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2016-2017 *FIRST*® Tech Challenge **VELOCITY VORTEXSM** **DIY Guide**

www.firstinspires.org

200 BEDFORD STREET ■ MANCHESTER, NH 03101



FOR INSPIRATION & RECOGNITION OF SCIENCE & TECHNOLOGY

Volunteer Thank You

Thank you for taking the time to volunteer for a *FIRST*® Tech Challenge event. *FIRST*® and *FIRST*® Tech Challenge rely heavily on Volunteers to ensure events run smoothly and are a fun experience for Teams and their families, which could not happen without people like you. With over 4,600 Teams competing annually, your dedication and commitment are paramount to the success of each event and the *FIRST* Tech Challenge program. Thank you for your time and effort in supporting the mission of *FIRST*!



Sponsor Thank You

Thank you to our generous sponsors for your continued support of the *FIRST* Tech Challenge!

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Revision History		
Revision	Date	Description
1	9/10/2016	Initial Release

Contents

Introduction.....	5
What is <i>FIRST</i> ® Tech Challenge?	5
<i>FIRST</i> Tech Challenge Core Values	5
<i>Gracious Professionalism</i> ®	6
Gracious Professionalism® for Volunteers	6
Youth Protection Program	7
Youth Protection Expectations and Guidelines.....	7
NOTICE OF NON-DISCRIMINATION	7
What is the <i>FIRST</i> ® Tech Challenge Velocity Vortex SM DIY Guide?	8
DIY Shopping Guide	8
Recommended Tools	9
Woodcut and PVC Diagrams.....	10
Overview: Center Goal Assembly (DIY17-2, DIY17-3, DIY17-4)	10
Center Vortex Wheel (DIY17-4-1)	10
Wood Base Plate (DIY17-2-1)	15
PVC Cuts for Center Vortex (DIY17-3-4, DIY17-3-5, DIY17-3-6, DIY17-4-3, DIY17-4-4)	16
Flat Sheet Cone (DIY17-4-7)	17
Overview: Corner Vortex (DIY17-1).....	18
Side Panel A (DIY17-1-1)	18
Side Panel B (DIY17-1-2)	19
Ramp Surface (DIY17-1-3)	20
Center Spine (DIY17-1-4)	21
Top Goal Definer (DIY17-1-5).....	22
Return Ramp (DIY17-1-6).....	23
Ramp Standoff (DIY17-1-7)	24
Step by Step Build Instructions: Center Vortex	25
Center Vortex Build Parts List	25
Recommended Tool List	25
Build Instructions.....	26
DIY17-2: Stationary Base	26
DIY17-3: Center Stand	27

DIY17-4: Center Goal	29
Step by Step Build Instructions: Corner Vortex	30
Corner Vortex Build Parts List	30
Recommended Tool List	30
Build Instructions	30
Side Panel Assembly	30
Ramp Surface Assembly	31
Ramp Assembly	32
Goal Assembly	33
Return Ramp Assembly	33
Final Assembly	33
Appendices	34
Appendix A: Resources	35
Game Forum Q&A	35
<i>FIRST</i> Tech Challenge Game Manuals	35
<i>FIRST</i> ® Headquarters Pre-Event Support	35
<i>FIRST</i> Website: firstinspires.org	35
<i>FIRST</i> Tech Challenge Social Media	35
Feedback	35

Introduction

What is FIRST® Tech Challenge?

FIRST Tech Challenge is a student-centered activity that focuses on giving students a unique and stimulating experience. Each year, Teams participate in a new Game that requires them to design, build, test, and program autonomous and driver-operated robots that must perform a series of tasks.

The playing field for the Game consists of the FIRST Tech Challenge game pieces set up on a foam-mat surface, surrounded by a metal and polycarbonate Field frame. Each Tournament features Alliances, which are comprised of two Teams, competing against one another on the playing field. Teams work to overcome obstacles and meet challenges, while learning from, and interacting with their peers and adult Mentors. Students develop a greater appreciation of science and technology and how they might use that knowledge to impact the world around them in a positive manner. They also cultivate life skills such as:

- Planning, brainstorming, and creative problem-solving.
- Research and technical skills.
- Collaboration and teamwork.
- Appreciation of differences and respect for the ideas and contributions of others.

FIRST Tech Challenge is MORE THAN ROBOTSSM! While competing, students develop personal and professional skills they will be able to rely on throughout their life.

To learn more about FIRST Tech Challenge and other FIRST Programs, visit www.firstinspires.org.

FIRST Tech Challenge Core Values

Volunteers are integral to the FIRST community. FIRST Tech Challenge relies on Volunteers to run the program at many levels, from managing a region to Mentoring an individual Team. Our Affiliate Partners coordinate the program in each region or state. These Affiliate Partners fundraise, run Tournaments, hold workshops and demonstrations, market FIRST Tech Challenge locally, handle public relations, and recruit Volunteers and Teams. They are a tremendous resource for Mentors and FIRST would not exist without them.

FIRST asks everyone who participates in FIRST Tech Challenge to uphold the following values:

- We display *Gracious Professionalism*[®] with everyone we engage with and in everything we do.
- We act with integrity.
- We have fun.
- We are a welcoming community of students, Mentors, and Volunteers.
- What we learn is more important than what we win.
- We respect each other and celebrate our diversity.
- Students and adults work together to find solutions to challenges.
- We honor the spirit of friendly competition.
- We behave with courtesy and compassion for others at all times.
- We act as ambassadors for FIRST and FIRST Tech Challenge.
- We inspire others to adopt these values.

Gracious Professionalism®

FIRST uses this term to describe our programs' intent. This is one of the most important concepts that can be taught to a young person who is learning to get along in the work world. At FIRST, Team members help other team members, but they also help other Teams.

Gracious Professionalism® is not clearly defined for a reason. It can and should mean different things to everyone.

Some possible meanings of *Gracious Professionalism*® include:

- Gracious attitudes and behaviors are win-win.
- Gracious folks respect others and let that respect show in their actions.
- Professionals possess special knowledge and are trusted by society to use that knowledge responsibly.
- Gracious Professionals make a valued contribution in a manner pleasing to others and to themselves.

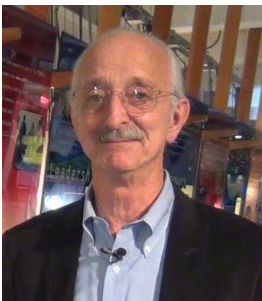
An example of *Gracious Professionalism*® is patiently listening to a Team's question and providing support despite having several pressing things to do on the day of the event.

In the context of FIRST, this means that all Teams and participants should:

- ☐ Learn to be strong competitors, but also treat one another with respect and kindness in the process.
- ☐ Avoid leaving anyone feeling as if they are excluded or unappreciated.
- ☐ Knowledge, pride and empathy should be comfortably and genuinely blended.

In the end, *Gracious Professionalism*® is part of pursuing a meaningful life. When professionals use knowledge in a gracious manner and individuals act with integrity and sensitivity, everyone wins, and society benefits.

Watch Dr. Woodie Flowers explain *Gracious Professionalism*® in this [short video](#).



"The FIRST spirit encourages doing high-quality, well-informed work in a manner that leaves everyone feeling valued. Gracious Professionalism seems to be a good descriptor for part of the ethos of FIRST. It is part of what makes FIRST different and wonderful."

- Dr. Woodie Flowers, National Advisor for **FIRST**

***Gracious Professionalism*® for Volunteers**

It is a good idea to spend time going over this concept with Volunteers. Provide Volunteers with real-life examples of *Gracious Professionalism* in practice before, during, and after the event and recognize great *Gracious Professionalism* when you see it in action!

Youth Protection Program

The purpose of the *FIRST*® Youth Protection Program (*FIRST* YPP) is to provide Coaches, Mentors, Volunteers, employees, others working in *FIRST* programs, team members, parents, and guardians of team members with information, guidelines, and procedures to create safe environments for everyone participating in *FIRST* programs.

The *FIRST* YPP sets minimum standards recommended for all *FIRST* activities. Adults working in *FIRST* programs must be knowledgeable of the standards set by the *FIRST* YPP, as well as those set by the school or organization hosting their team.

Youth Protection Expectations and Guidelines

Coaches and Mentors are expected to read and follow elements in the [FIRST Youth Protection Program guide](#) that are labeled as required are mandatory in the United States and Canada, and may not be waived without the approval of the *FIRST* Youth Protection Department.

FIRST recommends that the standards set forth in the [FIRST Youth Protection Program guide](#) be applied outside of the United States and Canada to the extent possible. At a minimum, local regulations regarding youth protection must be complied with.

