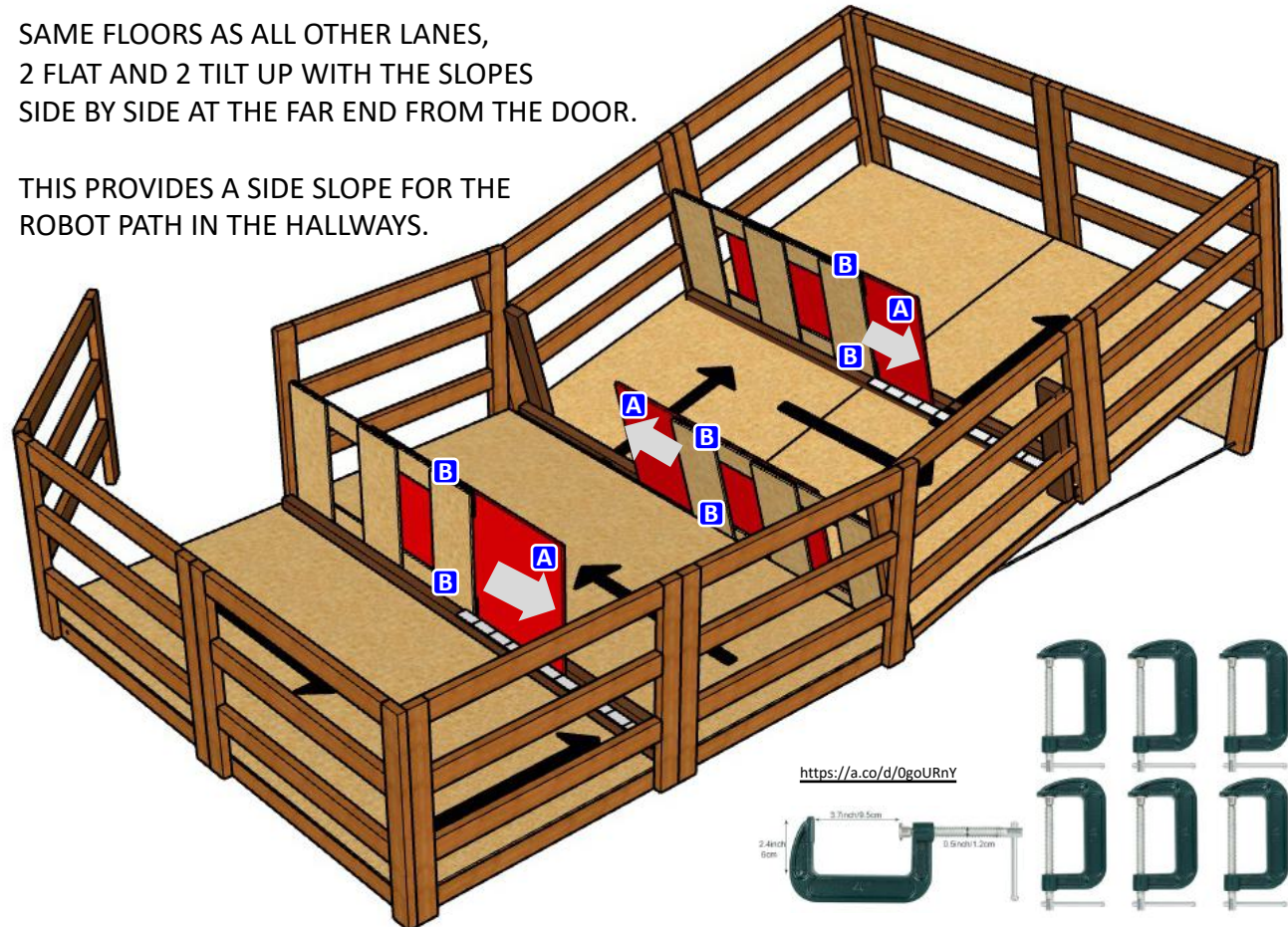
- A** [2] "THIN OSB" SLIDING PANELS
80cm x 120 cm (32 x 48 in)
CUT TO SLIDE ON FLOOR AND NOT
EXCEED THE TOP OF THE RAILING
DIVIDERS FOR FOR CLAMPING
- B** [4] C-CLAMPS
10 cm (4 in)

FABRICATION TIPS:

- Cut down 3 typical RAILINGS to lose the legs used to screw to the perimeter.
- Fasten these as perpendicular DIVIDERS 90 degrees from the railings. Use diagonals in corners to make sturdy.
- Clamp the SLIDING OSB to the DIVIDER over the top rail and through a hole in the SLIDING OSB just above the bottom rail.
- Draw a metric on the sliding panel with marks every 1 cm (1/2 in).

SAME FLOORS AS ALL OTHER LANES,
2 FLAT AND 2 TILT UP WITH THE SLOPES
SIDE BY SIDE AT THE FAR END FROM THE DOOR.

THIS PROVIDES A SIDE SLOPE FOR THE
ROBOT PATH IN THE HALLWAYS.



THE 3 SLIDING DOORS (SHOWN AS RED OSB PANELS)
ARE SET AND CLAMPED FOR EACH ROBOT WIDTH, SO
RESET AND FIXED QUICKLY FOR EVERY TRIAL.

Pallets & Pipes

Fabrication



Lane Difficulty Settings

SMOOTH OR SLATTED SIDE UP

Prelims



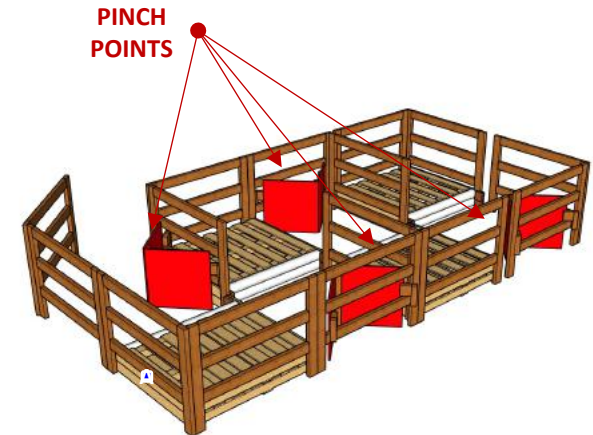
INCREMENTAL ELEVATIONS

Prelims/Semis



ADDITIONAL OBSTACLES

Semis/Finals



Pallets & Pipes:

- Incremental elevation plateaus with solid or porous surfaces for feet and wheels to fall into.
- Rolling pipes eliminate friction to force climbing.



Pinch Points:

- 60 cm (24 in) triangular panels hang on railings.
- Require precise steering in terrains and obstacles.
- Also complex approaches to dexterity tasks.





Pallets & Pipes

Fabrication



Version 2026C-Korea

Page: 47

QUANTITY: [8] FABRICATED GRID PALLETS. OSB STOPS FEET FROM FALLING THROUGH AND CAN FLIP TO USE SMOOTH OR COMPLEX SIDE UP.

PURCHASE LIST:

- [4] "THIN OSB" PANELS
120 x 240 cm (48 x 96 in)
- [40] "2x4" LUMBER
240 cm (96 in)
- [24] PVC PIPES
OUTER DIAMETER: 10 cm (4 in)
LENGTH: 100 cm (40 in)

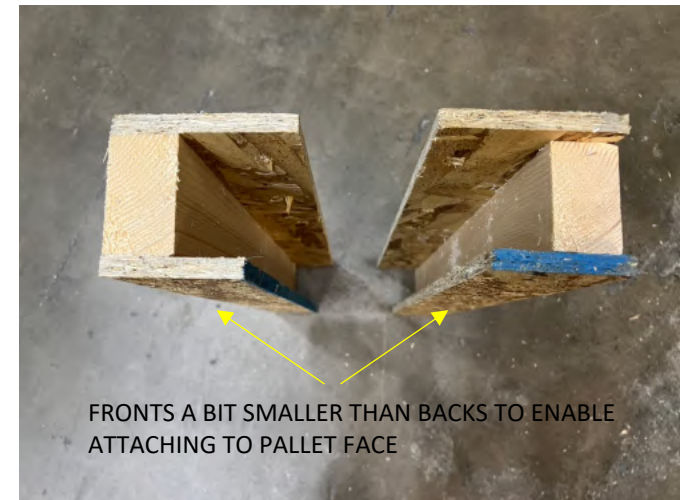
CUT LIST:

- A** [8] "THIN OSB" PALLET BOTTOMS
120 x 120 cm (48 x 48 in)
Legged feet can't fall through.
- B** [80] "2x4" RAILS TO MAKE GRID
120 cm (48 in)
Screw them together at every joint
- C** [12] VERTICAL PVC PIPE SLEEVES
60 cm (24 in) tall
Fits purchased pipe outer dimension plus 1 cm (1/2 in) to allows the pipes to SPIN FREELY.

FABRICATED GRID PALLET



VERTICAL PIPE SLEEVES



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Pallets & Pipes

Lane Set Up



Version 2026C-Korea
Page: 48

QUANTITY: [16] PALLETS THAT CAN BE CONNECTED TOGETHER TO FORM A LANE OR STACKED TO FORM CLIMBING OBSTACLES

ALIGN EDGES AND CORNERS



USE SPACER BLOCKS EQUALIZE GAPS



ADD SECOND LAYER SIMILARLY



ALIGN EDGES AND CORNERS



ALIGN EDGES AND CORNERS



ALIGN EDGES AND CORNERS



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Pallets & Pipes

Lane Set Up



Version 2026C-Korea
Page: 49

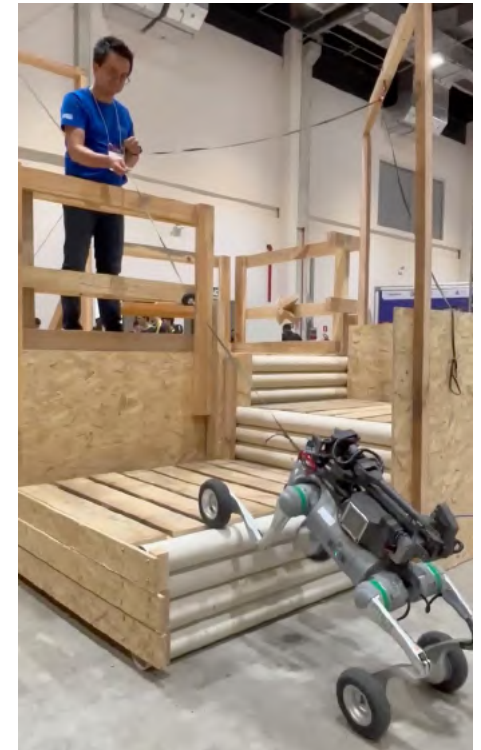
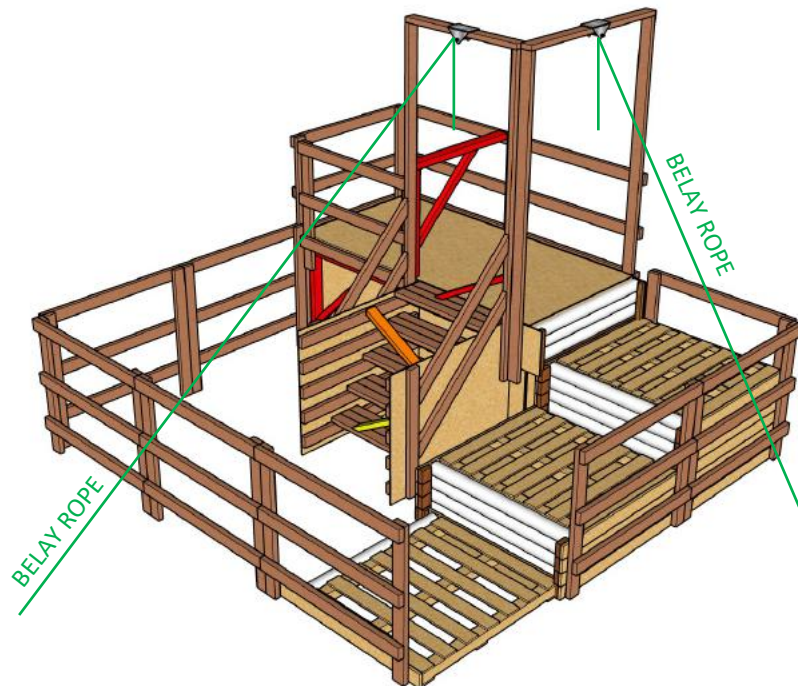
QUANTITY: [16] PALLETS & PIPES THAT CAN BE CONNECTED TOGETHER TO FORM A LANE OR STACKED TO FORM CLIMBING OBSTACLES



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.

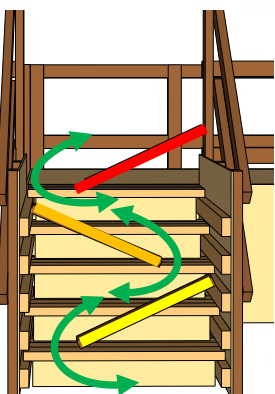
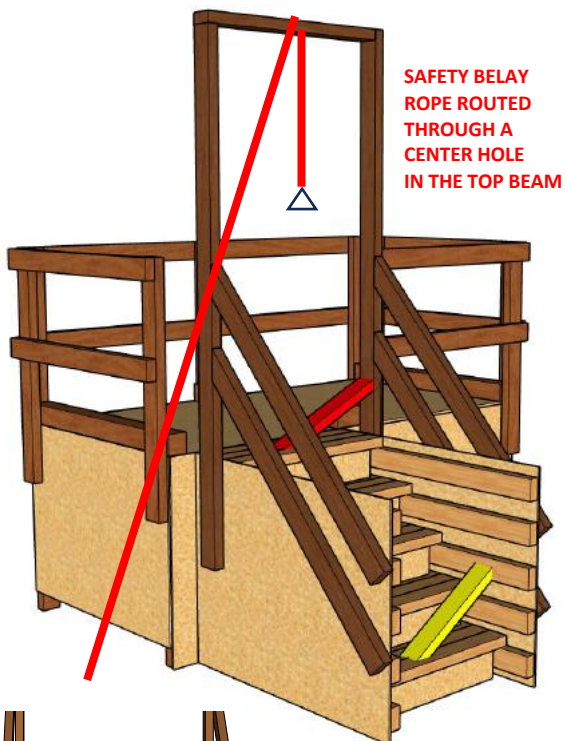
Stair Debris | Pallet Climb

Fabrication



Stairs and Railings Ship Inside Inverted Landing

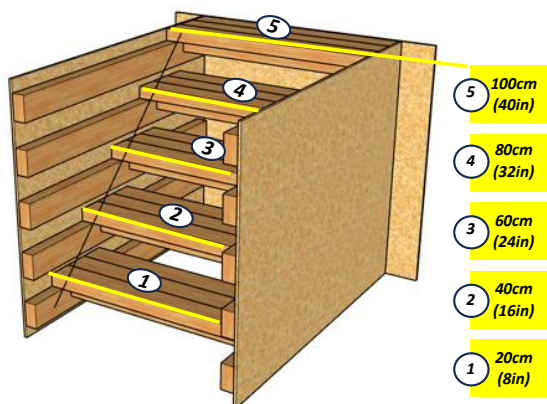
20cm (8in) Stairs with Debris



Optional stair DEBRIS can be placed incrementally as three levels of difficulty to require steering on the stair or climbing behaviors (color coded yellow-orange-red).

