

FIRST Robotics Competition

Robot Bumpers Guide

Note: Remember to read the bumper section in the game manual for specific rules.

What is this?

After spending a lot of time in the FRC world making various types of bumpers I've put together a little document to hopefully help teams to construct bumpers that would be best fit for their robot and strategy.

- Kelsey Draus

Table of Contents

3 Pre-Fabrication Checklist

4 Materials Selection

- Attachment Hardware
- Pool Noodles
- Fabric
- Numbers (Types and Application Instructions)

14 Bumper Types and Construction

- General Tips
 - Cutting Pool Noodles
 - Spacing and Number Placement
 - Attaching Hardware
- General Fabrication Outline
- Types of Corners and Ends
- Wrap Around
 - Separate Pieces
 - One Piece Wrap Around
 - One Piece Other
- Reversible Covers

29 Quick Fixes for Competition

- Fabric
- Number

31 Gallery of Bumpers

Photographs of various types of bumpers and mounting systems for inspiration.

Pre-Fabrication Checklist

Wood

- Purchase Wood
- Cut to Size

Pool Noodles

- Purchase Noodles
- Cut and Tape (depending on method)

Fabric

- Purchase Red and Blue Material
- Cut to Size

Hardware

- Select attachment method
- Purchase or Fabricate hardware

Numbers

- Purchase Fabric
- Select a Font
- Cut out Numbers
- Adhesion Method (Glue, Iron-on, Embroidered, etc.)

Quick Fix Items

- Purchase items for fixing bumpers
- Remember to bring items to competition

Things you may want to have handy while making bumpers:

- Good Scissors (such as sharp sewing scissors)
- Duct Tape
- Sharpie Marker
- Staple Gun and Lots of Staples
- Ruler and Tape Measure (to help with spacing)
- Tools Needed to Attach Hardware (drill, screwdriver, hammer, etc)
- Hand Saw or Serrated Knife (for cutting pool noodles)
- Wood Saw

Materials Selection- Attachment Hardware

Note: Remember to read the rules on bumpers hardware in the game manual. Typically hardware cannot protrude more than a certain amount, and there is often a weight limit. The type of hardware depends on the type of attachment method used. Here are some commonly used types:

Pull Pins:

- **Pros:** Quick and easy to make and maintain, also does not usually take up a lot of space within the robot. Pins are easily replaceable if bent and inexpensive.
- **Cons:** If the holes are not drilled properly for the pins, the bumpers can wiggle and feel loose. Remember to pack extra pins in case some are lost or bent.



Latches:

- **Pros:** Quick and easy to switch the bumpers and there is no need to worry about losing or missing parts. Often very secure when installed properly.
- **Cons:** Can be more expensive and more difficult to install. If one breaks it takes more effort to replace it. Wear over time can cause difficulty depending on the kind of latch.



Bolts/Nuts

- **Pros:** Inexpensive and uses things that are commonly found in a typical shop. Easy to do and easy to fix.
- **Cons:** Often takes additional time to change bumpers and if locking nuts are not used they can loosen. Can be difficult to have holes lined up perfectly.



Materials Selection- Pool Noodles

Note: Remember to read the rules on pool noodle types in the game manual.

Round Solid:

- **Pros:** Does not compress as easily and will hold shape better than other types. With less compression, the fabric does not move as much and often numbers will stay on better. This type of noodle is also great for angled corners since when cut on an angle there is more material to support the corner.
- **Cons:** These noodles are stiffer and thus harder to bend around corners or complex shapes. They can also be more expensive or harder to find than round hollow noodles.



Round Hollow:

- **Pros:** Compress easily which helps to absorb impact more than solid noodles. With the possibility of more compression, it also allows for fabric to be wrapped tighter. These noodles bend easily which means they can conform to wrap around corners and complex shapes. Round hollow noodles are often easy to find in the store at a low cost.
- **Cons:** If cut on an angle there is minimal material support for a corner. Also these noodles often compress and deform more with time. Since the material compresses more on impact, it also increases the surface area in contact with another bumper and thus often there is more friction.



Pedal:

- **Pros:** Often the stiffness is somewhere between the round solid and round hollow. These can also be easy to find on sale at the end of summer.
- **Cons:** The ridges on the outside are often hard to cover with fabric for a smooth finish.



Materials Selection- Fabric

Note: Remember to read the rules on fabric types and colors in the game manual. Typically fabrics must be red and blue.

Material: Sports Twill

Pros: Works on all types of bumpers. Low amount of friction. Wears well and resists tearing. Easy to work with when covering. Easy to adhere numbers to.

Cons: Adhesive backing is difficult to work with for complex shapes and the material has to be ordered in advance due to shipping time.

Where to Buy: US Twill: <https://www.twillusa.com/material.aspx>

- Type is "Sports Twill"
- Colors are "Red" and "Royal"
- Non-adhesive backing or Adhesive Backing
 - Non Adhesive: Easier to cover and get the fabric tight, also can do complex shapes
 - Adhesive: Helps prevent saggy bumpers, but is best for straight shapes

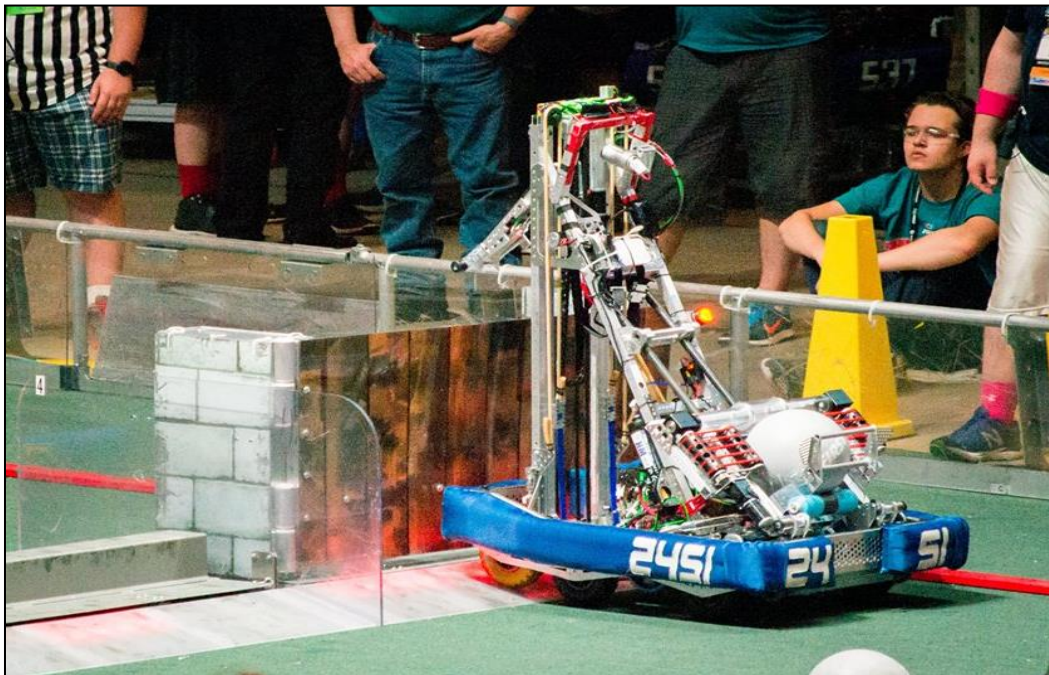


Figure 1: Team #2451 with Non-Adhesive backed bumpers. Wrap around method.

Material: Dacron Sail Cloth

Pros: Slick surface and low amount of friction. Lightweight and has a very smooth appearance. Great for making sharp corners. Smooth surface makes number application easy.

