How To Make Gus Balls

A tutorial on making durable analogs for 2009 FRC Moon Rocks

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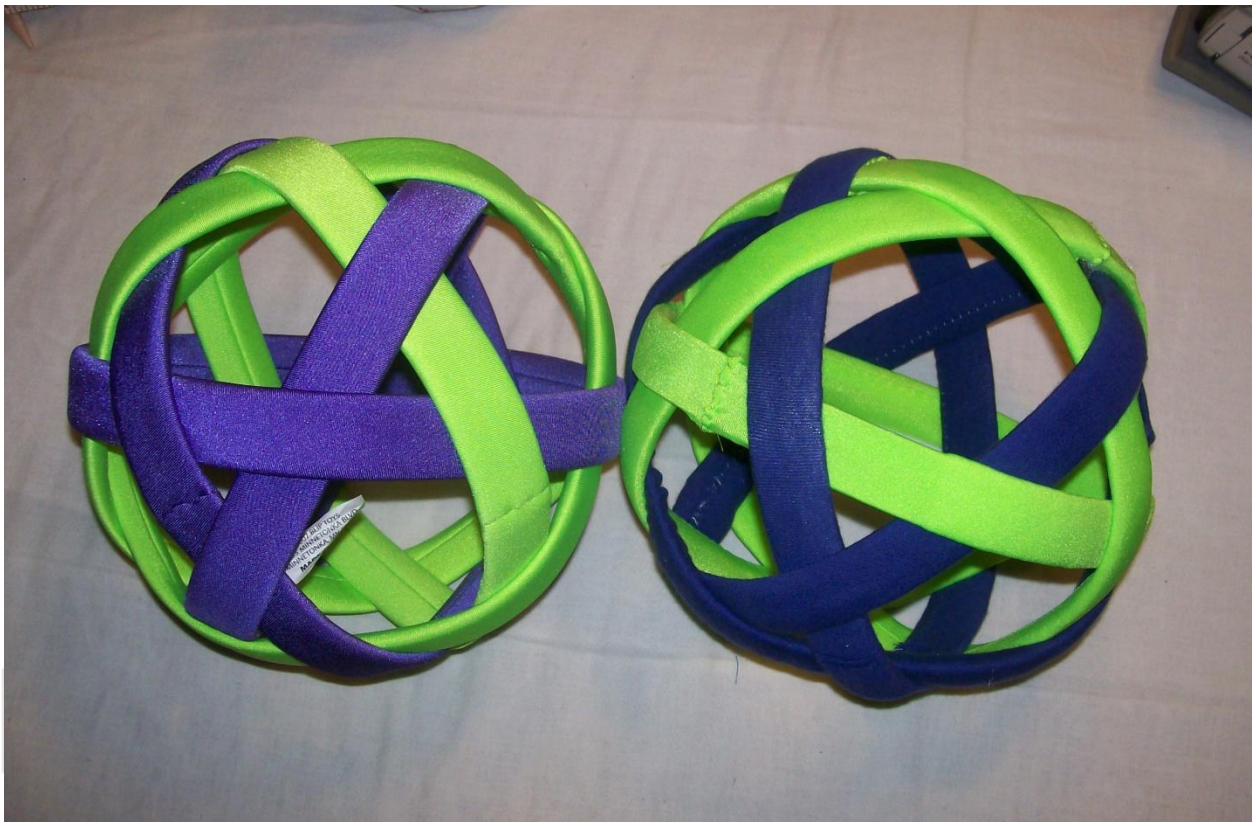


Wild Time Orbit Ball next to a finished Gus Ball

FRC build season is upon us again. The Game Design Committee has once again delivered another challenging problem for teams to solve. Unfortunately, a second problem has also appeared; the limited supply of playing field pieces at the start of the season. Members of FRC team 228, Gus Robotics made a quick search of several local Walmart stores on the evening of Kickoff. We were successful in finding four of the Wild Time Orbit Balls in only one of six stores we visited.

We could have pressed on and found more balls, but our success would have been at the expense of other area teams. We decided that a better solution could be found for the FIRST community at large. On day two of the build season we decided to attempt creating an Orbit Ball analog.