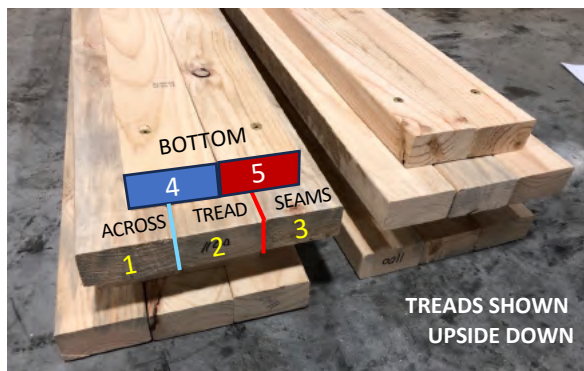
Adjustable Incline 35-45°

Treads slide like shelves



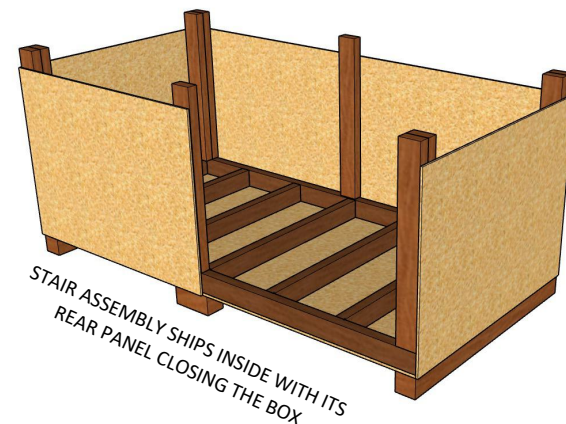
90 cm (36 in) wide treads are made of [5] "2x4s" screwed together.

They can be interchangeable with purchased metal treads.



Landing Inverted for Transport

Stair assembly fits inside



- The ELEVATED LANDING is a typical FLOOR with added "2x4" joists every 40cm (16in) so multiple people can walk on it.
- The walking surface is "THICK OSB or double layer of "THIN OSB."
- All walls are "THIN OSB." They mount flush with the ELEVATED LANDING surface, so assembly them with the LANDING SURFACE inverted on the floor.
- The legs make the LANDING surface elevated 100cm (40in).
- POSTS and SKIDS and BLOCKS can be double "2x4s" or "4x4s."



Adjustable Stair Assembly



Version 2026C-Korea

Page: 52

Sliding Treads with 20cm (8in) Steps

QTY: [1] STAIR ASSEMBLY

PURCHASE LIST:

- [2] "THIN OSB" PANELS
120 x 240 cm (48 x 96 in)
- [20] "2x4" LUMBER
240 cm (96 in)
- [3] HINGES (FOR DEBRIS RAILS)

CUT LIST:

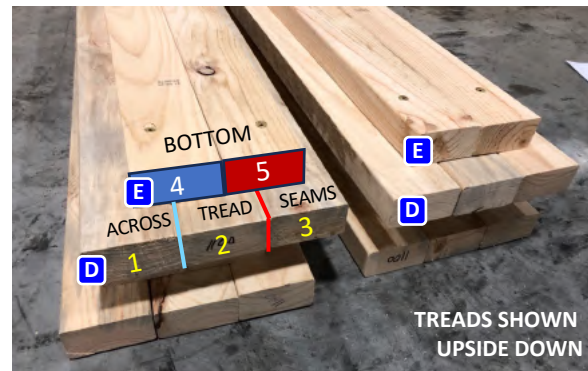
- A** [3] "THIN OSB" SIDES & BACK
100 cm TALL x 120 cm WIDE
(40 in TALL x 48 in) WIDE
- C** [10] "2x4" HORIZONTAL SLIDE RAILS
115 cm (46 in)
- D** [15] "2x4" STAIR TREAD TOPS
90 cm (36 in)
- E** [10] "2x4" STAIR TREAD BOTTOMS
75 cm (30 in)
- [3] "2x4" HINGED DEBRIS RAILS
75 cm (30 in)

FABRICATION TIPS:

- MOUNT THE SUPPORT RAILS 1 TREAD THICKNESS LOWER THAN 20cm (8 in), 40 cm (16 in), 60 cm (24 in), 80 cm (32 in), 100 cm (40 in) above ground level.
- BACK PANEL extends EQUALLY beyond the SIDE WALLS to attach to the LANDING.

FABRICATED TREADS

Using [5] "2x4s" for each tread



USE 40mm (1-1.2in)
WASHER/WAFER HEAD
TORX SCREWS
THROUGH OSB PANELS

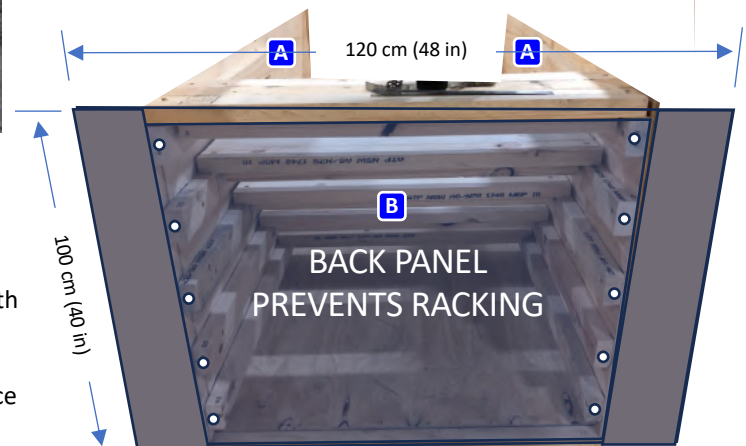
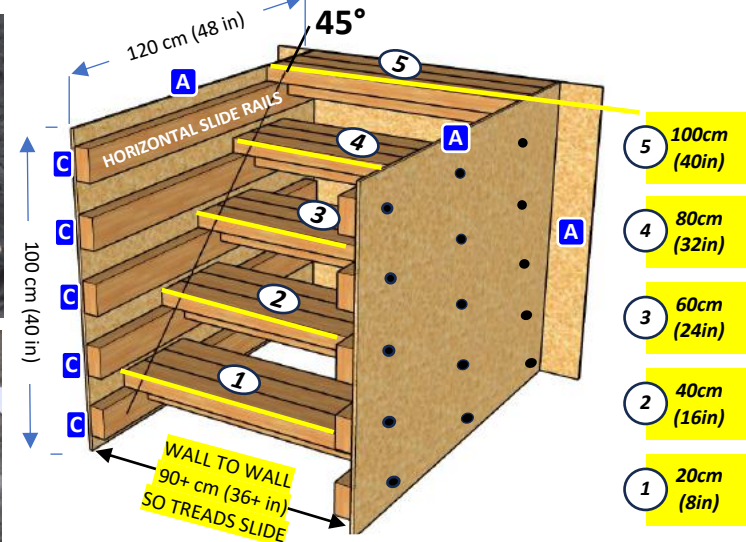


Both bottom "2x4s" are shorter than the treads so they easily slide BETWEEN the side wall support rails.

The bottom "2x4s" add a lot of strength for really heavy and dynamic robots. Their thickness also provides a way to attach a front recessed OSB panel piece as an optional riser

STEP ELEVATIONS = 20cm (8in)

Sliding tread adjust from 35° - 45°



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Stair Landing & Shipping Crate

Landing Elevation = 100 cm (40 in)



Version 2026C-Korea

Page: 53

QUANTITY: [1] LANDING (SHOWN FLIPPED OVER AS SHIPPING CRATE) ADD SUPPORT JOISTS TO HOLD MULTIPLE PEOPLE WALKING ON IT.

PURCHASE LIST:

- [3] "THIN OSB" PANELS
120 x 240 cm (48 x 96 in)
- [7] "2x4" or "4x4" LUMBER
240 cm (96 in)

CUT LIST:

- A** [1] FABRICATE TYPICAL FLOOR THEN
ADD [3] MORE "2x4s" JOISTS
SPACED EVERY 40 cm (16 in)
- B** [6] "2x4" or "4x4" LEGS
90 cm (36 in)
MUST ELEVATE LANDING SURFACE
TO 100 cm (40 in) WHEN INVERTED
- C** [5] "THIN OSB" SIDES ALL AROUND
90 x 120 cm (36 x 48 in)
ATTACH ALL OSB PANELS FLUSH
WITH THE INVERTED FLOOR SURFACE
SITTING ON THE GROUND
- D** [2] FORKLIFT SKIDS
120 cm (48 in)
PROP UP THE ASSEMBLY ONTO SKIDS
AND SCREW THROUGH THE FLOOR
- E** [2] FORKLIFT BLOCKS
20 cm (8 in)
THEN ADD BLOCKS SIMILARLY

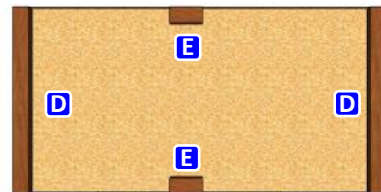
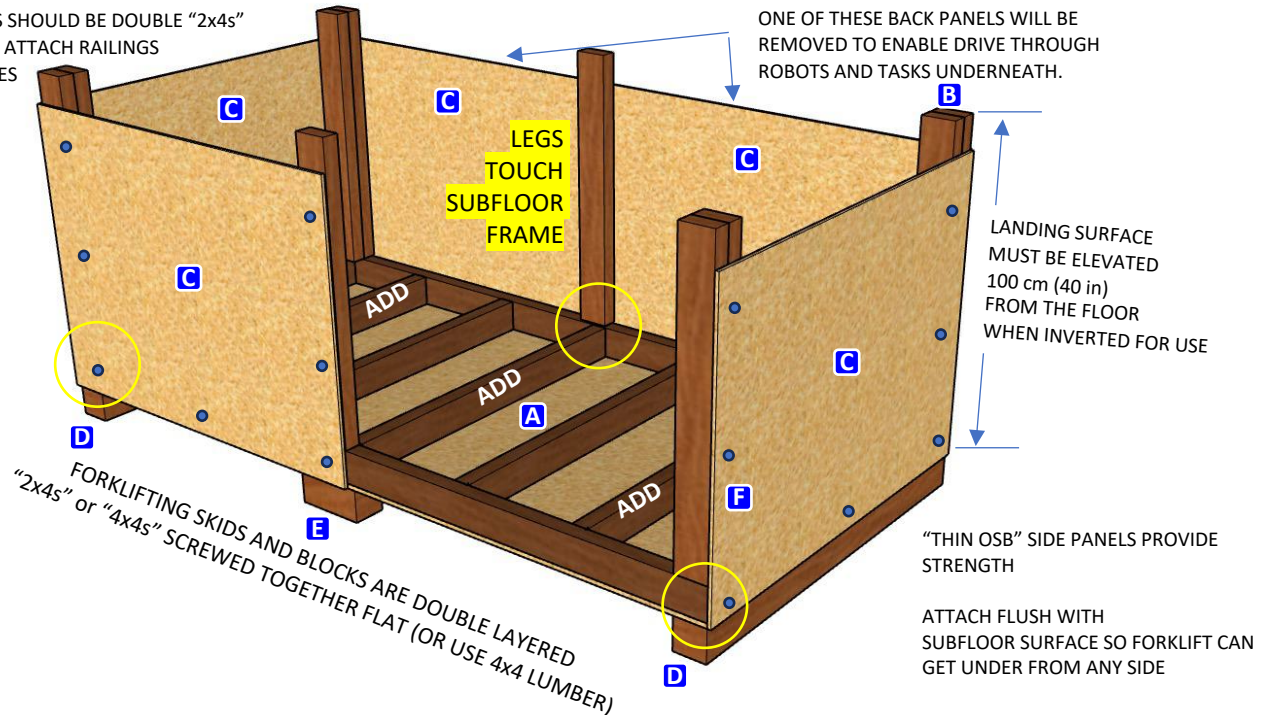
FABRICATION TIPS:



USE 40 mm (1-1/2 in)
WASHER/WAFER HEAD SCREWS
TO ATTACH ALL OSB PANELS

CORNER LEGS SHOULD BE DOUBLE "2x4s"
OR "4x4s" TO ATTACH RAILINGS
ON BOTH SIDES

ONE OF THESE BACK PANELS WILL BE
REMOVED TO ENABLE DRIVE THROUGH
ROBOTS AND TASKS UNDERNEATH.



BOTTOM



INVERTED FOR USE AS ELEVATED LANDING

NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Stair Debris & Pallet Climb

Angled Railings and Safety Belays



Version 2026C-Korea
Page: 54

QUANTITY: STAIR SIDE RAILINGS PLUS [2] SAFETY BELAY ARCHES, AND ROPES

PURCHASE LIST:

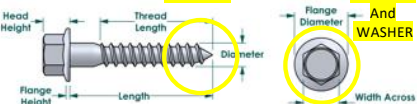
- [7] "2x4" LUMBER
240 cm (96 in)
- [1] SAFETY BELAY ROPE
500 kg (1100 lbs) | 30 m (100 ft)
<https://a.co/d/05NCyEZ7>

CUT LIST:

- A** [4] "2x4" DIAGONAL STAIR RAILINGS
120 cm (48 in)
45° BOTH ENDS PARALLEL
CUT FLAT ON THE MITER SAW
(WILL LOOK BETTER THAN SHOWN)
- B** [4] "2x4" SAFETY BELAY VERTICALS
240 cm (96 in) FULL BEAM
- C** [1] "2x4" THINNER STAIR BELAY TOP
100 cm (40 in) with oversized center
belay rope hole.
- D** [1] "2x4" WIDER PALLET BELAY TOP
(OVERSIZED CENTER ROPE HOLE
140 cm (46 in) with oversized center
belay rope hole.

