FIRST® GAME CHANGERS™ powered by Star Wars: Force for Change

2020-2021 FIRST® Tech Challenge

DIY Field Element Guide
Sponsor Thank You

Thank you to our generous sponsors for your continued support of the FIRST® Tech Challenge!
## Revision History

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9/12/2020</td>
<td>Initial Release</td>
</tr>
<tr>
<td>1.1</td>
<td>10/7/2020</td>
<td>- Tower Goal Instructions, Step 3 – Updated image with corrected measurements. Height of tower goal opening is 5.5”  &lt;br&gt; - Tower Goal Instructions, Step 10 – Updated image with corrected measurements. Height of divider line is 11”  &lt;br&gt; - Power Shot Instructions, Step 2 – Updated image with corrected measurement. Fold line is 6.5”  &lt;br&gt; - Return Rack Instructions, Step 5 - Updated image with corrected measurements for return rack placement.</td>
</tr>
</tbody>
</table>

## Contents

Contents .................................................................................................................................................................. 3  

Introduction ......................................................................................................................................................... 4  

  What is FIRST® Tech Challenge? .......................................................................................................................... 4  

  FIRST Core Values .............................................................................................................................................. 4  

Gracious Professionalism® .................................................................................................................................... 4  

Overview ................................................................................................................................................................ 5  

Part List .................................................................................................................................................................. 6  

  Materials ............................................................................................................................................................ 6  

  Tools Needed .................................................................................................................................................... 6  

Tower Goal Instructions ........................................................................................................................................ 8  

Power Shot Instructions ...................................................................................................................................... 17  

Return Rack Instructions .................................................................................................................................... 22  

Barrier .................................................................................................................................................................... 25  

Final Field Assembly .......................................................................................................................................... 28  

Drawings ................................................................................................................................................................. 29  

  Tower Goal ....................................................................................................................................................... 29  

  Power Shot ....................................................................................................................................................... 30  

  Return Rack ..................................................................................................................................................... 31  

  Barrier and Return Rack Cut Guide .................................................................................................................. 32  

Appendix A – Resources ........................................................................................................................................ 33  

  Game Forum Q&A ............................................................................................................................................. 33  

  FIRST Tech Challenge Game Manuals ................................................................................................................ 33  

  FIRST Headquarters Pre-Event Support ................................................................................................................ 33  

  FIRST Websites ............................................................................................................................................... 33  

  FIRST Tech Challenge Social Media .................................................................................................................. 33  

  Feedback ........................................................................................................................................................... 33

*Gracious Professionalism®*: “Doing your best work while treating others with respect and kindness - It’s what makes FIRST first.”
Introduction

**What is FIRST® Tech Challenge?**

FIRST® Tech Challenge is a student-centered program that focuses on giving students a unique and stimulating experience. Each year, teams engage in a new game where they design, build, test, and program autonomous and driver operated robots that must perform a series of tasks. To learn more about FIRST® Tech Challenge and other FIRST® Programs, visit [www.firstinspires.org](http://www.firstinspires.org).

**FIRST Core Values**

We express the FIRST® philosophies of Gracious Professionalism® and Coopertition® through our Core Values:

- **Discovery**: We explore new skills and ideas.
- **Innovation**: We use creativity and persistence to solve problems.
- **Impact**: We apply what we learn to improve our world.
- **Inclusion**: We respect each other and embrace our differences.
- **Teamwork**: We are stronger when we work together.
- **Fun**: We enjoy and celebrate what we do!

**Gracious Professionalism®**

FIRST® uses this term to describe our programs’ intent.

Gracious Professionalism® is a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community.

Watch Dr. Woodie Flowers explain Gracious Professionalism in this [short video](http://shortvideo).
Overview

The Do It Yourself (DIY) Field Element Guide provides step by step instructions on how to build a partial ULTIMATE GOAL℠ presented by Qualcomm field elements using cardboard and tape. These instructions are not intended for a full field.

The shopping list includes inexpensive off the shelf cardboard boxes that can easily create the field elements with some minor modifications. Although gaffers tape is recommended for sturdiness of the structure, teams may use any tape available to hold the structure together.

Note: These instructions are for a Red Side Version. For a Blue Side Version, the Power Shot targets will have to be cut as a mirror image and the Return Rack taped to the opposite side of the Tower.

**IMPORTANT:** Please read through all the steps prior to building the partial field assembly.
## Part List

### Materials

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Home Depot SKU</th>
<th>Part Photo</th>
<th>Est. Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra-Large Moving Box (22in. L x 22 in. W x 21 in. D)</td>
<td>3</td>
<td>SKU# 115733 Model# 1001015</td>
<td><img src="image1.jpg" alt="Extra Large Moving Box" /></td>
<td>$2.48</td>
</tr>
<tr>
<td>Extra-Small Moving Box (15 in. L x 12 in. W x 10 in.)</td>
<td>2</td>
<td>SKU# 1002852868 Model# XSMBOX</td>
<td><img src="image2.jpg" alt="Extra Small Moving Box" /></td>
<td>$0.78</td>
</tr>
<tr>
<td>2” Tape</td>
<td>As Needed</td>
<td>N/A</td>
<td><img src="image3.jpg" alt="Tape" /></td>
<td></td>
</tr>
</tbody>
</table>

### Tools Needed

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Part Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Gloves</td>
<td>1</td>
<td><img src="image4.jpg" alt="Safety Gloves" /></td>
</tr>
<tr>
<td>Utility Knife</td>
<td>1</td>
<td><img src="image5.jpg" alt="Utility Knife" /></td>
</tr>
<tr>
<td>Item</td>
<td>Quantity</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>25' Tape Measure</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yardstick</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Pencil or Marker</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Printer*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Paper*</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

*A printer is optional for those who would like to print out the Return Rack template. Teams can either print the template to trace out the Return Rack; or use the dimensions in the drawings section to draw out the shape prior to cutting it out of cardboard.
Tower Goal Instructions

The Tower Goal assembly will require:

- One (1) extra-large box, model# 1001015
- Two (2) extra-small boxes, model# XSMBOX.

