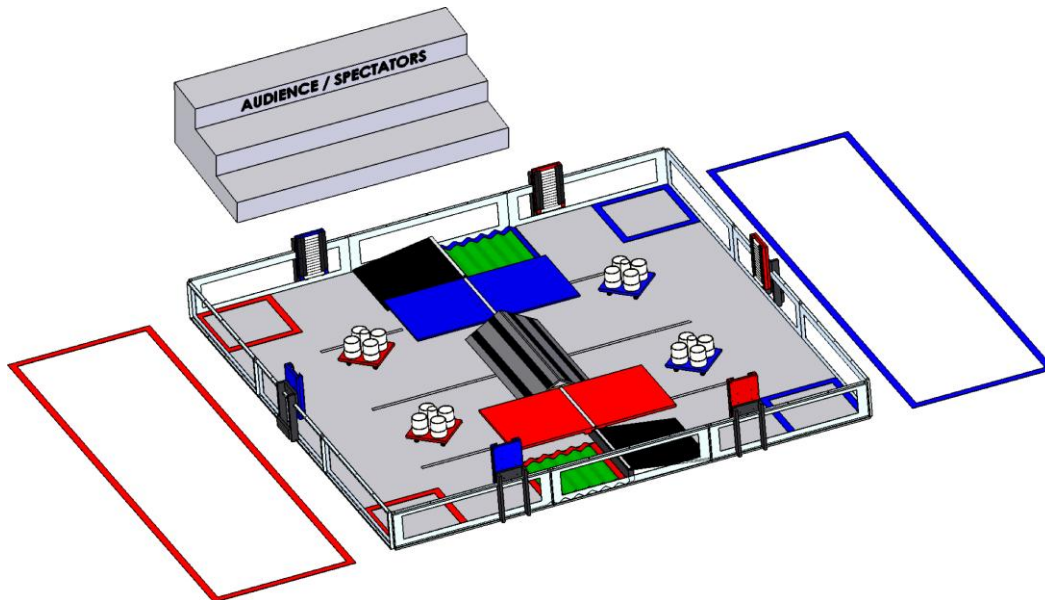




ZEN AND THE ART OF FIELD CONSTRUCTION

A manual of construction tips and techniques for
building the Get Over It! playing field.



Release Date 9/11/2010

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Overview

The Game Design Committee (GDC) realizes that while the field drawings show the field elements and dimensions, actually constructing the field can be a challenge. The purpose of this document is to help clarify the design intent of the field elements and to share some construction tips, tricks, and techniques.

First of all, don't panic. While there appears to be quite a few elements most are duplicates so once you have mastered the first one the rest are easy. You can even mass produce many of the elements and then just assemble them. The GDC has designed this field using readily available parts that should be available at any Home Depot or Lowe's across the country. All the parts can be made using simple hand tools; you do not have to be a master carpenter or machinist to construct this field. The GDC has listened to the input from the Affiliate Partners (AP) and this year's field has been designed to disassemble into small, easily carried and stored elements.

Where possible we have identified parts by their SKU and UPC number to make it easy for you to find the correct part. However, we have found that not all parts are carried by all stores so where possible we have identified where you can make substitutions without affecting the play of the game. In general, if the substitution does not affect how the robot interacts with the field element then you can feel comfortable with the substitution. If you have any questions feel free to contact FIRST or the GDC for clarification.

Remember, Rule G12 is your friend. This rule stipulates that field tolerances can vary by as much as $\pm 1"$ which gives you a lot of leeway during construction. Teams must design their robots to accommodate this level of variation in the field, if they don't it is their problem not yours. While you should try to construct the field as close as possible to the official drawings there is always going to be slight variability ($\pm 1/8"$ is probably normal) in parts, assemblies, etc. The key dimensions and parts that are critical to the game are noted in the following sections.

Some of the field elements are made from PVC pipe and fittings. This is a cheap and readily available material but we have found that fittings purchased in different stores even within a chain can vary in size. So it is always a good idea to dry fit the parts first and adjust the lengths until everything fits properly. It is worth investing in a good PVC cutter. It is faster and makes cleaner cuts than a saw.