Forms are available here: <http://www.firstinspires.org/sites/default/files/uploads/about/FORMS.zip>

Information on the US Screening process is available here:

<http://www.firstinspires.org/sites/default/files/uploads/about/us-screening-2016-2017.pdf>

Information on the Canadian Screening process is available here:

<http://vimeo.com/30137373>

You can find FAQ and additional information about the *FIRST* Youth Protection Program on the *FIRST* website at:

<http://www.firstinspires.org/resource-library/youth-protection-policy>

**Everyone working with
FIRST Teams should be
familiar with the FIRST
YPP policies.**

NOTICE OF NON-DISCRIMINATION

United States Foundation for Inspiration and Recognition of Science and Technology (*FIRST*®) does not discriminate on the basis of race, color, national origin, sex, disability, or age in its programs and activities. The following person has been designated to handle inquiries regarding the non-discrimination policies: Lee Doucette, Youth Protection Program Manager, 200 Bedford Street, Manchester, NH 03101, 603-666-3906, Ext. 250.

What is the FIRST® Tech Challenge Velocity VortexSM DIY Guide?

This guide includes instructions on how to build a HALF field for the 2016 – 2017 Velocity VortexSM game.

DIY Shopping Guide

Full Shopping Guide for a HALF field.

*Cost per unit will vary

**Can purchase one 4x4 panel and cut in half

***Same 3/4in pipe, cut to size

DIY Part Number	Part Name	Raw Material	Shopping list and Qty	Cost Per Unit*	Final Qty
DIY17-1 Corner Ramp					Makes 1 ramp
DIY17-1-1	Side Panel A	4ft x 4ft panel 3/8in plywood (15/32" plywood also works, NOTE: it is referenced 3/8" plywood in document)	2	\$15.95	2
DIY17-1-2	Side Panel B				2
DIY17-1-3	Ramp Surface				1
DIY17-1-4	Center Spine				1
DIY17-1-5	Top Goal Definer				1
DIY17-1-6	Return Ramp	2ft x 4ft panel ¼" plywood	1	\$10.02	2
DIY17-1-7	Ramp Standoff	2" x 2" board, 5ft in length	1	\$1.89	4
Hardware	Wood Screw 1" long	Use as Purchased	1 box	\$1.94	As needed
	Wood Screw 1 ½" long	Use as Purchased	1 box	\$1.94	1/2 box
	Zip Ties 11" long	Use as Purchased	1 bag	\$9.99	As needed
DIY17-2 Stationary Base			Makes 1 Base		
DIY17-2-1	¾" Wood Base Plate	2ft x 2ft panel ¾" plywood**	1	\$15.28	1
DIY17-2-2	¾" Steel Pipe Base Flange	Use as Purchased	1	\$7.87	1
DIY17-2-3	¾" x 24.000in Steel Pipe	Use as Purchased	1	\$8.51	1
DIY17-2-4	¼-20 flat head bolt	Use as Purchased	4	\$1.18	4
DIY17-2-5	¼-20 Spike (tee) nut	Use as Purchased	4	\$1.18	4
DIY17-3 Center Stand			Makes 1 Stand		
DIY17-3-1	1 ¼" Tee Fitting	Use as Purchased	1	\$1.74	1
DIY17-3-2	1 ¼" 90 Elbows	Use as Purchased	2	\$1.61	2
DIY17-3-3	1 ¼" to ¾" reducer fitting	Use as Purchased	2	\$0.98	2

DIY17-3-4	1 ¼" PVC Pipe x 30.000in	1 1/4 "PVC Pipe,	1	\$4.82	1
DIY17-3-5	1 ¼" PVC Pipe x 13.250in	6ft or 10ft			2
DIY17-3-6	¾" PVC Pipe x 6.000in	¾" PVC Pipe***	1x 2ft pipe***	\$2.81	2
DIY17-4 Center Goal			Makes 1 Goal		
DIY17-4-1	Center Vortex Wheel	3/4in plywood, 2ft x 2ft panel**	1	\$15.28	1
DIY17-4-2	PVC end cap (flat bottom)	Use as Purchased	14	\$0.42	14
DIY17-4-3	¾" PVC x 8.500in	3/4 PVC Pipe***	3x 6ft Pipe***	2.81	7
DIY17-4-4	¾" PVC x 12.000in				7
DIY17-4-5	10-32 x 1.250in bolt	Use as Purchased	14	\$1.18	14
DIY17-4-6	10-32 Nylock nut	Use as Purchased	14	\$1.18	14
DIY17-4-7	Thin sheet cone	1/16in polycarbonate	1x 2ft x 2ft panel	\$16.93	1
			TOTAL	\$125.51	

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.

- ☐ 1/4" drill bit
- ☐ 1/8" drill bit
- ☐ 3/16" drill bit
- ☐ 5/16" drill bit
- ☐ 3/32" drill bit
- ☐ 1/2" spade bit
- ☐ 1" spade bit
- ☐ 2" hole saw
- ☐ 3" hole saw
- ☐ Band saw or sheet metal shears
- ☐ Clamps
- ☐ Circular saw
- ☐ Drill motor
- ☐ Framing square
- ☐ Jigsaw
- ☐ Mallet
- ☐ Philips head screw driver or Philips bit for the drill
- ☐ Rivet gun
- ☐ Rivets
- ☐ Sandpaper
- ☐ Tape measurer
- ☐ Wood glue

Woodcut and PVC Diagrams

Overview: Center Goal Assembly (DIY17-2, DIY17-3, DIY17-4)

The parts listed are the parts used in the following Wood cut and PVC cut sections. The total lists for assembly will be listed out in the [Build Instructions](#).

DIY Part Number	Part Name	Final Qty	Raw Material
DIY17-2	Stationary Base	Makes 1 Base	
DIY17-2-1	¾" Wood Base Plate	1	¾" plywood
DIY17-2-2	¾" Steel Pipe Base Flange	1	Use as Purchased
DIY17-3	Center Stand	Makes 1 Stand	
DIY17-3-4	1 ¼" PVC Pipe x 30.000in	1	1 ¼" PVC Pipe
DIY17-3-5	1 ¼" PVC Pipe x 13.250in	2	
DIY17-3-6	¾" PVC Pipe x 6.000in	2	¾" PVC Pipe
DIY17-4	Center Goal	Makes 1 Goal	
DIY17-4-1	Center Vortex Wheel	1	¾" plywood
DIY17-4-2	PVC end cap (flat bottom)	14	Use as Purchased
DIY17-4-3	¾" PVC x 8.500in	7	¾" PVC Pipe
DIY17-4-4	¾" PVC x 12.000in	7	
DIY17-4-7	Thin sheet cone	1x 2ft x 2ft panel	1/16" polycarbonate

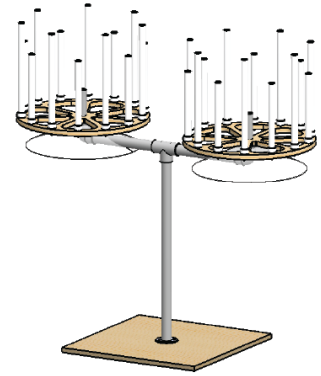


Figure 1: Finished Center Goal Assembly

Center Vortex Wheel (DIY17-4-1)

Materials and Tools

- ☐ (1) ¾" plywood (2ft x 2ft panel)
- ☐ (14) PVC end caps (flat bottom)
- ☐ 1/4" drill bit
- ☐ 3/16" drill bit
- ☐ 1/2" spade bit
- ☐ 3" hole saw
- ☐ Drill motor
- ☐ Jigsaw
- ☐ Sandpaper
- ☐ Tape measure

NOTE: The shopping list and build instructions only creates one Center Vortex Wheel. If you want two, double up the materials where appropriate.

