How to Make Reversible Bumpers

By Team 2052 KnightKrawler

This tutorial will assume that you have already cut the plywood bumper boards and have attached the pool noodles to the board. The bumper construction rules are very specific in the game rules and you should ensure that your bumpers are properly constructed following those rules. Pay attention to minimum and maximum bumper heights and how that will impact the size of your bumper boards and where they will mount on the robot. We like to leave 1/8" to 3/16" space between the robot frame and the bumper boards. This allows for the bumper fabric to be wrapped around the bumper boards. If your boards are too snug to the frame, they may no longer fit after you attach the fabric. The method you use to attach the bumper to the frame may dictate the space you can have between the bumper boards and the frame. Make sure your boards, attachment hardware, and noodles are complete before sewing your fabric.

There are a variety of ways you can handle noodles in the corners (overlap, vertical noodle, wrap, etc). Check the rules each year before attaching the noodles to your bumper boards.

KnightKrawler started using the expensive solid core noodles from "Oodles of Noodles". The solid core noodles were the proper 2.5" size when purchased with the solid core (no hole). It can be very difficult to find pool noodles in Minnesota in January. When we found local stores selling pool noodles they were often below the required minimum diameter. The rules on noodle diameter have since been relaxed, but we find the solid noodles hold up better over the course of the season. The extra durability comes in handy when you encounter tough defense. Noodles are secured to the bumper boards every 6-8", around the noodles and board, with duct tape. The tape should not noticeably compress the noodle.

The fabric used in this example is the official Cordura fabric from AndyMark. We have used the same techniques for the "slick" fabric option, also referred to as Sail Cloth. The techniques below work for both fabric types.

In the photos below, our bumper board is a recycled piece of 3/4" plywood board from the 2018 Power Up Week Zero field. The black, white and blue painted pixels were part of the scale field element that year. It was fun to bring some of the past forward to the 2023 robot. You will probably have unpainted bumper boards on your robot.

In these photos, the wooden bumper board and pool noodles have been covered with temporary fabric. In this case we cut a bed sheet and heat transferred numbers on the bumpers. The temporary bumper

coverings will be used for practice and Week Zero competitions to avoid tearing our good bumpers before competition. You do not need to cover your bumpers with fabric under your bumper fabric. The photos reflect that we made bumpers while keeping the temporary fabric in place. We won't put the real bumper fabric on until after Week Zero to avoid damaging them on plywood field elements during our practice tournament. After the tournament, we will remove the temporary covering and put the official bumper fabric directly on the noodles.

This year, our robot uses a single complete bumper. There is no bumper cut out. We find that in years when bumpers are on all sides of the robot, using a single bumper, rather than 2 or 4 bumpers makes the process of making bumpers faster, rather than making a bumper for each side of the robot. The bumpers are also more durable when a single piece.

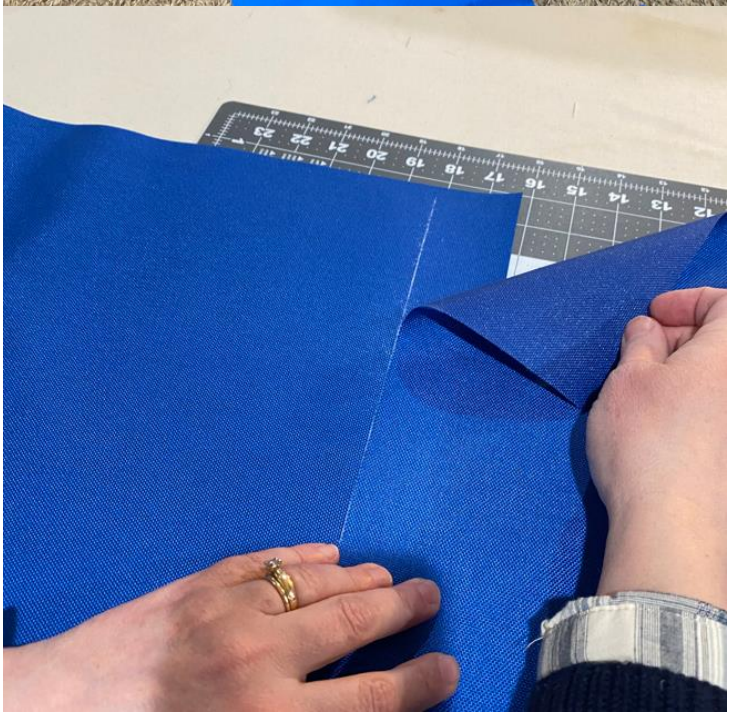
If you are making bumpers that are not a full circle, this guide can still be relevant. You will need to adjust your fabric length to wrap around your bumper board ends. Your fabric length can be less precise because they will be stapled behind the bumper on the ends.

PLEASE READ THE ENTIRE SET OF INSTRUCTIONS AT LEAST ONCE BEFORE YOU START

Let's get started!