Please note that the Zen guide was prepared prior to Kickoff and it is possible that some of the field dimensions and designs might have changed slightly. This is why the parts shown in the photos may seem a little different than those shown in the field drawings. Whenever there is discrepancy you should always go by the Field drawings as they are kept up to date.

1. Mobile Goals

There are four (4) mobile goals per field, two (2) red and two (2) blue. Each mobile goal is made from 3/4" plywood with four (4) casters on the bottom and four (4) 4" PVC goals and one (1) 2" PVC goal on the top. Parts are held together with #8 x 3/4" long pan head wood screws. These can be purchased in packs of 100 from most hardware stores.

1.1. Base

1.1.1. The base is a pretty simple part to make. It is recommended that 1/8" dia. pilot holes are drilled approximately 1/2" deep on the top and bottom surfaces to aid in accurately positioning the PVC caps and casters. The exact location of the goals and casters is not critical to the smooth operation of the mobile goal so a tolerance of $\pm 1/8$ " is accurate enough.

1.2. Casters

1.2.1. The casters used on the mobile goals are called out in the Bill of Material (BOM). However you can substitute the casters used on the hexagonal goals from Quad Quandary for the parts called out in the BOM. So if you have any of these goals you can save a few dollars by recycling these parts.



1.3. 4" Goal

1.3.1. The bottom of the goals consists of a pipe cap screwed on to the base. Hardware stores carry two types of 4" caps, a thick walled version with rounded corners and a thin walled type with squared off corners. The thin walled type is used for the mobile goals. Each of caps needs to have an 11/64 dia. (.172") hole drilled through the center. The exact diameter is not critical, just so long as it is big enough to fit the screw through.



1.3.2. The 4" PVC that made up the Ball Chutes used in Hot Shot can be cut up and used in the 4" goal.

Note: Depending on your area, white 4" PVC may not be available. Different colored PVC is acceptable.

1.4. 2" Goal

1.4.1. These plugs have an open grid in the bottom that the screw fits through so there is no need to pre-drill these parts.



1.4.2. The fit between the plug and the 2" PVC pipe is loose so it is recommended that the pipe be glued securely to the plug.

1.4.3. A 1" x 1 ½" x 1 ½" wooden block is placed inside the 2" pipe to raise the level of the batons that get scored in the goal. The exact size of the block is not critical since its only purpose is to make the batons visible to the teams and audience.



2. Stationary Goals

There are two (2) Stationary goals on the field, one (1) Red and one (1) Blue. The goals consist of corrugated fiberglass roofing material. One version of the panel is called out in the BOM however due to regional availability the exact type and style of the fiberglass panel will vary from event to event. The corrugated panel from Face Off can be used as the stationary goal.

To identify the alliance of the goal, each corrugated panel is outlined with 2" wide red or blue gaffers tape.

The stationary goal is designed to fit snugly inside the space left when a floor tile is removed. The tabs on the surrounding tiles should not be removed. When placed onto the field the valleys in the panel should run parallel to the Cliff face.

3. Dispenser

There are six (6) dispensers located on the field, three (3) red and three (3) blue. There are six (6) Support brackets that are used to hold the dispensers onto the perimeter walls. The Dispensers and Support brackets can be assembled in different ways to allow for three different dispenser heights. Be sure to check the field drawings to insure that the dispensers are located in the proper location and at the correct height.

3.1. Dispenser Body

The Dispenser body consists of a Back Panel made from 3/4" thick plywood, two Side Bars made from 1" square dowel, and two Front Panels made from 3/32" polycarbonate (Lexan). There are several dimensions that are critical to the proper operation of the dispenser. The following fabrication process will help you maintain the critical dimensions.

3.1.1. Back Panel

3.1.1.1. The back panel is a simple part to fabricate. The pre-drilled holes along the edges are pilot holes to make screwing on the sides easier. Their exact position is not critical but they should be made so that the screws end up roughly centered on the sides otherwise you run the risk of splitting the 1" wide square dowel.

3.1.1.2. The three (3) pairs of holes on the back panel are used to mount the dispenser to the Support bracket. Each pair of holes defines the height of the dispenser when placed on the field. Two (2) dispensers, one (1) Red and one (1) Blue, are assembled at each height. See the Field Assembly drawings to determine where each dispenser is located. The holes are drilled to be a tight fit for a #10-32 machine screw. It is expected that the first time you assemble the Dispenser to the Support you will have to drill through the holes to make them line up. The holes are chamfered so that the heads of the 10-32 flat head screws do not protrude into dispenser and interfere with the smooth movement of the batons.