FABRICATION TIPS:

- Use HEX HEAD ROOFING SCREWS WITH SHARP TIP AND WASHER

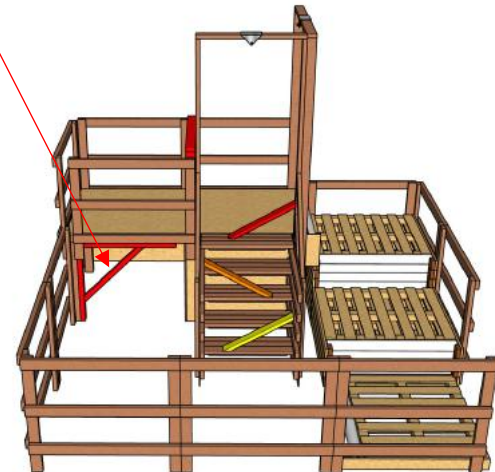
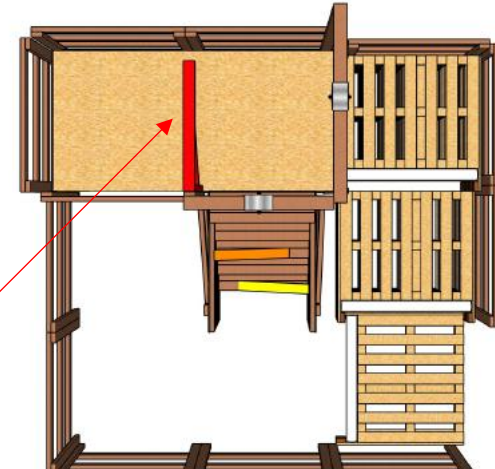
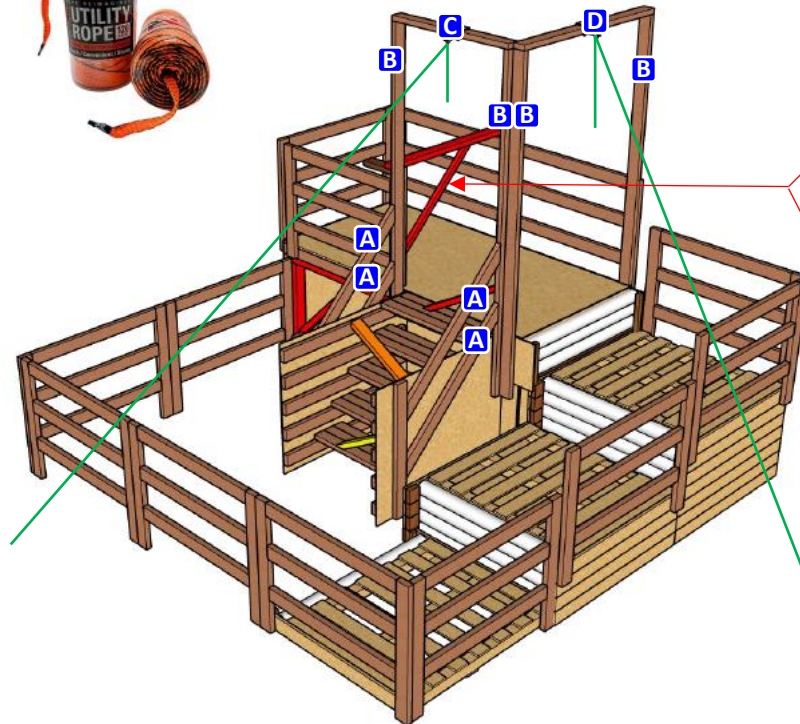


SAFETY BELAY ROPE

500 kg (1100 lbs)
30 m (100 ft)



NEGOTIATE OBSTACLES
BLOCK BOTH END ZONES
(OVER & UNDER)



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Stair Debris & Pallet Climb

Angled Railings and Safety Belays



Version 2026C-Korea
Page: 55

QUANTITY: STAIR SIDE RAILINGS PLUS [2] SAFETY BELAY ARCHES, EYE BOLTS, AND ROPES

PURCHASE LIST:

- [7] "2x4" LUMBER
240 cm (96 in)

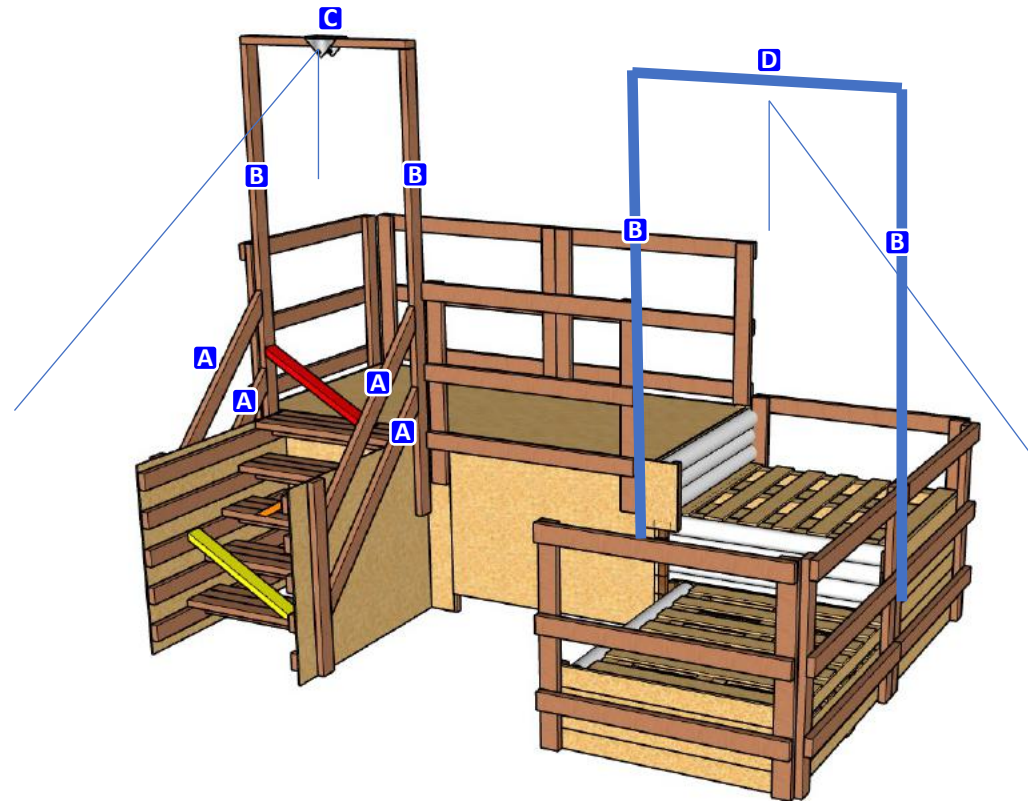
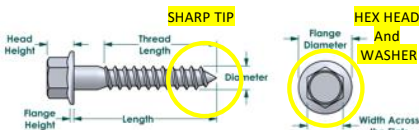
CUT LIST:

- A** [4] "2x4" DIAGONAL STAIR RAILINGS
120 cm (48 in)
45° BOTH ENDS PARALLEL
CUT FLAT ON THE MITER SAW
(WILL LOOK BETTER THAN SHOWN)
- B** [4] "2x4" SAFETY BELAY VERTICALS
240 cm (96 in) FULL BEAM
- C** [1] "2x4" THINNER SAFETY BELAY TOP
100 cm (40 in) PARTIAL BEAM
- D** [1] "2x4" WIDER SAFETY BELAY TOP
140 cm (46 in) REMAINING BEAM

FABRICATION TIPS:

- Use HEX HEAD ROOFING SCREWS WITH WASHERS (and magnetized socket bits) to attach all railings so they can be removed easily on site.

5 mm (#10 in) x 75 mm (3 in) long



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Version 2026C-Korea

Page: 56

Push/Pull Doors

Fabrication



Door

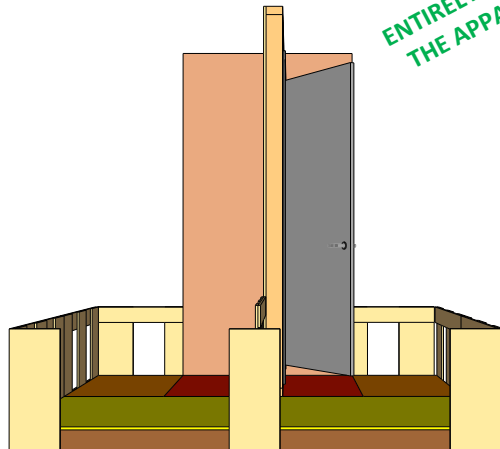
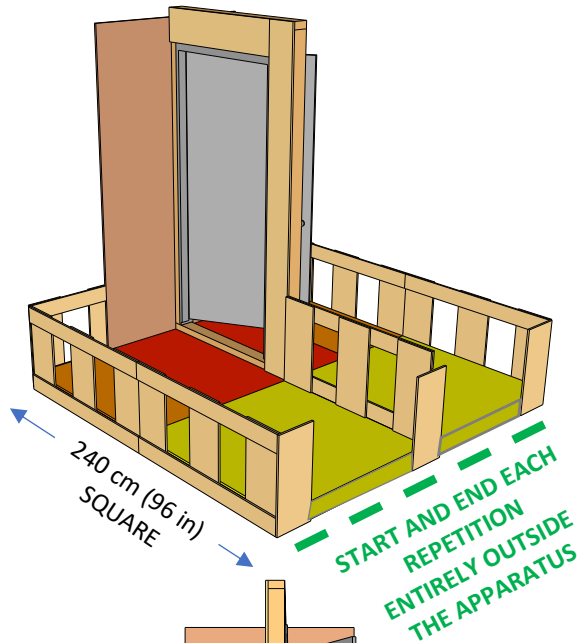


Version 2026C-Korea
Page: 57

Push/Pull, Weighted Closure, Flooring Complexity

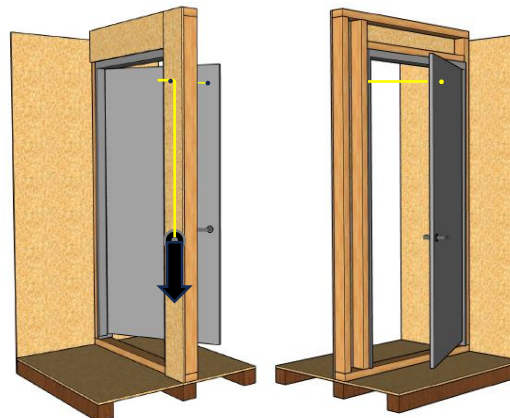
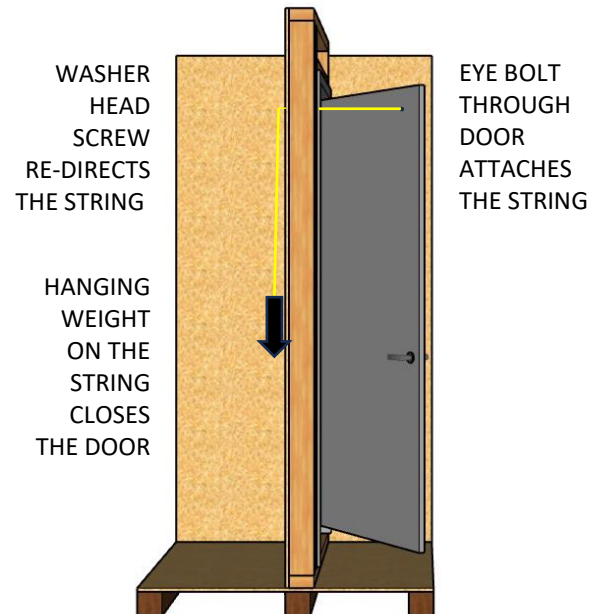
Square Apparatus

Push and Pull U-Turns



Weighted Closure Mechanism

Adjustable Force

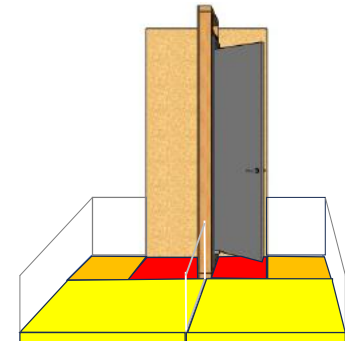


Flooring Complexity

Half and Full Stoops

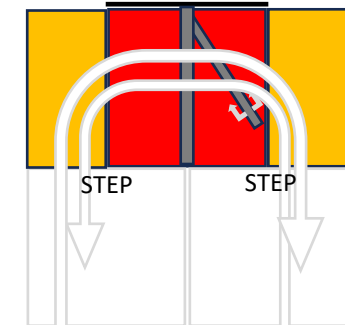
FLAT FLOOR
U-TURN PATH
240 x 240 cm
(96 x 96 in)

YELLOW, ORANGE,
AND RED PALLETS
FORM FLAT FLOOR



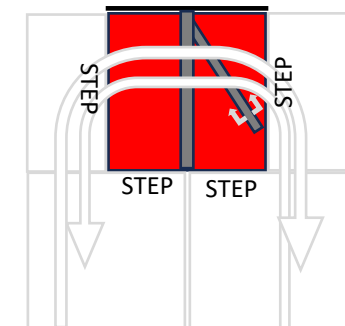
TOP VIEW
SQUARE STEPS
BOTH SIDES
120 cm (48 in)

REMOVE BOTH
YELLOW PALLETS



TOP VIEW
SHORT STEPS
BOTH SIDES
60 cm (24 in)

REMOVE ORANGE
HALF PALLETS TOO





Door



Version 2026C-Korea

Page: 58

Door Element

QTY: [1] DOOR ELEMENT

PURCHASE LIST:

- [2] "THIN OSB"
120 x 240 cm (48 x 96 in)
- [1] "THICK FLOOR OSB"
120 x 240 cm (48 x 96 in)
- [8] "2x4" LUMBER
240 cm (96 in)
- [1] FRAMED DOOR with LEVER HANDLE
90 cm (36 in) WIDE

CUT LIST:

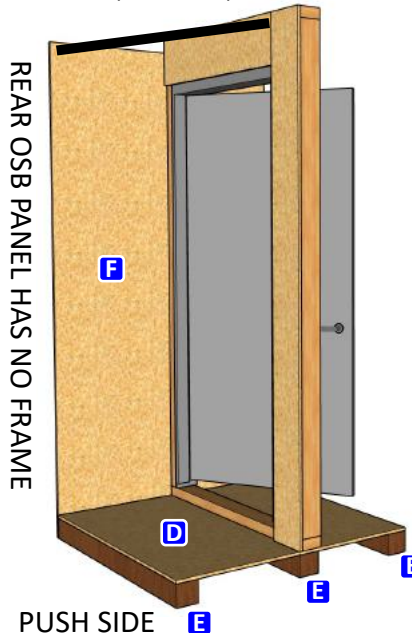
- A** [2] "2x4" TOP/BOTTOM THRESHOLD
120 cm (48 in)
- B** [3] "2x4" VERTICALS
Approximately 230 cm (93 in)
MUST FIT FULL OSB PANEL
- C** [1] "2x4" DOOR FRAME TOP
MUST FIT YOUR DOOR WIDTH
- D** [1] "THICK OSB" FLOOR
120 x 120 cm (48 x 48 in)
- E** [6] "2x4" DOUBLE SKIDS FOR PALLET JACK
120 cm (48 in)
**ATTACH TALL UNDER FLOOR TO BE
EVEN WITH REMOVABLE STEPS**
- F** [1] "THIN OSB" FULL PANEL
120 x 120 cm (48 x 48 in)
- G** [2] "2x4" DIAGONAL TOP SUPORTS
120 cm (48 in)
45° BOTH ENDS OPPOSING
CUT FLAT ON SAW

FABRICATION TIPS:

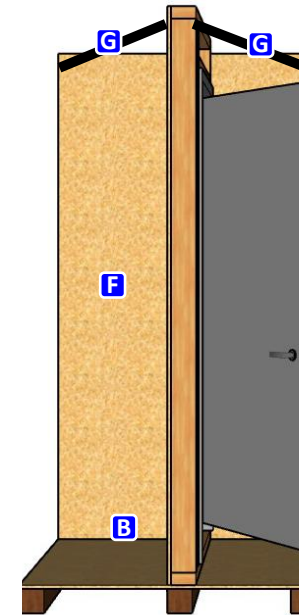
- Lay door on the floor so it can open upward to expose the inside of the door frame.
- Build a 120 x 240 cm (48 x 96 in) wall around the purchased door frame using all "2x4s" standing tall. Place the door hinge side against the frame.
- Cover the frame with "THIN OSB" on both sides (one side is shown exposed).
- Screw through the PURCHASED DOOR FRAME all around to attach to the wall.
- Attach the upright door wall centered on the floor pallet.
- Attach the rear OSB panel touching the floor. Screw through to connect all 3 skids and the door wall.
- Add 2x4 DIAGONAL TOP SUPPORTS level with the top frame.
- Add an optional triangle on top to stiffen the entire door.