Cons: Not easy to work with for complex shapes and can tear easily. Over time wear is visible. Since the material does not have any stretch to it, it is difficult to pull material tight. Wrinkles easily on rounded corners.

Where to Buy: <https://www.sailmakersupply.com/product/colored-dacron-sailcloth/sailcloth>

- Type is "COLORED DACRON SAILCLOTH SKU 1010-P"
- Color is "10102 - Red" and "10106 - Dark Blue"



Figure 2: Team #5934 with Sail Cloth bumpers. One piece method with angled corners.

Material: CORDURA® or Slick Nylon

Pros: Inexpensive and easy to work with. Does not tear easily and has good wear resistance.

Cons: Thinner than other fabrics. Any dark tape or different colored pool noodles may slow slightly in certain lighting.

Where to Buy: <http://www.rockywoods.com/Fabrics-Kits/1000D-Cordura-Nylon/1000-Denier-Coated-Cordura-Nylon-Fabric>

- Type is "1000 Denier Coated CORDURA® Nylon Fabric"
- Color is "Red" and "Royal Blue"

Where to Buy: AndyMark

- <http://www.andymark.com/product-p/am-2955.htm>
- <http://www.andymark.com/product-p/am-2956.htm>



Figure 3: 1000 Denier Coated Cordura® Nylon Fabric

Material: Heavy Duty Nylon

Pros: Inexpensive and easy to work with. Does not tear easily and has good wear resistance. Great for iron on numbers and easy to sew.

Cons: Surface is not as slick and has a higher amount of friction.

Where to Buy: AndyMark

- <http://www.andymark.com/product-p/am-2675.htm>
- <http://www.andymark.com/product-p/am-2676.htm>



Materials Selection- Numbers

Note: Remember to read the rules on number sizes in the game manual. Typically numbers are 4 in. in height and must have at least ½ in. stroke (line thickness) and are usually required to be on all four sides of the robot.

Type	Best to Put on Before Bumpers are Covered	Cost	Wear and Bond to Fabric	Level of Difficulty
Glue On		**	***	*
Hot Press Vinyl	X	****	*****	****
Embroidery	X	*****	*****	*****
Iron On	(Sometimes)	***	**	*
Paint		*	*	*
Sewn On	X	**	*****	***

Glue On Numbers

Pros: Glue on numbers can be done easily and in the shop. It's also a cheap way to do numbers that also looks nice. Can be done in a short amount of time with little preparation.

Cons: If glue is not properly spread to corners or not enough glue is used then ends may come loose.

Material Types:

Vinyl: Inexpensive and easy to find at a local fabric store. Easy to keep clean. Important to make sure layers (if any) of the fabric adhere well to each other.

Oil Cloth: Inexpensive and easy to find at a local fabric store. Easy to cut out and glue on. Edges may fray if not well glued and they can get dirty easily.

Method:

Print and cut out stencil for numbers

- Choose a kind which meets the game manual requirements
- Print out the numbers on a piece of paper
- Check the requirements using a ruler
- Tape the back side of the paper to stiffen the paper (masking tape works well)
- Cut out the numbers

Trace stencil onto the fabric

- Make sure it is being traced in mirror on the back side so that none of the tracing pen/marker/pencil shows on the final numbers

- Note: It may be helpful to mark on the back side a reminder that when tracing number onto the fabric, you should be tracing the mirror image of the number onto the back of the fabric.

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Cut the numbers out

- Use sharp scissors
- Take your time to ensure edges are clean with no fraying or small tears

Glue the Numbers on

- Use a tape measure or paper to help space the numbers evenly on the center or side of the bumper
- Cover the back of the number in glue, clear e-6000 works well, making sure there is plenty of glue especially on the edges and corners.



Figure 4: Team #5934 with glue on numbers.

Hot Press Vinyl

Pros: These numbers look very professional and often adhere really well to the material.

Cons: A greater amount of planning is required. Numbers must be applied before the fabric is put on the bumpers. The turnaround time may depend on the vendor so often these cannot be done at the last minute. Can become crooked while covering the bumpers.



Embroidery

Pros: These numbers look very professional and there is no risk of them coming off the fabric.

Cons: A greater amount of planning is required. Numbers must be applied before the fabric is put on the bumpers. The turnaround time may depend on the vendor so often these cannot be done at the last minute. The font and numbering size may be limited depending on the vendor and machine. This method can also be expensive. The numbers pick up dirt and are difficult to clean once dirty. Can become crooked while covering the bumpers.



Note: Location of numbers will need to be marked on the fabric before the embroidery process. Talk with the person doing the embroidery to see if they need the fabric prepared in any special way.

Iron On

Pros: These numbers look very professional and are easy to apply. They can be done in a short time frame and materials to do this can be found at a fabric store.

Cons: Depending on the iron on type, numbers may need to be applied before the fabric is put on the bumpers due to the heat needed (potential to melt the pool noodles). If they are not applied properly, they can come off and the corners may peel. They often do not wear as well as other methods. Can become crooked while covering the bumpers if applied before covering.

Note: Read iron instructions carefully. Adhesive method may be different depending on the brand and type.



Paint

Pros: These numbers are quick and easy to apply. The type of paint that is often used is acrylic, which is inexpensive and easy to find. The numbers can be applied after the bumpers have already been assembled.

Cons: Painted numbers often do not as look professional as other methods. The paint can seep into the fabric or may have a hard time adhering to the fabric depending on the paint/fabric combination. Sometimes multiple coats are necessary. A test run is encouraged to make sure the paint and fabric are compatible before painting the final bumpers. Depending on the type of paint, it can also flake off and wear poorly through the season.



Note: It's often easiest to stencil the numbers using pencil or chalk and then paint to fill it in.

Sewn On

Pros: These numbers look professional when done correctly and have little to no risk of them coming off. They are easy to do using a standard sewing machine.

Cons: It's important to choose a fabric that will not fray. To have the numbers look good, the sewn part needs to be on the outermost edge of the numbers. This method can also take time and must be done before the fabric goes on the bumpers.

Note: Using an iron on backing as well as sewing the edges can make for a really great combination. The iron on adhesive holds the numbers on and in place while the sewn edges make sure there is no peeling and the numbers do not come off.



Bumper Types and Construction- General Tips

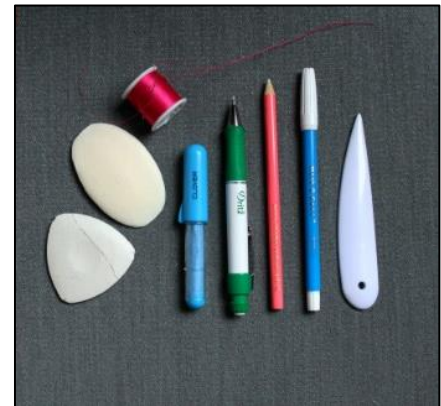
Cutting Pool Noodles

- The most effective way to trim pool noodles is with a hand saw or a large serrated knife. Typically it is good to avoid cutting the noodles until it is absolutely necessary.



Spacing and Number Placement

- A piece of paper and your letter template in conjunction with a tape measure to help with number spacing. Sometimes fabric chalk is also helpful in marking where numbers go, and it can easily be washed off later.



Attaching Hardware

- If hardware needs to be put in specific locations, it is sometimes easier to mark both the wood and fabric while you are covering in order to keep track of the desired locations.

Using a Metal Frame

- When making bumpers which secure into a metal frame it is important to remember to leave a little extra wiggle room for the fabric when cutting the wood.



Figure 5: Team #3928 with metal frame bumpers.