Critical Dimension



3.1.2. Side Bar

3.1.2.1. The Side Bars should be cut to length but do not pre-drill any holes.

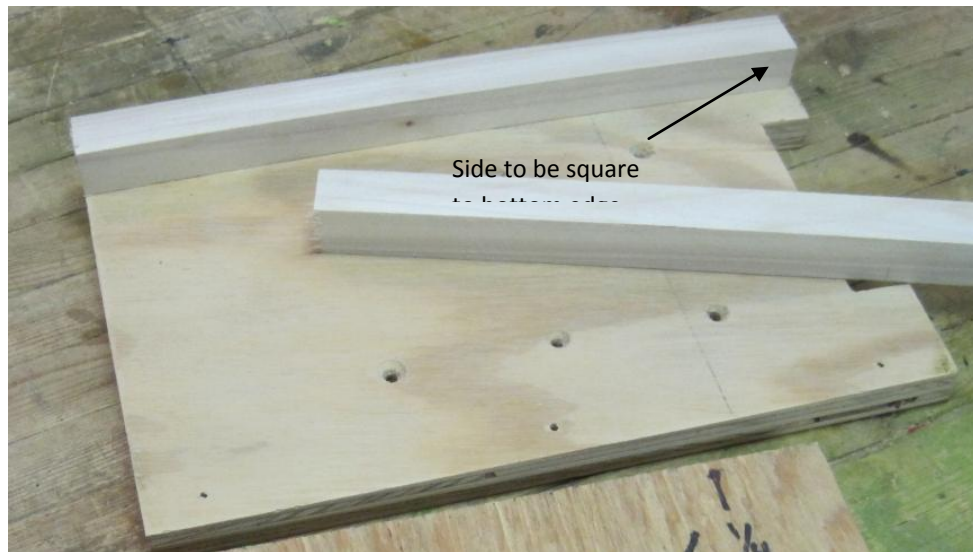
3.1.3. Front Panel

3.1.3.1. Cut and pre-drill the holes in the polycarbonate. The exact diameter and location of the holes is not critical since these are clearance holes and the final location of the panel will be determined at assembly. It is important that the edges be carefully

deburred since the field reset people will be touching these edges when they refill the dispensers.

3.2. Fabrication Process

- 3.2.1. Step 1: Align one Side Bar to the top and edge of the Back Panel then glue and screw into position. Check to make sure the Side Bar is square to the bottom edge of the Back Panel. The Side Bar must be attached to surface of the Back Panel that has the chamfered holes.

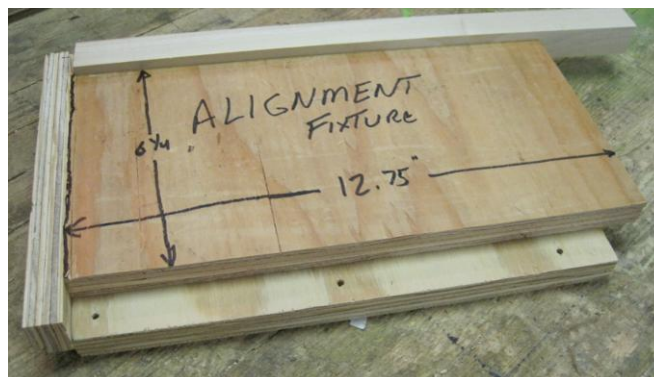


- 3.2.2. Step 2: The attachment of the second Side Bar is critical and will be much easier to accomplish if you first make an alignment fixture. The fixture is a piece of plywood cut to 6 1/4" wide by 12 3/4" long. Take time to get this correct since the accuracy of the fixture will determine the accuracy of the final dispenser. Attach an 8 1/4" long piece of plywood across the top of the fixture (like a crossing a T).