FRAMED WALL
AROUND DOOR
120 x 240 cm
(48 x 96 in)

REAR OSB PANEL HAS NO FRAME



PUSH SIDE

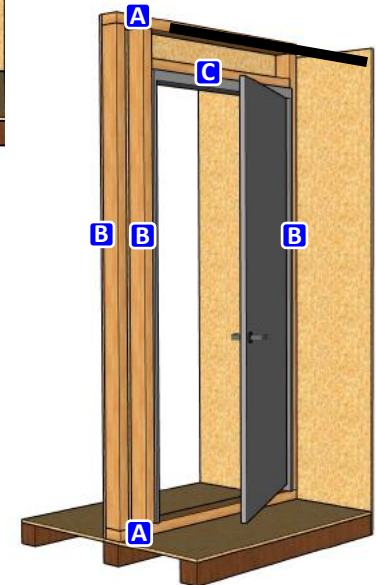


SQUARE BASE CAN
MOVE WITH A
PALLET JACK
120 x 120 cm
(48 x 48 in)

2x4 DIAGONAL TOP SUPPORTS
(TOP OSB TRIANGLE OPTIONAL)

FRAMED WALL
AROUND DOOR
120 x 240 cm
(48 x 96 in)

REAR OSB PANEL HAS NO FRAME



PULL SIDE

NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Door



Version 2026C-Korea

Page: 59

Removable Floor Steps

QTY: [2] SQUARE, [2] HALF

PURCHASE LIST:

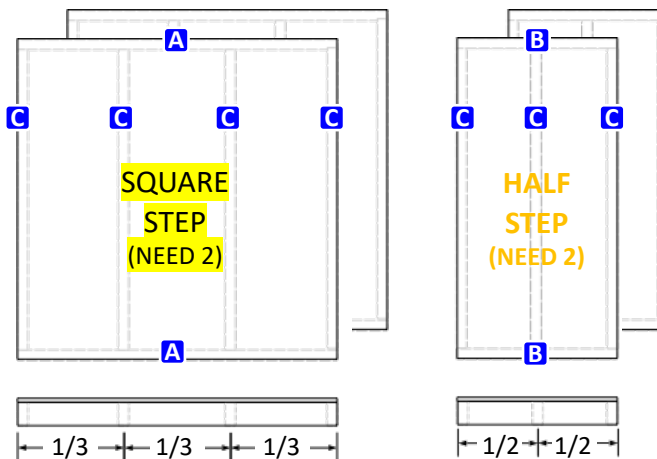
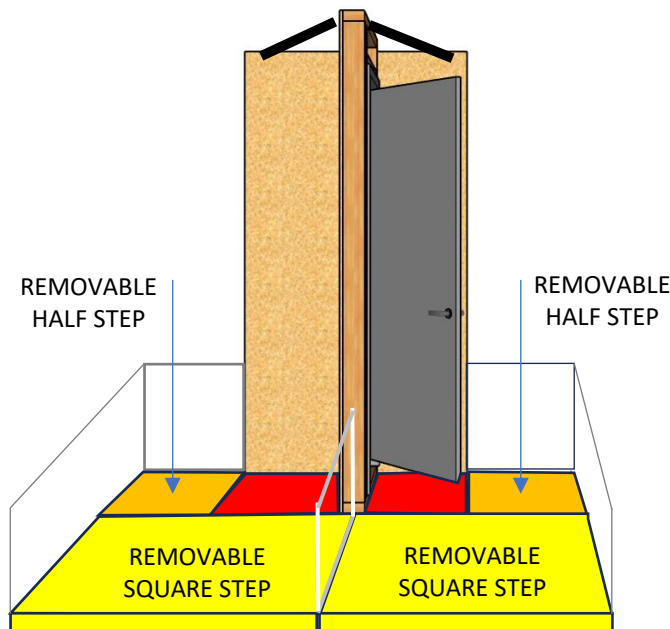
- [2] "THICK FLOOR OSB" PANELS
120 x 240 cm (48 x 96 in)
- [8] "2x4" LUMBER
240 cm (96 in)

CUT LIST:

- A** [4] "2x4" PANEL EDGES – SQUARE STEP
120 cm (48 in)
- B** [4] "2x4" PANEL EDGES – HALF STEP
60 cm (24 in)
- C** [14] "2x4" CENTERS – ALL STEPS
MEASURE TO FIT YOUR PANEL FRAME
Approximately 110 cm (45 in)

FABRICATION TIPS:

- These removable SQUARE STEPS and HALF STEPS have tall "2x4" lumber frames all the way around because tracked and wheeled robots use the edges to ascend.



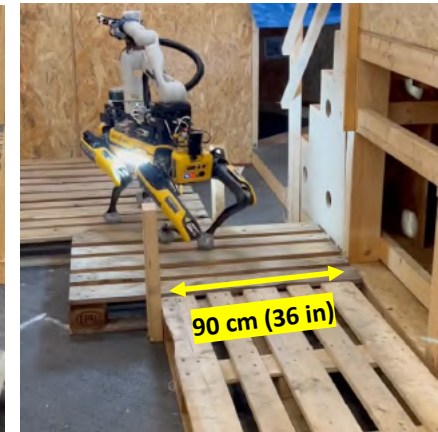
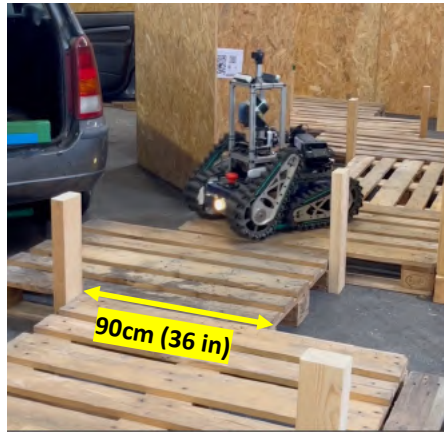


Version 2026C-Korea
Page: 60

Avoid Holes/Posts

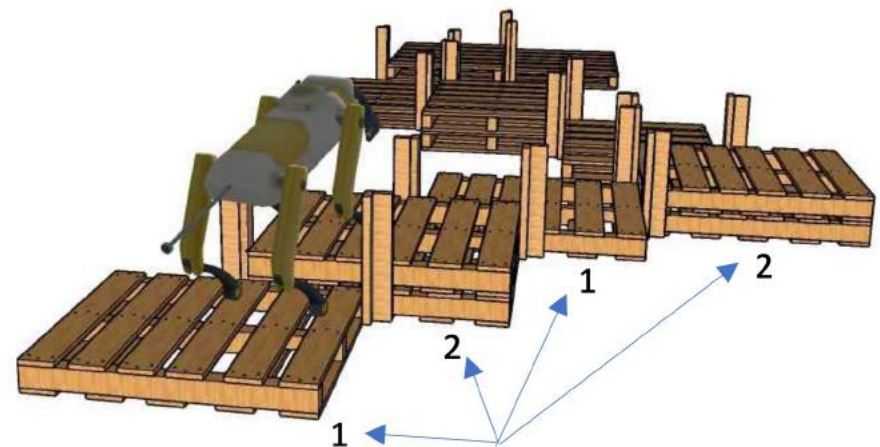
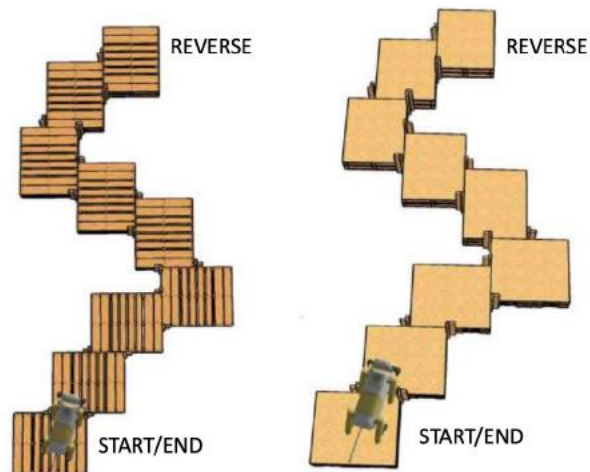
Fabrication

Levels of Difficulty



POROUS PALLETS OR SOLID SURFACES

SINGLE LEVEL OR WITH STEPS



Pallet stacks can also vary in height.



Avoid Fabrication



Version 2026C-Korea

Page: 62

QTY: [20] PALLETS, [20] POSTS

PURCHASE LIST:

[20] PALLETS

100 x 120 x 10-15 cm THICK
(40 x 48 x 4-6 in THICK)

[20] "2x4" LUMBER

240 cm (96 in)

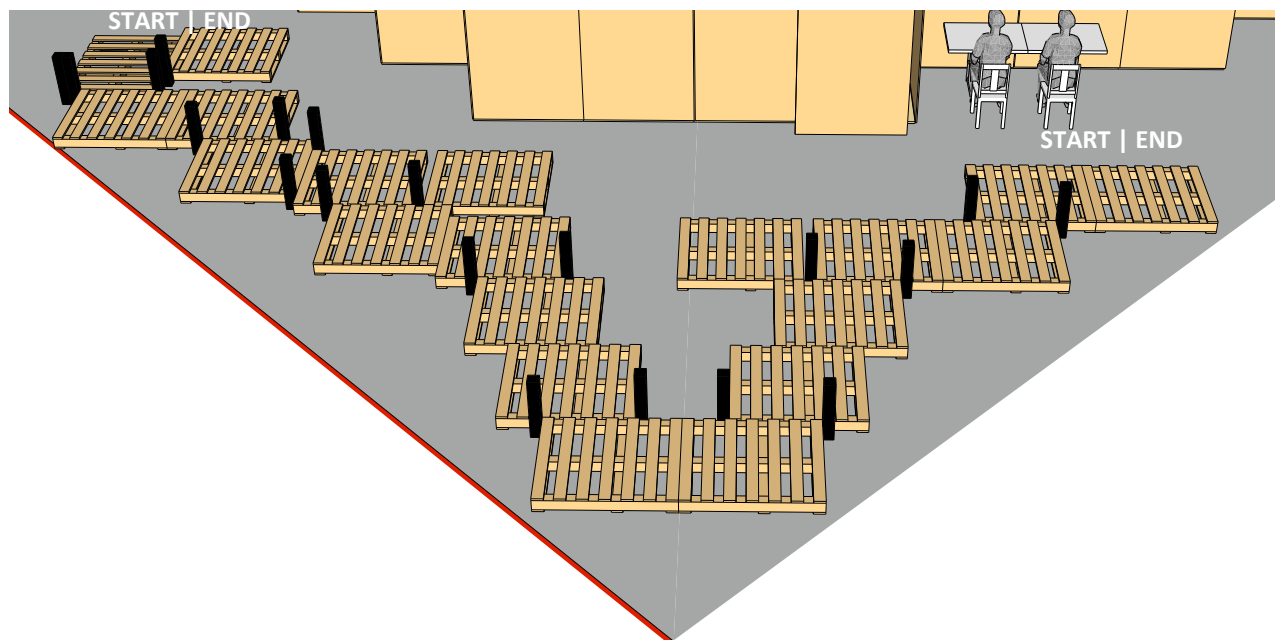
CUT LIST:

A [20] POSTS

45 cm (18 in)

FABRICATION TIPS:

- The design shown is just an example layout. Any meandering path can be made, and should change during the course of the competition.
- Add dead ends that move the robot directly closer to the goal point as a distraction.
- If a vehicle is provided, this path can circumnavigate the vehicle with a couple of doors, trunk, or windows open to inspect inside.



**USE 65mm (2.5in)
WASHER/WAFER
HEAD TORX SCREWS
FOR ATTACHING
POSTS – EASY TO
FIND AND REMOVE.**



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Version 2026C-Korea
Page: 63

Search & Map Maze

Fabrication



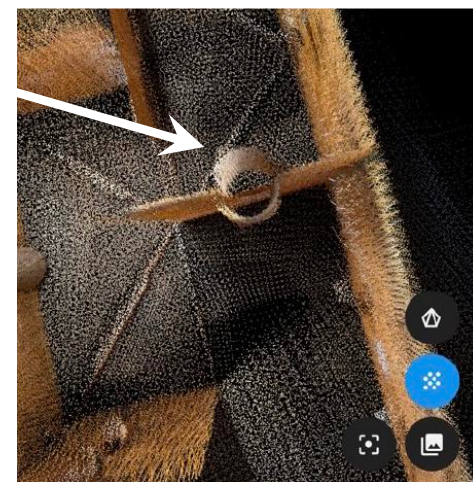
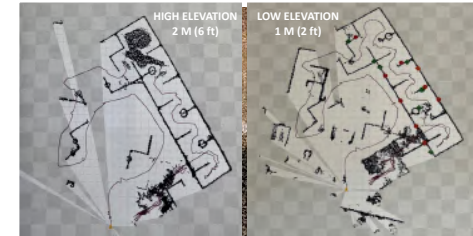
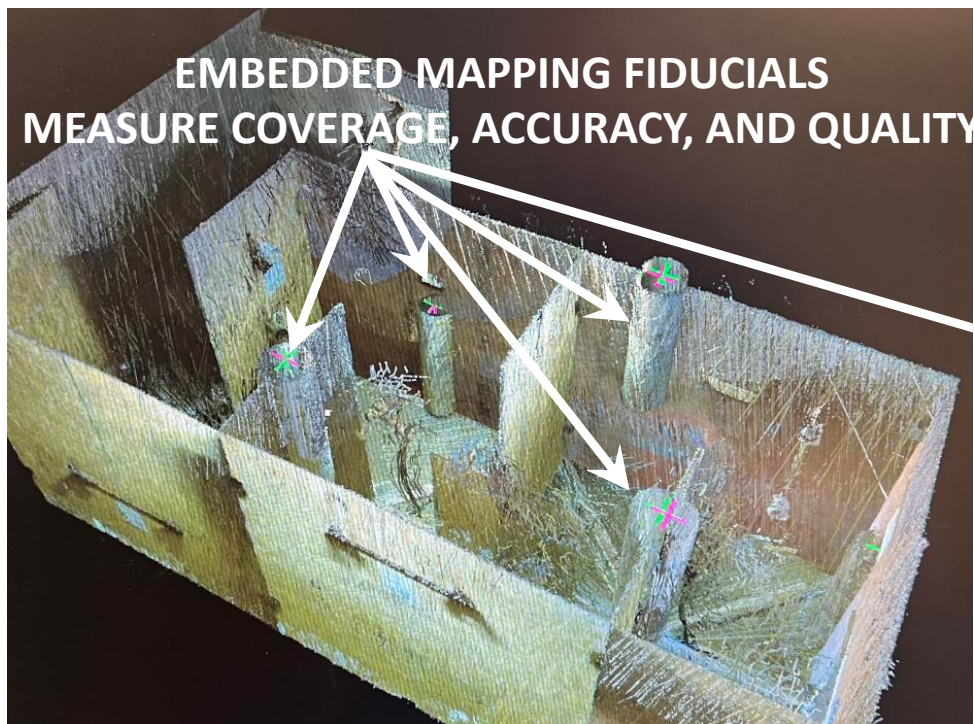
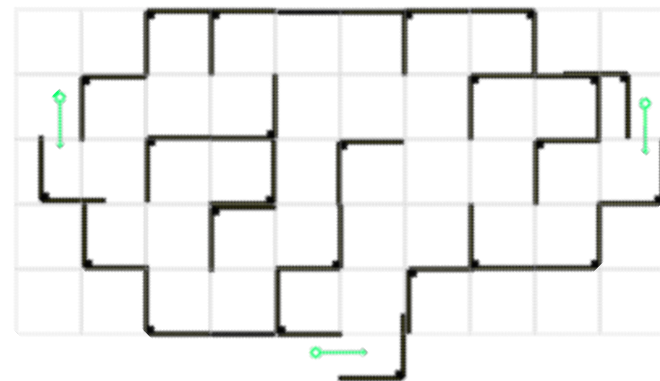
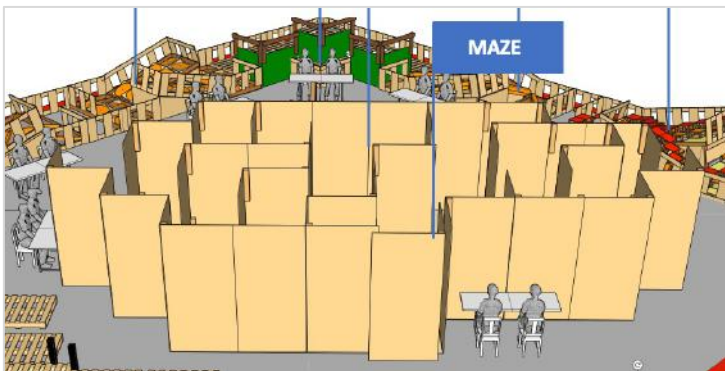
Maze