Center Vortex Wheel Cut Diagram

UNLESS OTHERWISE SPECIFIED:

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

INTERPRET GEOMETRIC
 TOLERANCING PER:

MATERIAL
 3/4" Plywood

FINISH
 Sanded

DO NOT SCALE DRAWING

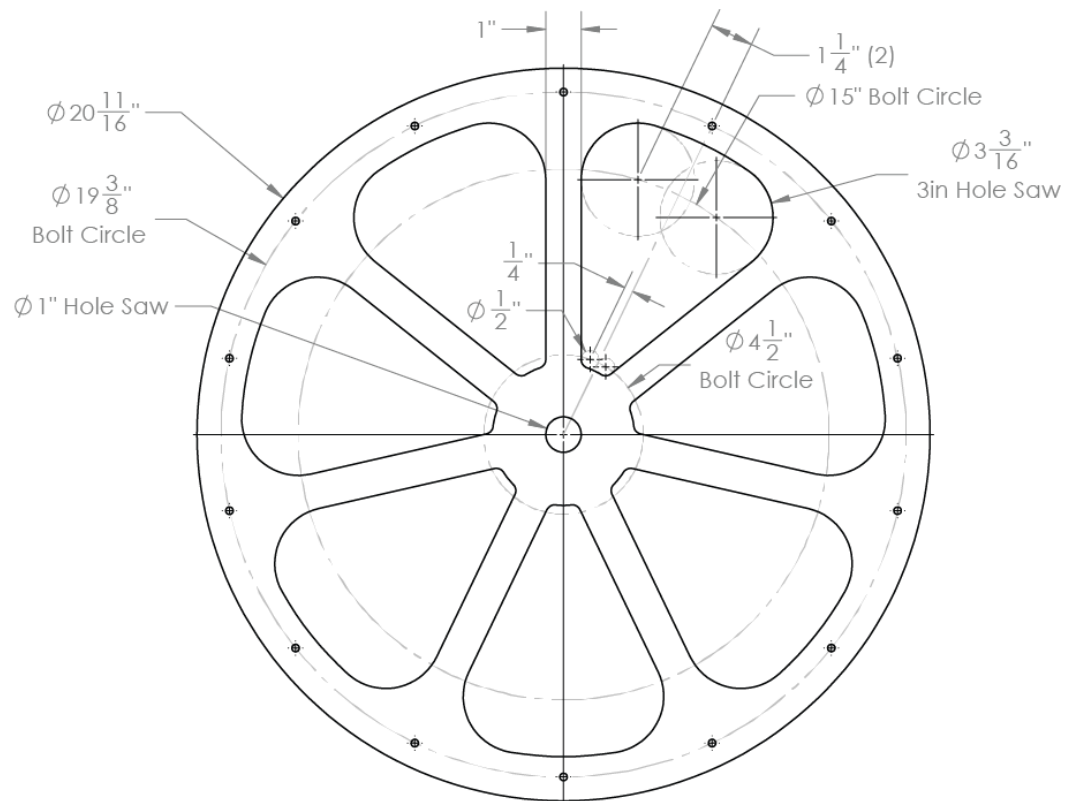


Figure 2: Center Vortex Wheel Cut Diagram

Center Vortex Wheel Cut Instructions

1. Cut out 2ft x 2ft piece from the 3/4" plywood
2. Layout hole center points and cut lines



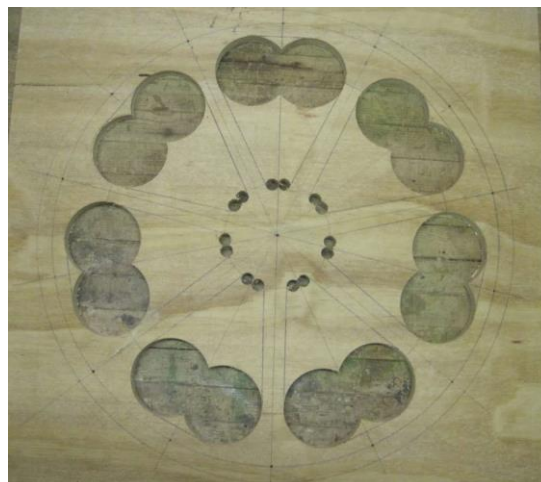
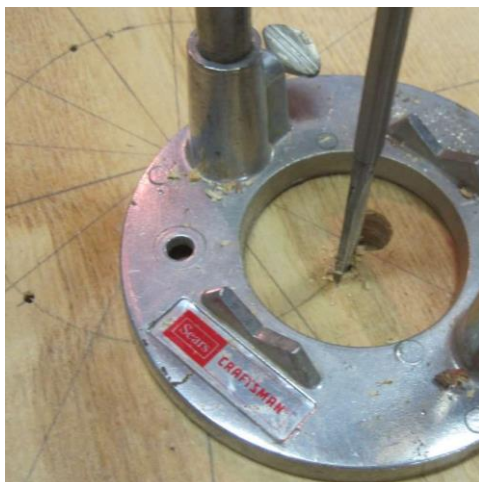
3. Drill pilot holes. Outer ring holes: 1/8" drill bit.



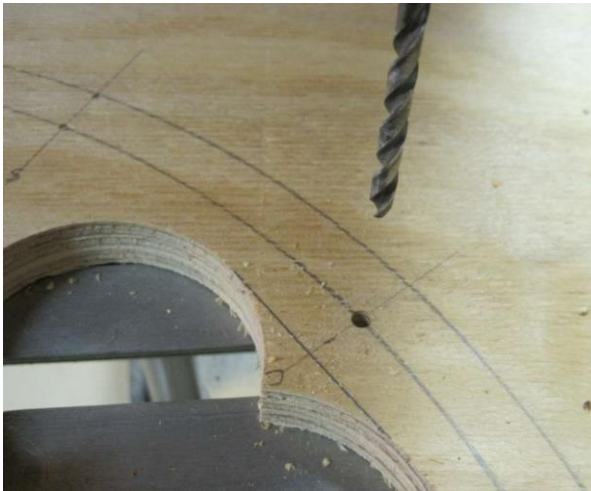
4. Use 3" hole saw to cut out large outer holes



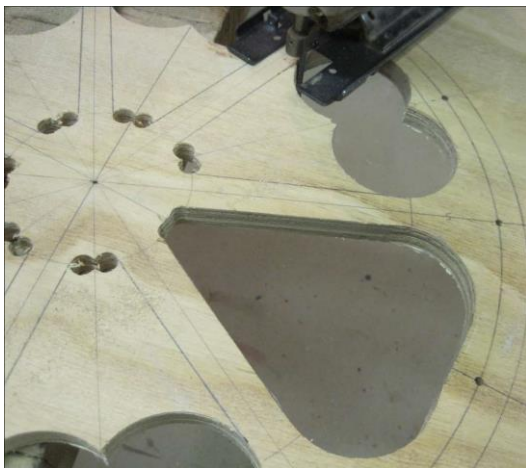
5. Use 1/2" spade bit for interior ring of holes



6. Use 3/16" drill for bolt holes along perimeter



7. Use jigsaw to cut out openings



8. Use jigsaw to cut out perimeter



9. Drill the center holes with a 1" spade bit (You may have to enlarge the hole slightly with sandpaper to fit the $\frac{3}{4}$ " PVC pipe)



10. Finish sand the wheel to smooth out any rough edges and remove splinters
11. Drill a $\frac{3}{16}$ " diameter hole (using the $\frac{3}{16}$ " drill bit) in the center of each PVC end cap (14)



NOTE: End Caps from Lowes and Home Depot have rounded ends. They work, but will increase the height of the pipes on the DIY Center Vortex Wheel.



Wood Base Plate (DIY17-2-1)

Materials and Tools

- ¾" plywood (2ft x 2ft panel)
- ¾" Steel Pipe Base Flange
- 5/16" drill bit
- Circular Saw
- Drill Motor
- Sand Paper
- Tape Measurer

Wood Base Plate 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	¾" Plywood
FINISH	Sanded
DO NOT SCALE DRAWING	

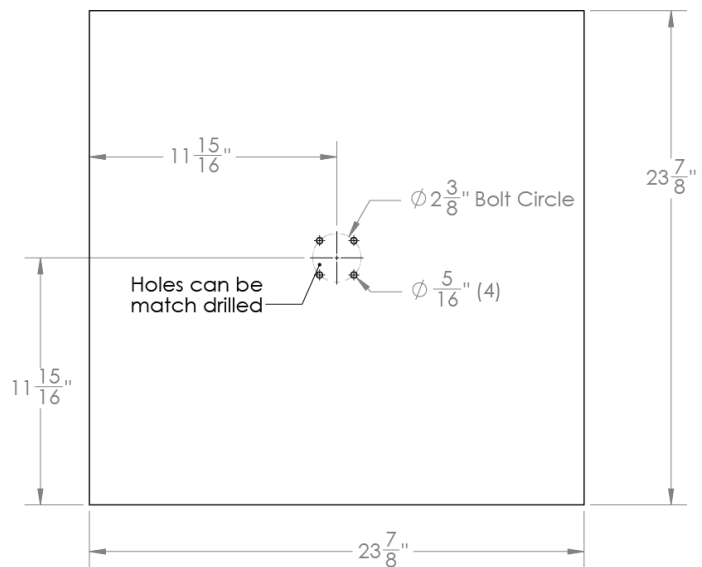


Figure 3: Wood Base Plate Cut Diagram

Wood Base Plate Cut Instructions

1. Cut out 23 7/8" by 23 7/8" piece from the ¾" Plywood
2. Drill the four holes using the flange as a guide (5/16" drill bit)



3. Using the Sandpaper to sand the edges

PVC Cuts for Center Vortex (DIY17-3-4, DIY17-3-5, DIY17-3-6, DIY17-4-3, DIY17-4-4)