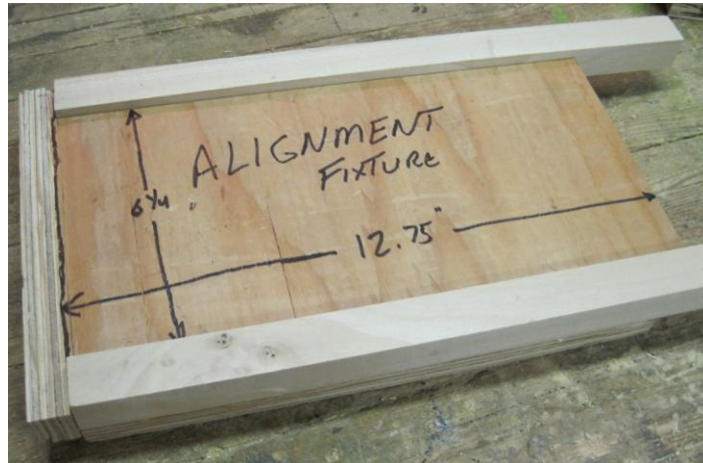


Critical Dimension

3.2.3. Step 3: Place the fixture onto the partially completed Back Panel.

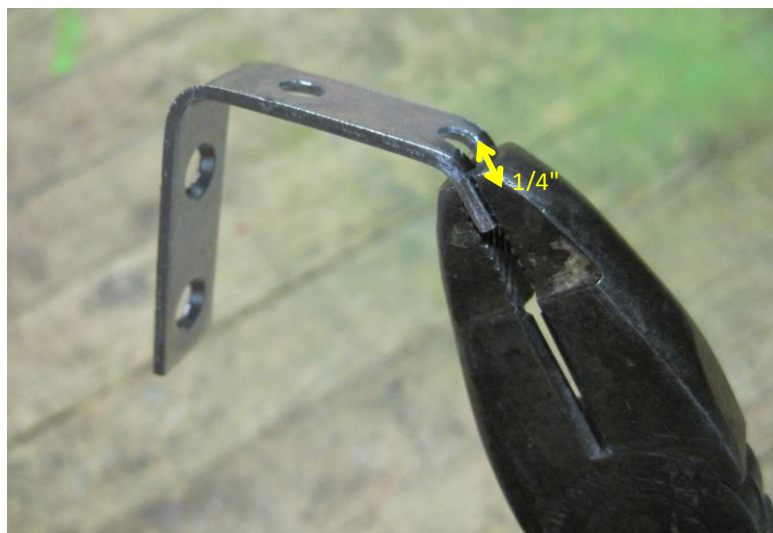


- 3.2.4. Step 4: Line up the second Side Bar snugly against the Alignment Fixture. The intent is to insure that the distance between the two Side Bars is a uniform $6\frac{1}{4}"$. If the gap is too small the batons will jam (but a little wider won't hurt). The fixture insures that the gap will never be less than $6\frac{1}{4}"$. Glue and screw the Back Panel to the second Side Bar.