Materials

We chose **0.062" polycarbonate** for the test skeletons. We had some in stock, and a quick online search revealed that it would also be a resonably priced material compared to other plastics.

Spandex cloth covering. We chose spandex because of its elastic qualities and similarity to the real Orbit Ball covering. Sewing the matrial slightly under sized would allow it to be stretched over the skeleton members closely matching the real Moon Rock covers. Spandex can be slightly expensive at $9.00 to $15.00 USD per yard, but it doesn't take much to make a ball.

We didn't have access to a damaged Orbit Ball when we started our tests, so we weren't sure whether the cloth on the real balls was a heavier weight fabric, or if there was padding under the cloth cover. We decided to add **poly fiber batting** material, used inside quilts, to pad the skeleton. This material can be found in a fabric store, such as Joann Fabrics where we purchased ours. Use the thinest batting you can find, ours was about 0.125" thick. The material is inexpensive and you need very little, but it come in blanket sized rolls.

1/8" pop rivets. Even at Kickoff, teams noticed that the real Orbit Balls could be damaged fairly easily. We decided to make our skeleton splices durable so the balls would survive repeated rough human player practices and hopefully driver practices. We chose to make use a simple overlapped splice with two pop rivets. These joints do not seems to have much impact on the balls preformance especially if you stagger the joints after assembling your ball.

Transparent tape to hold the batting in place while the spandex cover is installed. We had more success using an **aresol spray adhesive** to bond the batting to the polycarbonate.

Tools

- Cloth tape ruler
- Sewing Machine
- Scissors and/or rotary fabric cutter
- Pop Rivet tools
- Drill and 1/8" drill bit
- Safety Glasses
- Sewing Needle and thread

Construction

Cut the polycarbonate into 1.1" by 27.5" strips, six strips per ball. Our initial test balls used strips that were only 1" wide and this is a little under sized.

Cut six strips of batting per ball 2” by 26”.

Spray adhesive on the polycarbonate strips, when glue is ready to bond, place polycarbonate centered on batting and wrap batting around sides of strip lengthwise. Leave approximately 0.75” of polycarbonate free of batting at ends to make the splice. The seam in the batting will be towards the inside of the ball.

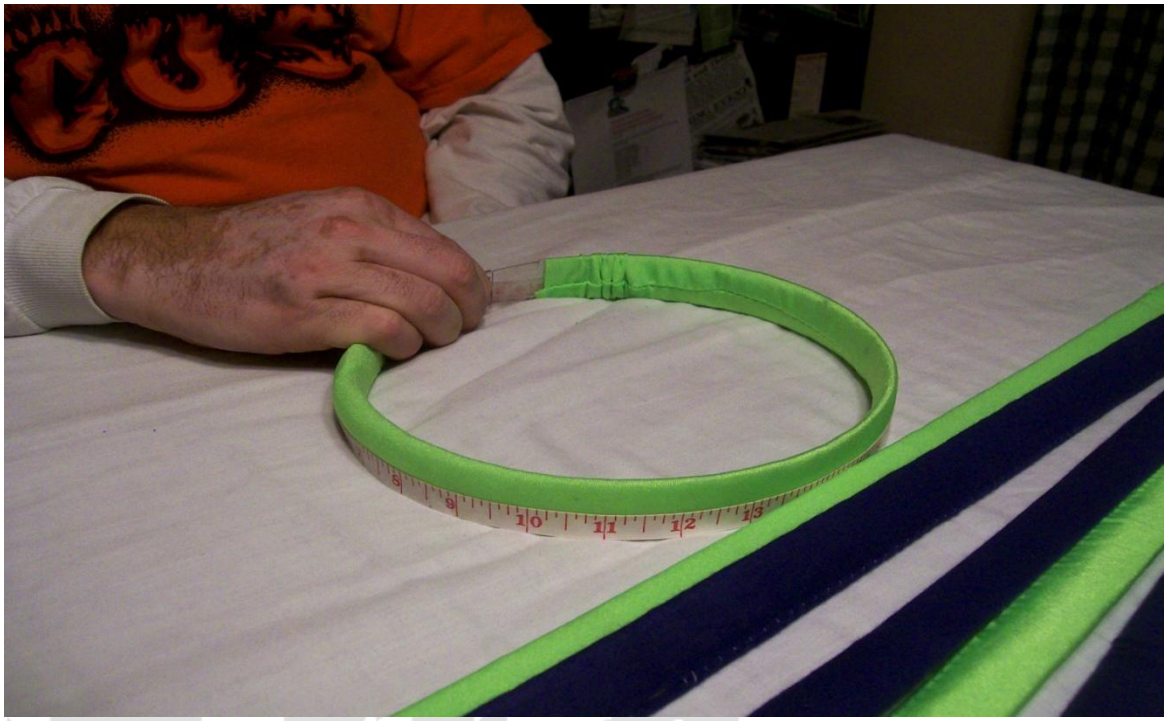
Cut six strips of spandex per ball, three of each color. Fabric should be roughly 3” by 24-25” depending on how well your fabric stretches.