Materials and Tools

- 1 ¼" PVC
- ¾" PVC
- Circular Saw
- Tape Measure

PVC Cut Instructions

1. DIY17-3-4: Cut one 30" long pip from 1 ¼" PVC
2. DIY17-3-5: Cut two 13 ¼" long pipes from 1 ¼" PVC
3. DIY17-3-6: Cut two 6" long pipes from ¾" PVC



4. DIY17-4-3: Cut seven 9.5" long pipes from ¾" PVC
5. DIY17-4-4: Cut seven 13" long pipes from ¾" PVC



Flat Sheet Cone (DIY17-4-7)

Materials and Tools

- 1/16" polycarbonate
- 1/4" drill bit
- 2" hole saw
- Drill motor
- Band saw or sheet metal shears

Flat Sheet Cone Cut Diagram

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES

TOLERANCES:

FRACTIONAL $\pm 1/8$

ANGULAR: MACH \pm BEND $\pm 5^\circ$

TWO PLACE DECIMAL ± 0.010

THREE PLACE DECIMAL ± 0.005

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

1/16" Polycarbonate

DO NOT SCALE DRAWING

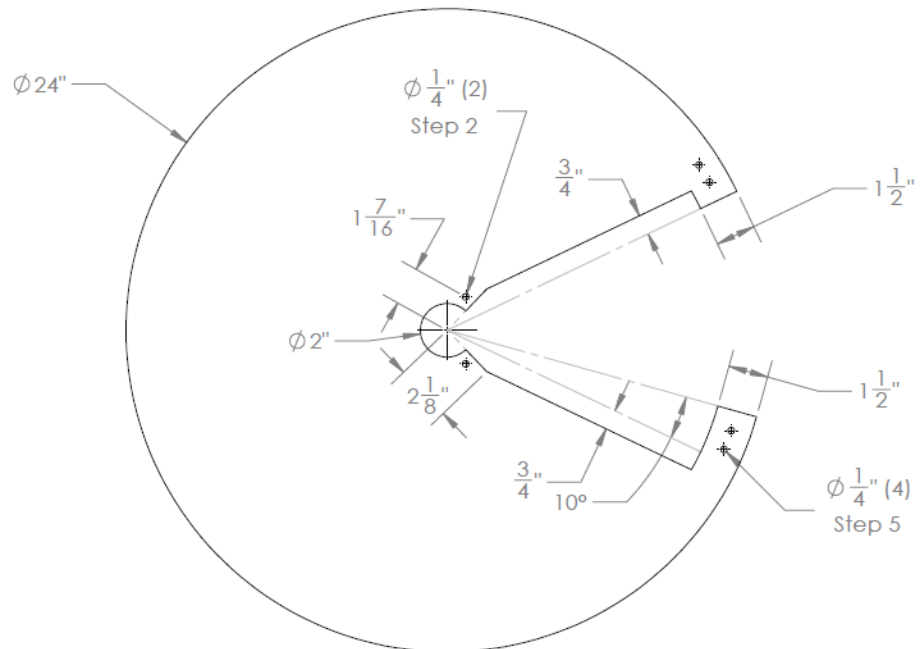


Figure 4: Flat Sheet Cone Cut Diagram

Flat Sheet Cut Instructions

1. Layout holes and cuts
2. Drill small holes using the 1/4" drill bit
3. Drill the larger center hole using a 2" hole saw
4. Cutout the perimeter of the 24" diameter disk
5. Cutout the pie wedge using the band saw or sheet metal shears

Overview: Corner Vortex (DIY17-1)

The parts listed are the parts used in the following Wood cut and PVC cut sections. The total lists for assembly will be listed out in the [Build Instructions](#).

DIY Part Number	Part Name	Final Qty	Raw Material
DIY17-1	Corner Ramp	Makes 1 ramp	
DIY17-1-1	Side Panel A	2	3/8" plywood (15/32" plywood also works)
DIY17-1-2	Side Panel B	2	
DIY17-1-3	Ramp Surface	1	
DIY17-1-4	Center Spine	1	
DIY17-1-5	Top Goal Definer	1	
DIY17-1-6	Return Ramp	2	1/4" plywood
DIY17-1-7	Ramp Standoff	4	2x2 board

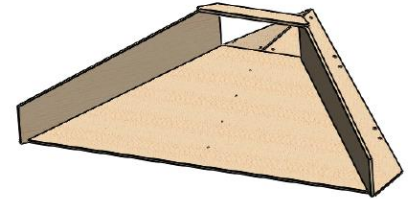


Figure 5: Corner Vortex

Side Panel A (DIY17-1-1)*Materials and Tools*

- ☐ 3/8" plywood
- ☐ 3/8" drill bit
- ☐ Circular Saw
- ☐ Drill Motor
- ☐ Sand Paper
- ☐ Tape Measure

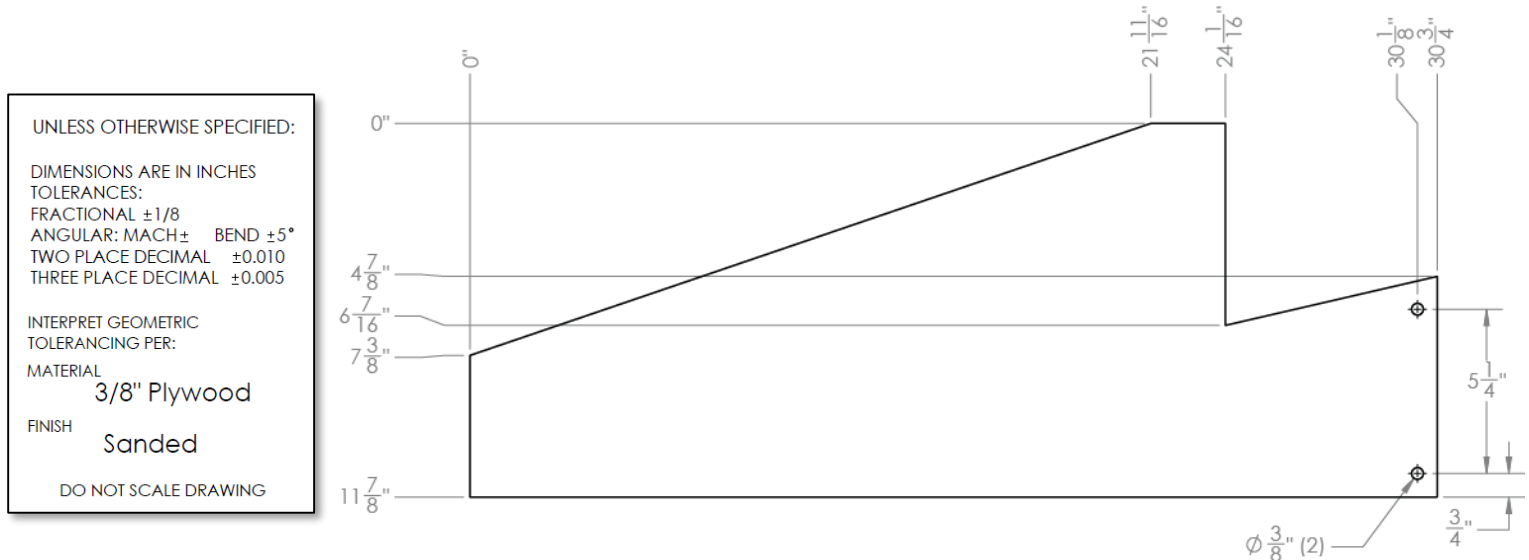
Side Panel A Cut Diagram

Figure 6: Side Panel A Cut Diagram

Side Panel A Cut Instructions

1. Cut out two identical parts from 3/8" plywood
2. Drill Pilot Holes using a 3/8" drill bit



3. Using the Sandpaper to sand the edges

Side Panel B (DIY17-1-2)*Materials and Tools*

- ☐ 3/8" plywood
- ☐ Circular Saw
- ☐ Sand Paper
- ☐ Tape Measurer

Side Panel B Cut Diagram

UNLESS OTHERWISE SPECIFIED:	
DIMENSIONS ARE IN INCHES	
TOLERANCES:	
FRACTIONAL $\pm 1/8$	
ANGULAR: MACH \pm BEND $\pm 5^\circ$	
TWO PLACE DECIMAL ± 0.010	
THREE PLACE DECIMAL ± 0.005	
INTERPRET GEOMETRIC TOLERANCING PER:	
MATERIAL	3/8" Plywood
FINISH	Sanded
DO NOT SCALE DRAWING	