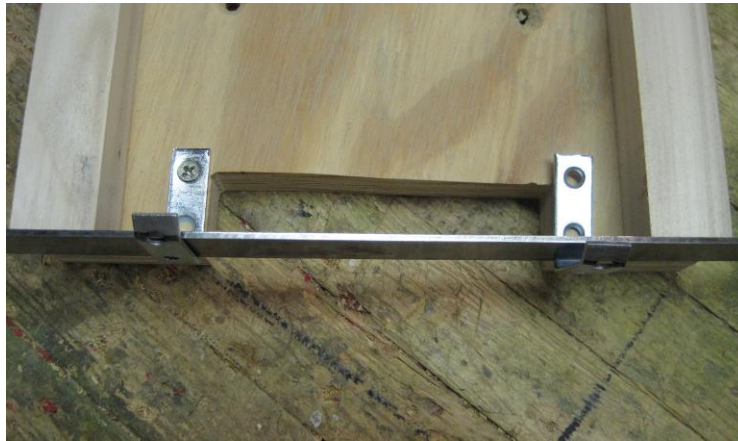


Critical Dimension

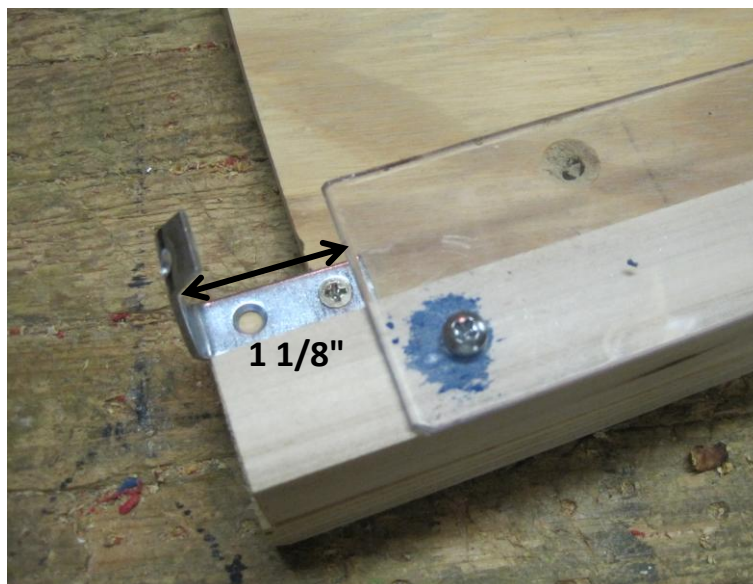
- 3.2.5. Step 6: Mark a line $\frac{1}{4}"$ from one end of the corner bracket and using a bench vise or a pair of pliers bend the end to about a 45° angle. The exact angle is not that important. Its purpose is to keep the batons from freely exiting the dispenser. If you need to you can always adjust the bend after the dispenser is assembled.



- 3.2.6. Step 7: The brackets should be attached so that there is a $1 \frac{1}{8}$ " gap between the front panel and the bracket. One easy way to do this is to place a $\frac{1}{8}$ " thick ruler (like that from a combination square) across the bottom of the side bars. Then push the brackets up against the ruler and screw the bracket in place.



- 3.2.7. Step 8: Align the top of the front panel to the top of the side bars and attach with screws. If everything is made right there should be a $1 \frac{1}{8}$ " gap between the bracket and front panel.

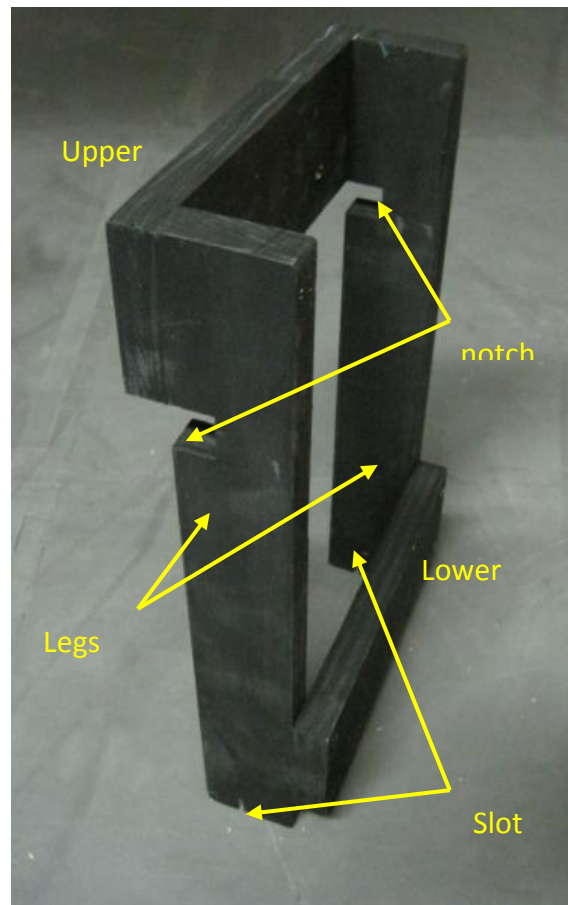


- 3.2.8. Test the performance of the dispenser. With all 15 batons loaded in the dispenser the batons should remain in place and not fall out freely, the bent tabs should hold them in place. If the batons come out too easily bend the tabs up more until the batons stay in place.



4. Support Bracket

There are six (6) Support brackets located on the field, three (3) on the red side and three (3) on the blue side. The Support fits onto the outside of the perimeter walls and bolts onto the Dispenser. The Upper Crossbar provides the mounting surface for the Dispenser and the Lower Cross bar provides a mounting surface for the IR beacon (used only on the mid height dispensers).