Fold spandex lengthwise with the good side of fabric folded in on itself. Use a sewing machine set on a zigzag stitch to sew the fabric into a long tube approximately 0.75” wide. Trim off excess from the sewn seam and turn fabric right side out.

Sliding the spandex over the batting covered skeleton takes a little practice. One of the techniques that worked well for us was to take glossy heavy weight poster paper the length of the skeleton and wrap it around the skeleton, tape it into a sleeve, and taper the end. Slide the glossy paper sleeve over the skeleton, then slide the spandex onto the paper and over the skeleton. The spandex will need to be worked onto the skeleton a few inches at a time. Don’t just pull from the end of the fabric, eventually the friction will stretch the fabric to the point where the stitching in the seam will break. Once in place pull the glossy paper out from between the skeleton and the spandex. When the spandex is on the skeleton there should be about an inch of exposed polycarbonate as shown below:

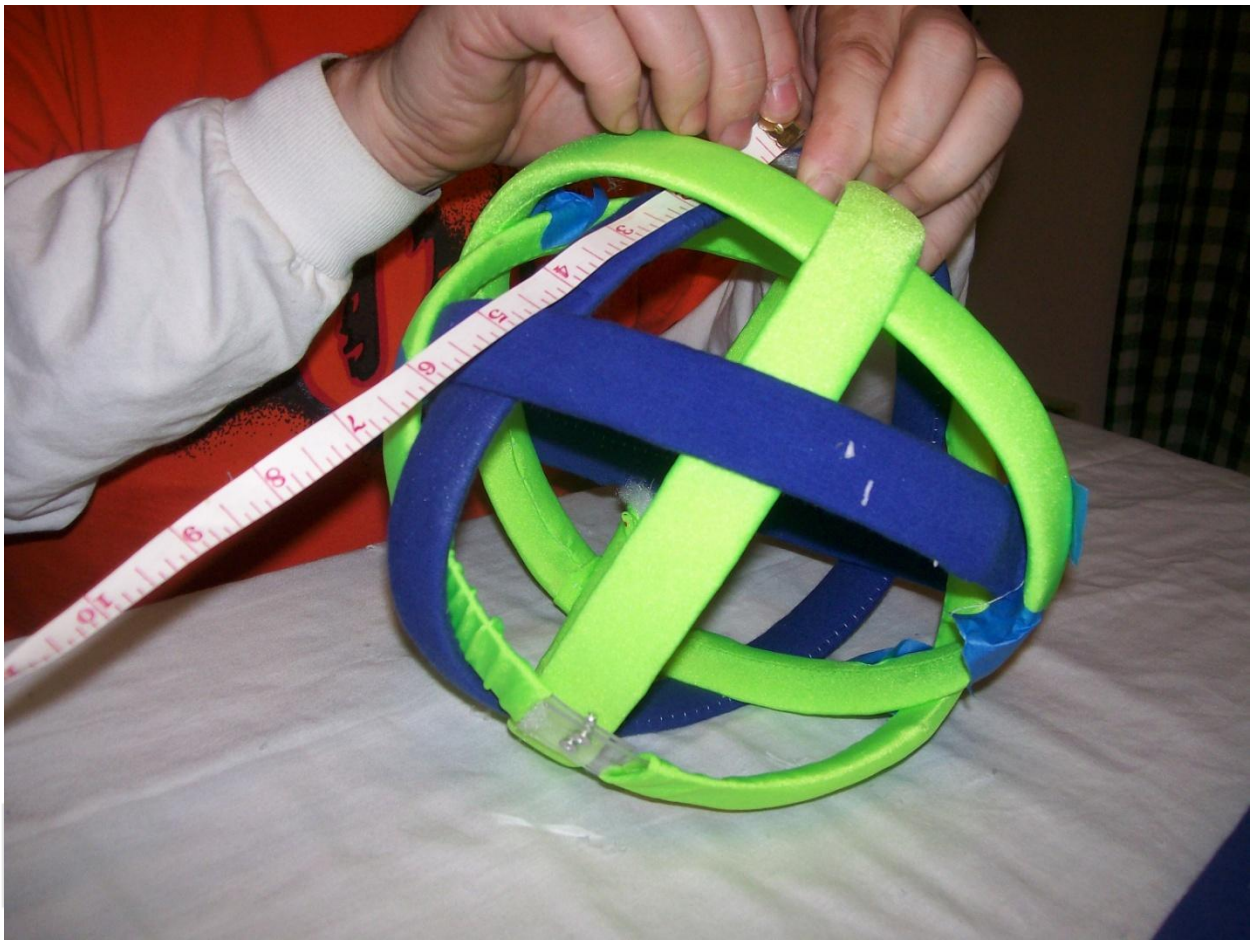
When all six strips have been covered with spandex, you're ready to begin assembling your ball. It's wise to have a real Orbit Ball handy to keep track of the weaving pattern.