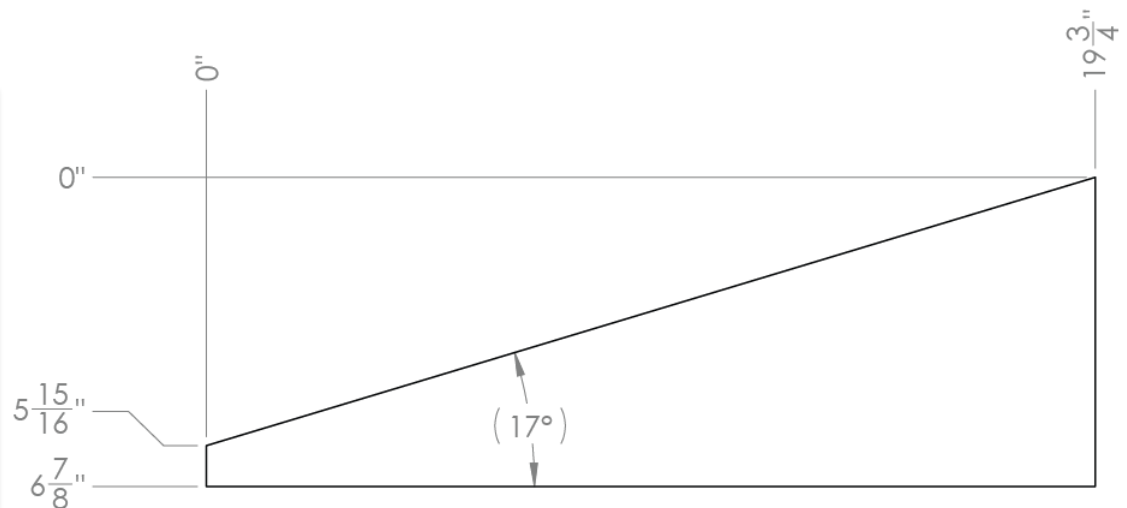


Figure 7: Side Panel B Cut Diagram

Side Panel B Cut Instructions

1. Cut out two identical parts from 3/8" plywood



2. Using the Sandpaper to sand the edges

Ramp Surface (DIY17-1-3)*Materials and Tools*

- ☐ 3/8" plywood
- ☐ 3/32" or 1/8" drill bit
- ☐ Circular Saw
- ☐ Drill Motor
- ☐ Sandpaper
- ☐ Tape Measurer

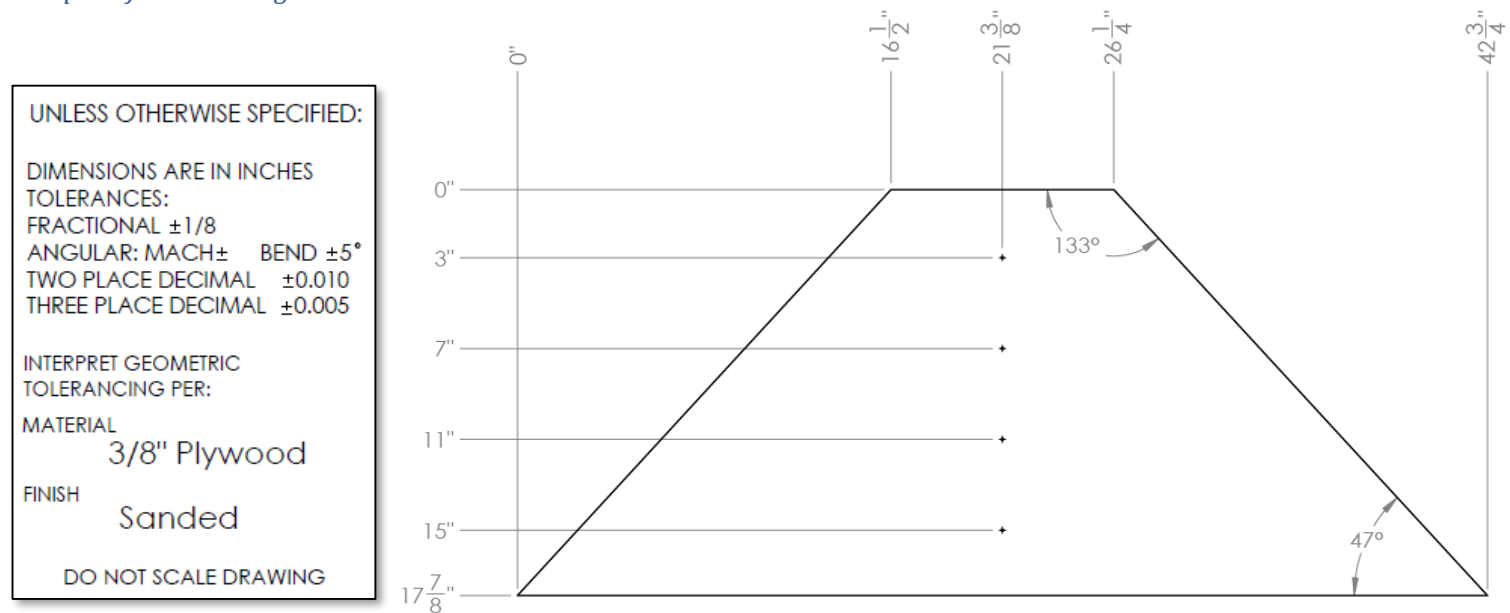
Ramp Surface Cut Diagram

Figure 8: Ramp Surface Cut Diagram

Ramp Cut Instructions

1. Cut out one part from 3/8" plywood (using the Cut Diagram)
2. Drill pilot holes using a 3/32" or 1/8" drill bit



3. Using the Sandpaper to sand the edges

Center Spine (DIY17-1-4)

Materials and Tools

- ☐ 3/8" plywood
- ☐ 3/8" drill bit
- ☐ Circular Saw
- ☐ Drill Motor
- ☐ Sand Paper
- ☐ Tape Measurer

Center Spine Cut Diagram

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES

TOLERANCES:

FRACTIONAL $\pm 1/8$

ANGULAR: MACH \pm BEND $\pm 5^\circ$

TWO PLACE DECIMAL ± 0.010

THREE PLACE DECIMAL ± 0.005

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL
3/8" Plywood

FINISH
Sanded

DO NOT SCALE DRAWING

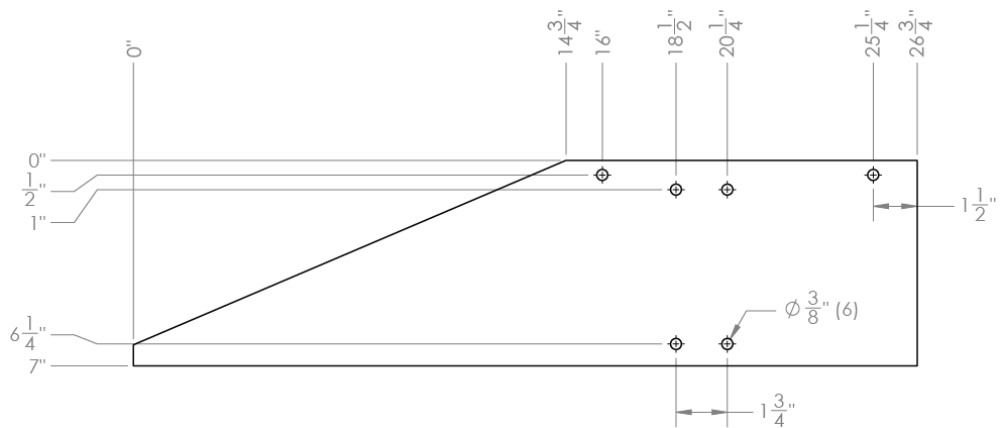


Figure 9: Center Spine Cut Diagram

Center Spine Cut Instructions

1. Cut out one part from 3/8" plywood
2. Drill 3/8" holes using 3/8" drill bit



3. Using the Sandpaper to sand the edges

Top Goal Definer (DIY17-1-5)

Materials and Tools

- ☐ 3/8" plywood
- ☐ 3/32" or 1/8" drill bit
- ☐ Circular saw
- ☐ Drill motor
- ☐ Sandpaper
- ☐ Tape measurer

Top Goal Definer 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	Sanded
DO NOT SCALE DRAWING	