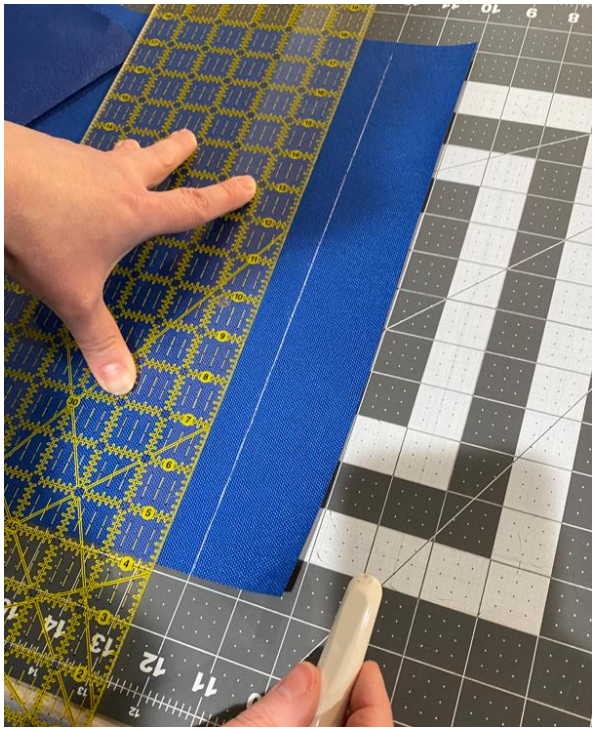
Determine the width of the bumper fabric by measuring around the bumper. In this case the full length needed to fully wrap the bumper is 16". We have made our fabric 14" wide. This leaves 2" in the bumper board to expose the mounting hardware but leaves plenty of fabric so the fabric can be stapled to the plywood.

Measure how long your fabric must be to cover the entire bumper. In this case we find a



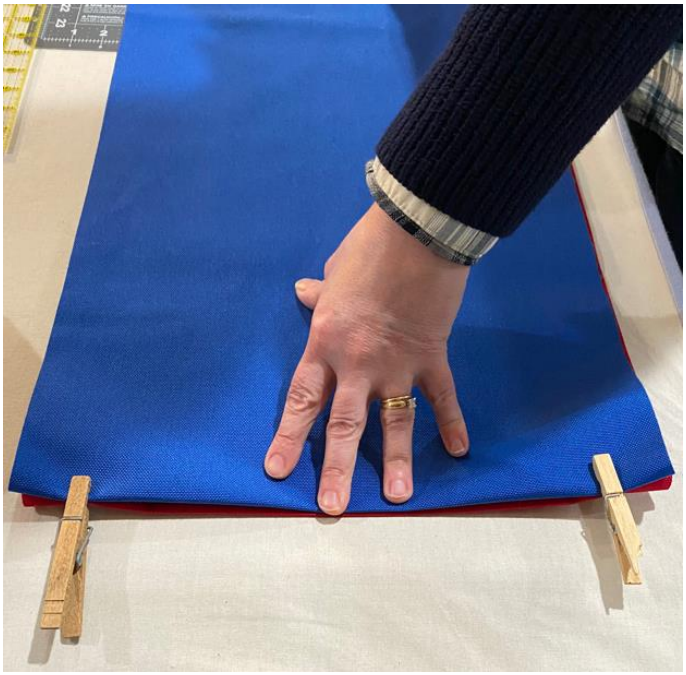
measurement of 126 inches. Be sure to measure on the noodle, not in between.

Plan for a 2” overlap of the fabric to allow for multiple sewing lines to handle the stress on the seams. This means 126” would become 128” to account for an overlap when you sew the complete circle. If you need to join multiple pieces of fabric to make the full length, each overlap should be 2". When sewing your first complete circle of fabric, only sew one stitch to join your pieces, you will come back to sew reinforcing stitches once you have completed your dry fit of both pieces. Use chalk or a washable marker to make temporary lines.



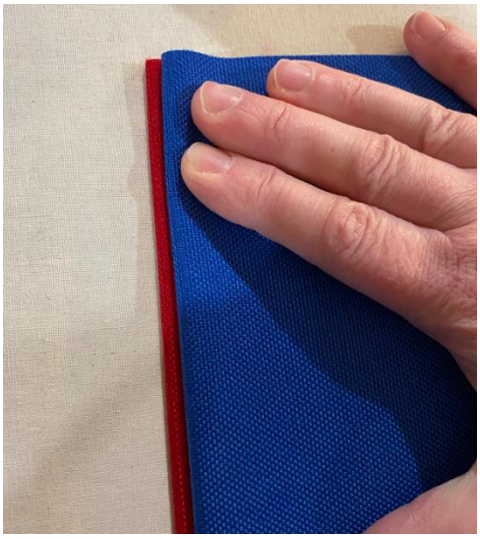
Once you have your dimensions determined, sew your fabric into a complete circle. Fit the material over the bumper. Check to ensure it is tight. In this case, the fabric was too loose. A tight bumper will help to avoid movement of the noodles, especially dropping down and rubbing on the floor. If you use hollow core noodles they will compress over time, the fabric may also stretch. Having them be tight from the start will reduce the probability that your bumpers are “sloppy” by the end of the season. In this photo, first fitting, the material is too loose. We removed the seam with a seam ripper and reduced the fabric to 127” and were much happier with the fit. It should be very snug, but not a huge struggle to slip the fabric over the noodles. The fabric shouldn’t be noticeably compressing the noodles.