Tall "L" Walls



Version 2026C-Korea

Page: 64





Maze

Tall "L" Walls



Version 2026C-Korea

Page: 65

HIGH/LOW MAPPING FIDUCIALS

QTY: [25] TALL "L" WALLS

PURCHASE LIST:

- [50] "MAZE OSB" PANELS
(ODD DIMENSIONS/INEXPENSIVE)
10 mm x 122 cm WIDE x 220 cm TALL
(7/16 in x 48 in x 96 in)
<https://www.leroymerlin.com.br/cha>

[pa-osb-2-20x1-22x10mm--multiplac-1571449323](#)

- [3] "2x4" LUMBER
240 cm (96 in)

- [1] BLACKOUT TARP TO COVER THE
ENTIRETY OF THE MAZE

CUT LIST:

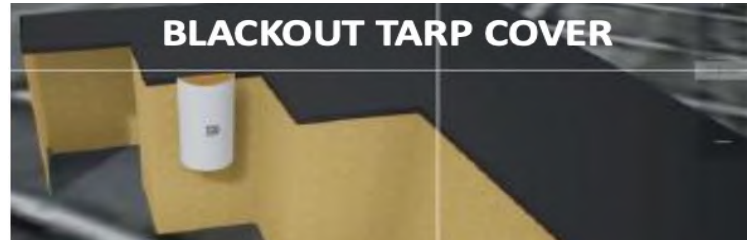
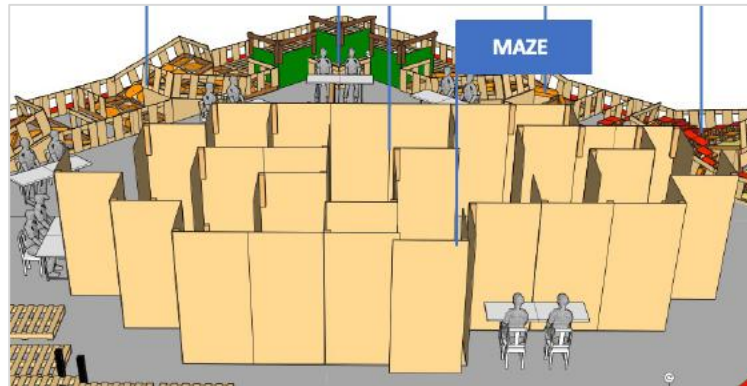
- A** [75] "2x4" JOINT BLOCKS
6 x 12 m (20 x 40 ft)

FABRICATION TIPS:

- "MAZE WALL OSB" are used as FULL PANELS
(uncut) so can be recycled after the event for
other uses.

- Cut JOINT BLOCKS and bring to the venue in
a crate for final assembly in place.

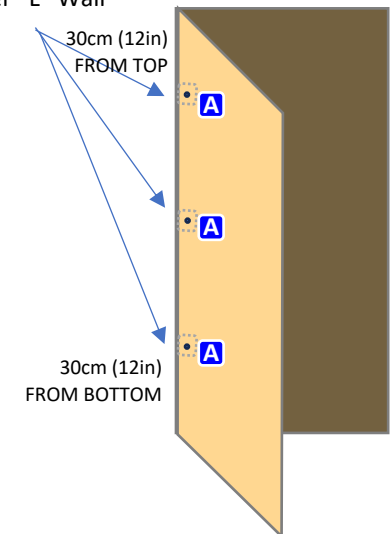
USE 40mm (1.5in)
WASHER/WAFER
HEAD TORX SCREWS
FOR SCREWING
THROUGH OSB



- [3] "2x4" JOINT BLOCKS
10 cm (4 in)

- [6] Screws per "L" Wall

TALL "L" WALL



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Maze



Version 2026C-Korea
Page: 66

QTY: [25] TALL "L" WALLS

PURCHASE LIST:

[50] "OSB" PANELS
(ODD DIMENSIONS/INEXPENSIVE)
10 mm x 122 cm WIDE x 220 cm TALL
(7/16 in x 48 in x 96 in)
<https://www.leroymerlin.com.br/cha-pa-osb-2-20x1-22x10mm--multiplac-1571449323>

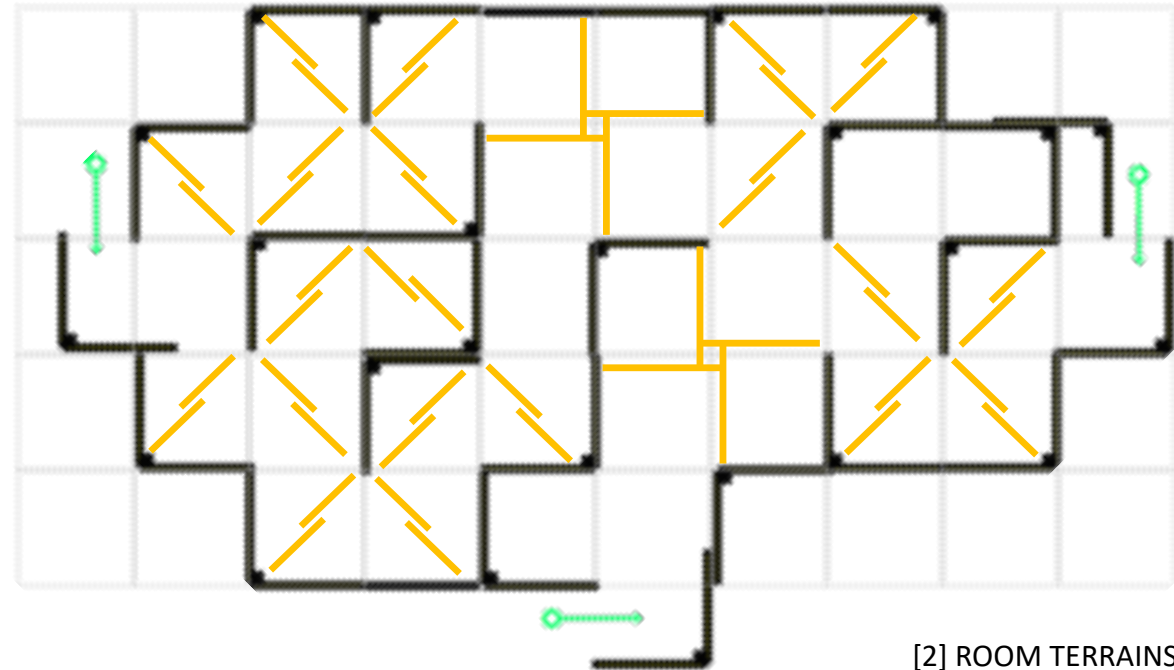
[3] "2x4" LUMBER
240 cm (96 in)

CUT LIST:

A [75] "2x4" JOINT BLOCKS FOR "L" WALL
5 x 10 x 10 cm (2 x 4 x 4 in)

FABRICATION TIPS:

- Cut JOINT BLOCKS and bring to the venue in a crate for final assembly in place.



[20] HALLWAY DIAGONALS

NEED [2] 5 x 10 x 120 cm (2 x 4 x 48 in)
WITH 45° CUT TALL ON MITER SAW ON ONE END

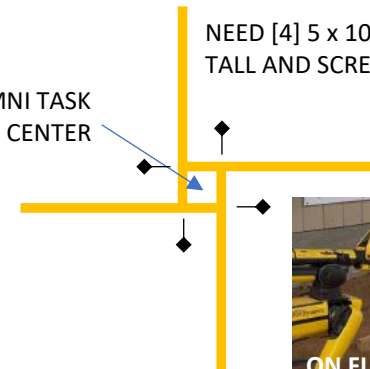


PLACED TALL DIAGONALLY IN THE HALLWAY
CORNER TO CORNER THEN [2] SCREWS IN THE
CENTER OVERLAP

[2] ROOM TERRAINS

NEED [4] 5 x 10 x 130 cm (2 x 4 x 52 in)
TALL AND SCREWED TO EACH OTHER

OMNI TASK
IN CENTER



ON FLOOR OR CRATE STACK

USE 40mm (1.5in)
WASHER/WAFER
HEAD TORX SCREWS
FOR SCREWING
THROUGH OSB



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Maze



Version 2026C-Korea

Page: 67

QTY: [10] SPLIT CLYINDERS

PURCHASE LIST:

- [5] **CONCRETE FORM TUBES**
30 cm DIAM x 120 cm LONG
(12in DIAM x 48 in LONG)
- [3] **"2x2" LUMBER**
240 cm (96 in)
- [10] **BOLTS (ANY DIAM/THREAD)**
15 cm (6 in)
- [10] **WING NUTS (SAME DIAM/THREAD)**

CUT LIST:

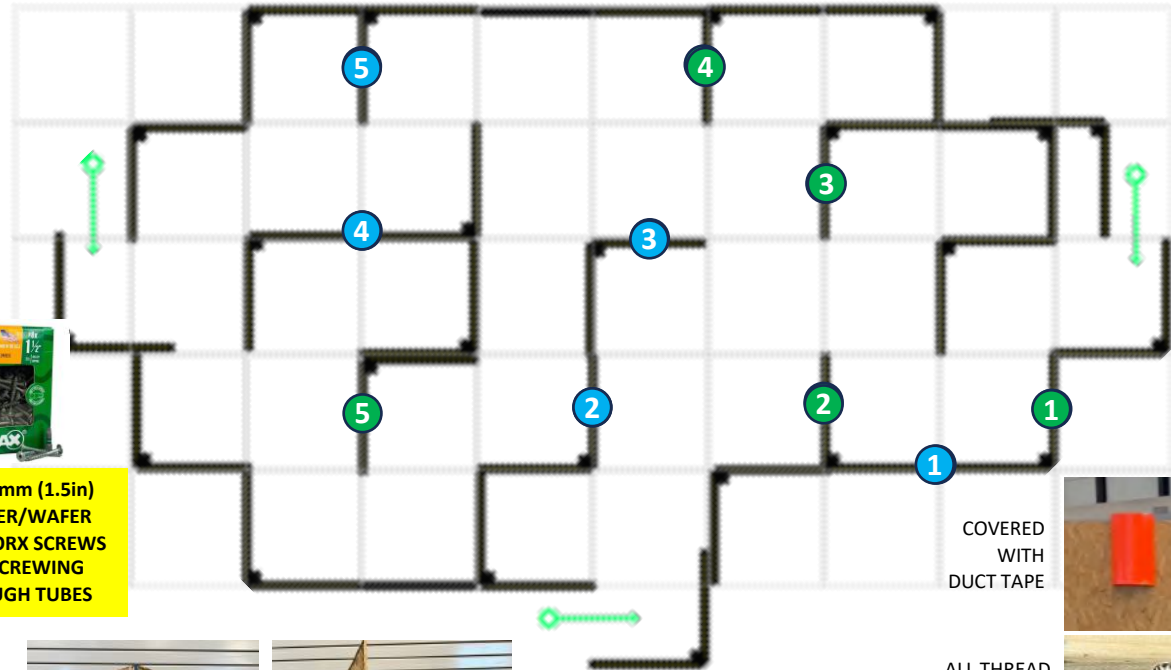
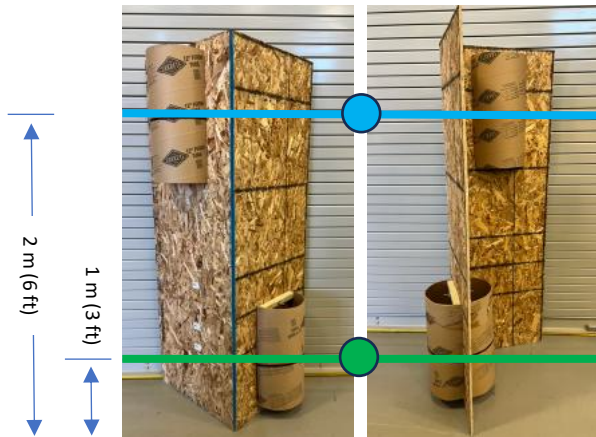
- A** [20] **CONCRET FORM HALVES**
30 cm DIAM x 60 cm LONG
(12 in DIAM x 24 in LONG)
- B** [40] **"2x2" HIGH/LOW SPINES**
28 cm (11 in)

FABRICATION TIPS:

- Drill a center hole in the TOP SPINE to pass through a 15cm (6 in) long bolt for mounting with a nut.
- Use a single screw into both ends of the TOP and BOTTOM SPINES to hold the form and enable mounting to the walls.
- Cover the EXTERNAL/CONVEX side of the half cylinders with duct tape so no commercial logos are visible.
- Drill many mounting hole options in the MAZE walls at 210 cm (84 in) AGL and 130 cm (48 in)



USE 40mm (1.5in)
WASHER/WAFER
HEAD TORX SCREWS
FOR SCREWING
THROUGH TUBES



COVERED
WITH
DUCT TAPE



ALL THREAD
&
WING NUTS



"2x2s" HIGH
AND LOW



ALWAYS
BOTH SIDES
OF THE WALL



HIGH SLICE OF 3D MAP:

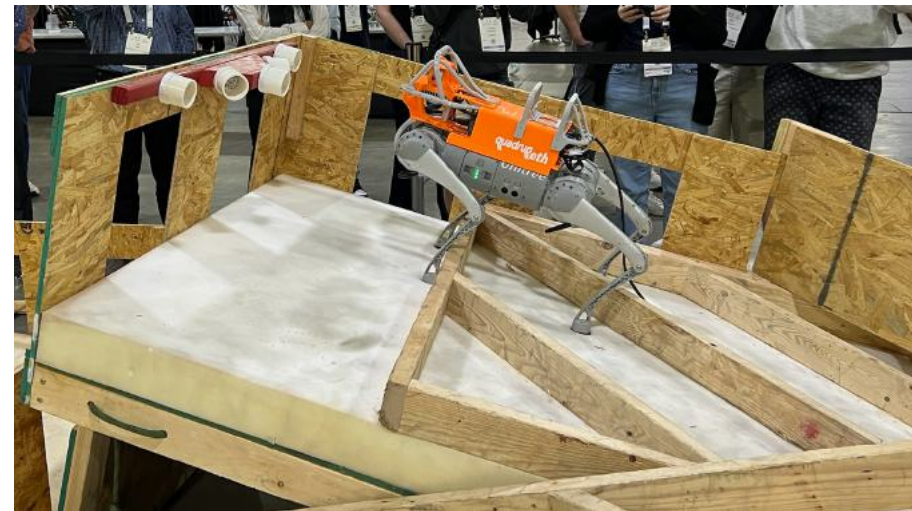
CENTERED VERTICALLY AT 2 m (6 ft)
WALL HOLES AT 210 cm (84 in)
ABOVE GROUND LEVEL (AGL)

LOW SLICE OF 3D MAP:

CENTERED VERTICALLY AT 1m (3 ft)
WALL HOLES AT 130 cm (48 in)
ABOVE GROUND LEVEL (AGL)

NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.