Bumper Types and Construction- General Fabrication Outline

- ❑ Gather all materials for the desired method
- ❑ Cut wood
- ❑ Plan out hardware and locations
- ❑ Tape the pool noodles together
- ❑ Mock up / build the bumpers using tape aka tape the noodles on the wood and make sure it will work
- ❑ Cut and prepare the fabric
- ❑ Cover the bumpers with fabric
- ❑ Trim any excess fabric
- ❑ Apply the numbers (may be done before covering process depending on the type of number)

Bumper Types and Construction- Types of Corners and Ends

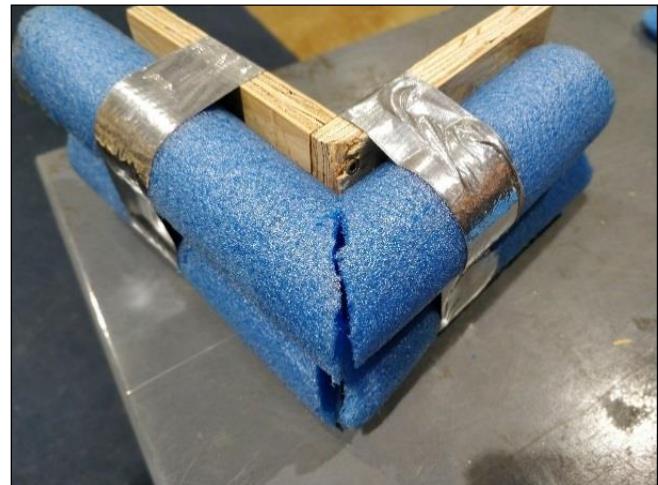
Corner: Wrap Around

- **Description:** Noodles are together and wrap around the corner seamlessly.
- **Pros:** Rounded corners which help to not get stuck when pinned by other robots.
- **Cons:** Doesn't have a clean corner appearance.
- **Tips:** Use extra tape to make sure the noodles wrap. There may be some resistance in bending them. The thickness around the corners needs to follow guidelines in the rules manual.



Corner: 45 Degree Angle Cut

- **Description:** Ends of noodles are cut at an angle so they fit together at the corner.
- **Pros:** Easy to cover and has a clean look.
- **Cons:** Corner does not have as much strength as other types since it is just the tips of the noodles. Can be difficult to cut the angles properly.
- **Tips:** A sharper angle is better than a shallow one to be sure that the tips fit together snugly.



Corner: Vertical Noodle

- **Description:** Noodles on the sides are cut so that there is a 90 degree gap. A small vertical noodle is placed to fill in the gap.
- **Pros:** Slightly rounded and easy to cover.
- **Cons:** Can be slightly harder to cover with fabric and have it look nice (aka it will take more tweaking and a tighter fold).
- **Tips:** Make sure the height of the noodle is correct, it's sometimes best to have it slightly shorter than the noodles on the sides since those compress more due to the hollow insides.

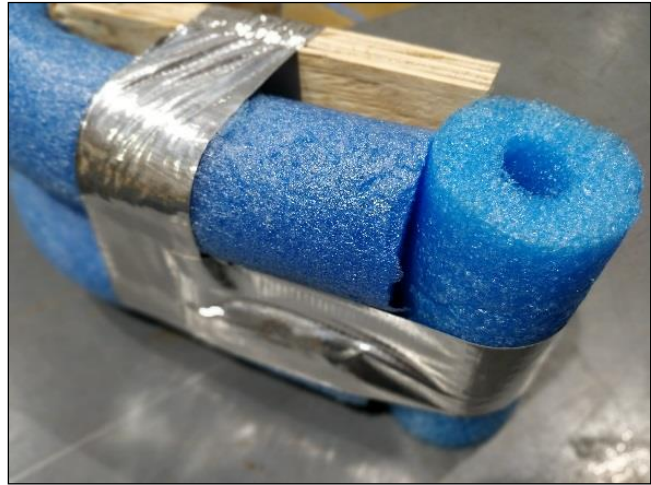


End: Noodles Extending Over the Edge

- **Description:** The two noodles extend over the edge of the wood slightly in order to butt up to the other sides.
- **Pros:** Easy to do and easy to keep them uniform.
- **Cons:** Sometimes they do not fit together as well if some are hanging off the end more than others.
- **Tips:** Make sure they fit together well and there are no gaps before covering them with fabric. Also taping the ends can help to give them more stability.

End: Full Vertical Noodle

- **Description:** The two noodles are cut flush with the wood and one vertical noodle is at the end to help join the noodles with the other sides.
- **Pros:** Nice looking rounded corners and the squish makes them easy to mate up to the other sides. Also is uniform on all corners.
- **Cons:** Sometimes if using large noodles it may extend out too much and trimming of the side noodles may be needed.
- **Tips:** It's sometimes good to cut the vertical noodles just a tad shorter to account for the squish of the side noodles. Using tape to hold them on is useful in checking the fit and for covering with fabric.



End: Half Vertical Noodle

- **Description:** Similar to the vertical noodles corner, but with half.
- **Pros:** Easy to cover with fabric. Slightly less rounded end.
- **Cons:** Sometimes depending on the noodle it may not be enough to have a tight fit on the corners so adjustments may have to be made.
- **Tips:** $\frac{3}{4}$ of a noodle can also be used if there is more space to cover. Using tape to hold them on is useful in checking the fit and for covering with fabric.



Bumper Types and Construction- Wrap Around

Cut the wood for the bumpers (check the game manual for wood requirements)

Tape noodles together so that you have 2 long noodles which wrap all the way around. Duct tape works well for this.

- Press the pool noodle ends together so that there is some compression then place two strips of tape in the longitudinal direction and then one strip wrapped around the joint.
- Then take the two very long noodles and tape them together with a piece of tape every 1 to 2 feet.

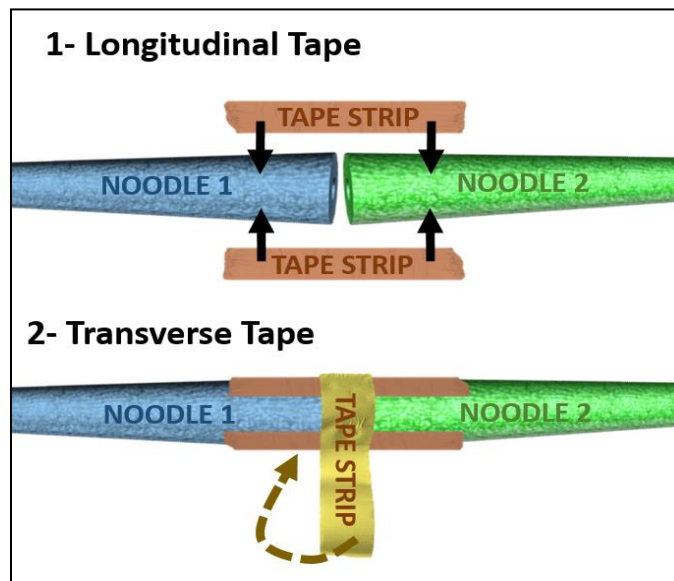


Figure 6: Taping pool noodles together.

Lay the cut boards into the frame or hold them up to the robot and hold the bumpers onto the wood (this may require more than one person). Using a sharpie marker, make a mark where the wood hits the pool noodles. This will help to make sure the wood is spaced properly

Tape the noodles onto the wood

- There should be one to two pieces in the middle and one at each end of each piece of wood.
- This also helps to prevent sagging of bumpers

Once they are taped, hold the bumpers up to the robot or frame and check

the fit. Adjust the wood location if necessary.

- A little extra room between the wood pieces is often ideal since the fabric will cause the bumpers to wrap slightly tighter.