4.1. Leg

- 4.1.1. Cut the legs from 3/4" plywood. Since you need 12 legs per field you may find it easier to clamp the legs together and cut the notches and slots all at once. The slot width is made using the saw kerf (about 1/8"); the height is not critical, just as long as it is deep enough to clear the bottom rail. The notch height and depth are not too important so long as it clears the top rail.



4.2. Crossbar

- 4.2.1. The cross bar is cut from 3/4" plywood. The two holes on either side are pilot holes for the woodscrews so the diameter and location are not critical but try to drill them so that the screw ends up in the center of the leg. The two 3/16" holes should line up with the corresponding holes in the Dispenser so the 4" spacing is very important. The holes are purposely drilled to be a tight fit on the 10-32 screws; you may need to re-drill them at final field assembly.

4.3. Fabrication

- 4.3.1. Glue and screw the legs to the crossbar, being careful to keep everything square.
- 4.3.2. Glue and screw the lower crossbar in place
- 4.3.3. Paint the entire assembly black.
- 4.3.4. Attach the Velcro strip on the lower crossbar such that the top of the IR beacon is level with the top surface of the Lower Crossbar.



4.4. Field Assembly

- 4.4.1. Place the Support onto the Perimeter wall first. Put the flat head screws through the Dispenser holes (depending on height) then through the Support holes. Tighten the wing nuts to clamp the assembly onto walls.



4.4.2. You will need to zip tie the Support to the wall to hold it firmly in place.



5. Baton

There are three (3) types of batons on the field:

- Regular Baton, 100 per field
- Doubler Baton, two (2) per field, one (1) Red and one (1) Blue
- Magnet Batons, four (4) per field, two (2) Red and two (2) Blue

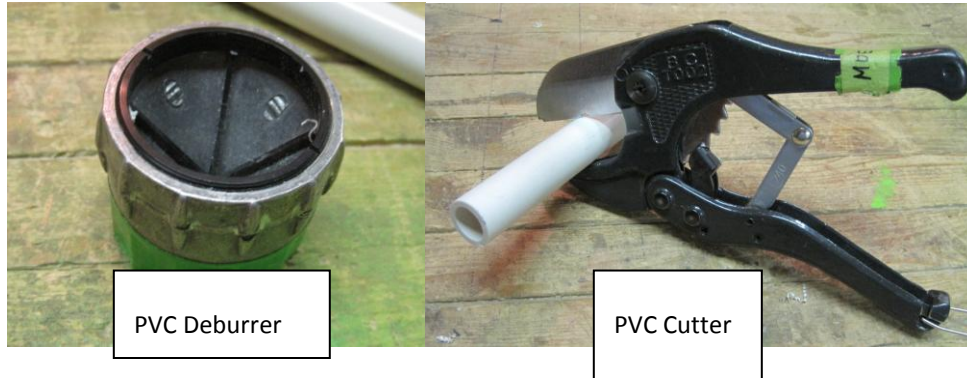
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It is suggested that you make extras of all types as they will get damaged or lost during competition. Also it is important that the Bonus batons be indistinguishable from the regular batons. So if the Bonus batons get marked up you may want to have extras to swap in so that teams can't recognize the Bonus baton.



5.1. Regular Baton

5.1.1. Batons are made from 1/2" PVC Sch 4 pipe cut to 6" lengths. Slightly less than 6" long is not a problem but it is important that the length of the baton not exceed 6 1/8" or they may jam in the Dispenser. Use of a PVC cutter is recommended, as it will provide a cleaner cut than a saw, and is also faster. The ends of the pipe should be deburred inside and outside to insure that the Batons operate smoothly in the Dispenser and do not have sharp edges that can cut the hands of the field reseters. A PVC deburring tool makes this job easier and faster.



Critical Dimension

5.1.2. There is no scoring difference between Red and Blue batons, meaning that the red alliance can score Blue batons and vice versa. However to make field reset easier the batons will be identified with a single stripe of red or blue tape.

5.1.3. Each Alliance is provided with five (5) Batons to preload into their robots. While they score and are handled as a regular Baton they will be marked with two tape stripes to make it easier for the field reseters.