Dexterity Align/Inspect





Align/Inspect Tasks (Green)



Version 2026C-Korea
Page: 69

Levels of Difficulty

ALIGN/INSPECT TASKS

5 cm (2 in) INNER DIAMETER PIPES

Align/Inspect tasks are mounted on the walls at 60cm (24in) elevation or on the ground to reward robots moving throughout the terrains and obstacles with enough manipulator dexterity to perform the tasks. Zooming, exposure control, and image processing score more points.

OPERATOR SCORING



AUTOMATIC SCORING



TARGET OPTIONS

MANUAL AND AUTO TASKS

COLOR and ACUITY



Scored by the remote operator. Align with the pipe to see the entire colored ring as shown, then correctly identify the color, then read at least two concentric ring gap orientations – similar acuity to read the gauges. Zooming is generally encouraged to inspect details.



GAUGES

Scored by the remote operator. Align with the pipe to see the entire inscribed ring as shown, then correctly identify the pressure reading.



QR CODES

Scored by the robot using image processing, even when teleop driving. The robot must PAUSE with the UNIQUE CODE displayed prominently on the operator interface for the Proctor to confirm. The operator may then press one button to continue the search.



PARTIAL HAZMAT LABELS

Scored by the robot using image processing, even when teleop driving. The robot must to PAUSE with the WORD and NUMBER prominently displayed on the operator interface for the Proctor to confirm. The operator may then press one button to continue the search.



Linear Align/Inspect Tasks (Green)



Version 2026C-Korea

Page: 70

Fabrication

QTY: [12] LINEAR INSPECT

PURCHASE LIST:

- [6] **"2x2" LUMBER**
240 cm (96 in)
- [2] **"2x4" LUMBER**
240 cm (96 in)
- [2] **PVC PIPES (DRAIN PIPES)**
5 cm INNER DIAMETER x 240 cm
(2 in INNER DIAMETER x 96 in)
- [60] **PVC CAPS**
MATCH THE PIPES
- [1] **CIRCLE PAPER PUNCH**
5 cm (2 in) DIAMETER
<https://a.co/d/iOAShg8>

CUT LIST:

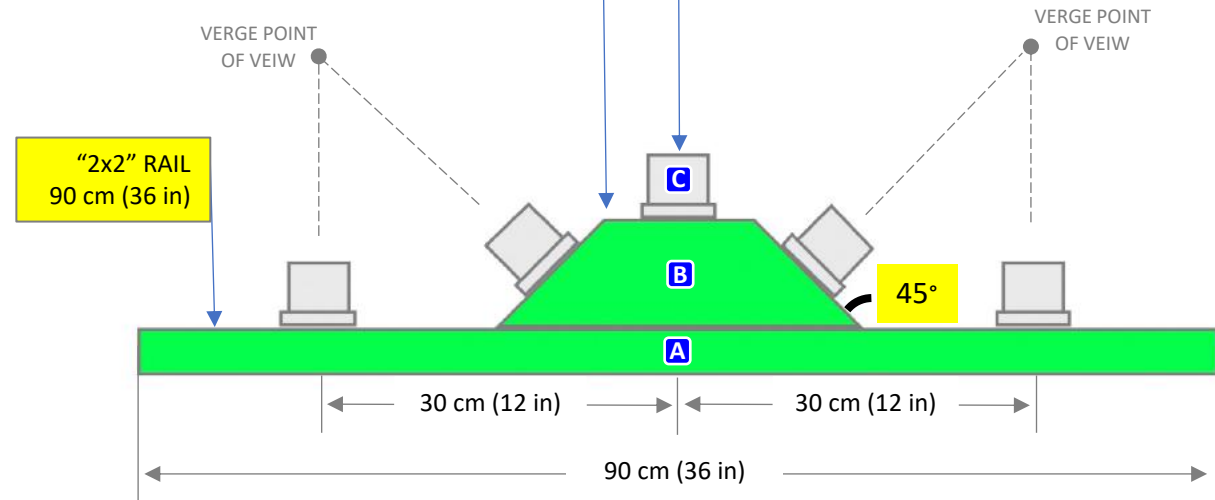
- A** [12] **"2X2" RAILS**
90 cm (36 in)
- B** [12] **"2X4" CENTERS**
30 cm (12 in)
45° BOTH ENDS CUT FLAT OPPOSING
- C** [60] **PVC PIPES**
5 cm (2 in)

FABRICATION TIPS:

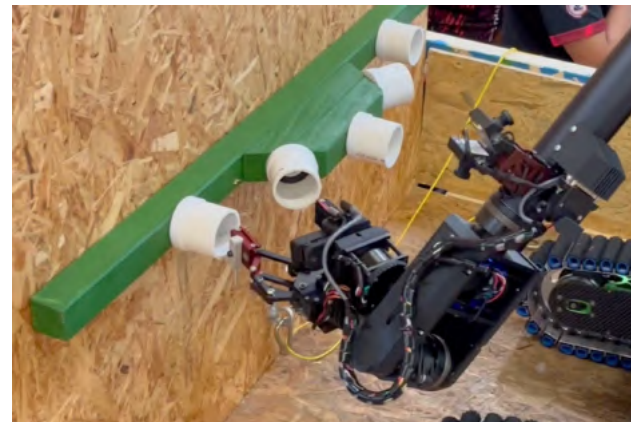
- Center and screw both pieces of lumber together lying flat their sides. Push up against as clamped beam or wall.
- Attach the pipe caps with ONE CENTER SCREW so they can rotate from HORIZONTAL to VERTICAL placements

"2x4" CENTER PIECE
30 cm (12 in) with 45° BOTH ENDS CUT FLAT

PVC PIPES WITH CAPS
5 cm (2 in) INNER DIAMETER x 5 cm (2 in) LONG



USE 40mm (1.5in)
WASHER/WAFER
HEAD TORX SCREWS
FOR SCREWING
THROUGH PIPES



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



OMNI Align/Inspect Tasks (Green)



Version 2026C-Korea

Page: 71

Fabrication

QTY: [12] OMNI INSPECT

PURCHASE LIST:

- [3] "2x4" LUMBER
240 cm (96 in)
- [1] "THIN WALL OSB" PANEL
120 x 240 cm (48 x 96 in)
- [2] PVC PIPES (DRAIN PIPES)
5 cm INNER DIAMETER x 240 cm
(2 in INNER DIAMETER x 96 in)
- [60] PVC CAPS
MATCH THE PIPES
- [1] CIRCLE PAPER PUNCH
5 cm (2 in) DIAMETER
<https://a.co/d/i0A5hg8>

CUT LIST:

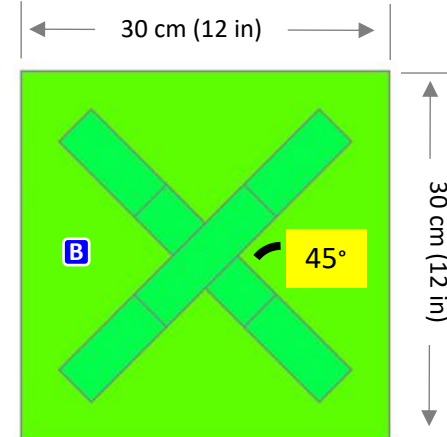
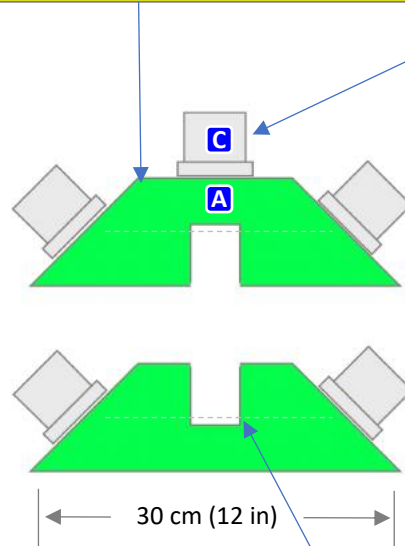
- A** [24] "2X4" CENTERS
30 cm (12 in)
45° BOTH ENDS CUT FLAT ON SAW
- B** [12] "THIN WALL OSB" BASES
30 cm (12 in) SQUARE
- C** [60] PVC PIPES
5 cm (2 in)

FABRICATION TIPS:

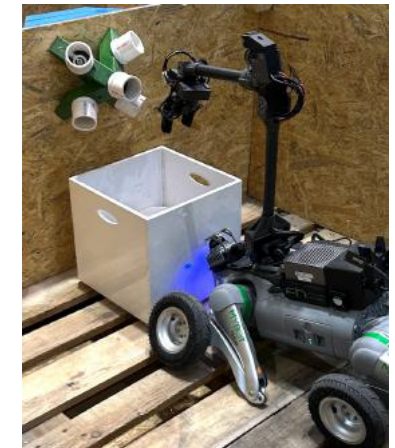
- Notch half the CENTER PIECES on the TOP and on the BOTTOM in pairs.
- A single long screw from the bottom can attach the two elements together.
- The OSB base makes Omnis easier to mount on walls from the front.

"2x4" CENTER PIECE
30 cm (12 in) with 45° BOTH ENDS CUT FLAT

PVC PIPES WITH CAPS
5 cm (2 in) INNER DIAMETER x 5 cm (2 in) LONG



SCREW OMNI TO BASE
FROM UNDERSIDE



NOTCHES MUST BE WIDE ENOUGH TO
ACCOMMODATE THE "2x4" USED AND JUST
PAST HALF THE DEPTH

USE 40mm (1.5in)
WASHER/WAFER HEAD
TORX SCREWS
FOR SCREWING
THROUGH PIPES



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Visual/Color Acuity



Version 2026C-Korea

Page: 72

Inspect Tasks for Remote Operators to Read

Print this page and cut or punch 5cm (2in) diameter circles



LEFT 90 DEGREE



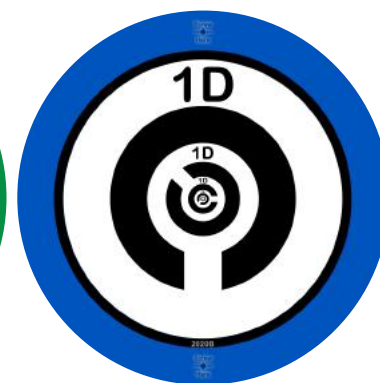
LEFT 45 DEGREE



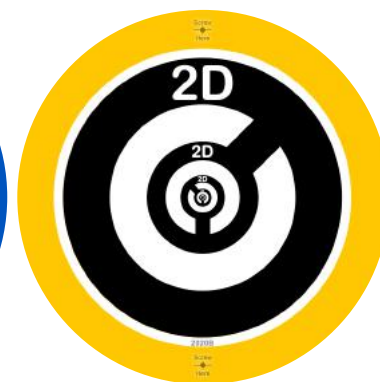
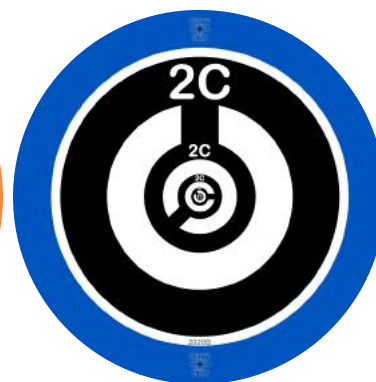
CENTER



RIGHT 45 DEGREE



RIGHT 90 DEGREE





Pressure Gauges

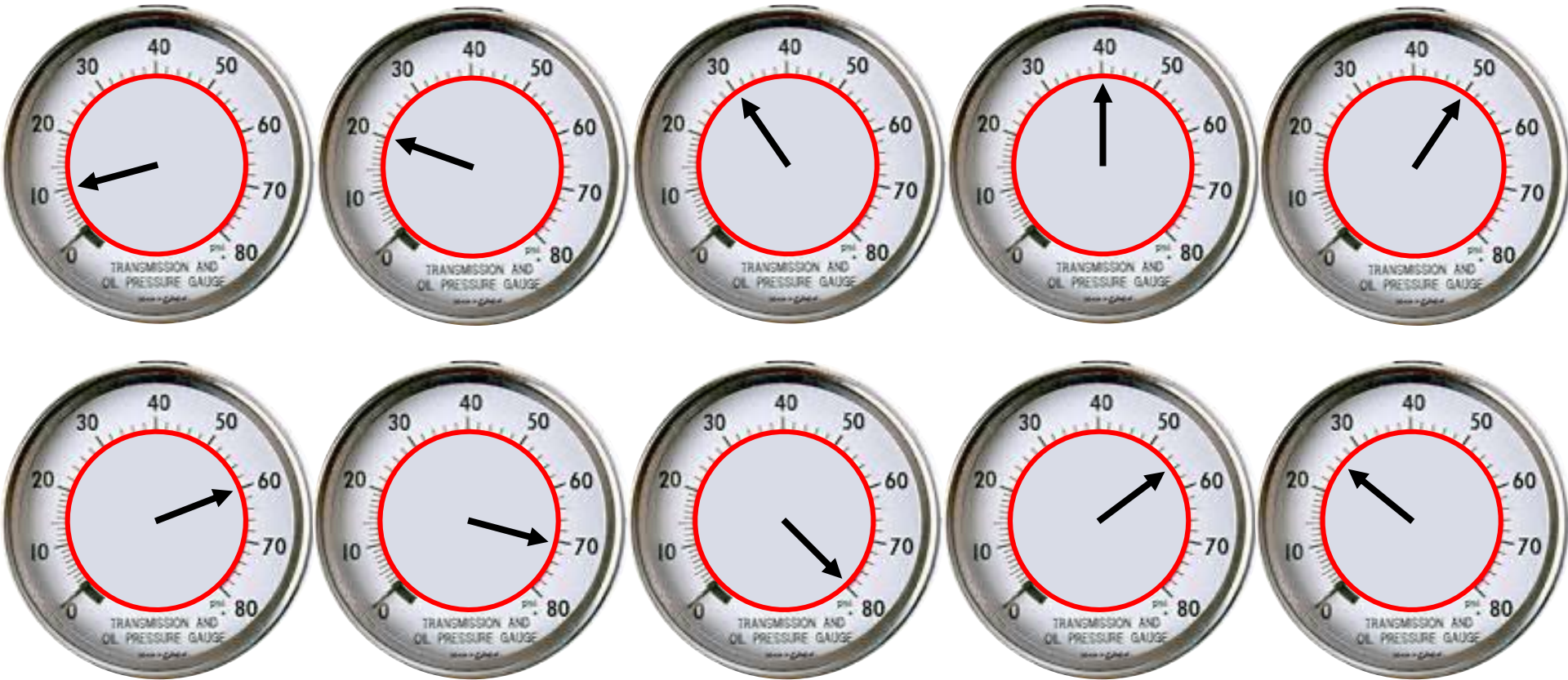


Version 2026C-Korea

Page: 73

Inspect Tasks for Remote Operators to Read

Print this page and cut or punch 5cm (2in) diameter circles





QR Codes



Version 2026C-Korea

Page: 74

Inspect Tasks for Image Processing

Print this page and cut or punch 5cm (2in) diameter circles



LINEAR 1-A
LINEAR 2-A



LINEAR 1-B
LINEAR 2-B



LINEAR 1 (CENTER)
LINEAR 2 (CENTER)



LINEAR 1-C
LINEAR 2-C



LINEAR 1-D
LINEAR 2-D





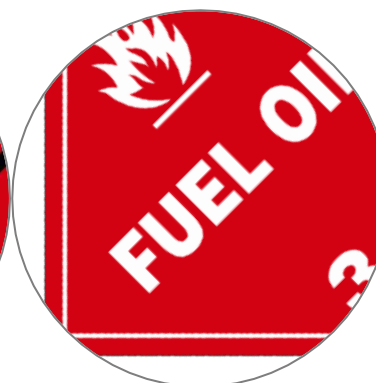
Partial Hazmat Labels



Version 2026C-Korea
Page: 75

Inspect Tasks for Image Processing

Print this page and cut or punch 5cm (2in) diameter circles
Representing selected sections of an actual label.