Once you have the first complete loop the dimension you want, make an identical loop. An easy way to verify they are the identical length is to lay the first loop down and place the second piece of fabric on top. Use



In this photo, both ends are pinned, with the blue fabric overlapping somewhere in the middle. A line is marked to show where the two ends will meet when sewn. Cut an extra two inches for a correct overlap. In this case the extra two inches are to the left of the line on the blue fabric

clothes pins to secure the completed loop (red) to the next loop (blue). Mark the overlap where the fabrics must be sewn to have an identical length.



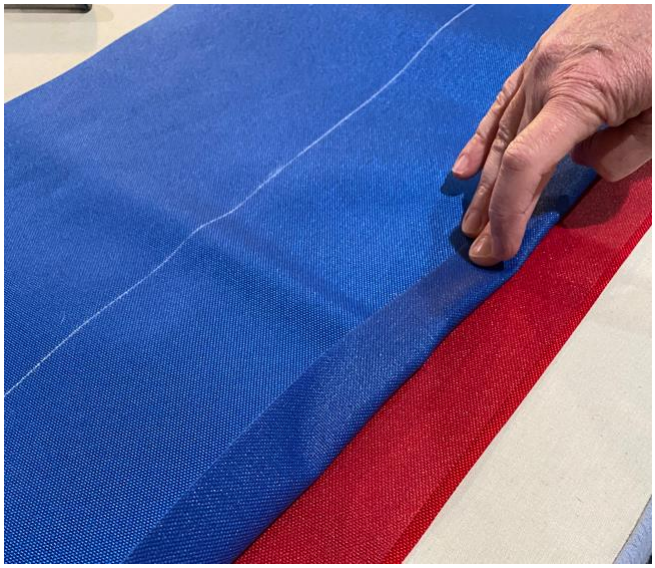
Once both the red and blue fabrics are sewn into a complete loop, lay them on top of each other (folded in half). Pin one end and compare the other end. Both loops must be the identical length. In this photo we see that the blue fabric is shorter than our red fabric by about 1/8". The seam rippers quickly removed the last stitch on the blue fabric and the blue loop was adjusted to be 1/8" longer.

On the second try, both fabrics are the identical size. It is critical that booth loops must be the same length. This is because when on the bumpers, the fabrics will be attached to the fame side by side. This will be more obvious in future pictures.

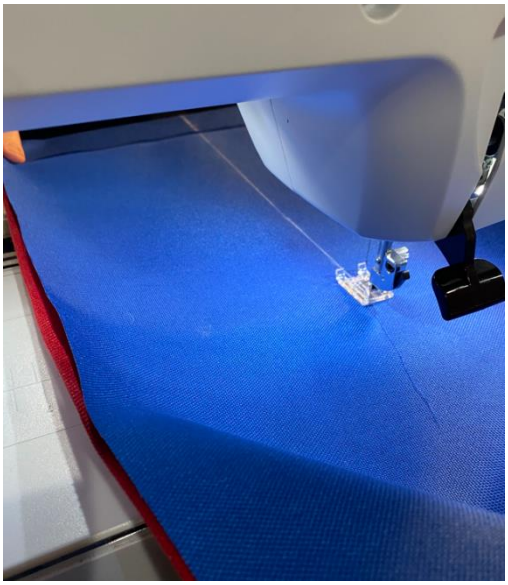
If you are making bumpers that are not a full circle, the need to have identical loop sizes does not apply.

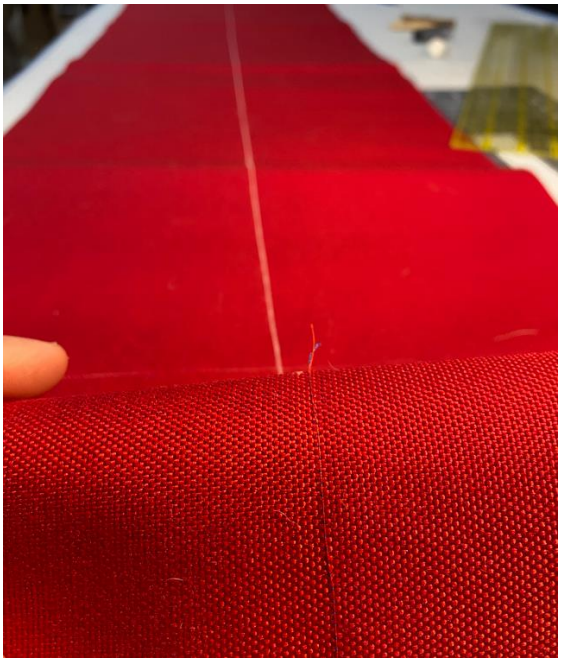
After getting both loops to the identical size, do another fit test to double check both fit as expected. Then return to the sewing machine and add your reinforcing stitches to each 2” overlap. In this case we used 3 straight stitches on the 2-inch overlap and a zig-zag stitch to secure the flap.