Trim the ends of the noodles using a hand saw or serrated knife. Then choose the type of end for the desired design:

- Trimming the ends flush to the wood will create a clean flat corner.
- Having a little left over at the end will create a softer end.
- Trimming the ends flush to the end then inserting a vertical piece of noodle will create a rounded corner.
- Trimming the ends flush to the end then inserting a half vertical piece will create a compact rounded corner.

Cut the fabric to the correct width so that it will wrap around the wood and noodles with some overlapping fabric on the back. Do not worry about trimming the ends to length, leave them long in order to have enough material to properly wrap the ends.

- Note: If you are gluing on numbers, this can be done once the bumpers are constructed before the hardware and/or frame is put on. Other number method may require number application before the fabric wrapping process.

Lay the cut fabric out on a flat surface, such as a table or the floor, with the fabric side you want on the outside of the bumper facing downwards. Place the noodle/wood structure onto the fabric with the noodles touching the fabric and the wood side facing up. Make sure that the noodle/wood structure is centered properly.

Starting in the center, staple one side of the fabric onto the wood, then pull tight and staple the other side. Work from the middle outwards, continuing to staple one side, pull the fabric tight, and then staple the other side, until everything is stapled except for the ends.

Once you get to the ends, fold the fabric then pull it tight and staple. It's best to leave extra fabric on the ends which can be trimmed off later after the staples are in place. This step is easiest with two people.

- Present Fold: Similar to wrapping the end of a present, you fold in the sides then wrap around, pull the fabric tight, and staple.
- Origami Fold: The sides fold into the middle, then wrap the end around, pull the fabric tight, and staple.

Bumper Types and Construction- Multiple Pieces

Cut the wood so that it fits into the frame or fits to the robot.

- Remember- if you are making the kind where the wood and whatnot fits into the frame, the wood should fit, but don't forget to leave room for the fabric
- You may also want to mark where the hardware will be placed for later.

Trim the ends of the noodles using a hand saw or serrated knife. Then choose the type of end for the desired design:

- Trimming the ends flush to the wood will create a clean flat corner.
- Having a little left over at the end will create a softer end.
- Trimming the ends flush to the end then inserting a vertical piece of noodle will create a rounded corner.
- Trimming the ends flush to the end then inserting a half vertical piece will create a compact rounded corner. Always trim them later.

Tape the noodles on to the wood.

- There should be one to two pieces in the middle and one at each end of each piece of wood.
- This also helps to prevent sagging of bumpers
- You may also have to tape the ends depending on what method is being used.

Hold the noodles as they are this far up to the robot to make sure pieces still fit and that the corners join together properly.

Cut the fabric to the correct width so that it will wrap around the wood and noodles with some overlapping fabric on the back. Do not worry about trimming the ends to length, leave them long in order to have enough material to properly wrap the ends.

- Note: If you are gluing on numbers, this can be done once the bumpers are constructed before the hardware and/or frame is put on. Other number method may require number application before the fabric wrapping process.

Lay the cut fabric out on a flat surface, such as a table or the floor, with the fabric side you want on the outside of the bumper facing downwards. Place the noodle/wood structure onto the fabric with the noodles touching the

fabric and the wood side facing up. Make sure that the noodle/wood structure is centered properly.

Starting in the center, staple one side of the fabric onto the wood, then pull tight and staple the other side. Work from the middle outwards, continuing to staple one side, pull the fabric tight, and then staple the other side, until everything is stapled except for the ends.

Once you get to the ends, fold the fabric then pull it tight and staple. It's best to leave extra fabric on the ends which can be trimmed off later after the staples are in place. This step is easiest with two people.

- Present Fold: Similar to wrapping the end of a present, you fold in the sides then wrap around, pull the fabric tight, and staple.
- Origami Fold: The sides fold into the middle, then wrap the end around, pull the fabric tight, and staple.

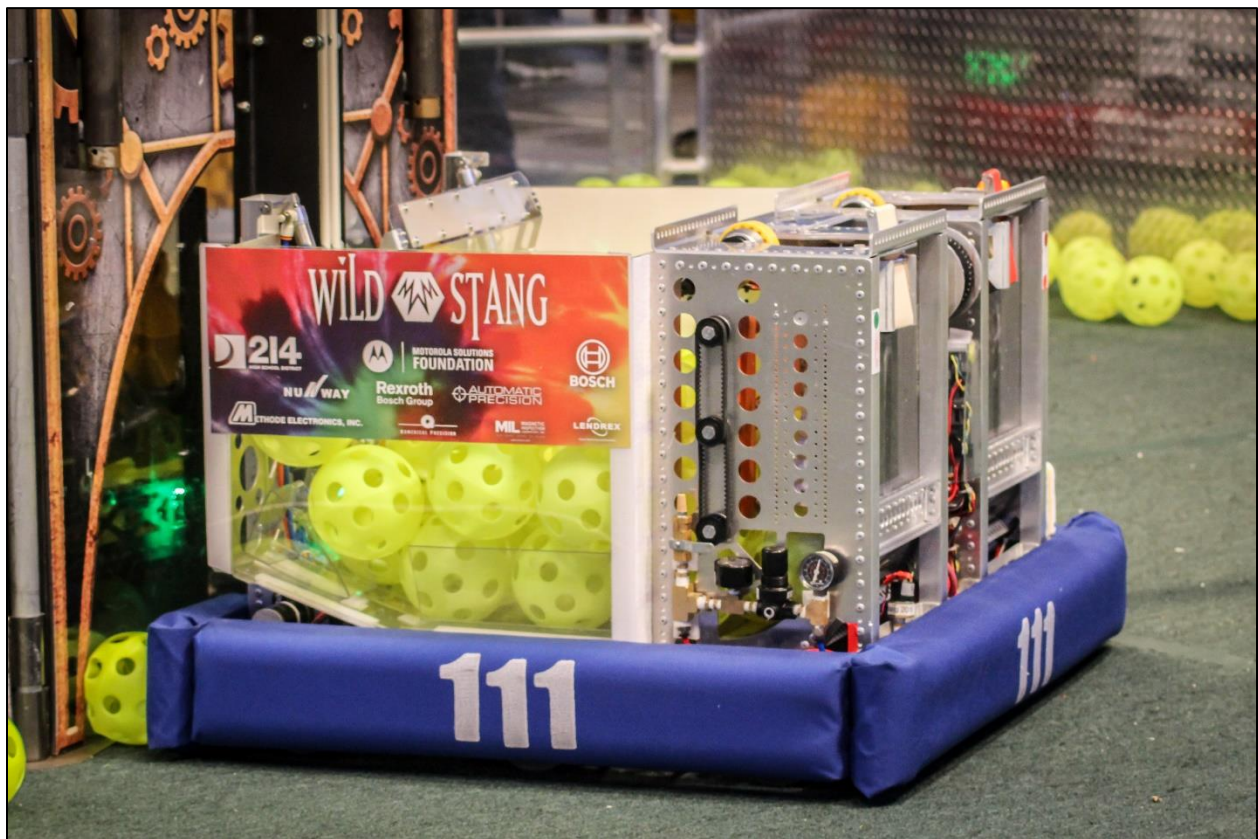


Figure 7: Team 111 with multi-piece bumpers.