5.2. Doubler Baton

5.2.1. Doubler Batons are painted a solid Red or Blue color. There is only one (1) Doubler baton per field per alliance and it is always loaded in the medium height dispenser. Use Krylon Fusion to paint the batons as this paint has been found to adhere the best to the PVC.

5.3. Magnet Baton

5.3.1. Magnet Batons are identical to Regular Batons but with the addition of a magnet hidden inside the pipe. It is important that from the outside, the Magnet Batons cannot be distinguished visually from the Regular Batons.

5.3.2. The magnet is held in a wooden dowel that is pressed into the center of the Baton. It is difficult to drill exactly into the center of the dowel, don't worry as this is not that important. However it is important that the magnet fit tight so that it doesn't come loose in a match. If needed you can glue the magnet into the dowel. The 5/8" dowel called for in the drawings is a tight fit inside the baton. You will probably have to sand it down a bit to fit. Don't make it too loose or it will fall out. It is better to be on the tight side. Press the dowel so that it is centered in the baton.

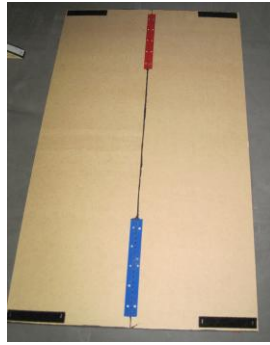
6. Mountain

There is one (1) Mountain per field. The Mountain is made from 1/2" thick MDF sheet.

- 6.1. It is easier to start with a single 2' x 4' sheet of MDF and then cut it to length per the official field drawings. (~42").
- 6.2. Then rip the sheet lengthwise to create two (2) 12" wide x 42" sheets. Depending on the starting dimensions of the original sheet you may end up with two pieces that are slightly less than 12" wide, this is ok as it will not affect game play.
- 6.3. Place the two pieces back to together and line up the hinge over the seam. Attach the hinge with the recommended screws. The hinges specified in the field drawings are the same ones used for the Hot Shot center goal. So you can save some money and just reuse the parts. The actual type of hinge is not important to game play so if your local store does not carry the recommended hinge you can substitute an equivalent hinge.



- 6.4. It is recommended that you paint all sides of the MDF to prevent warping in humid climates.
- 6.5. Attach the Velcro to the 4 corners. Make sure you use the loop side of the Velcro. To insure the Velcro does not come loose I suggest stapling the Velcro onto the MDF.



Bridge

There are two (2) Bridges on the field, one Red and one Blue. They are identical except for color. The Bridge is made from a single sheet 2' x 4' of 1/2" MDF. There are two rails on the bottom surface that keep the Bridge in position on the Bridge Support. They are spaced far enough apart to allow the Bridge to tilt without jamming. Care should be taken when attaching these rails because the Bridge should balance at the start of the match.

- 6.6. It is recommended you drill pilot holes through the MDF. This will make it easier to attach the rails.
- 6.7. The drawing calls for the rails to be 23" long if they end up being slightly shorter due to losses from cutting this is OK . The absolute length is not critical (even a few inches short won't affect game play). Just make sure you center them on the Bridge when you attach them.
- 6.8. Mark a line on the bottom of the Bridge 23" from one edge and align one rail to the line. Clamp the rail in place and then screw the rail to the Bridge.
- 6.9. Measure 2" from the first rail and clamp the second rail in place. Take care placing the second rail. If the gap between the rails is too small, the Bridge will jam when it tilts. If it is too loose the bridge might not balance correctly.
- 6.10. Paint the bridge either red or blue. It is recommended that you paint all sides to prevent warpage of the MDF, especially in humid climates.



7. Cliff

There are two (2) Cliffs on the field, both painted black. They are made from 1/2" MDF sheet

- 7.1. Cut a sheet of 2' x 4' 1/2" MDF sheet in half to form two 2'x2' sheets. Depending on the starting dimensions of the original sheet you may end up with two pieces that are slightly less than 24" square, this is ok as it will not affect game play.
- 7.2. Attach the Velcro to one edge of the Cliff bottom. Make sure you use the loop side of the Velcro. To insure the Velcro does not come loose I suggest stapling the Velcro onto the MDF.