Hazmat Label Lexicon



Version 2026C-Korea

Page: 76

Complete Set of Hazmat Labels to Learn

These images are not intended for printing
They are not actual size labels, only examples of the variety of options.





Version 2026C-Korea
Page: 77

Dexterity Touch/Insert



Linear Touch/Insert Tasks (Blue)



Version 2026C-Korea
Page: 78

Fabrication

QTY: [12] LINEAR TASKS

PURCHASE LIST:

- [6] "2x2" LUMBER
240 cm (96 in)
- [2] "2x4" LUMBER
240 cm (96 in)
- [60] THREADED INSERTS
8 mm (5/16 in) THREADS
EXAMPLE: <https://a.co/d/c2r2Vi9>
- [20] SANDER TOOLS WITH SHAFTS
FITS EASILY IN THREADED INSERTS
EXAMPLE: <https://a.co/d/9i8XJJO>
- [1] DRILL BITS FOR PILOT HOLES
8.7 mm 11/32 in)
EXAMPLE: <https://a.co/d/1ToPFud>

CUT LIST:

- A** [12] "2X2" RAILS
90 cm (36 in)
- B** [12] "2X4" CENTERS
30 cm (12 in)
45° BOTH ENDS CUT FLAT OPPOSING

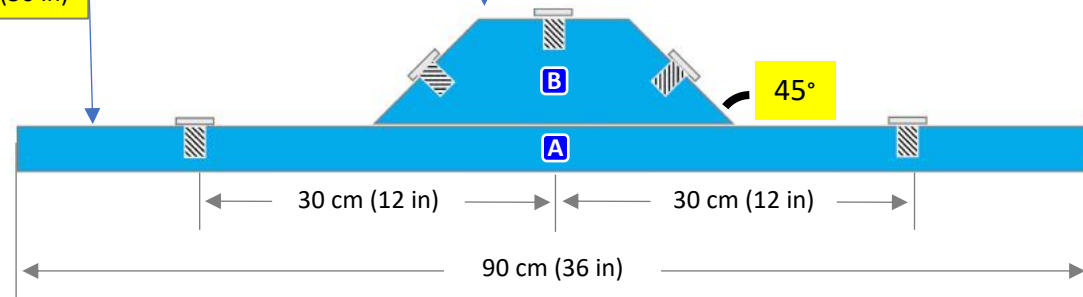
FABRICATION TIPS:

- Center and screw both pieces of lumber together lying flat their sides. Push up against as clamped beam or wall.
- Use the appropriate pilot hole drill so the threaded inserts can be installed by hand easily. Be sure the hole isn't too large.

"2x4" CENTER PIECE
30 cm (12 in) with 45° BOTH ENDS CUT FLAT

THREADED INSERTS 8 mm (5/16 in)
TO EASILY FIT TOOL SHAFTS 7 mm (1/4 in)

"2x2" RAIL
90 cm (36 in)



Steel Shaft with Handle:
6 mm (1/4 in) diameter shaft
at least 25 mm (1 in) long



Small Round Abrasive Flap Wheel Sanders
Grasp Object: 25 mm (1 in) diam high friction cylinder
Shaft: 6 mm (1/4 in) diameter, at least 25 mm (1 in) long
<https://www.amazon.com/dp/B007242014>



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Omni Touch/Insert Tasks (Blue)



Version 2026C-Korea

Page: 79

Fabrication

QTY: [12] OMMI TASKS

PURCHASE LIST:

- [3] "2x4" LUMBER
240 cm (96 in)
- [1] "THIN WALL OSB" PANEL
120 x 240 cm (48 x 96 in)
- 60] THREADED INSERTS
8 mm (5/16 in) THREADS
EXAMPLE: <https://a.co/d/c2r2Vi9>
- [20] SANDER TOOLS WITH SHAFTS
FITS EASILY IN THREADED INSERTS
EXAMPLE: <https://a.co/d/9i8XJJO>
- [1] DRILL BITS FOR PILOT HOLES
8.7 mm 11/32 in)
EXAMPLE: <https://a.co/d/1ToPFud>

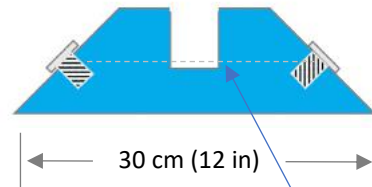
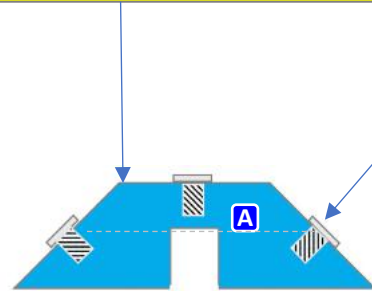
CUT LIST:

- A** [24] "2X4" CENTERS
30 cm (12 in)
45° BOTH ENDS CUT FLAT ON SAW
- B** [12] "THIN WALL OSB" BASES
30 cm (12 in) SQUARE

FABRICATION TIPS:

- Notch half the CENTER PIECES on the TOP and on the BOTTOM in pairs.
- A single long screw from the bottom can attach the two elements together.
- The OSB base makes Omnis easier to mount on walls from the front.

"2x4" CENTER PIECE
30 cm (12 in) with 45° BOTH ENDS CUT FLAT



NOTCHES MUST BE WIDE ENOUGH TO
ACCOMMODATE THE "2x4" USED AND JUST
PAST HALF THE DEPTH

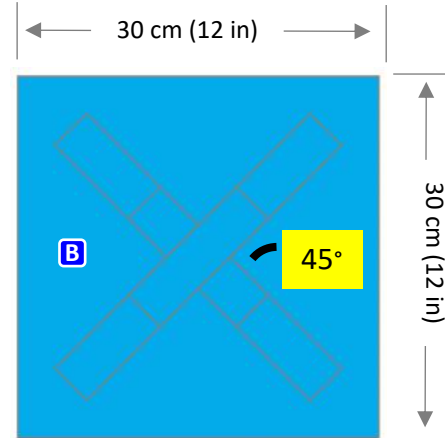
THREADED INSERTS 8 mm (5/16 in)
TO EASILY FIT TOOL SHAFTS 7 mm (1/4 in)



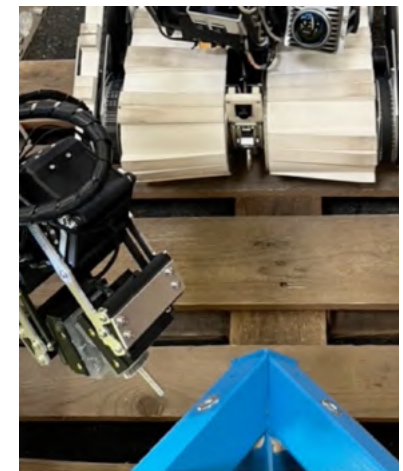
THREADED INSERTS
8 mm (5/16 in) THREADS
INSIDE FOR SHAFT TO FIT



TOOL SHAFT FITS EASILY
7 mm (1/4 in) DIAMETER
25 mm (1 in) LONG



SCREW OMNI TO BASE
FROM UNDERSIDE



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Version 2026C-Korea
Page: 80

Dexterity

E-Stops & Valves



Omni E-Stop Tasks (Black)



Version 2026C-Korea

Page: 81

Fabrication

QTY: [6] OMNI E-STOPS

PURCHASE LIST:

- [2] "2x4" LUMBER
240 cm (96 in)
- [1] "THIN WALL OSB" PANEL
120 x 240 cm (48 x 96 in)
- [30] E-STOP BUTTONS
Example: <https://a.co/d/hy28aQi>

CUT LIST:

- A** [12] "2X4" CENTERS
30 cm (12 in)
45° BOTH ENDS CUT FLAT ON SAW
- B** [6] "THIN WALL OSB" BASES
30 cm (12 in) SQUARE

FABRICATION TIPS:

- See the detailed OMNI fabrication instructions for ALIGN/INSPECT.
- Notch half the CENTER PIECES on the TOP and on the BOTTOM in pairs.
- A single long screw from the bottom can attach the two elements together.
- The OSB base makes Omnis easier to mount on walls from the front.



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Omni Valve Tasks (Black)



Version 2026C-Korea

Page: 82

Fabrication

QTY: [6] OMNI VALVES

PURCHASE LIST:

- [2] "2x4" LUMBER
240 cm (96 in)
- [1] "THIN WALL OSB" PANEL
120 x 240 cm (48 x 96 in)
- [30] SHUT-OFF VALVES (90 DEGREE)
Example: <https://a.co/d/a2CrT4Z>

CUT LIST:

- A** [12] "2X4" CENTERS
30 cm (12 in)
45° BOTH ENDS CUT FLAT ON SAW
- B** [6] "THIN WALL OSB" BASES
30 cm (12 in) SQUARE

FABRICATION TIPS:

- See the detailed OMNI fabrication instructions for ALIGN/INSPECT.
- Notch half the CENTER PIECES on the TOP and on the BOTTOM in pairs.
- A single long screw from the bottom can attach the two elements together.
- The OSB base makes Omnis easier to mount on walls from the front.



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Version 2026C-Korea
Page: 85

Complexity

Fabrication

Optional Complexity

PINCH POINT TRIANGLES TO HANG ON WALLS



- Forces more steering within terrains.
- Can be used on opposite side walls to form serpentine paths.
- Useful as mapping fiducials as well when distributed throughout a sequence of test lanes. Known locations of mapping fiducials can be used to evaluate map accuracy and consistency.

ANGLED OBSTACLES WITH MAGNETS



- Forces larger robots with advantages in the terrains and step-over obstacles to steer precisely and crouch at times. Small robots simply steer clear.
- All bars are magnetized in place so that any touched bar falls. Hitting the walls hard can also do it, so precise control is rewarded.
- Fallen bars act as debris so are not removed until the robot has moved past them to the next repetition or terrain. Extra points can be given for the number of bars left intact for each repetition (reset at the start).



Pinch Points

Optional Complexity



Version 2026C-Korea

Page: 87

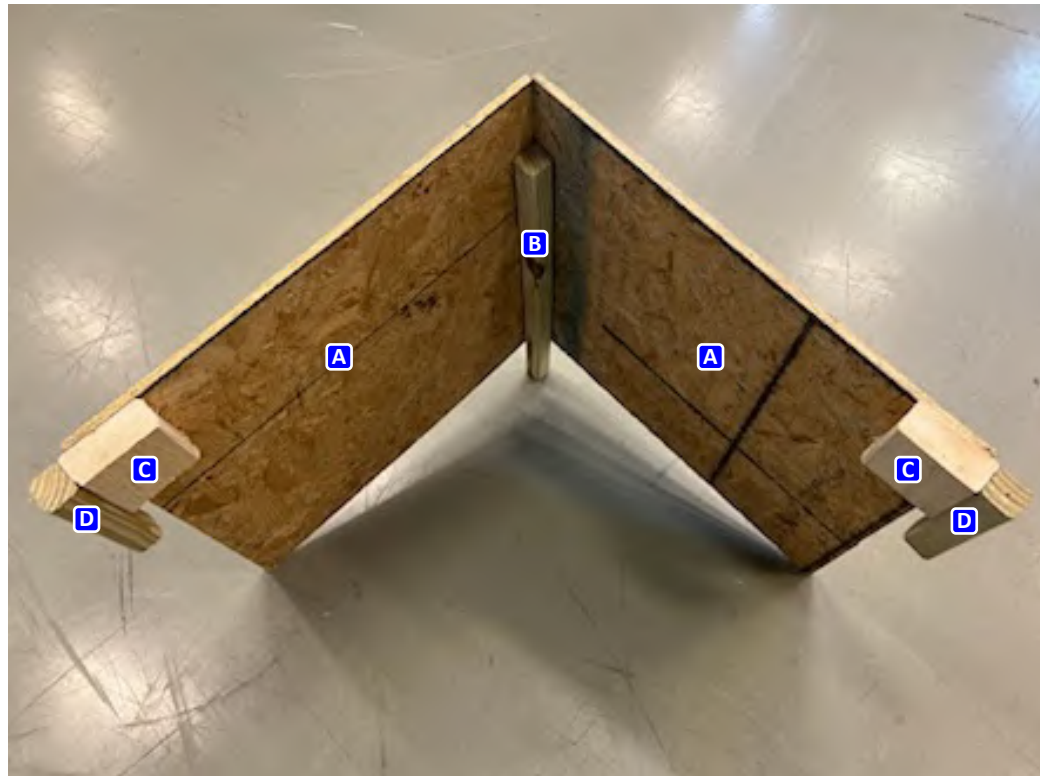
QTY: 40 PINCH POINTS

PURCHASE LIST:

- [10] "THIN WALL OSB" PANELS
120 x 240 cm (48 x 96 in)
- [6] "2x4" LUMBER
240 cm (96 in)
- [14] "2x2" LUMBER
240 cm (96 in)

CUT LIST:

- A** [80] PINCH POINT PANELS
60 x 60 cm (24 x 24 in)
- B** [40] "2x2" CENTER SPINE/LEG
60 cm (24 in)
- C** [80] WALL HANGING BLOCKS
15 cm (6 in)
- D** [80] WALL HANGING POSTS
15 cm (6 in)



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Negotiate Angled Obstacles

Optional Complexity



Version 2026C-Korea

Page: 88

QTY: 20 ARCHES

PURCHASE LIST:

- [40] "2x2" LUMBER
240 cm (96 in)
- [40] MAGNETS WITH CENTER HOLES
WITH RELATED WASHERS
3+ cm diameter, 50 kg force)
(1.3+ in diameter, 110 lb force)
<https://a.co/d/8grevJL>

CUT LIST:

- A** [40] VERTICAL WALL POSTS
90 cm (36 in)
- B** [20] HORIZONTAL SPANS
120 cm (48 in)
- C** [20] DIAGONAL OBSTACLES
100 cm (40 in)



- MAGNETS with WASHERS and SCREWS should be purchased together to ensure they work.
<https://a.co/d/8grevJL>
- If they must be purchased separately, be certain NOT to purchase STAINLESS STEEL WASHERS.