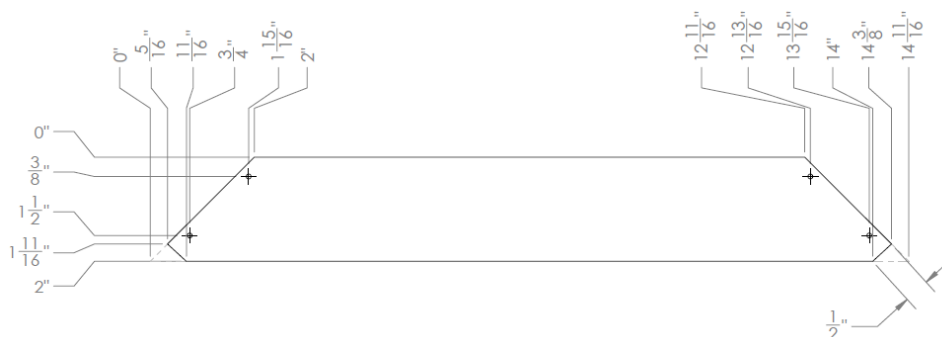


Figure 10: Top Goal Definer Cut Diagram

Top Goal Definer Cut Instructions

1. Cut out one part from 3/8" plywood
2. Drill pilot holes using a 3/32" or 1/8" drill bit



3. Using the Sandpaper to sand the edges

Return Ramp (DIY17-1-6)

Materials and Tools

- ☐ 1/4" plywood
- ☐ Circular Saw
- ☐ Drill Motor
- ☐ Sandpaper
- ☐ Tape Measurer

Return Ramp Cut Diagram

UNLESS OTHERWISE SPECIFIED:

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

INTERPRET GEOMETRIC
TOLERANCING PER:

MATERIAL
1/4" Plywood

FINISH
Sanded

DO NOT SCALE DRAWING

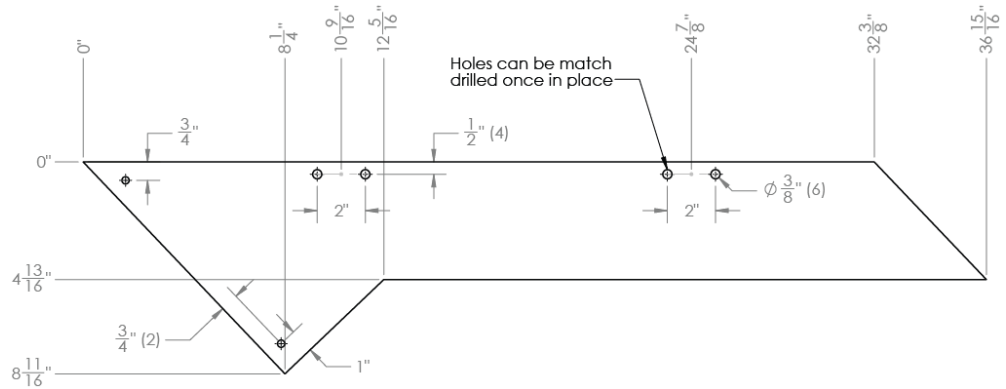
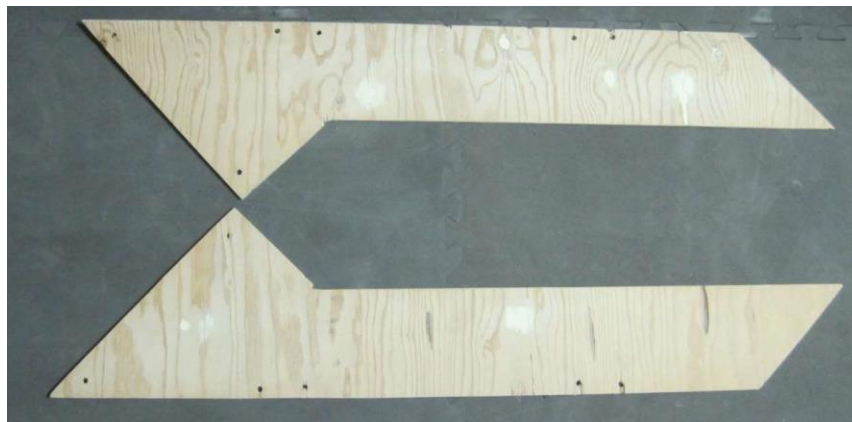


Figure 11: Return Ramp Cut Diagram

Return Ramp Cut Instructions

1. Cut out two parts from 1/4" plywood
2. Drill 3/8" holes using the 3/8" drill bit



3. Use the Sandpaper to sand down the edges

Ramp Standoff (DIY17-1-7)*Materials and Tools*

- 2" x 2" Board
- Circular Saw
- Sandpaper
- Tape Measure

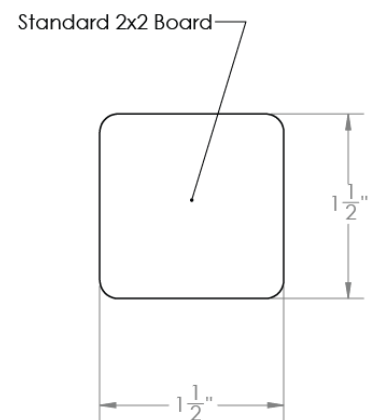
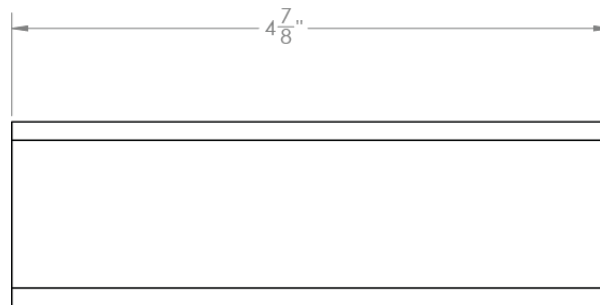
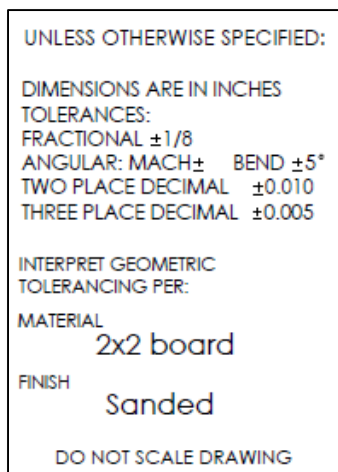
Ramp Standoff Cut Diagram

Figure 12: Ramp Standoff Cut Diagram

Ramp Standoff Cut Instructions

1. Cut out four parts from 2" x 2" furring strip



2. Using the Sandpaper to sand the edges

Step by Step Build Instructions: Center Vortex

Center Vortex Build Parts List

DIY Part Number	Part Name	Final Qty	Raw Material
DIY17-2 Stationary Base		Makes 1 Base	
DIY17-2-1	¾" Wood Base Plate	1	¾" plywood
DIY17-2-2	¾" Steel Pipe Base Flange	1	Use as Purchased
DIY17-2-3	¾" x 24.000 Steel Pipe	1	Use as Purchased
DIY17-2-4	¼-20 flat head bolt	4	Use as Purchased
DIY17-2-5	1/4-20 Spike (tee) nut	4	Use as Purchased
DIY17-3 Center Stand		Makes 1 Stand	
DIY17-3-1	1 ¼" Tee Fitting	1	Use as Purchased
DIY17-3-2	1 ¼" 90 Elbows	2	Use as Purchased
DIY17-3-3	1 ¼" to ¾" reducer fitting	2	Use as Purchased
DIY17-3-4	1 ¼" PVC Pipe x 30.000in	1	1 ¼" PVC Pipe
DIY17-3-5	1 ¼" PVC Pipe x 13.250in	2	
DIY17-3-6	¾" PVC Pipe x 6.000in	2	¾" PVC Pipe
DIY17-4 Center Goal		Makes 1 Goal	
DIY17-4-1	Center Vortex Wheel	1	¾" plywood
DIY17-4-2	PVC end cap (flat bottom)	14	Use as Purchased
DIY17-4-3	¾" PVC x 8.500in	7	¾" PVC Pipe
DIY17-4-4	3/4 "PVC x 12.000in	7	
DIY17-4-5	10-32 x 1.250in bolt	14	Use as Purchased
DIY17-4-6	10-32 Nylock nut	14	Use as Purchased
DIY17-4-7	Thin sheet cone	1	1/16" Polycarbonate

Recommended Tool List

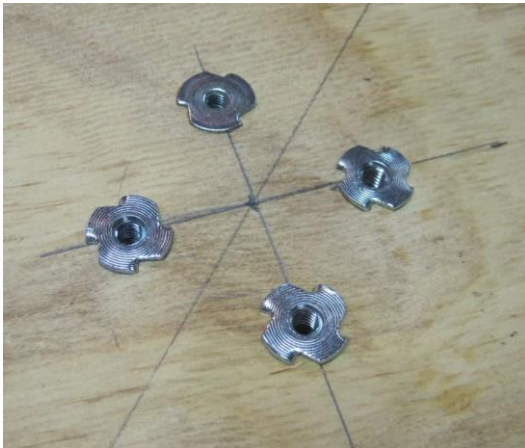
- ☐ Clamps
- ☐ Framing square
- ☐ Jigsaw
- ☐ Mallet
- ☐ Phillips head screw driver or Philips bit for the drill
- ☐ Rivet gun
- ☐ Rivets
- ☐ Sandpaper
- ☐ Tape measurer
- ☐ Wood glue

Build Instructions

DIY17-2: Stationary Base

1. Base Flange Mounting

- Insert the ¼-20 spike (tee) nuts (DIY17-2-5) into the holes from the bottom surface, but do not tap these in yet.
- Insert the four ¼-20 x 1" flat head bolts (DIY17-2-4) from the top and use the screw to pull the T nuts in. (This makes it easier to align all four of them to the base Flange (DIY17-2-2))



2. Pipe Assembly

- Screw in the 24" pipe (DIY17-2-3) into the flange, hand tight.