Bumper Types and Construction- One Piece Wrap Around

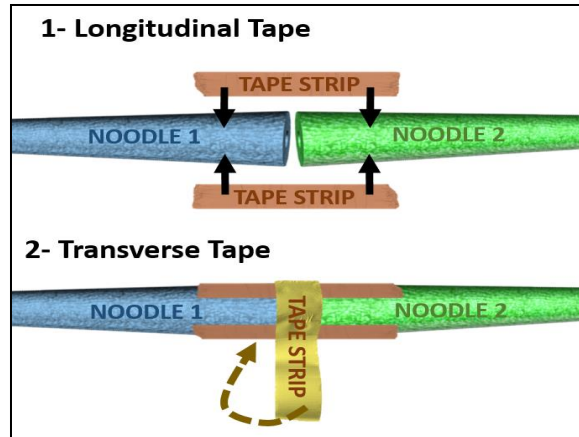


Photo: <https://www.team254.com/day-45-home-stretch/>

Cut the wood for the bumpers (check the game manual for wood requirements)

Tape noodles together so that you have 2 long noodles which wrap all the way around.

- Press the pool noodle ends together so that there is some compression then place two strips of tape in the longitudinal direction and then one strip wrapped around the joint.
- Then take the two very long noodles and tape them together with a piece of tape every 1 to 2 feet.



Lay the cut boards into the frame or secure them into the desired position.

Tape the noodles onto the wood

- There should be one to two pieces in the middle and one at each end of each piece of wood.
- This also helps to prevent sagging of bumpers
- Make sure where the noodles join is on a side, not a corner.

Cut the fabric to the correct width so that it will wrap around the wood and noodles with some overlapping fabric on the back. Leave room so that the fabric can overlap in the desired location. It is sometimes easy to put the overlap area near the numbers and cover the seam with one of the numbers.

Starting in the center, staple one side of the fabric onto the wood, then pull tight and staple the other side. Work from the middle then around each side, continuing to staple one side, pull the fabric tight, then staple the other side, until you get to the two corners.

Once you get to the corners, fold the fabric then pull it tight and staple. This step is easiest with two people.

At the very end, fold the fabric so that the seam is a folded edge, not a cut edge. This prevents the material from fraying. Some glue can be added to make sure the seam stays down.

Bumper Types and Construction- One-Piece Other Methods

This is very similar to the one piece wrap around, but with different corners. The noodles can be cut on a 45-degree angle to join at the corners, or a vertical piece of noodle can be used to join the side pieces. The noodles are taped together and then onto the pieces of wood, the same as with the wrap around type, and then covering with fabric is the same process. For one-piece bumpers, the fabric covering process is often a lot easier with sharp corners.

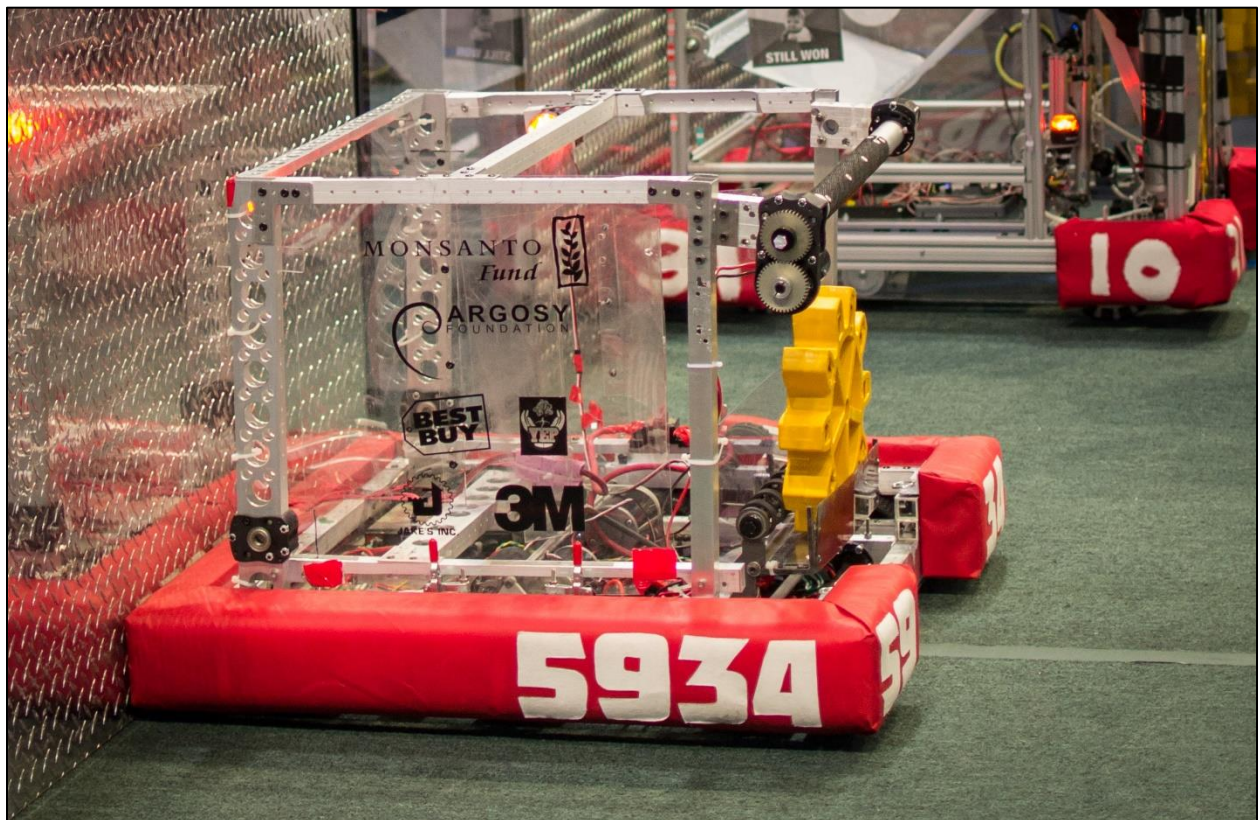


Figure 8: Team #5934 with one-piece bumpers using 45-degree angled corners.

Bumper Types and Construction- Reversible Covers

It is a cover that can be flipped or changed to switch the bumper color.

Pros: These covers can be made to work with any type of bumper. They are often a good way to save space and use less construction materials (less noodles and wood). Both colors are on the robot at all times so the other color cannot be “forgotten” in the pit at any time. The attachment method to the robot is not quite as important since the bumpers will be coming on and off less.

Cons: These typically take more sewing and fabric experience as well as planning to be done correctly. It is often a lot more difficult than having two sets and if done incorrectly, it does not look as professional. It can also be difficult to get straight when covering.

Folding Cover: These are covers which fold up or down (securing the edges to the top or bottom) to switch between blue and red. Velcro and snaps are often used to secure the fabric. Using elastic or a draw string to tighten the fabric can also work but depends heavily on what kind of fabric is being used. The type of number and fabric selection is something to consider when making these since both will be tugged on and folded frequently.

