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2017-2018 *FIRST*® Tech Challenge
DIY Field Guide

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FIRST

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Revision History		
Revision	**Date**	**Description**
1	09.09.2017	Initial Release
1.1	10/3/2017	Page 4 – DIY Shopping Guide - Changed “* Plywood, 3/8” to “*Plywood 3/4”

Contents

DIY Shopping Guide

Full Shopping Guide for a HALF field.

* Plywood, 3/4" x 2' x 4' – *cuts are from a single sheet ($13.37)*
** Plywood, 3/8" x 2' x 4' – *cuts are from a single sheet ($9.52)*

DIY Part Number	Part Name	Raw Material	Qty	Cost Per Unit	Final Qty
DIY18-1	**Cryptobox**				**Makes 1 Box**
DIY18-1-1	Cryptobox Back Panel	Plywood, 3/8" x 2' x 4'	**	See Above	1
DIY18-1-2	Cryptobox Main Rail	Plywood, 3/4" x 2' x 4'	*	See Above	4
DYI18-1-3	Cryptobox Side Rails	Plywood, 3/8" x 2' x 4'	**	See Above	8
DIY18-2	**Balancing Stone**				**Makes 1 Stone**
DIY18-2-1	Main Panel	Plywood, 3/4" x 2' x 4'	*	See Above	1
DIY18-2-2	Upper Pylon				1
DIY18-2-3	Lower Pylon	Plywood, 3/8" x 2' x 4'	**	See Above	1
DIY18-2-4	Under Tile Plate				1
DIY18-3	**Jewel Holder**				**Makes 1 Jewel Holder**
DIY18-3-1	Jewel Holder	Plywood, 3/4" x 2' x 4'	*	See Above	1
Hardware					
		Finishing Nail, 1" long	44	$1.79 for box	
		Wood Screw, #8 x 1 3/4" long	20	$5.58 for box of 75	
		Carriage Bolt, 1/4" dia x 2" long	1	$0.80	
		1/4 in. Stainless-Steel Flat Washer	1	$1.18 for pack of 6	
		Nyloc nut, 1/4" - 20	1	$5.97 for Pack of 100	

Total Cost: $38.21

Recommended Tools

Listed below are all tool used in this Guide. Each Section will list the tools used in creating that element. Please note that some tools are used multiple times.

- ☐ 1/8” drill bit
- ☐ ¼” drill bit
- ☐ 2 ¼” hole saw
- ☐ 1 ¾” spade bit
- ☐ Compass
- ☐ Drill motor (or Drill press)
- ☐ Framing Square
- ☐ Phillips screwdriver bit
- ☐ Sandpaper
- ☐ Tape measure
- ☐ Table saw (or circular saw)

Cutting Materials to Size: ¾” x 2’ x 4’ Plywood

The below cut diagrams and cut instructions are for the ¾” x 2’ x 4” plywood. The following parts will be made from this plywood:

- DIY18-1-2: Cryptobox Main Rail
- DIY18-2-1: Balancing Stone – Main Panel
- DIY18-2-2: Balancing Stone – Upper Panel
- DIY18-3-1: Jewel Holder

DIY18-1-2: *Cryptobox Main Rail Cut Diagram*

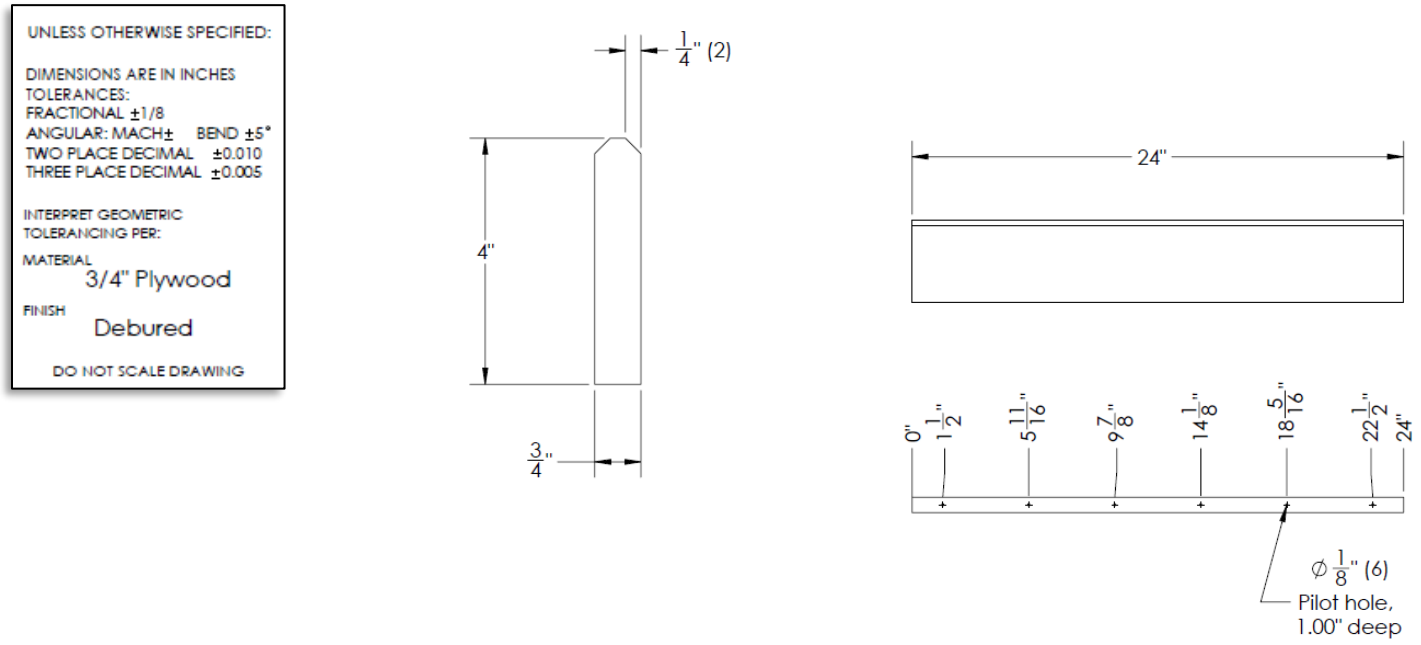


Figure 1: Cryptobox Main Fin Cut Diagram

DIY18-1-2: *Cryptobox Main Rail Cut Instructions*

1. Use a table saw or circular saw to cut (4) Cryptobox Main Rails.
    - 4” (10.16cm) in length
    - 24” (60.96cm) in height
2. Measure and layout and locations for the 1/8” diameter holes. *(Diagram is drawn using inches)*