With both loops complete, it is time to join them. Place one loop inside the other. The fabrics should have the wrong side touching. This bumper fabric has a shiny/glossy side and the more canvas-looking side that we want exposed. The shiny sides should be touching when placing the loops together. In this photo the red loop is inside the blue loop with the bad/shiny sides together. Mark a line down the center of the bumper on only one side. An extra step that can add extra durability and make things look nicer is to put the seams opposite each other on the loop, so they will be on opposite sides of the robot.



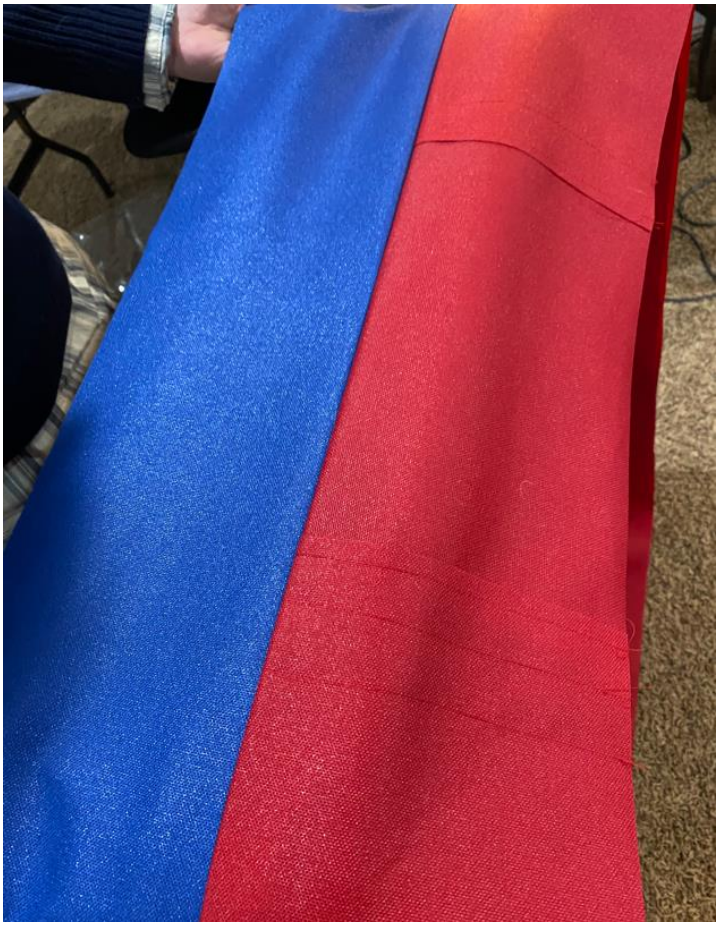
You will now attach the red and blue fabrics on this line. Sew down the line at the start of your chalk mark. You are sewing a loop, so move one side of the loop off to the side of your sewing machine.



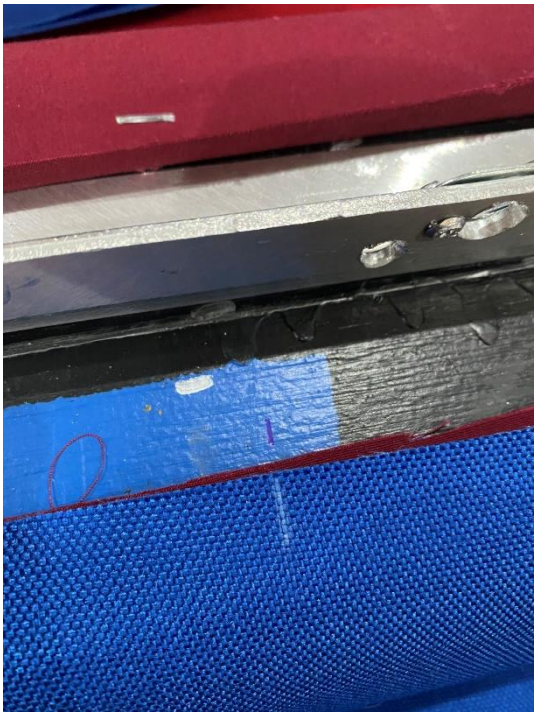


When you have completed that line, flip the loop inside-out so the red side is on top. Mark a center line on the red side and sew down that line. You want to sew one side of your loop with the blue side up and one side with the red side up. This will help to avoid puckering that could occur by having one color of fabric always on the inside. Remember, each piece is exactly the same length, so you need to give them equal chance to stretch while sewing. You should now have a complete straight-stitch seam that goes entirely around the loop. If you are using red and blue thread, you'll need to switch your bobbin too.