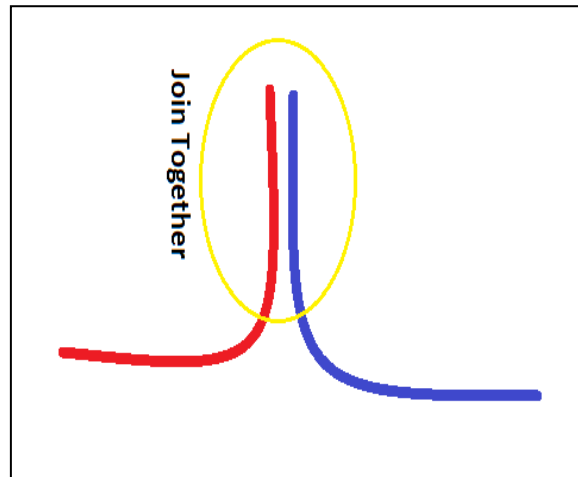
Example Video: <https://www.youtube.com/watch?v=BUDMB-aiBpo>



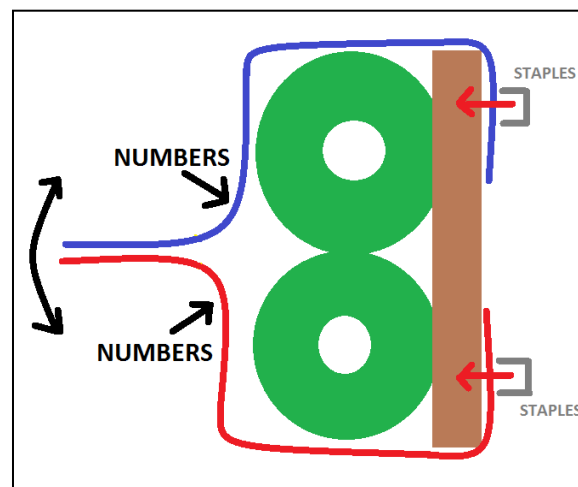
Figure 9: Folding reversible bumpers.

General Construction:

- Cut the wood and noodles and tape them according to the desired method.
- Join the back half of the blue and red fabrics together using a sewing machine or iron on double sided adhesive.



- Cover the bumpers. Tape can be used to hold fabric in place to test out the folding before the fabric is stapled to the back.



- Figure out what kind of hardware and numbers work best and install them. Make sure the fabric is tight when secured on both the top and bottom so that the numbers are easy to read. Numbers may need to be applied before or after the covering process depending on the method.

Cover: This is where you make a red or blue bumper and make a fabric cover for the second color. You can also make a “pretty” bumper, such as something that is your team colors that would look nice for demonstrations, and then make a red and blue cover for competition. Having full covers are nice since they do not take up a lot of space and can easily be replaced or fixed. The main downside is selecting a secure attachment method while having the fabric remain tight. Using large amounts of velcro is common. It’s important to make sure the fabric is tight so that the numbers are easily readable. It’s also important to make sure that the covers will not fall off regardless of what happens in the competition. Multiple types of attachment methods can be used if one type is not enough.



Figure 10: Bumpers with Velcro attaching cover.

Quick Fixes for Competition- Fabric

Sewing- Having some blue and red thread and a sewing needle is really great for a quick fix. Thread the needle so that the thread is doubled, then hand stitch the bumpers and pull tight to make sure fabric joins together well. This works well for most fabrics, but if you are using a fabric that tears easily it could create more issues due to the small holes from the sewing needle.

Red and Blue Tape- This is probably one of the most common fixes. Duct tape and Gaffers tape both work well and are quick and easy to apply. Often if there is a small rip it's better to tape all the way around so that the ends of the tape are on the back of the bumper. It may seem like too much, but it's less likely to fall off when the ends are on the back.

Patches- Iron on patches can be used with low heat. It's important to not melt the pool noodles when applying them. Stick on patches can also work similar to tape. Stick on patches can even be made with a piece of fabric and glue. E6000 glue works well but takes 24 hours to dry. Red or blue fabric with clear tape can also work as a temporary patch.

Fabric Section Recover- This involves taking a piece of fabric, preferably the same type used on the bumper, cutting a section, wrapping it around the bumper, and stapling it onto the back. The bumper hardware may have to be removed depending on the attachment method. It's important to wrap it tight so that the edges stay down. Sometimes a little glue on the edges can also be helpful.



Figure 11: Bumper with tape covering ripped areas.

Quick Fixes for Competition- Numbers

Paint- This is often a great fix but can take a while to dry. Acrylic paint and a white paint marker will both work. A few layers may be needed if the paint soaks into the fabric.

Tape- White electrical, duct, and gaffers tapes work well for this. Cut the tape using scissors and apply it. Try to not let the adhesive touch anything other than where it is being placed on the bumper so that it does not lose any stickiness. Tape may need to be replaced multiple times during a competition and is often not a great long term solution.

Glue- If the numbers are intact but falling off, glue (such as e6000 or any clear glue) can be used to stick the corners back on. It's sometimes good to use this solution at the end of the day so the glue has time to dry. Tape such as masking tape can be used to hold the number down while the glue dries.



Figure 12: Bumper with white electrical tape over some numbers.

Bumper Gallery- Numbers



Figure 13: Hot press vinyl.



Figure 14: Iron on.

Bumper Gallery- Numbers



Figure 15: Hot press vinyl.



Figure 16: Sewn on.

Bumper Gallery- Numbers



Figure 17: Sewn on.



Figure 18: Embroidered.

Bumper Gallery- Hardware

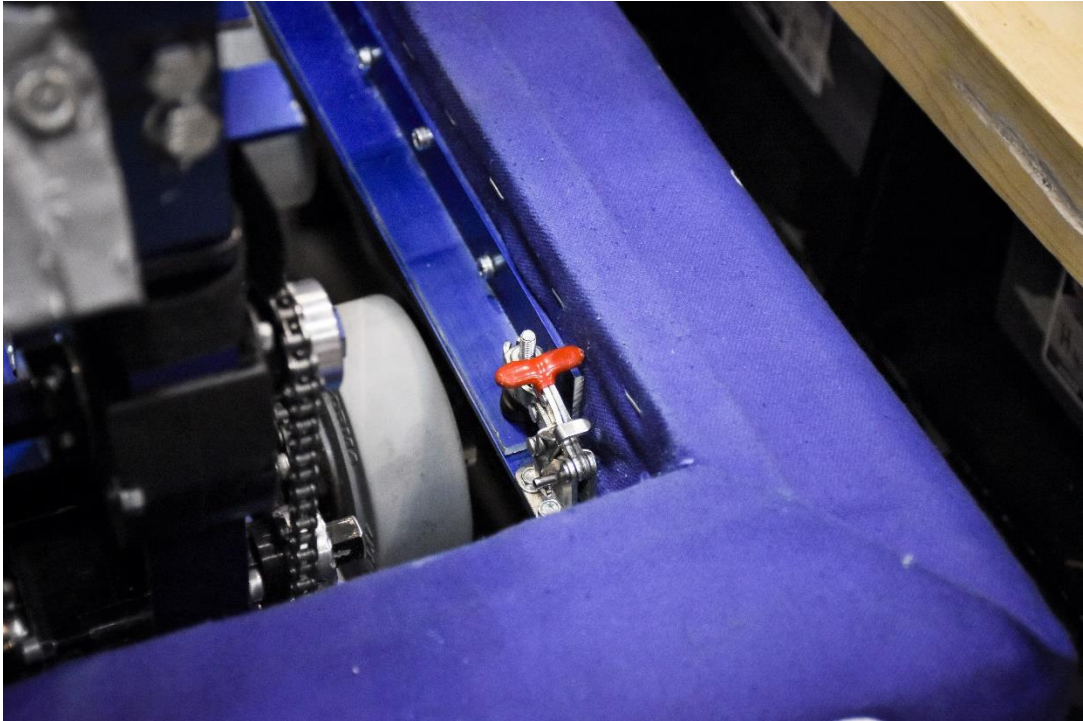


Figure 19: Latch.