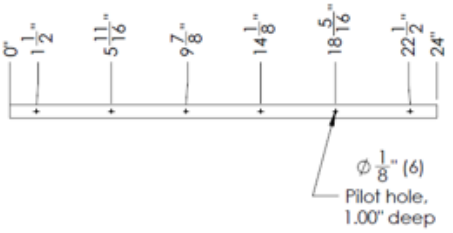


Figure 2: Cryptobox Main Rails (4 in total) - 4"x24" (10.16cm x 60.96cm)

3. Drill the 24 holes (6 per rail) using a 1/8” drill bit. The holes should be approximately 0.5 – 1” deep. *A drill press is handy for this work but it can be done with a hand drill.*

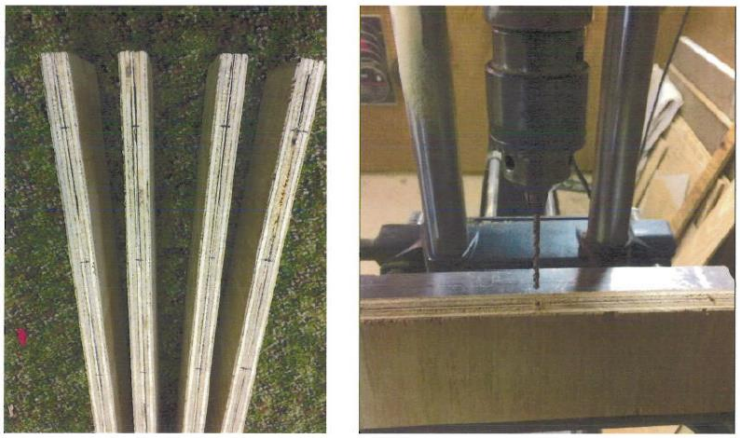


Figure 3: Drill 24 holes (6 per rail) in Main Rails

4. Creating the angle (chamfer) at the top of each Cryptobox Main Rail
    - Set the blade on a table saw to 45 degrees and run the wood strips through the saw to create the angle (chamfer).
    - Flip over and repeat to create the two angled sides
    - You can also use a 45 degree router bit and a router to chamfer the edge of the wood.

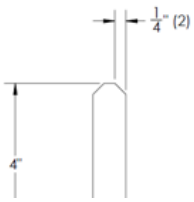


Figure 5: Set table saw to 45 degree angle.

Figure 5: You can also use a 45 degree router bit and a router to chamfer the edge of the wood.

DIY18-2-1: *Balancing Stone – Main Panel Cut Diagram*

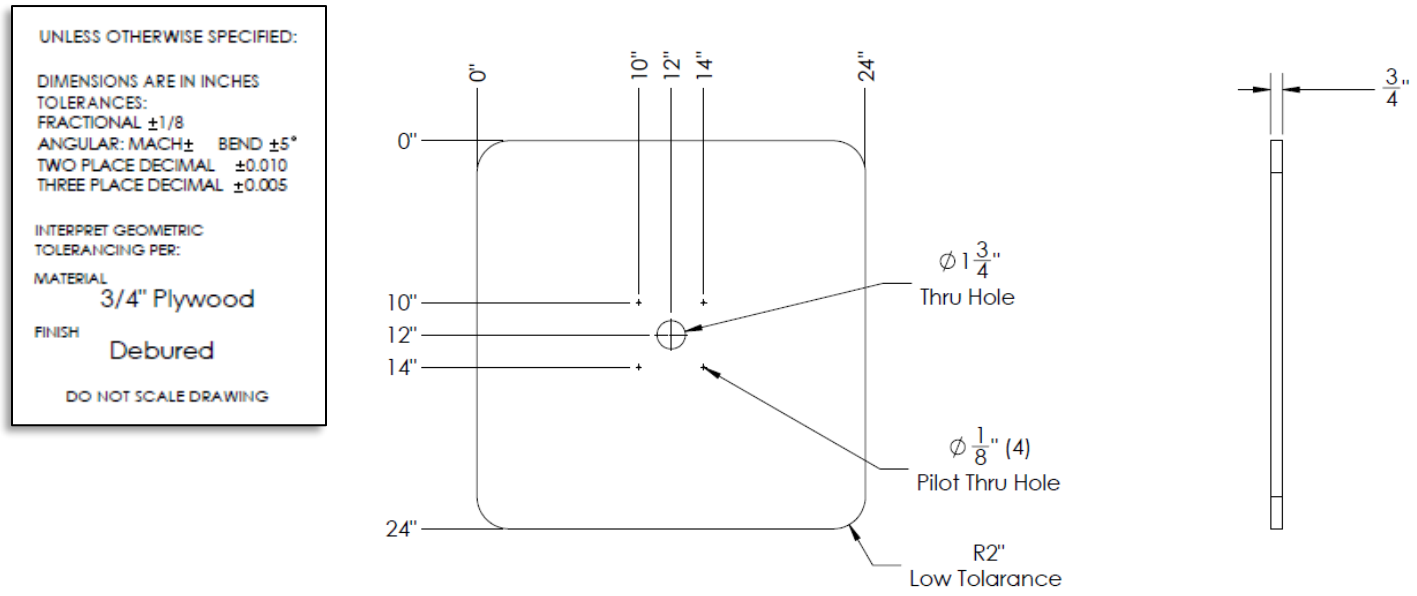


Figure 6: Balancing Stone - Main Panel Cut Diagram

DIY18-2-1: *Balancing Stone – Main Panel Cut Instructions*

1. Use a table saw or circular saw to cut the Main Panel.
    - Main Panel is 24” x 24” (60.96cm x 60.96cm)
2. Measure and layout the locations for the 1/8” holes, the center 1 ¾” hole, and the 2” corner radii.
    - Drill the four 1/8” diameter holes through the plywood using a 1/8” drill bit and hand drill.
        - Each hole should be measured 10” (25.4cm) from two sides.