Bend a strip of polycarbonate into a loop and measure the outside circumference with a cloth tape ruler to ensure that it is 27.5". Clamp the skeleton and drill the splice for two 1/8" pop rivets set across the splice to keep the splice flexible as shown below.




GUS

Using the real Orbit Ball as a guide, continue to add each remaining skeleton strip to the first assembled strip repeating the circumference measuring, clamping, drilling, and pop riveting. After the first three pieces are woven together it might be helpful to use some painters tape to hold the strips in position as you weave in the last three strips.



Finally you'll have a completely woven and assembled ball.

Next, work the spandex together at each splice and hand sew the cloth together to finish each splice. Teams may wish to try using hot glue or some other method of finishing the splice if you think hand sewing takes too long. We'd be interested in how other teams finished their splices and how durable gluing the cloth would be.

Finally, work each strip of the "Gus Ball" so that the splices are distributed evenly around the ball so there will be no hard spots that might affect the balls performance.

Options and Conclusion

This method should produce a ball which performs comparably with a real Orbit Ball. We tested the balls in simple drop tests where both balls bounced similarly. The balls were both thrown at the floor with similar bounce characteristics. Lastly, both balls had equal masses placed upon them and the deflection was measured. Both balls deflection under load was similar. We are very happy with the performance of these balls. The material costs were almost exactly identical to a commercially purchased Orbit Ball, and the balls take about two man-hours to fabricate. This is not an insignificant project for a team to assemble 20 balls for human player

and driver practice, but if the supply of real Orbit Balls continues to be spotty at best, this will allow teams to get practicing early in the build season.

By covering the balls with spandex, they should work well for driver practice and possibly robot testing too. We'll keep our real Orbit Balls for critical robot testing just to make sure ball performance is accurate.

If a team was interested in making Gus Balls strictly for human player practice, they could simplify construction by omitting the spandex and batting and just cover the polycarbonate with gaffers tape. If any teams can improve on this idea, or come up with a less expensive or faster construction technique, please share it with us and the FIRST community.

Hopefully, this experiment will also help those FIRST teams outside the United States who don't have access to Walmarts and Orbit Balls. We're sure FIRST, Walmart, and Blip Toys are working hard to make the Orbit Balls available to teams as quickly as possible. In the mean time, build a Gus Ball or two.

Go Teams!