As each step is completed, make sure to save scrap pieces as these will be used in later parts of the build.

1. Open up one extra-large box. Take two opposing flaps and fold them inside and then tape the flaps together.
2. Flip the box over and tape the other flaps together.

3. Fold one of the remaining flaps down and tape along each side.
4. Cut off the lower flap and save. This will be used as the Low Goal/Mid Goal Divider.

5. Turn the box around and, on the side opposite the side with the taped flap from Step 4, fold down the flap and mark a line 3 inches from the fold. Cut along this line to create a 3” wide flap.
6. Fold the 3" flap up and tape securely. This makes the lower edge of the Low Goal.

7. On the same side as the 3" flap, cut out a 5" x 16" opening in the top flap. This opening is the High Goal.
8. Take the excess cardboard that remained from when the 3" flap was cut and cut two 8" x 8" triangles.

9. Tape the triangles to the flap containing the high goal.
10. Mark the inside of the box for the Low Goal/Mid Goal divider. To help support the Divider during assembly you can cut a scrap piece of cardboard and tape it along the line.

11. Tape the divider inside the box. You may have to trim the length of the divider to make it fit, do not force it or the cardboard may buckle.
12. Additional tape along the edges of the divider and Low Goal edge will protect the cardboard from launched ring and improve durability. Note: this tape can be added before or after the Divider is installed.

13. This is what the finished Tower Goal should look like.
14. Fold the flaps and tape the bottom of both extra small (XSMBOX) boxes.
15. Tape the two boxes together as shown.

16. Place the Tower goal ontop of the two smaller boxes
Power Shot Instructions

The Power Shot assembly will require

- One (1) extra-large box, model# 1001015

1. Open up the extra-large box.

2. On one end of the box, mark a fold line on each of the four flaps 7 inches from the crease.
3. Fold in the flaps at the marked Fold line.

4. Tape all four corners where the flaps meet.
5. Turn the box over and fold three sides in and tape.
6. On the remaining flap, mark out the Power Shot Targets as shown in the following picture. Note: These dimensions are for a Red Tower Goal. If you are building a Blue Tower Goal, the dimensions should be flipped. That is, everything is measured from the left side of the box.

7. Cut out the excess material surrounding the Power Shot targets.
The Targets should look like this.

8. Add tape to the Targets to protect them during use.
Return Rack Instructions

The Return Rack assembly will require part (approximately one quarter) of the extra-large box. The remaining 3 quarters of the extra-large box will be used for the barriers in the next section. Please see the Barrier and Return Rack Cut Guide to cut out the cardboard for the Return Rack and Barriers, which all use a single extra-large box.

1. Print out the Return Rack PDF. The PDF must be printed to scale and will print on a total of 9 pages. Teams may also use the dimensions shown in the Drawings section to draw to scale and cut out of cardboard.

2. Using the template, cut out the Return Rack from corrugated cardboard. Draw in the lines to indicate folds.
3. Fold the cardboard at the indicated locations.

Helpful Hint: To fold on the lines, either score the lines using a utility knife, or use the straight edge of the yard stick as a guide when folding.

4. Tape the Return Rack together as shown.
5. Mark two lines on the side of the Tower Goal to help position the return rack. If you are building a red tower goal field, then the markings should be on the left side of the box (as shown). For a blue tower goal field, mark the box on the right.

The return rack is aligned to the marks as shown.

6. Tape the Return Rack onto the side of the Tower Goal
Barrier

For teams not using field perimeter walls, simple cardboard barriers can be made. The barriers are created using the remaining 3 quarters of one extra-large box. These barriers can be used to mount navigation images to aid in autonomous navigation and for the wobble goal End game task.

1. Draw the following outline on a piece of cardboard.

2. Cut the shape out being careful not to cut on the fold lines.
3. Fold the cardboard

4. Tape the triangular supports so that the vertical wall is straight up.
5. The finished barrier should look like this.
Final Field Assembly

This image shows the Power Shot, Return Rack, and Tower goal together. For specific placement onto the field please see the Field Setup Guide.
Drawings

Tower Goal

Gracious Professionalism® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
Red version of the Powershot Targets. For a Blue side field, the target dimension should be mirrored.
**Return Rack**

**Gracious Professionalism**: “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
Barrier and Return Rack Cut Guide

One of the extra-large boxes can be cut open and the material can be used to make three barriers and one return rack.
Appendix A – Resources

**Game Forum Q&A**
https://ftcforum.firstinspires.org/
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 username and password for your team.

**FIRST Tech Challenge Game Manuals**
Part 1 and 2: https://www.firstinspires.org/resource-library/ftc/game-and-season-info

**FIRST Headquarters Pre-Event Support**
Phone: 603-666-3906
Mon – Fri
8:30am – 5:00pm
Email: Firsttechchallenge@firstinspires.org

**FIRST Websites**
*FIRST* homepage – www.firstinspires.org
*FIRST Tech Challenge Page* – For everything *FIRST* Tech Challenge.
*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.

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