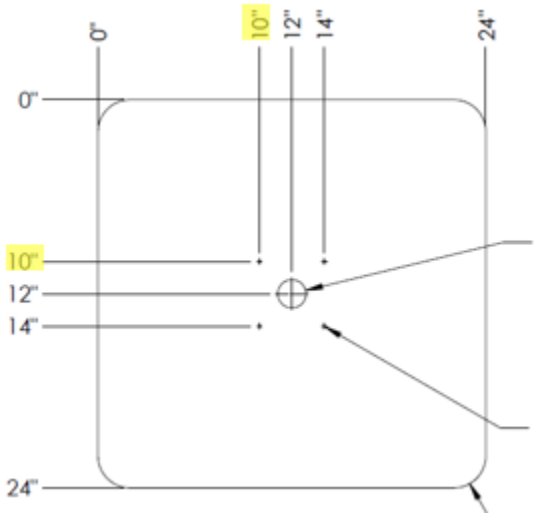


Figure 7: Balancing Stone - Main Panel

- Drill the 1 ¾” hole through the plywood using the 1 ¾” spade and hand drill.
    - Centered in the middle of the Panel.
    - Should be 12” (30.48cm) in from all four sides.

- Cut or sand the corners to a 2” (5.08cm) radius.
  - Using a simple ruler, measure 2” (5.08cm) from each side.
  - Use a compass to trace a quarter circle from side to side.

Figure 8: Measure a center point 2" (5.08cm) from each side.

Figure 9: Use a compass to trace a quarter circle on each corner.

Figure 10: Sand rounded corners down to a 2" (5.08cm) Radius.

Figure 11: Finished Balancing Stone - Main Panel

DIY18-2-2: *Balancing Stone – Upper Pylon Cut Diagram*

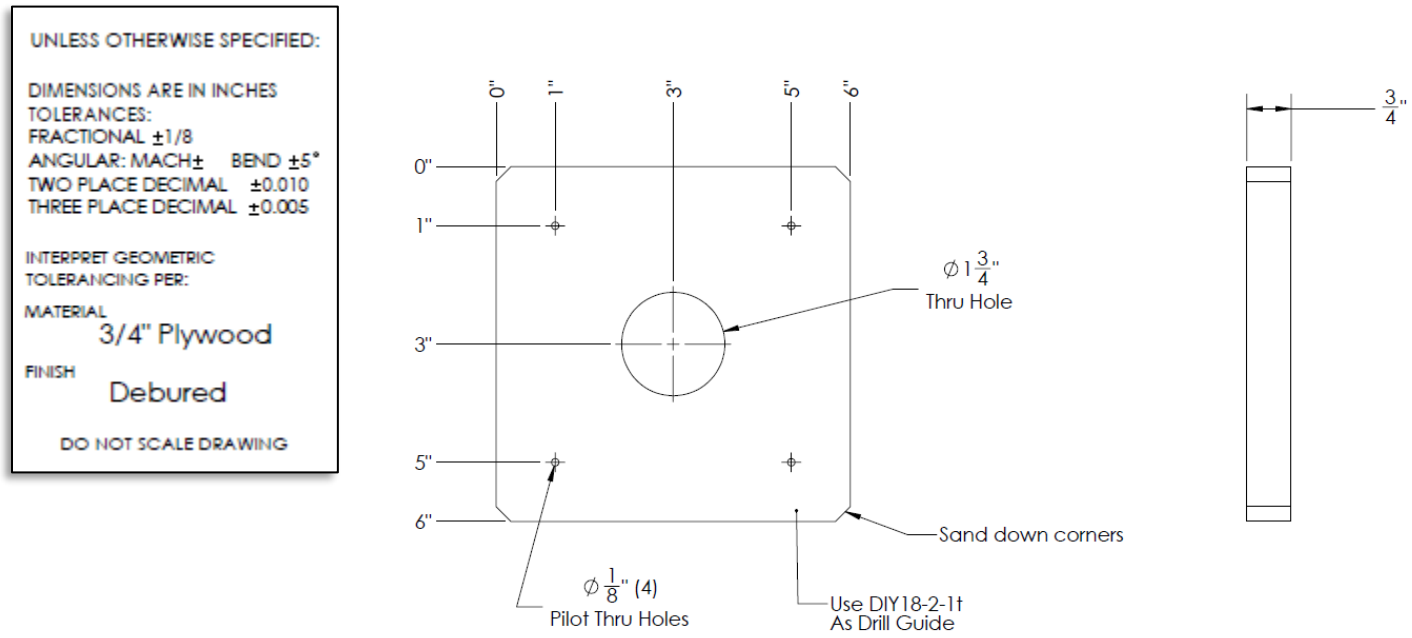


Figure 12: Balancing Stone - Upper Pylon Cut Diagram

DIY18-2-2: *Balancing Stone – Upper Pylon Cut Instructions*

1. Use a table saw or circular saw to cut the Upper Pylon.
    - Upper Pylon is 6” x 6” (15.24cm x 15.24cm)
2. Measure and layout the locations for the four 1/8” diameter holes and the 1 ¾” diameter hole.
    - The four 1/8” diameter holes are measured 1” (2.54cm) in from two sides.
    - The 1 ¾” is directly in the center of the Upper Pylon (3”x3” or 7.62cm x 7.62cm).
3. Drill the four 1/8” diameter holes through the plywood with a 1/8” drill bit and hand drill.
4. Drill the 1 ¾” diameter hole through the plywood with a 1 ¾” drill spade and hand drill.
5. Sand corners and edges to smooth with sandpaper.