DIY17-3: Center Stand

1. Insert the 30" 1 1/4" PVC pipe (DIY17-3-4) into the center leg of the Tee fitting (DIY17-3-1).
2. Insert the 13 1/4" 1 1/4" PVC pipes (DIY17-3-5) into the Tee fitting.
3. Use a soft mallet to insure the pipes are seated firmly.

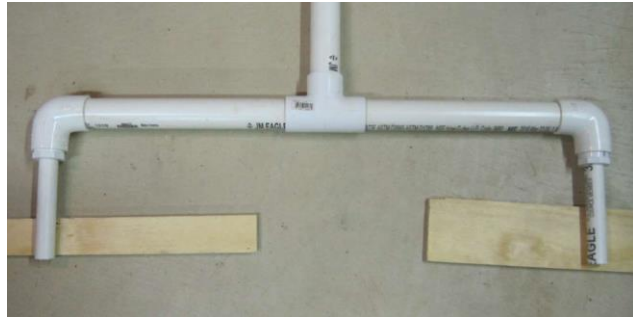


4. Insert one reducer fitting (DIY17-3-3) into each elbow (DIY17-3-2).
5. Insert a 6" 3/4" PVC pipe (DIY17-3-6) into each reducer fitting.
6. Slip the other end of the elbow onto the 13 1/4" pipes and tap with a mallet to insure they are fully seated onto the pipe.



NOTE: During use, the reducer fitting will be exposed to a lot of twisting forces, so it is important that the 13 1/4" pipes and elbows be locked in place. The PVC can be glued, but because the glue sets up so quickly it is difficult to insure that the two 6" pipes are aligned properly. A simpler way to accomplish this is to rivet the pipes to the fittings.

7. Lay the assembly on a smooth, flat surface.
8. Adjust the 6" pipes until the gap between the floor and the pipe is $\frac{1}{2}$ ". (You can use scrap pieces of the $\frac{1}{2}$ " plywood for this purpose)



9. Drill $\frac{1}{8}$ " diameter holes into the Tee fitting and the elbow. Rivet the fitting to the $1\frac{3}{4}$ " pipes.

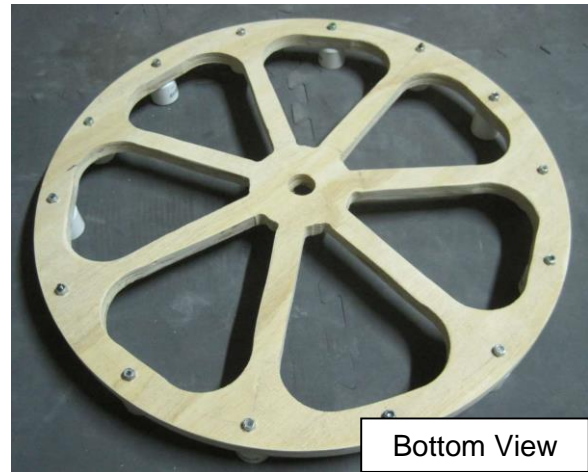
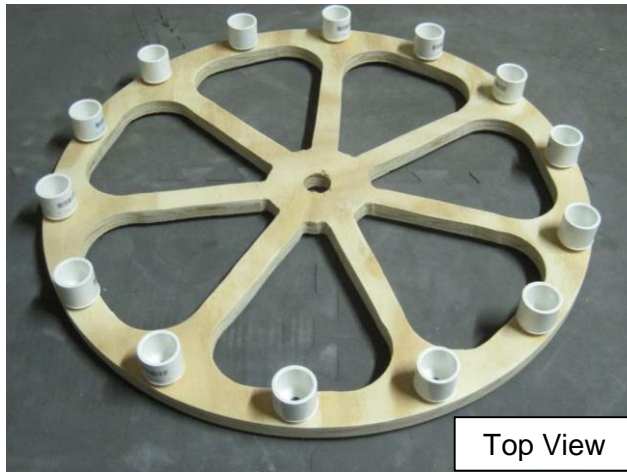


10. Slide the 30" $1\frac{1}{4}$ " PVC pipe over the 24" pipe of the Stationary Base (DIY17-2).



DIY17-4: Center Goal

1. Attach the (14) PVC endcaps (DIY17-4-2) to the Center Vortex Wheel (DIY17-4-1) with 10-32 x 1 ¼" long bolts (DIY17-4-5) and 10-32 Nylock nuts (DIY17-4-6).



2. Insert the (14) ¾" PVC pipes (DIY17-4-3, DIY17-4-4) into the End Caps, alternating heights.



3. Place the Center Vortex Wheel atop one of the 6" ¾" PVC pipe (DIY17-3-6).



4. Install the polycarbonate cone around the crossbar. Match drill holes and secure with a ziptie.

Step by Step Build Instructions: Corner Vortex

Corner Vortex Build Parts List

DIY Part Number	Part Name	Final Qty	Raw Material
DIY17-1	Corner Ramp	Makes 1 ramp	
DIY17-1-1	Side Panel A	2	3/8" plywood (15/32" plywood also works)
DIY17-1-2	Side Panel B	2	
DIY17-1-3	Ramp Surface	1	
DIY17-1-4	Center Spine	1	
DIY17-1-5	Top Goal Definer	1	
DIY17-1-6	Return Ramp	2	¼" plywood
DIY17-1-7	Ramp Standoff	4	2" x 2" board
Hardware	Wood Screw 1" long	1/2 box	Use as Purchased
	Wood Screw 1 1/2" long	1/2 box	Use as Purchased
	Zip Ties 11" long	1/2 bag	Use as Purchased

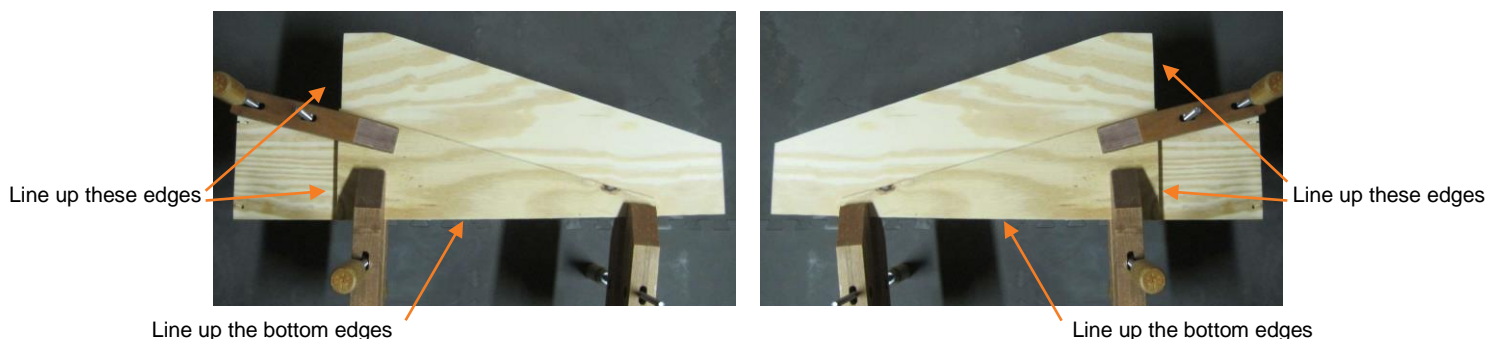
Recommended Tool List

- ☐ Clamps
- ☐ Framing square
- ☐ Jigsaw
- ☐ Mallet
- ☐ Phillips head screw driver or Philips bit for the drill
- ☐ Rivet gun
- ☐ Rivets
- ☐ Sandpaper
- ☐ Tape Measurer
- ☐ Wood glue

Build Instructions

Side Panel Assembly

- Apply wood glue to Side Panel B (DIY17-1-2) and clamp it to Side Panel A (DIY17-1-1).
 - The long vertical side of Panel B should line up with the vertical edge of the Panel A. The bottoms of the two panels should be aligned.
 - Make two of these assemblies, but they must be **MIRROR** images of each other.



2. Attach two Ramp Standoffs (DIY17-1-7) to each Side Panel Assembly with wood glue and 1 ½" Wood Screws.
 - The Standoffs should be attached to Panel A on the side opposite where Panel B is attached.