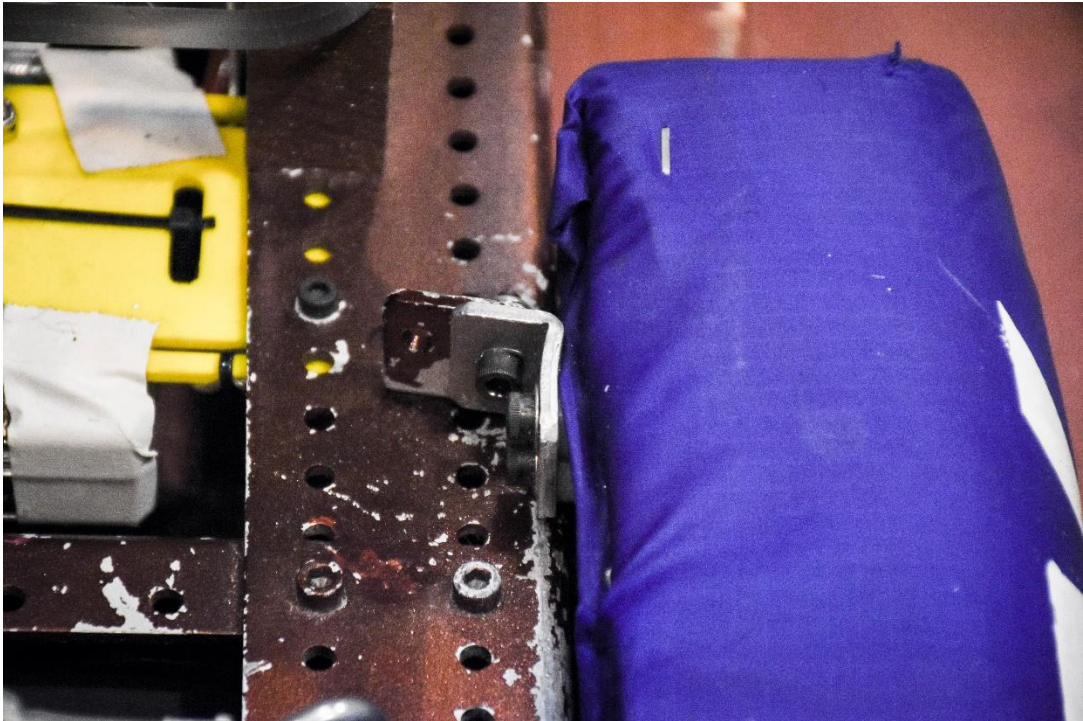


Figure 20: Nut and bolt.

Bumper Gallery- Hardware



Figure 21: Door hinge and pull pin.

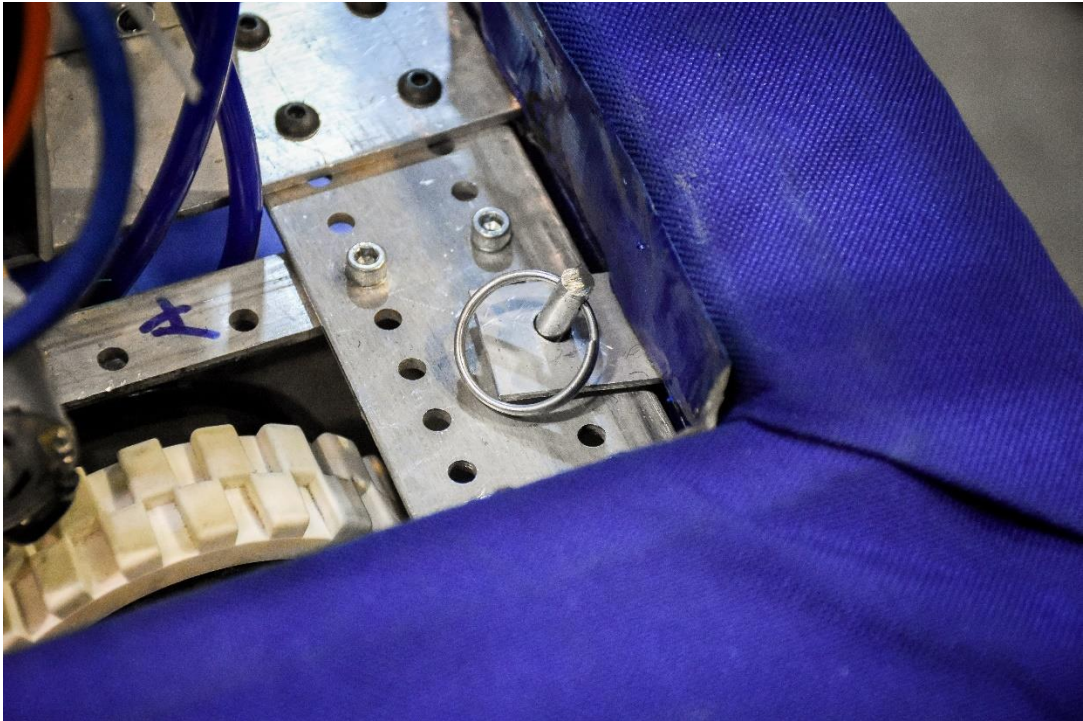


Figure 22: Quick release pin.

Bumper Gallery- Hardware

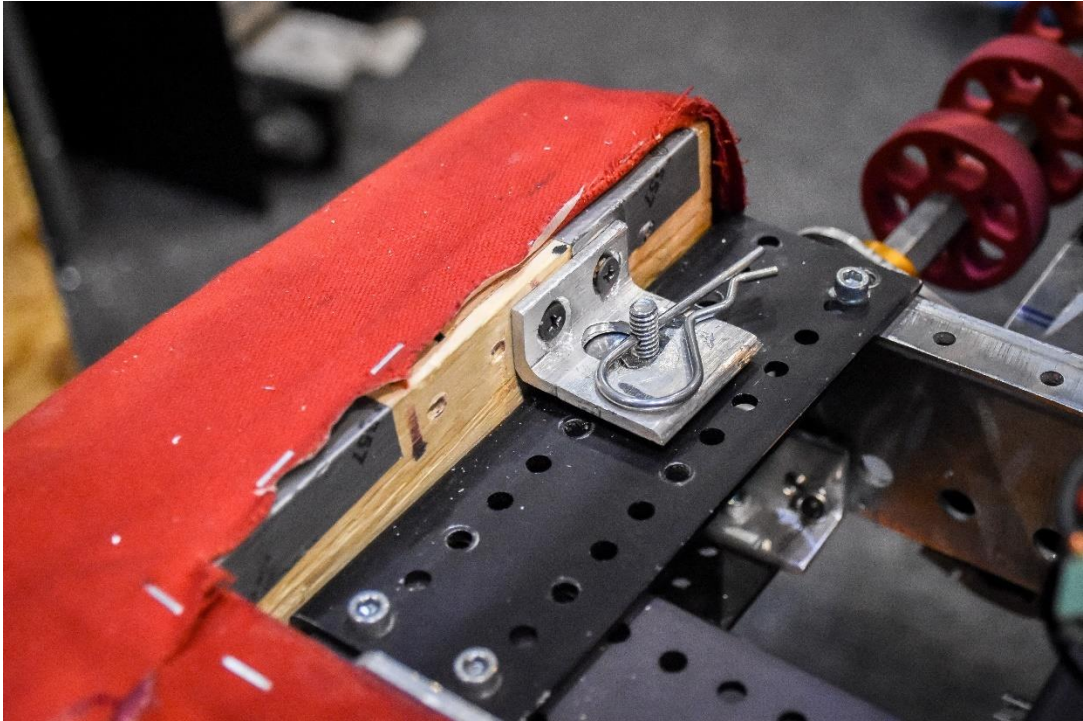


Figure 23: Pin through bolt.