Figure 13: Measure holes for the Balancing Stone - Upper Pylon

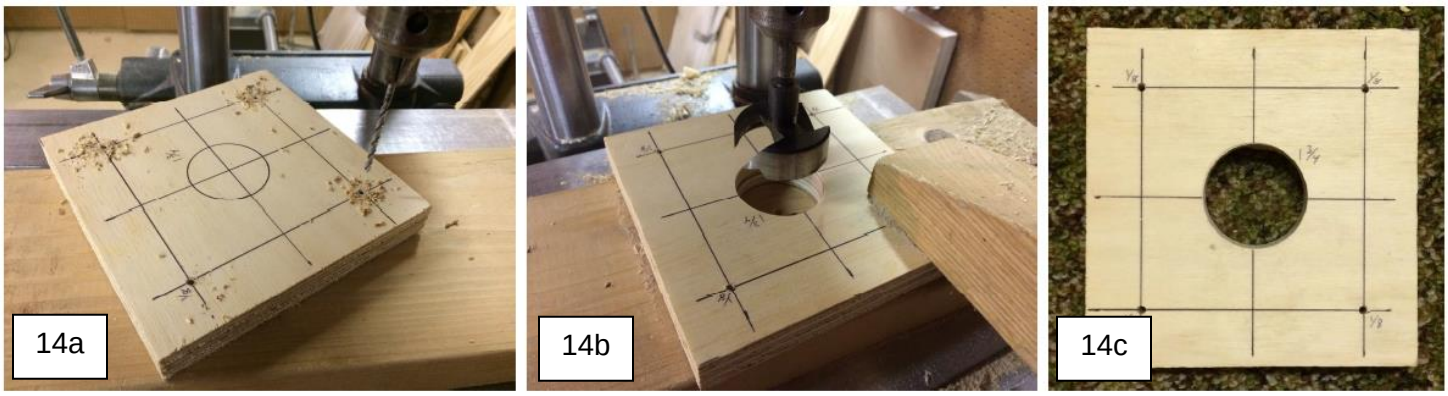


Figure 14a) Drill 1/8" diameter holes 14b) Drill 1 3/4" diameter hole 14c) Finished Upper Pylon

DIY18-3-1: *Jewel Holder Cut Diagram*

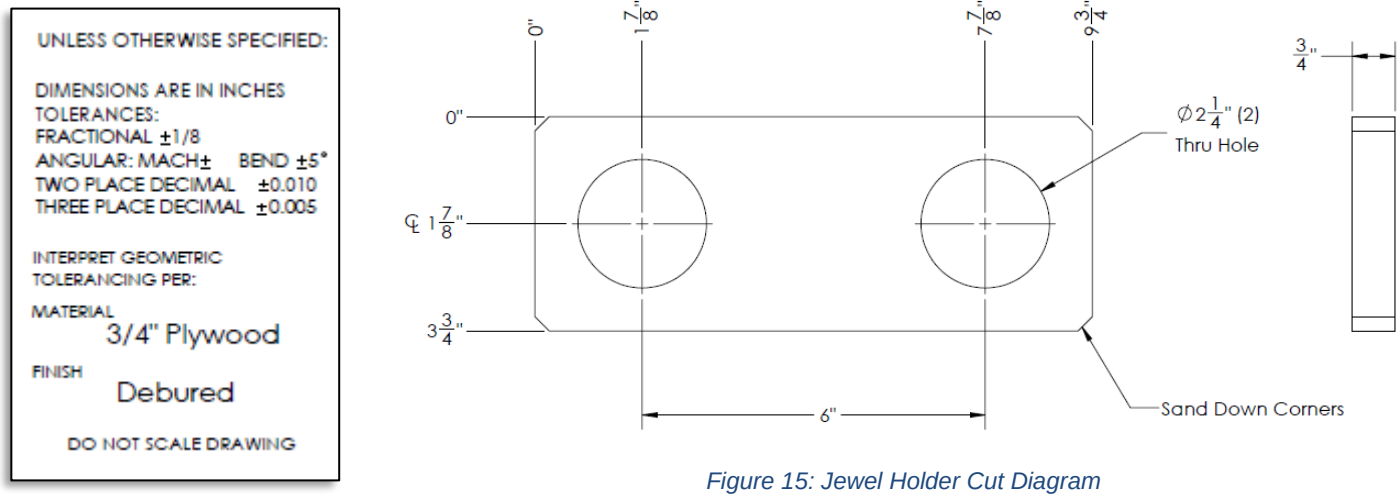


Figure 15: Jewel Holder Cut Diagram

DIY18-3-1: *Jewel Holder Cut Instructions*

1. Use a table saw or circular saw to cut the Jewel Holder.
    - 9 ¾” (24.765cm) in length.
    - 3 ¾” (9.525cm) in width.
2. Measure and layout the locations of the two 2 ¼” holes.
    - They are along the center axis (1 7/8” or 4.7625cm).
    - Each center is 1 7/8” (4.7625cm) from the end (and 6” or 15.24cm from the center of the next hole).

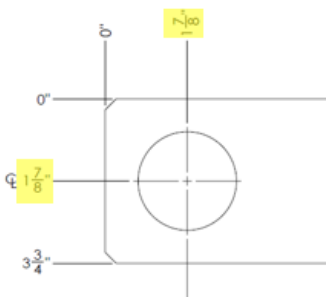


Figure 16: Finished Jewel Holder.

3. Use a 2 ¼” hole saw to cut the two Jewel Holder holes.

Figure 17: Use a 2 1/4" hole saw to cut out Jewel Holder holes.

4. Sand corners and edges to smooth with sandpaper.

Cutting Materials to Size: 3/8” x 2’ x 4’ Plywood

The below cut diagrams and cut instructions are for the 3/8” x 2’ x 4” plywood. The following parts will be made from this plywood:

- DIY18-1-1: Cryptobox Back Panel
- DIY18-1-3: Cryptobox Side Rails
- DIY18-2-3: Balancing Stone – Lower Pylon
- DIY18-2-4: Balancing Stone – Under Tile Plate