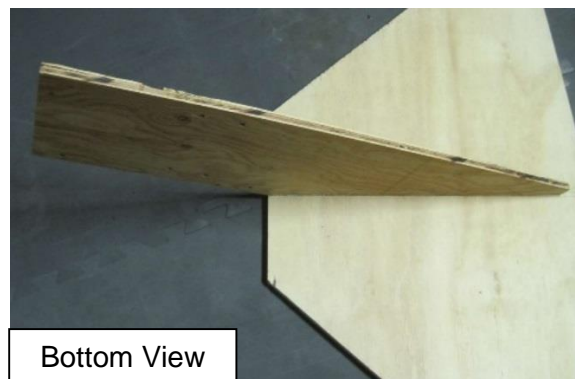
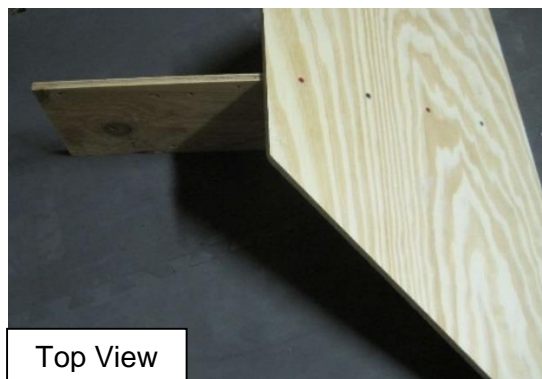


Ramp Surface Assembly

1. Line up the Center Spine (DIY17-1-4) to the center of the Ramp Surface (DIY17-1-3).
 - It may help to draw a set of alignment lines to insure the Spine is properly centered on the Ramp.
 - Then you can transfer the pilot holes from the Ramp Surface to the Ramp Spine.

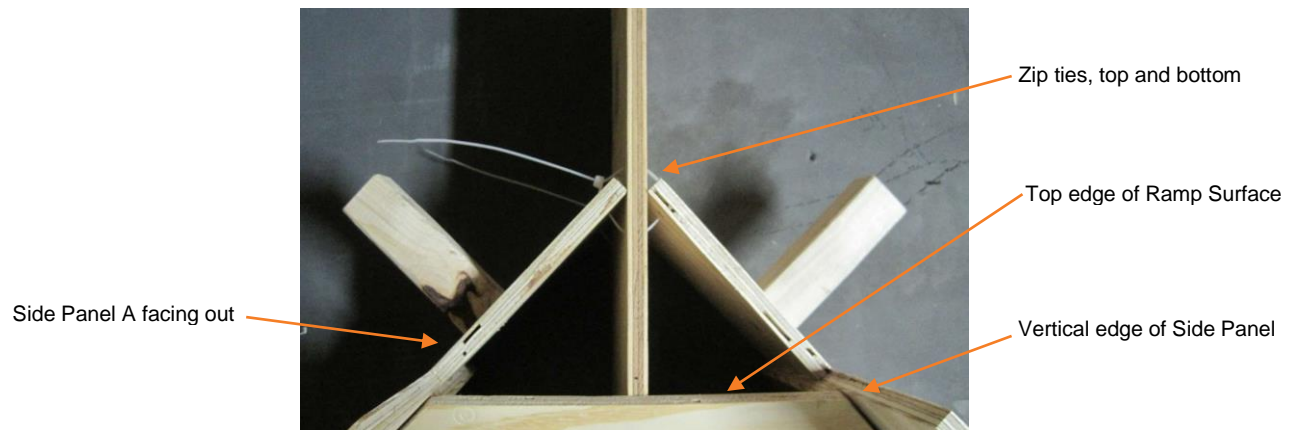


2. Apply wood glue to the angle edge of the Ramp Spine and use (4) 1" Wood Screws to attach the Ramp to the Ramp Spine.

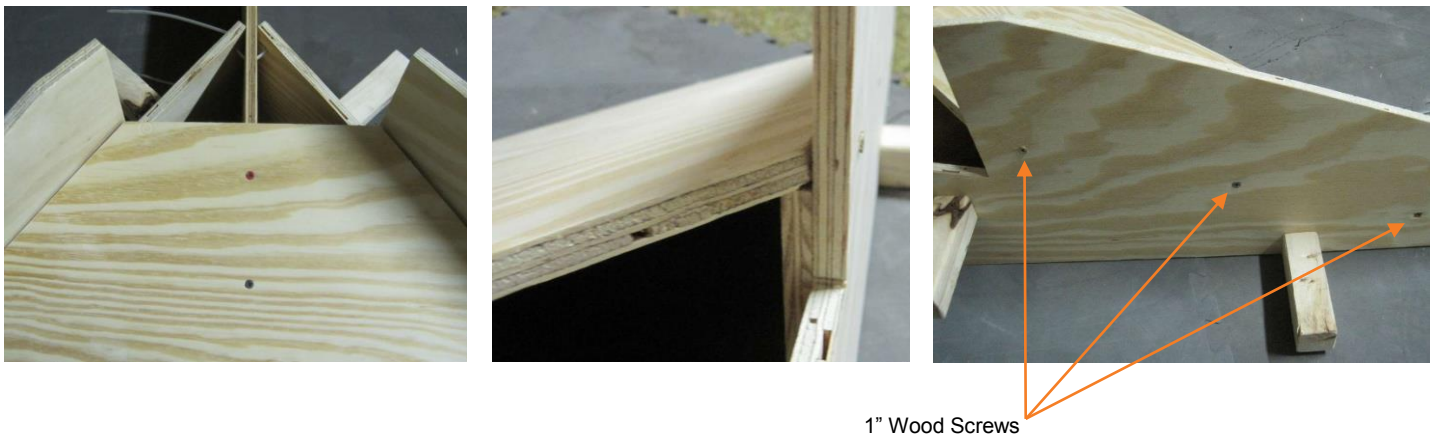


Ramp Assembly

1. Attach the Side Panel Assemblies to the Ramp Surface Assembly using the Panel B side of the Side Panel Assembly to support the Ramp Surface.
2. Align the top edge of the Ramp Surface with the vertical edge of Side Panel A.
 - The Side Panels and the Center Spine should meet together as shown in the photo (below).
 - It helps to tie all three parts together with two zip ties (keep them loose) to hold the parts in the proper location while you are trying to insert the wood screws.

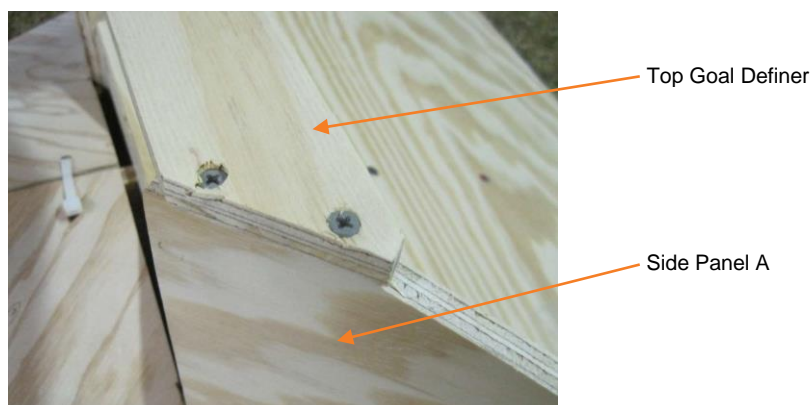


3. When parts are in proper alignment, use 1" Wood Screws to attach both Side Panel Assemblies to the Ramp Surface.

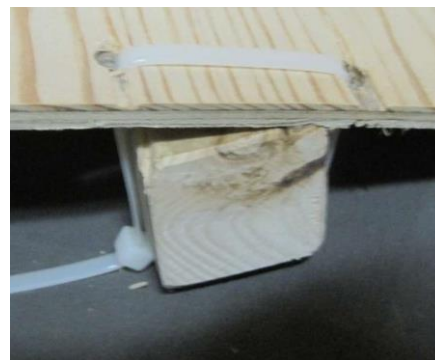


Goal Assembly

1. Align the Top Goal Definer (DIY17-1-5) to the top of both Side Panel A assemblies.
2. Use 1" Wood Screws to attach the Top Goal Definer to the Side Panels.

**Return Ramp Assembly**

1. Place the two Return Ramps (DIY17-1-6) on the Standoffs on either side of the Ramp Assembly.
2. Use two zip ties to attach the Return ramps together.
3. Use four zip ties to attach the Return Ramps to the Standoffs.

**Final Assembly**

2016-2017 *FIRST*® Tech Challenge VELOCITY VORTEXSM DIY Guide

Appendices

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. In order 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>

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