8. Bridge Support

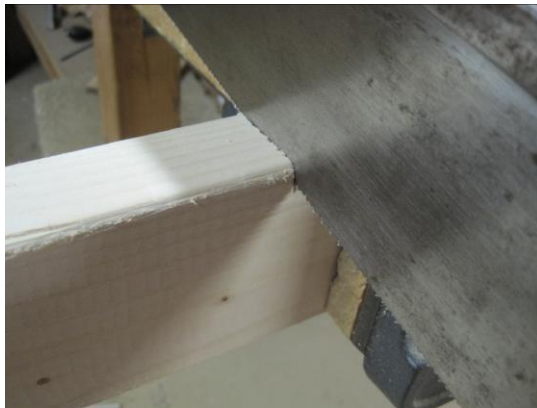
There are two (2) identical Bridge Supports on the field. Three parts make up the Bridge Support, a short end piece that hold the Mountain, a longer board that supports the Bridge and cliff, and the aluminum angles.



8.1. Long Board

8.1.1. Start by cutting the board to length.

8.1.2. Then 24" from one end make a stop cut with a handsaw. Make the cut a little longer than 24" since this will give you a little excess space for the Cliff to sit in.



8.1.3. The trickiest part is the 9° cut on the top of the long 2"x4". Getting the cut exactly 9° is not critical, so if your saw doesn't adjust to that fine an increment don't worry. Plus or minus a few degrees isn't going to affect game play. The easiest way to do this is with a table saw but in a pinch a circular saw will work or even a hand saw. Start by marking a line on one end at the correct angle.



Use the saw to cut almost all the way to the stop cut.

8.1.4. Using a handsaw complete the angled cut.



8.2. Short Board

8.2.1. Cut the ends of the short board to a 30° angle. The angle is not critical but try to keep the over all length per the drawing.

8.3. Aluminum rails

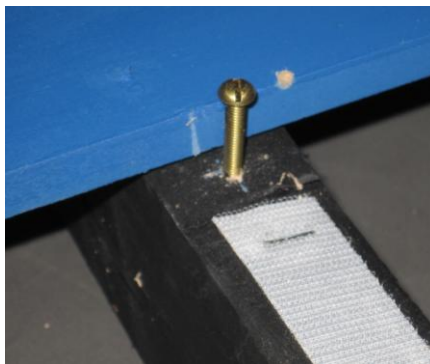
8.3.1. Drill the holes per the drawings. Make sure to drill the chamfers deep enough to insure the screw heads are recessed below the surface otherwise they may catch on the Bridge and cause it to stick.

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- 8.4. Attach the short board to the long board as shown in the drawings. In addition to screws, using a good quality wood glue will help keep the parts together through multiple events.
- 8.5. Paint the assembly before you put the rails and Velcro in place.
- 8.6. Attach the aluminum rails
- 8.7. Attach the Velcro onto the short board angles and on the 9° angled surface. Make sure you use the loop side of the Velcro. To insure the Velcro does not come loose I suggest using staples to hold the Velcro in place.



- 8.8. There are two (2) pan head machine screws that are screwed into the top of the Bridge support. These are intended to prevent the Bridge from moving sideways and possibly jamming on the Mountain or Cliff. A machine screw is used because it presents a smoother surface to the Bridge than a wood screw would. Drill the pilot hole per the drawings and screw the screws into the wood. There should be enough interference to give it a tight fit. When the Bridge is placed between the two screws it should be centered between the Mountain and Cliff. The bridge should have a little bit of clearance on either side and must rotate freely.



9. IR Beacon Connecting Cable

9.1. Constructing the Cable

The IR Beacons will be placed at opposite sides of the field for GET OVER IT! You will need to create a long cable to connect the two.

Part List: All available at www.digikey.com

- Connector: Part Number WM2901 – Female socket 0.10" pitch (2 required)
- Crimps: Part Number WM2555 Connection socket crimp (4 required)
- Crimp Tool: WM9999
- Wire: Red: K386-ND 26 AWG Red Wire
- Wire: Black: K387-ND 26 AWG Black Wire

Strip at least .25" end of wire to reveal the copper, then apply a crimp to the stripped end, and close with the crimp tool.

Insert the crimped wires into the connector housing. They should snap securely into place.

Be sure the red wire is always in the center position. The black wire can go into either of the outer slots on the connector.