DIY18-1-1: *Cryptobox Back Cut Diagram*

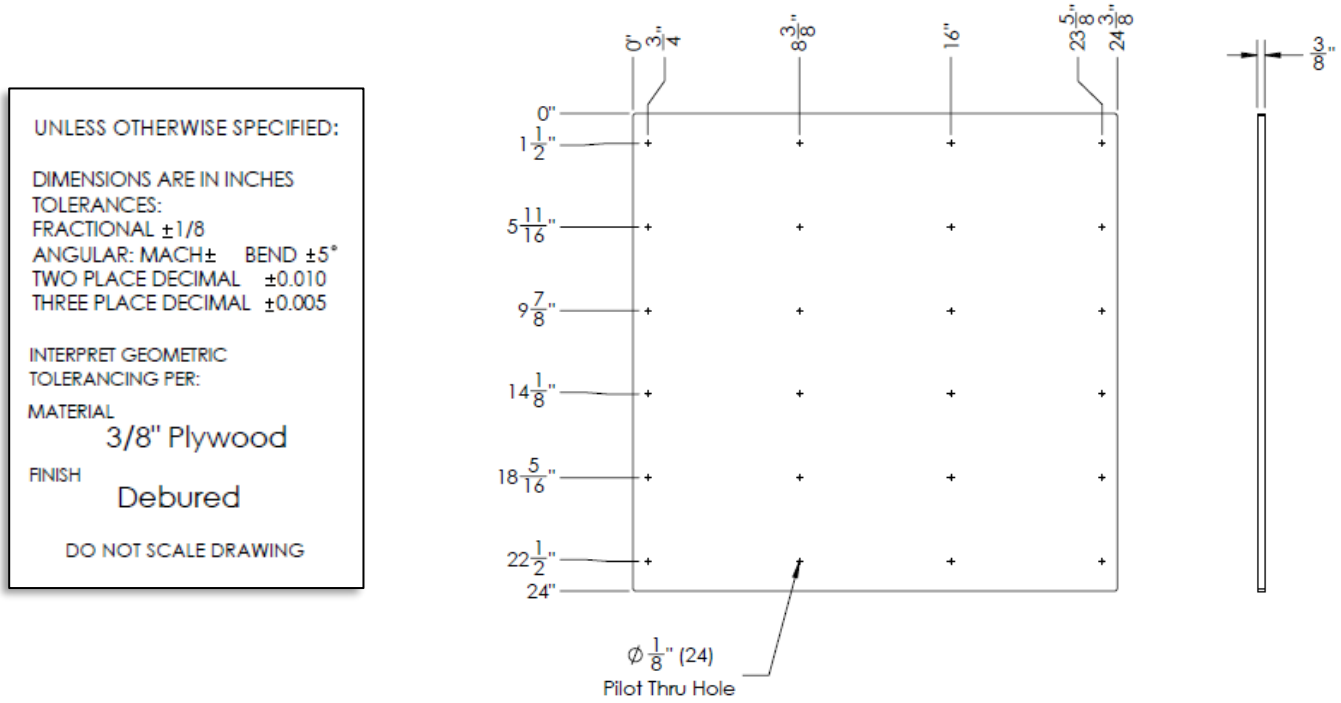


Figure 18: Cryptobox Back Cut Diagram

DIY18-1-1: *Cryptobox Back Cut Instructions*

1. Use a table saw or circular saw to cut the Cryptobox Back.
    - 24 3/8” (61.9125cm) in length
    - 24” (60.96cm) in height
2. Measure and layout the locations for the 1/8” diameter holes.
    - The four rows of holes should be laid out per the below measurements *(Diagram is drawn in inches).*

    - The 6 holes should be laid out per the below measurements *(Diagram is drawn in inches).*

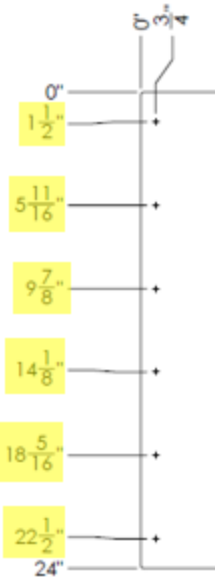


Figure 19: Cryptobox Back cut.

3. Drill the 24 holes using a 1/8” drill bit and a drill motor. The holes should go all the way through the plywood.

DIY18-1-3: *Cryptobox Side Rail Cut Diagram*

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±1/8
ANGULAR: MACH± BEND 5
TWO PLACE DECIMAL ±0.010
THREE PLACE DECIMAL ±0.005

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL
3/8" Plywood

FINISH
Debured

DO NOT SCALE DRAWING

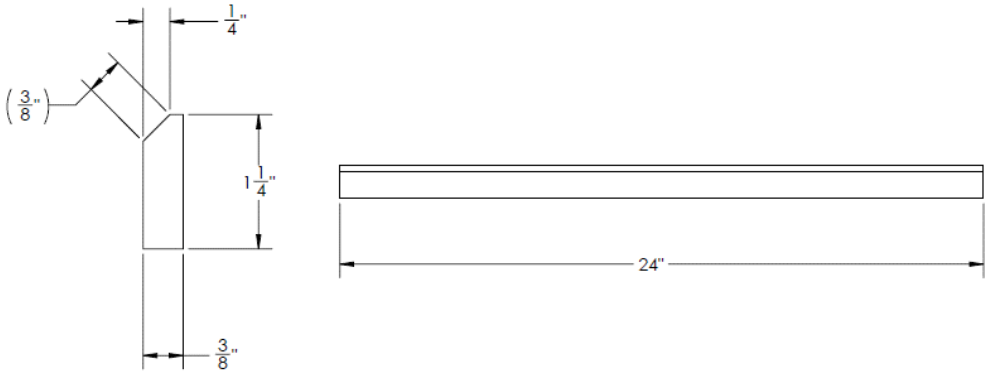


Figure 20: Cryptobox Side Fin Cut Diagram

DIY18-1-3: *Cryptobox Side Rail Cut Instructions*

1. Use a table saw or circular saw to cut the (8) Side Rails.
    a. 24” (60.96cm) in length.
    b. 1 ¼” (3.175cm) in height.

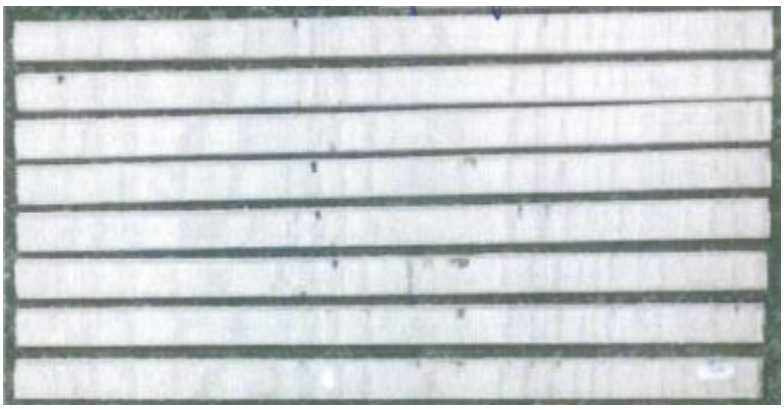


Figure 21: (8) Cryptobox Side Rails

2. Creating the angle (chamfer) at the top of each Cryptobox Side Rail
    - Set the blade on a table saw to 45 degrees and run the wood strips through the saw to create the angle (chamfer).
    - You can also use a 45 degree router bit and a router to chamfer the edge of the wood.