With the loops complete, flip the fabric so there is a red side and blue side. The shiny/wrong side of the fabric should be out. Slide the fabric over the bumpers and make sure everything fits.



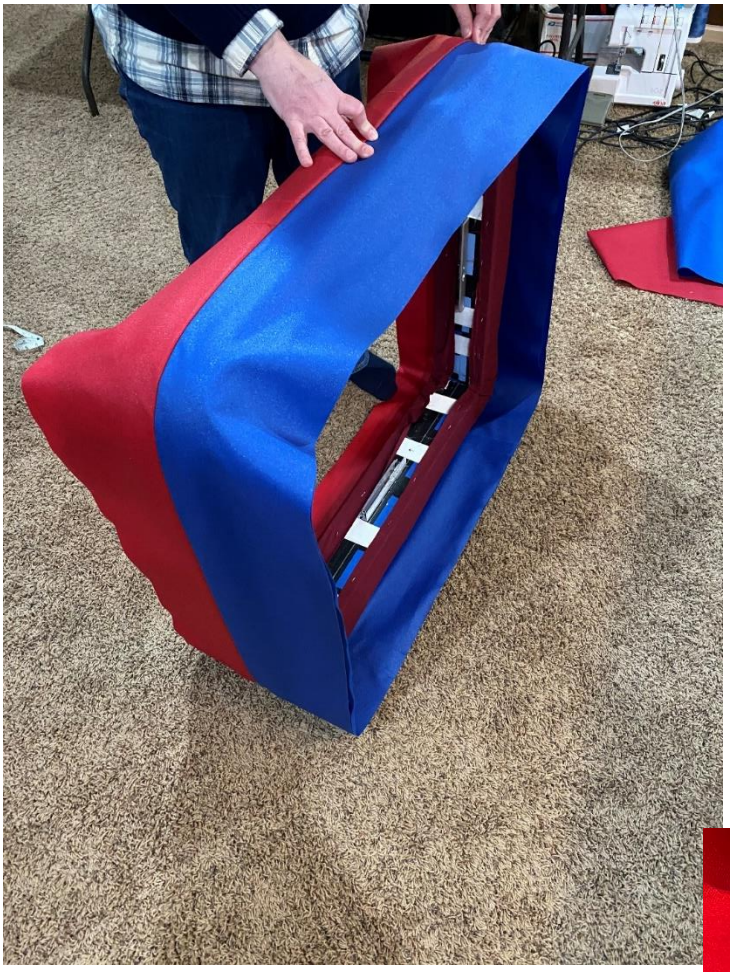
To make sure everything looks nice and to avoid seam breakage, try to avoid having seams close to the corners of the bumpers. In this case we decided to put the seams on the side of the bumpers that would be the sides of the robot (not front or back). We also placed our seams for the red and blue fabric on opposite sides of the robot.



If you want to be super perfect in your seams to make sure they are centered between the corner of your bumpers, mark the middle between the two seams on the fabric, and the center of the bumper boards. When

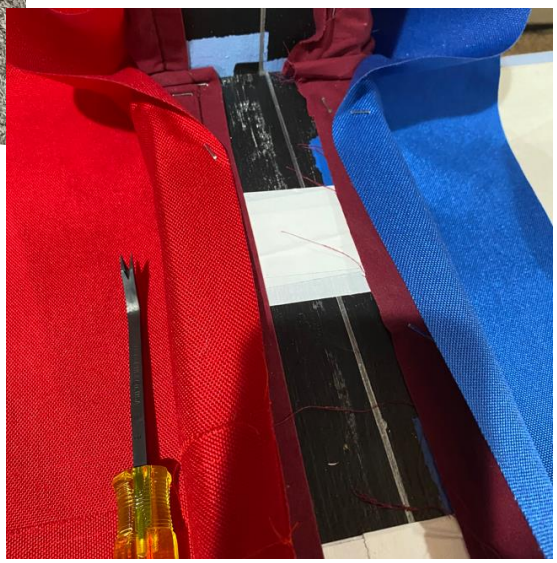
placing your fabric on the bumpers, match up these two lines.

Position the bumper fabric so that it is perfectly in the middle of the bumper noodles on all sides of the bumpers. If your fabric is snug, it should not shift as you rotate the bumper to adjust each side. We prefer to have the red side of the bumper fabric up. This requires you to know which side of your bumper boards is the top/up side. The Red Alliance is the higher ranked alliance in playoff matches, as such, many teams prefer to show their robot with red bumpers. By placing the red side up, the flap will be down when the red bumpers are visible. It is a nice clean look for photos and demos when the flap is tucked under the robot.