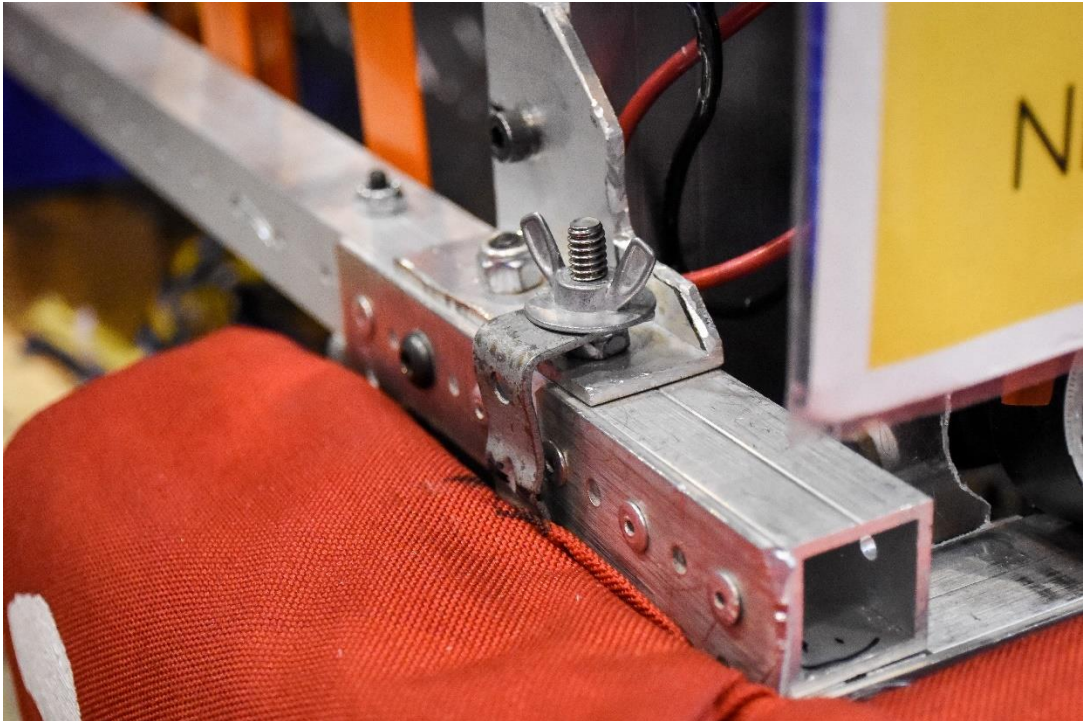


Figure 24: Bolt and wing nut.

Bumper Gallery- Hardware



Figure 25: Latch.

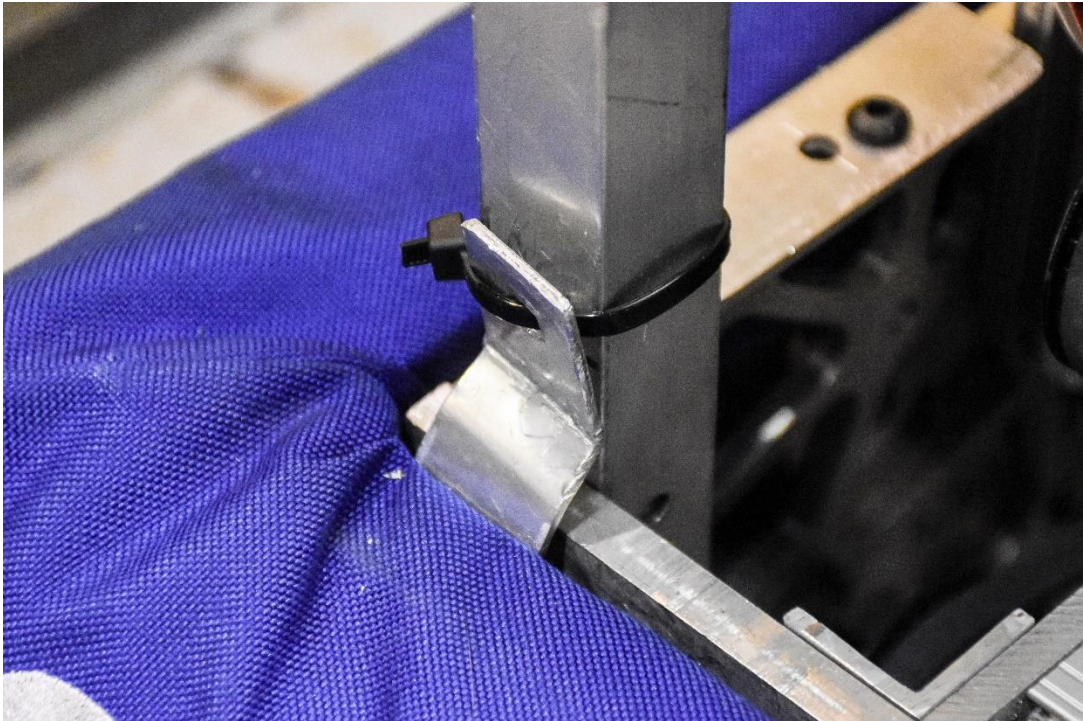


Figure 26: Zip tie.

Bumper Gallery- Other



Figure 27: Snap folding reversible.

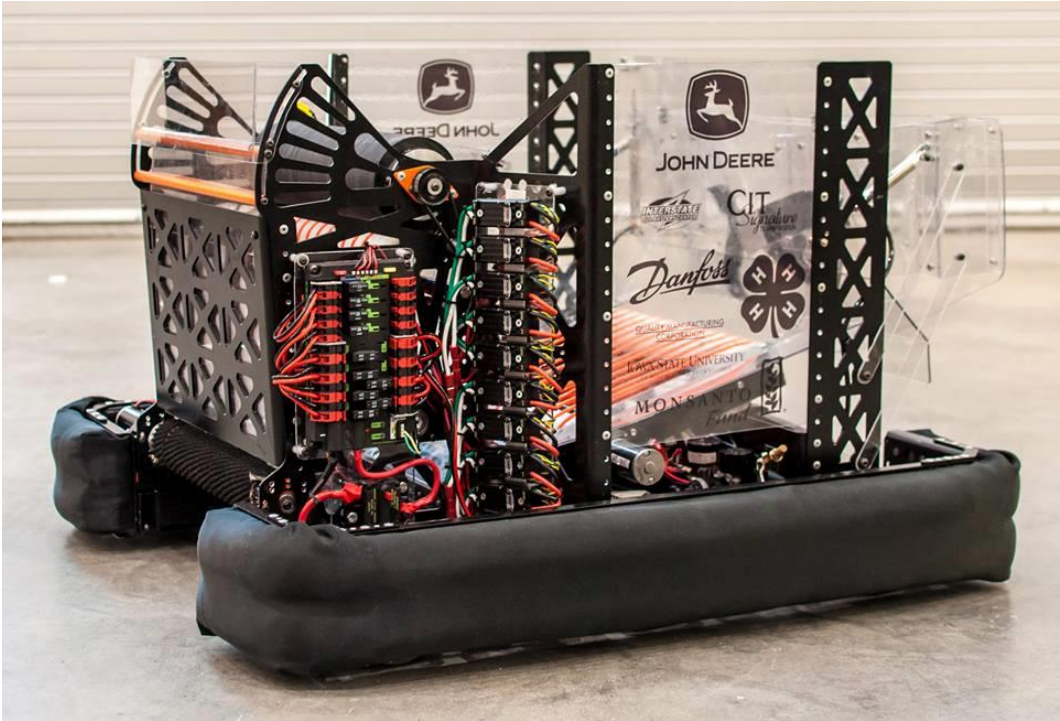


Figure 28: Team 3928 with wrap around bumpers and black sheet metal frame.

Contact Information

For any comments, suggestions, or questions regarding the content of this guide email Kelsey at KLDraus@gmail.com.