Figure 22: Set table saw to 45 degree angle.

Figure 23: You can also use a 45 degree router bit and a router to chamfer the edge of the wood.

DIY18-2-3: *Balancing Stone – Lower Pylon Cut Instructions*

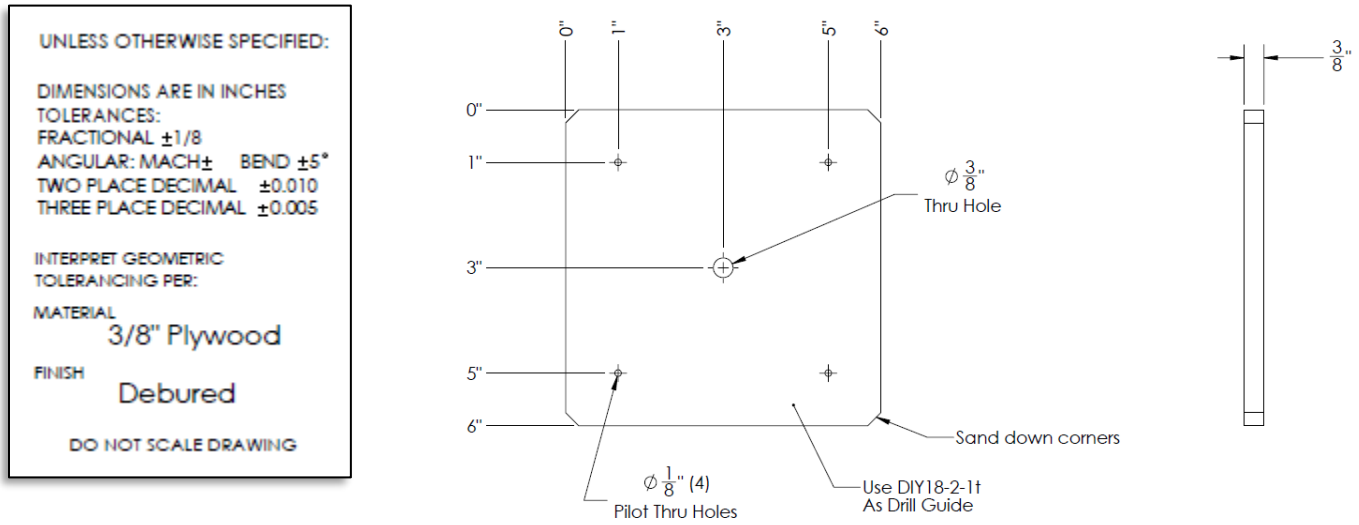


Figure 24: Balancing Stone - Lower Pylon Cut Instructions

DIY18-2-3: *Balancing Stone – Lower Pylon Cut Instructions*

1. Use a table saw or circular saw to cut Lower Pylon (6”x6” or 15.24cm x 15.24cm)
2. Measure and layout the location for the four 1/8” diameter holes and the ¼” diameter hole.
    - The four 1/8” diameter holes are measured 1” (2.54cm) in from two sides.
    - The ¼” diameter hole is directly in the center of the Lower Pylon (3”x3” or 7.62cm x 7.62cm).
3. Drill the four 1/8” diameter holes through the plywood with a 1/8” drill bit and hand drill.
4. Drill the ¼” diameter hole through the plywood with a ¼” drill bit and hand drill.
5. Sand corners and edges to smooth with sandpaper.

Figure 25: Measure, cut and draw drill holes for the Balancing Stone - Lower Pylon.

Figure 26: Finished Balancing Stone - Lower Pylon.

Figure 27: Use a 1/4" Drill Bit to drill the center hole in the Balancing Stone - Lower Pylon.

DIY18-2-4: *Balancing Stone – Under Tile Plate Cut Diagram*

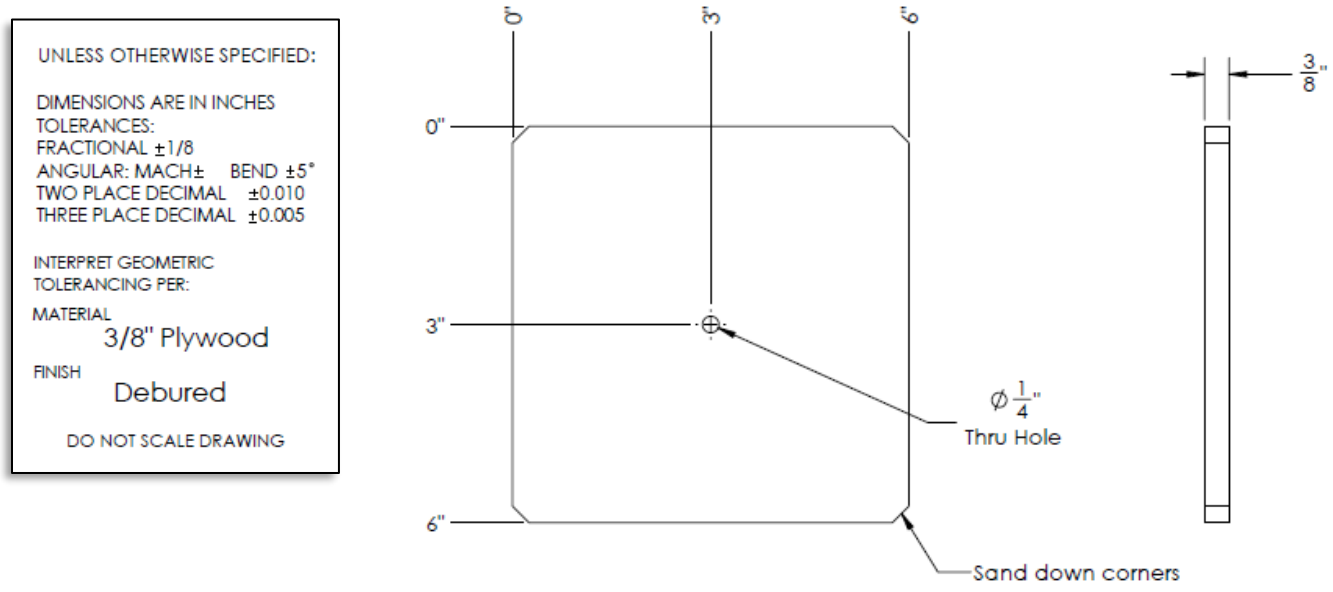


Figure 28: Balancing Stone - Under Tile Plate Cut Diagram

DIY18-2-4: *Balancing Stone – Under Tile Plate Cut Instructions*

1. Use a table saw or circular saw to cut Under Tile Plate (6”x6” or 15.24cm x 15.24cm)
2. Measure and layout the locations for the ¼” diameter hole.
    - The ¼” diameter hole is directly in the center of the Under Tile Plate (3”x3” or 7.62cm x 7.62cm).
3. Drill the ¼” diameter hole through the plywood with a ¼” drill bit and hand drill.
4. Sand corners and edges to smooth with sandpaper.