With the fabric perfectly centered, staple the fabric in each corner. This is temporary just to hold the fabric in place for now. Note, in this photo is an upholstery tool for removing staples. This can be very handy for anyone making bumpers every year.

With the corners temporarily fastened in place, pull one side of your fabric to the other side of the bumper so the red and blue flaps are touching. These two flaps will be sewn together to make the reversible flap. For best results, pull the fabric to the side so that the fabric will be up, when the bumpers are on the robot. If you followed the advice in a previous step to have the red on the top side of the robot, you will pull the red and blue flaps so that the blue is out. In other words, when the blue bumpers are shown, the flap is up, when the red side is shown, the flap is down. Having the flap up for the following steps will help to ensure the flap looks nice, clean and perfectly aligned with the flap is up. If there is a small variation in the corner overlap, or the flap is a little too short/long when the reds side is shown it won't matter because that part will be tucked under the robot.



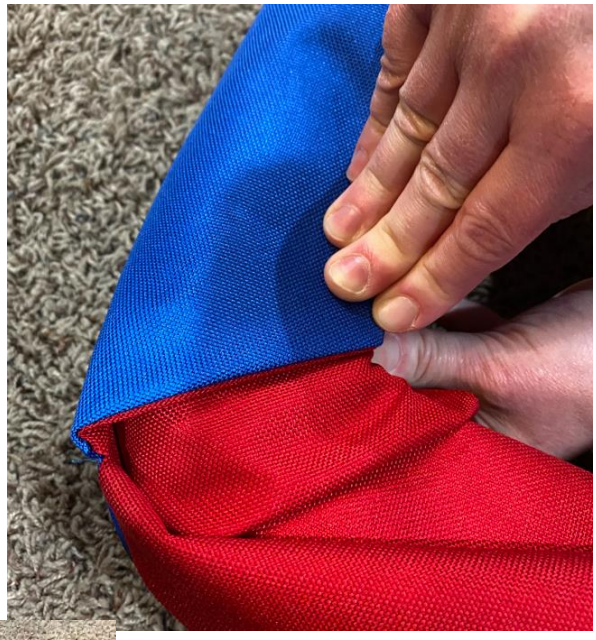
On this flap, at the corner, mark up from the center seam the distance that matches the diameter of your noodles. In this case, we use solid core noodles that are 2.5”. Many hollow core noodles will be 2.25”.

Cut from the edge of the flap fabric through both red and blue fabric to this line.

Fold the two pieces of flap fabric in on itself to make a nice seam. The distance of the flap should allow the flap to fold back to the inside edge of the wooden frame. Use clothes pins to secure the flaps until you are ready to sew.

In the corners, tuck the extra fabric in between the two pieces of fabric to make a roughly 45 degree angle. Rather than using a corner tool to find an exact 45 angle, adjust the fabric to ensure the inside meets the inside corner of the frame. The angle may be slightly more or less than 45 degrees. It is best to use whatever angle allows the corners to meet so that the underlying fabric is not showing.

With all corners cut, folded, and positioned your progress should look like this.



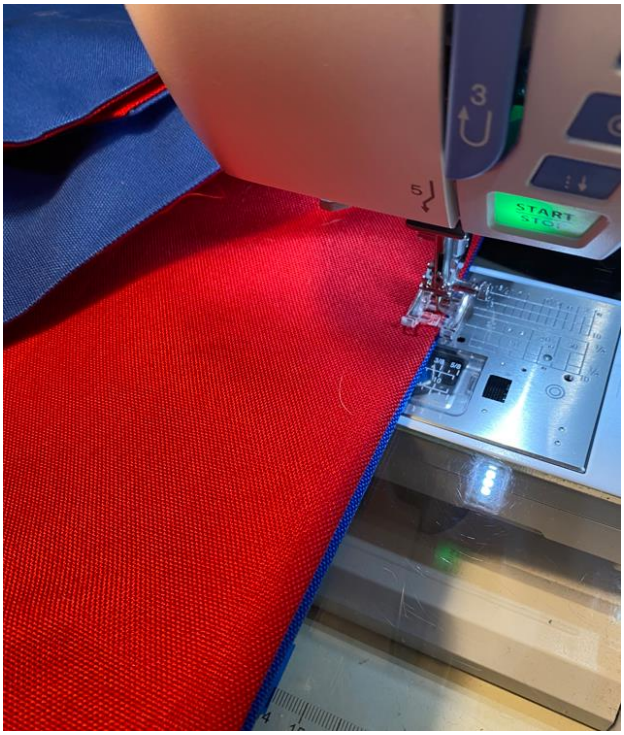
Next, determine your fastening method. Most years, we use Velcro. However, during the 2019 Deep Space season, we elected to use snaps. That year, one of the game elements used Velcro to attach to the field. We didn't want to run the risk of driving over a field element and accidentally picking up a game piece, which could incur a penalty. Be sure to check the game manual to ensure snaps are allowed for your game year. In this case we will be using Velcro. We prefer to fasten the stiff hook side to the bumper frame and have the

soft loop side on the flap. There are situations where you may not want to do that and may need to ensure the hook side is not capable of getting caught on the carpet if you have to drive over large bumps and your bumpers may bottom-out on the carpet, or if there is other fabric fixtures on the field where you want to avoid having your hook exposed. In 2022 Rapid React season, we found that our hook on the top of the bumper would catch the large tennis balls with our over-the-bumper intake. For that year we added a flap to our bumpers that would cover the Velcro while on the red alliance. There are often solutions to cover exposed hook Velcro if you find it is necessary.