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Version 2026C-Korea
Page: 89

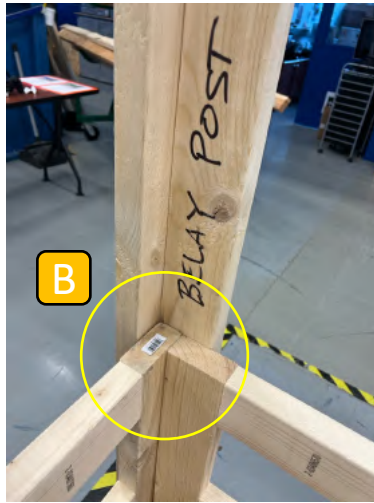
Integrated Lane Belay

Safety for Quadrupeds and Humanoids

Safety for Quadrupeds and Humanoids

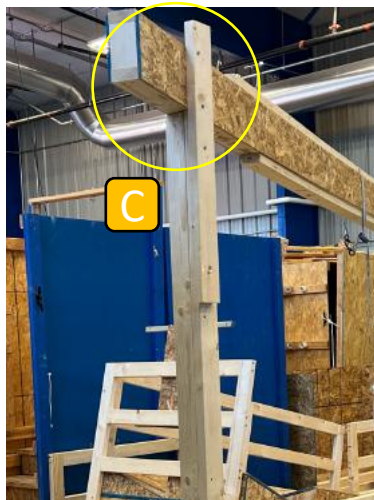
CORNER BELAY POSTS

Posts get mounted to the OUTSIDE of the overlapped corner railings.



A) The RAILING corners overlap and get screwed together with 1 top screw. Note that the overlap causes a slight gap in the RAILINGS in the center of the long edge of the flat terrain.

B) The BELAY POSTS get mounted to the OUTSIDE of the RAILING corners.



C) The BELAY BEAM is held in place with two vertical POST extensions.



Integrated Lane Belay



Version 2026C-Korea

Page: 91

Safety for Quadrupeds and Humanoids

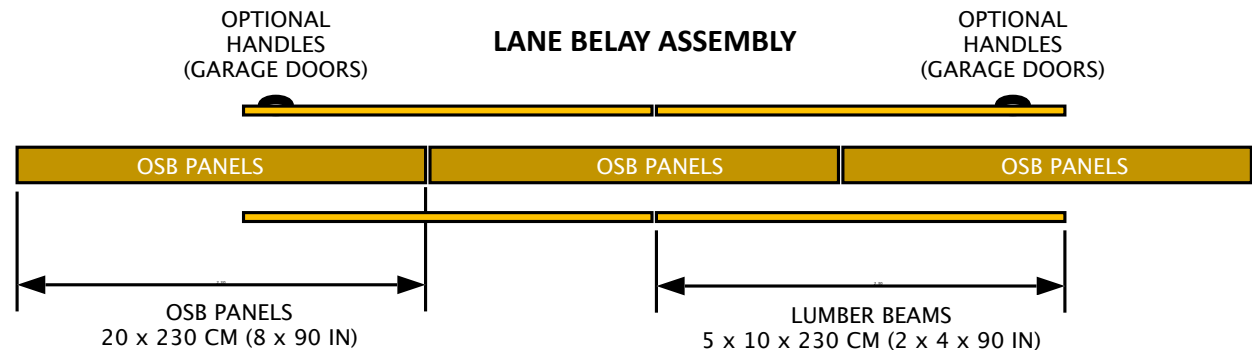
Fabricate: 1 per terrain lane

PURCHASE LIST:

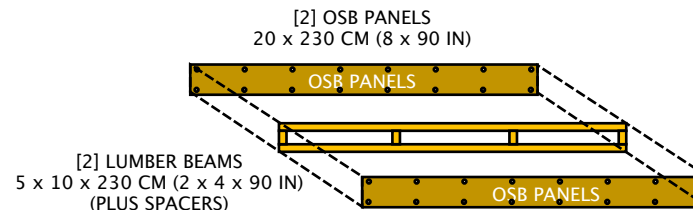
- [1] **"THIN OSB" PANELS**
120 x 240 cm (48 x 96 in)
- [9] **"2x4" LUMBER**
240 cm (96 in)
- [3] **TOP TRACK AND TROLLEY**
150 cm (60 in) length
RAIL: <https://a.co/d/gzLlpON>
TROLLEY: <https://a.co/d/bhYANVh>
- [1] **ROPE FOR GOOD HAND GRIP**
10 mm (1/2 in) x 10 m (30 ft)
<https://a.co/d/3aVigTE>
- [1] **CARABINER** or shackle
- [2] **MAGNETS with CLOSED EYE BOLT**
Stick together on the belay rope with a pipe cap between to know when pulled

FABRICATION TIPS:

- Assemble 1 simple composite beam for top span. Use full length "2x4s" plus 60 cm (24 in) cut fillers at both ends to total 3 m (10 ft).
- Note the tall orientation of the beams so the side plywood triangles are all on the same planes.
- Purchase a matching TOP TRACK and TROLLEY 150 cm (60 in) length.



INDIVIDUAL BOX BEAMS [3] PER LANE



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Version 2026C-Korea
Page: 92

Rolling Gantry Belay

Safety for Quadrupeds and Humanoids



Rolling Gantry Belay (Light)



Version 2026C-Korea

Page: 93

Safety for Quadrupeds and Humanoids

Fabricate: 1

PURCHASE LIST:

- [1] **"THIN WALL OSB" PANELS**
120 x 240 cm (48 x 96 in)
- [9] **"2x4" LUMBER**
240 cm (96 in)
- [4] **CASTERS (2 SWIVEL, 2 FIXED)**
10cm (4in) or larger
<https://a.co/d/f4lp85s>
- [4] **TOP TRACK AND TROLLEY**
150 cm (60 in) length
RAIL: <https://a.co/d/gzLlpON>
TROLLEY: <https://a.co/d/bhYANVh>
- [1] **ROPE FOR GOOD HAND GRIP**
10 mm (1/2 in) x 10 m (30 ft)
<https://a.co/d/3aVigTE>
- [1] **CARABINER or shackle**

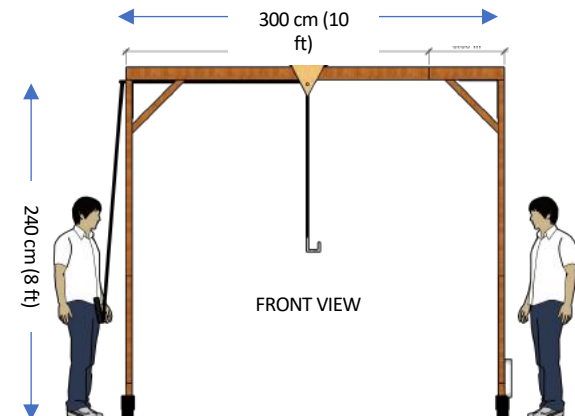
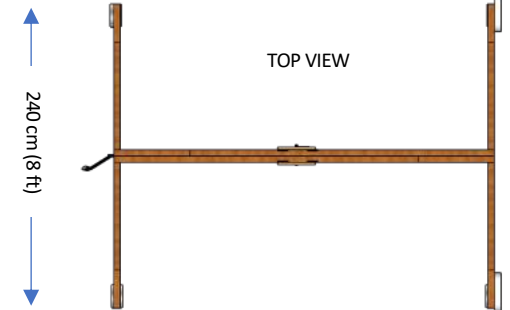
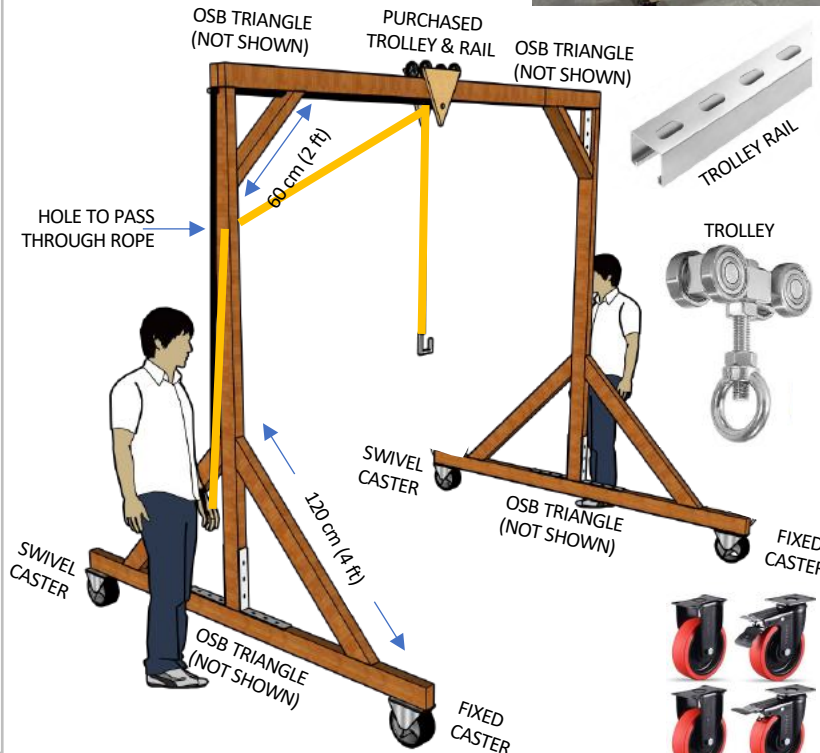
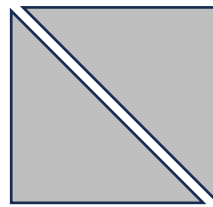
FABRICATION TIPS:

- Assemble 1 simple composite beam for top span. Use full length "2x4s" plus 60 cm (24 in) cut fillers at both ends to total 3 m (10 ft).
- Note the tall orientation of the beams so the side plywood triangles are all on the same planes.
- Purchase a matching TOP TRACK and TROLLEY 150 cm (60 in) length.

"THIN WALL OSB" TRIANGLES

120 cm (48 in)

60 cm (24 in)



NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Version 2026C-Korea
Page: 96

Shipping Crates



Shipping Crates



Version 2026C-Korea
Page: 97

“First In – Last Out” Packing Order

QUANTITY: [1] SHIPPING CRATE PER LANE HOLDS EVERYTHING NEEDED IN THAT LANE: FLOORS, RAILINGS, TERRAIN, DEXTERITY, & BELAY

PURCHASE LIST PER SHIPPING CRATE:

- [4] “THIN WALL OSB” PANELS
9.5 mm x 120 cm x 240 cm
(7/16 in x 48 in x 96 in)⁴
- [6] “2x4” LUMBER
5 x 11 x 240 cm (2 x 4 x 96 in)
- [2] “4x4” LUMBER
10 x 10 x 240 cm (4 x 4 x 96 in)

CUT LIST PER SHIPPING CRATE:

- A** [2] “2x4” SHORT SIDES (TALL)
5 x 10 x 120 cm (2 x 4 x 48 in)
SHOULD BE SAME AS OSB PANEL
- B** [4] “2x4” LONG CENTERS (TALL)
5 x 10 x 230 cm (2 x 4 x 93 in)
CUT TO FIT BETWEEN SHORT BEAMS
- C** [2] “4x4” CORNER BLOCKS
10 x 10 x 10 cm (4 x 4 x 4 in)
TEMPORARILY SCREW TOGETHER
UNTIL THE FLOORS GET LOADED
- D** [3] “4x4” PALLET SKIDS
10 x 10 x 120 cm (4 x 4 x 48 in)
SHOULD BE SAME AS OSB PANEL

FABRICATION TIPS:

1. Assemble the crate base first without the forklift skids. Just the panel with frame.
2. Attach three OSB sides to the base while everything is SITTING FLAT ON FLOOR.
3. Add exterior vertical corner supports.
4. Then lift the entire crate onto the skids to attach through floor (washer head screws).

LEVEL #4: MISCELLANEOUS BETWEEN TOP TWO FLAT FLOORS

- [*] HEX HEAD SCREWS FOR SET UP (LONG AND SHORT)
- [*] HEX HEAD MAGNETIZED BITS FOR SET UP (SPARES)
- [2] HINGES FOR DOOR RAILING
- [1] LATCH FOR DOOR RAILING
- [2] HINGE BEAM SPACERS FOR BOTTOM OF TILT FLOOR
- [2] NEGOTIATE SETS (RED)
- [4] PINCH POINTS (RED) HINGED TO FOLD AND STOW

LEVEL #3: FLOORS

- [2] FLAT FLOORS (facing each other to form a cavity)
- [2] TILT-UP FLOORS (with legs up)

LEVEL #2: TERRAIN ELEMENTS

- [8] TERRAIN ELEMENTS AFFIXED TO SQUARE OSB PANELS

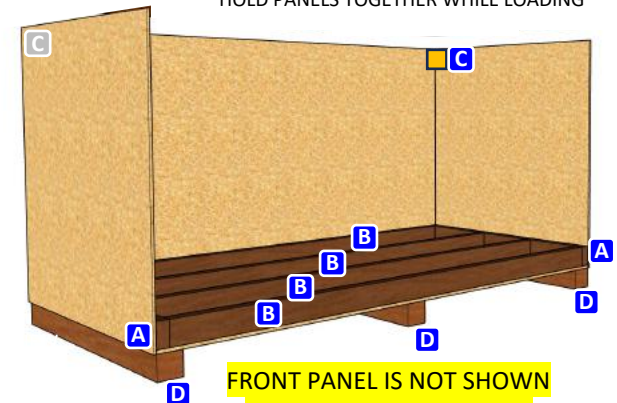
LEVEL #1: RAILINGS & DEXTERITY

- [14] RAILINGS (in two stacks left and right with retainers)
- [1] DEXTERITY ALIGN/INSPECT COMBO PANEL (GREEN)
- [1] DEXTERITY TOUCH/INSERT COMBO PANEL (BLUE)
- [1] DEXTERITY VALVE OMNI (BLACK)
- [1] DEXTERITY E-STOP OMNI (BLACK)

LEVEL #0: FIT BETWEEN THE PALLET RAILS AND BORDERS

- [3] BELAY BOX BEAMS
- [2] BELAY POSTS
- [4] BELAY POST EXTENSIONS
- [4] BELAY TOP/BOTTOM BOX BEAM CONNECTORS
- [8] BELAY CORNER ATTACHMENTS
- [3] BELAY METAL TROLLEY TRACKS
- [1] BELAY TROLLEY AND ROPE

TEMPORARY BLOCK IN CORNER SUPPORTS
HOLD PANELS TOGETHER WHILE LOADING



FORKLIFTABLE BASE PALLET MADE

NOTE: Your dimensions may vary slightly depending on the your purchasable materials. The goal is to minimize purchase costs and cuts while maintaining the rough dimensions shown.



Shipping Crates



Version 2026C-Korea
Page: 98

“First In – Last Out” Packing Order



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