Figure 29: Finished Balancing Stone - Under Tile Plate.

Figure 30: Drill the 1/4" diameter center hole with a 1/4" drill bit.

Step by Step Build Instructions: Cryptobox

Materials and Tools

- ☐ DIY18-1-1: Cryptobox Back Panel (1)
- ☐ DIY18-1-2: Cryptobox Main Rails (4)
- ☐ DYI18-1-3: Cryptobox Side Rails (8)
- ☐ Finishing Nail, 1" long (44)
- ☐ Wood Screws, 1 ¾” long (24)
- ☐ Wood Glue

Assemble the Rails

1. Partially nail seven 1” finishing nails into a Side Rails, on the side with the chamfer. The nails should not protrude from the back surface of the Side Rail.
    - Starting 1” (2.54cm) from the end, the nails should be placed 4” (10.16cm) from each other.

Figure 31: Partially nail in (6) nails on the chamfer side of the Cryptobox Side fins.

Repeat for all (8) Side Rails

Figure 32: Nailing method.

2. On the back surface of the Side Rail (the side without the chamfer; the flat side) apply wood glue.

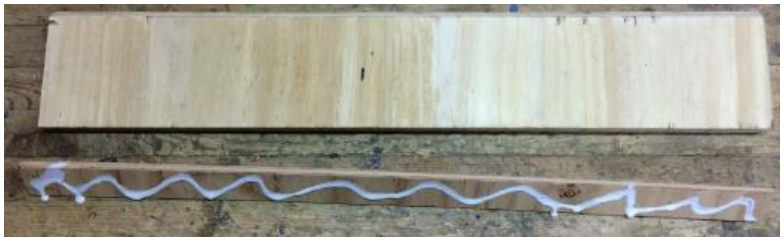


Figure 33: Apply wood glue.

3. Nail two Side Rails to each Main Rail. *Insure that the bottoms of both Side Rails and the Main line up with each other.*
4. Repeat steps 1-3 for four finished Rail Assemblies. *Use 5 nails on the second Side Rail, placing nails in an alternate pattern from the 6 previously nailed nails.*
5. Allow the glue to cure before starting the assembly of the Rails to the Cryptobox Back.

Assemble the Cryptobox

1. Apply wood glue to the flat bottom surface of the Rail Assembly.

Figure 34: Finished Rail Assembly (4).

Figure 35: Apply wood glue to bottom surface of Rail Assembly.

2. Use six, 1 ¾" long wood screws to hold each Rail Assembly to the Cryptobox Back.
3. The finished Cryptobox should look like below.

Figure 36: Drill from the back of the Cryptobox Back Panel.

Figure 37: Finished Cryptobox.

Step by Step Build Instructions: Balancing Stone

Materials and Tools

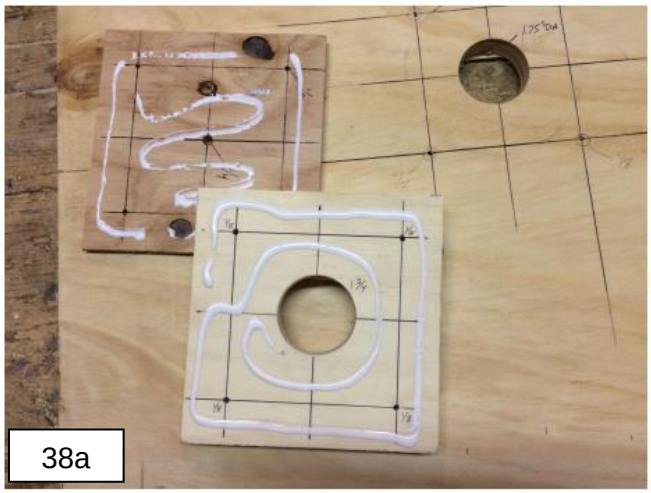
- ☐ DIY18-2-1: Balancing Stone – Main Panel (1)
- ☐ DIY18-2-2: Balancing Stone – Upper Pylon (1)
- ☐ DYI18-2-3: Balancing Stone – Lower Pylon (1)
- ☐ DYI18-2-4: Balancing Stone – Under Tile Plate (1)
- ☐ Wood Screws, 1 ¾" long (4)
- ☐ Carriage Bold, 1/4" dia x 2" long (1)
- ☐ Flat washer, 1" ID x 1" OD (1)
- ☐ Nyloc nut, 1/4" x 20 (1)
- ☐ Hand Drill
- ☐ Wood Glue

Assemble the Balancing Stone

1. The order of the Balancing Stone panels is:
    - TOP: Main Panel (DIY18-2-1)
    - Upper Pylon (DIY18-2-2)
    - Lower Pylon (DIY18-2-3)
    - BOTTOM: Under Tile Plate (DIY18-2-4)

Make sure panels are centered.

2. Apply wood glue to the Upper Pylon and Lower Pylon.
3. Once glue has dried, use the 1 ¾" long wood screws to assemble the Main Panel to the Upper and Lower Pylons.
    - This should be done from the top of the Main Panel.
    - *The screws should be driven so that they are flush with the Main Panel*.