Start by marking the location of the bumper frame edge all the way around the bumpers on both sides.

In addition to the edges, mark in from the folded corner fabric far enough to allow the Velcro without impacting the ability to create a fold for the gathered corner fabric. The excess fabric gathered on the corners can be gathered and stapled to the frame in final assembly.

With the bumper frame marked on both sides and starting location for the Velcro, you can remove the staples and take the fabric off the bumpers.



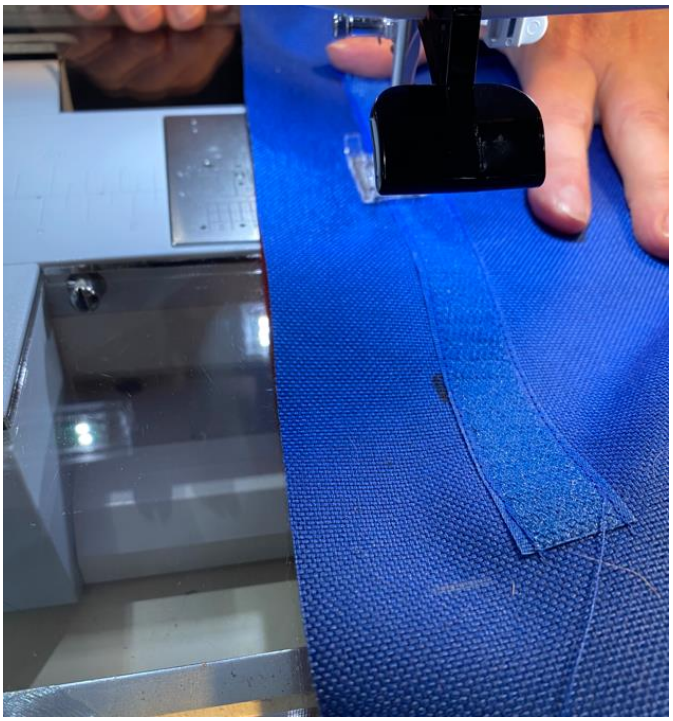
Begin sewing the flap edge all the way around the bumpers. You should be able to make a continuous stitch around the entire perimeter of the bumper flap.

In the corners, keep your extra fabric tucked in nice and tight to make a good-looking corner. You will come back to this location where you cut the fabric later and add extra stitches to reinforce the corner. It will be under a lot of strain as you flip the bumper colors. To avoid this strain, you could cut this corner all the way to the center line. In a previous step we ended this cut 2.5" (noodle diameter) from the center line. If you cut all the way to the center line, you create a place where your robot could get snagged on a field element. Evaluate the pros and cons of making bumpers easier to flip versus less likely to get snagged.

Having the cut end 2.5" from the center line also helps keep the flap up, if the Velcro comes loose. If your bumpers change from blue to red mid match because the flap falls down easily, you could incur a penalty.

Reinforce the corners with a few zig-zag stitches.

Sew on the hook Velcro using your guide marks that identify the bumper board.

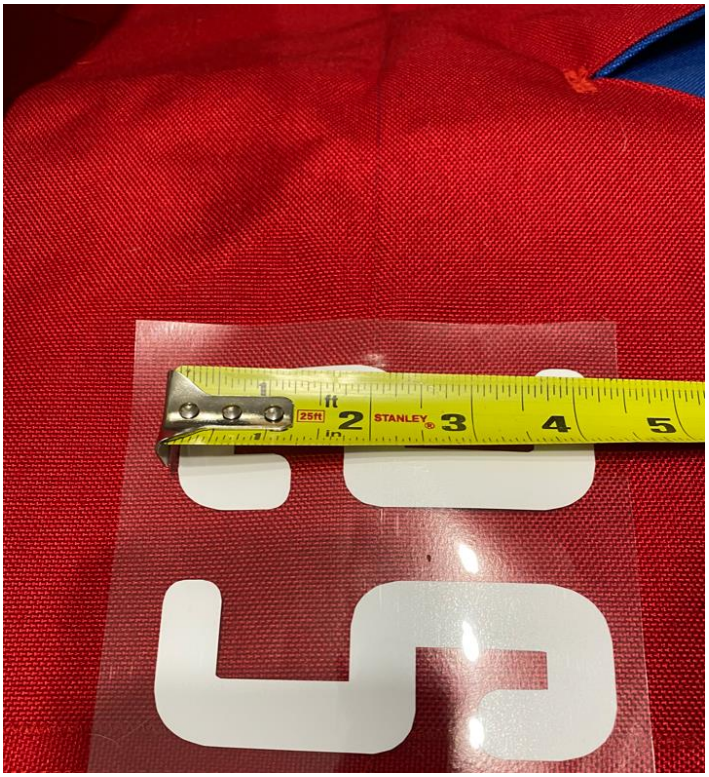


Sew on the loop Velcro around the flap edge.