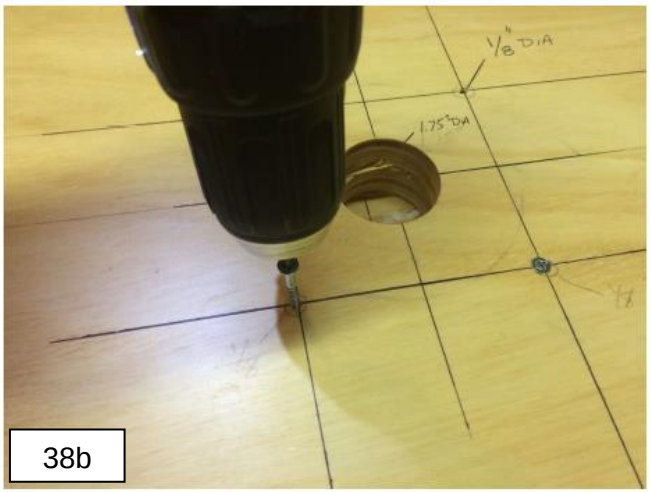


Figure 38a) Apply wood glue to Upper and Lower Pylons 38b) Drill 1 3/4" long wood screws from the top of the Balancing Stone - Main Panel.

4. Insert the carriage bolt into the Under Tile Plate from the bottom. Use a hammer to firmly seat the bolt into the plywood.
5. Insert the carriage bolt from the bottom into the Main Panel and place the washer and nut onto the bolt fro the top.

Figure 39a) View of Carriage Bolt from bottom into the Under Tile Plate. 39b) Underside view of the Balancing Stone. 39c) Top view of Balancing Stone.

6. Your finished Balancing Stone

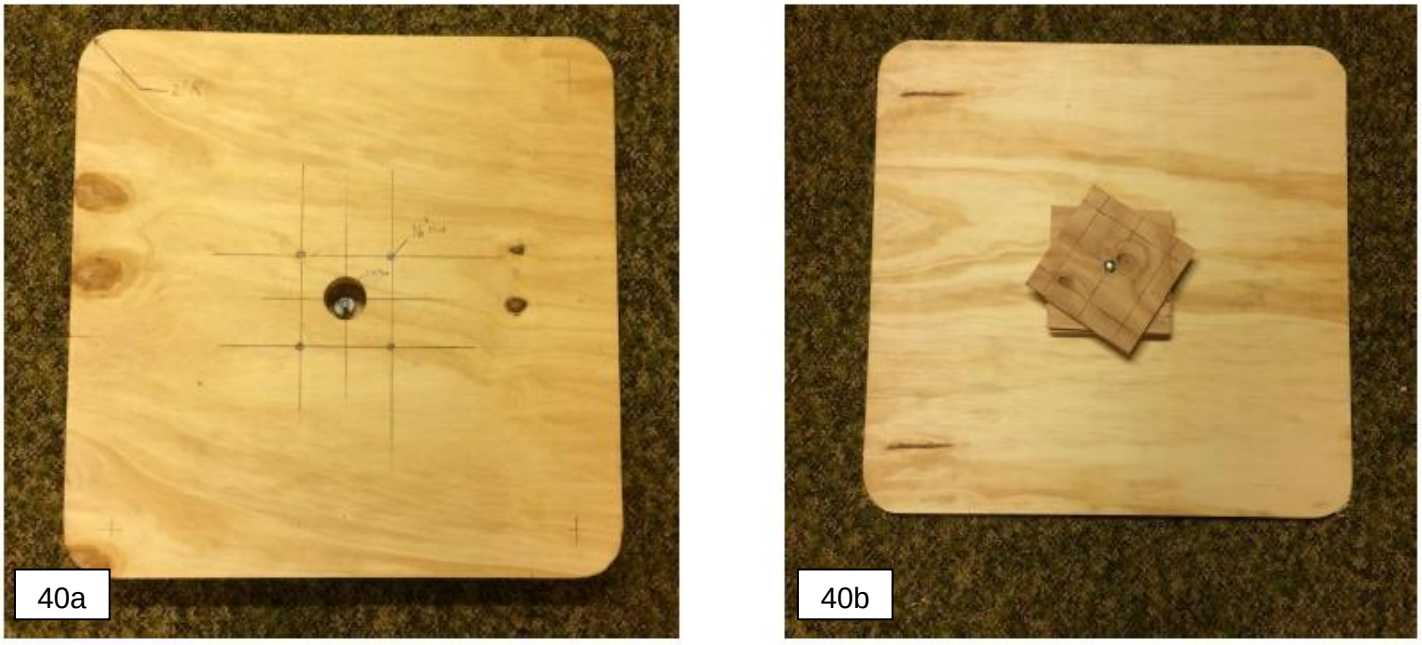


Figure 40a) Finished Balancing Stone (Top View) 40b) (Bottom View)

Appendix A – Resources

Game Forum Q&A

http://ftcforum.usfirst.org/forum.php
Anyone may view questions and answers within the *FIRST*® Tech Challenge Game Q&A forum without a password. To submit a new question, you must have a unique Q&A System User Name and Password for your team.

FIRST Tech Challenge Game Manuals

Part 1 and 2 - http://www.firstinspires.org/node/4271

FIRST Headquarters Pre-Event Support

Phone: 603-666-3906
Mon – Fri
8:30am – 5:00pm
Email: FTCTeams@firstinspires.org

FIRST Tech Challenge Event On-Call Support

*These numbers are available for event personnel only. Please **do not** call these numbers if you are a team looking for a ruling, a decision, or assistance. We trust that you will not misuse this resource.*

Day of Event Robot Control System Support: 603-206-2450
All other Day of Event support: 603-206-2412

FIRST Websites

FIRST homepage – www.firstinspires.org

FIRST Tech Challenge Page – For everything *FIRST* Tech Challenge.

FIRST Tech Challenge Volunteer Resources – To access public Volunteer Manuals.

FIRST Tech Challenge Event Schedule – Find *FIRST* Tech Challenge events in your area.

FIRST Tech Challenge Social Media

FIRST Tech Challenge Twitter Feed - If you are on Twitter, follow the *FIRST* Tech Challenge Twitter feed for news updates.

FIRST Tech Challenge Facebook page - If you are on Facebook, follow the *FIRST* Tech Challenge page for news updates.

FIRST Tech Challenge YouTube Channel – Contains training videos, Game animations, news clips, and more.

FIRST Tech Challenge Blog – Weekly articles for the *FIRST* Tech Challenge community, including Outstanding Volunteer Recognition!

FIRST Tech Challenge Team Email Blasts – contain the most recent *FIRST* Tech Challenge news for Teams.

FIRST Tech Challenge Google+ community - If you are on Google+, follow the *FIRST* Tech Challenge community for news updates.

Feedback

We strive to create support materials that are the best they can be. If you have feedback about this manual, please email ftcteams@firstinspires.org. Thank you!