At this point, your sewing should be complete.

With sewing complete. It is time to add the team numbers. Start by marking the position for the numbers on your fabric. Be sure to identify which way is up on your bumpers. In this case the red side of our bumpers is visible when the flap is down. For KnightKrawler, we prefer to place our numbers in the right corner of the bumpers. For this year we decided to place them 4” from the corner. You can place your numbers anywhere, just be sure to mark them for consistency.

KnightKrawler uses heat transfer vinyl for our numbers and a heat press, typically used for making T-shirts. The vinyl can be cut a variety of different ways, but using a Cricut cutter is a common way many teams cut vinyl and is something many schools have available for use.



Bumper rules can vary, so check the game manual for lettering requirements. This year the numbers are required to be at least 4” tall and 0.5” thick, with solid white letters. You can use any font you want as long as it meets the requirements specified in the rules.

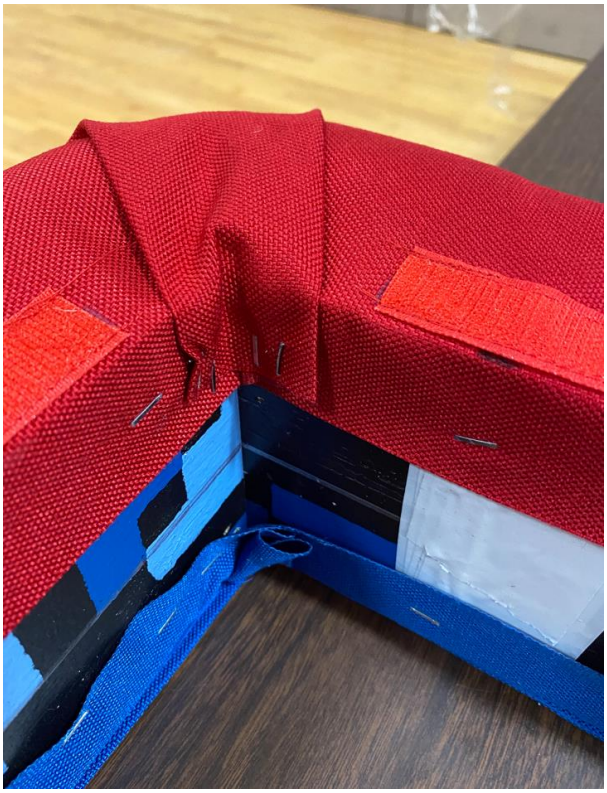
If you are new to vinyl heat transfer, remember that you need to cut your heat transfer in a mirror image, because you cut the vinyl from the back side in your machine. It is easy to forget this step.

With your vinyl numbers cut position this so they are centered on the center seam of the bumper.

If you have access to a T-Shirt heat press, or are simply using an iron, apply enough head until the vinyl melts into the fabric. All vinyl transfer will have guidelines on time and temperature for applying heat. We find that you should apply heat until you can see the texture of the canvas through the vinyl to ensure you have good adhesion.

With the red side done, flip the flap of the bumper fabric and transfer the numbers to the blue side. Be sure to maintain “up” so that all numbers are correct when the fabric is placed on the bumpers. When you fold the flap to show the blue side, your numbers on the red side will be folded together. We have never had an issue with heat pressing the blue side, when the white vinyl numbers folded together on the red side. However if your heat press is too hot or you hold the heat for too long, you may end up with your numbers on the red side melting together. To

avoid this, you could use some Teflon paper or baking sheet paper inside the red flap to keep the white vinyl from touching each other while folded over.



With numbers complete, it is time to staple the fabric to the bumper boards. We typically use 1/4" or 3/8" staples to attach the fabric to the bumper wood. We use an Arrow staple gun with T50 staples that can be purchased an any hardware store. Start on the top side (red) and align your Velcro to the bumper boards. Staple all the sides first to make sure you have a snug and symmetric alignment all around the bumpers. Before doing the corners, do the sides of the blue fabric. Be sure to pull the fabric tight when stapling. Use a hammer to pound the staples flat to the board. With all side fastened, fold the corner fabric anyway you like to create a nice corner. You should be able to make a nice corner without cutting the fabric. Staple the folded corner to the inside of the bumper boards and use a hammer to ensure the staples hold well. You may need longer staples if you are having trouble with the multiple layers of folded fabric.

This completes our bumper fabric tutorial. If you have questions or want to provide feedback, please email info@team2052.com.

Good Luck!