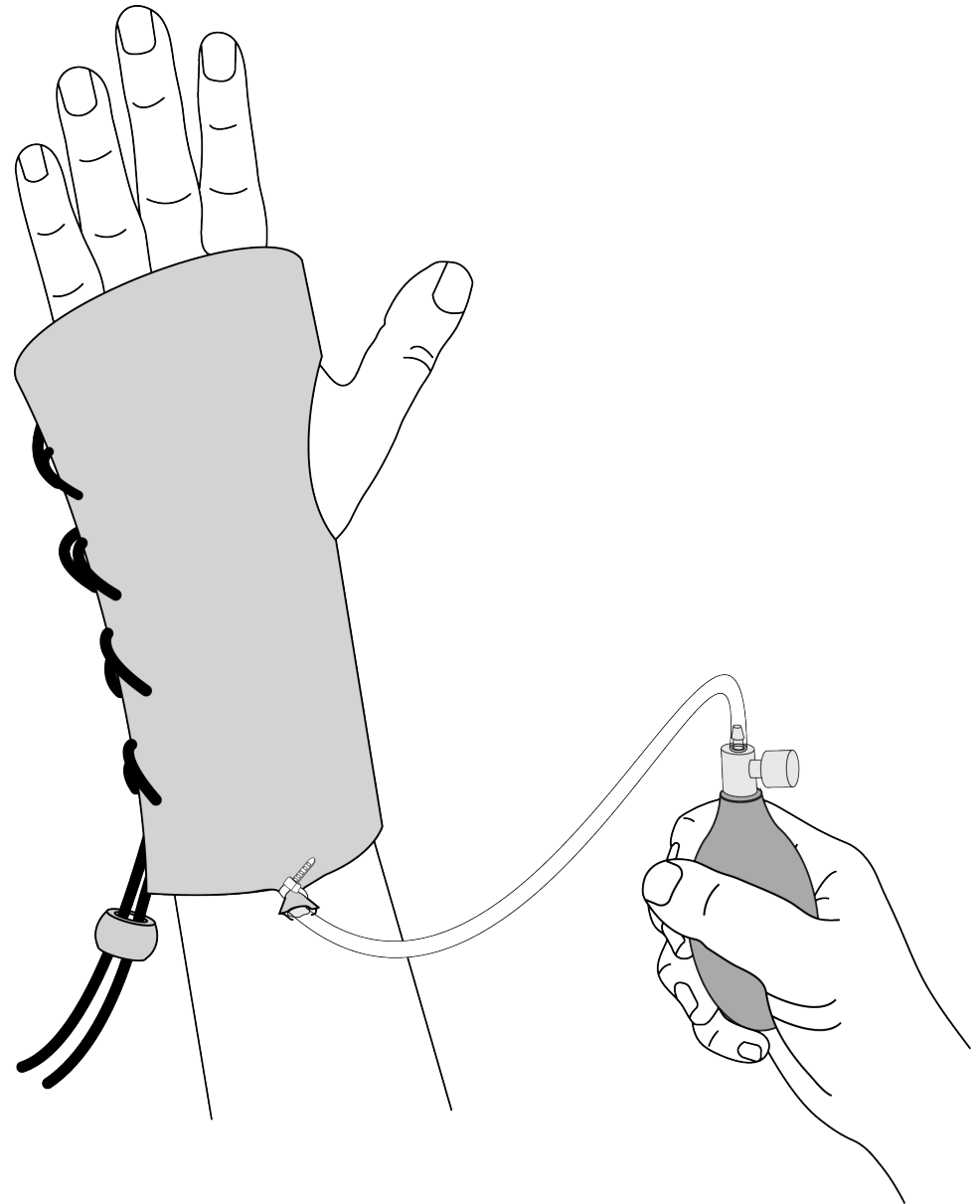
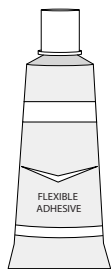


# PNEUMATIC WRIST BRACE

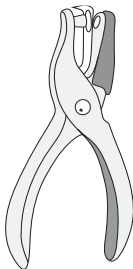
An Educator's Guide  
*Soft Robotics Toolkit, 2017*  
[www.softroboticstoolkit.com](http://www.softroboticstoolkit.com)



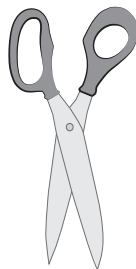
# SUPPLIES



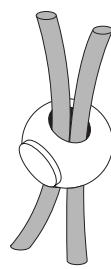
FLEXIBLE GLUE



HOLE PUNCH



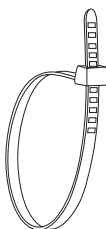
SCISSORS



CORD LOCK



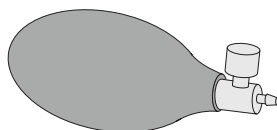
ELASTIC CORD



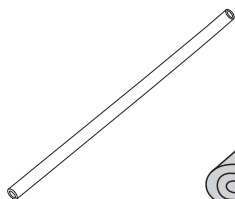
ZIP-TIES



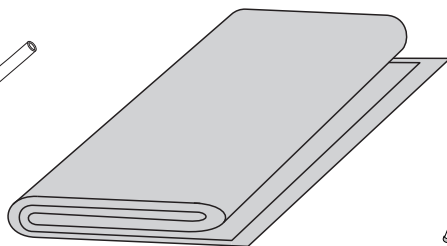
MARKER



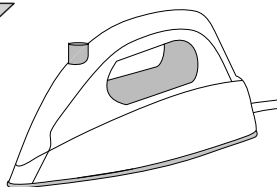
HAND PUMP



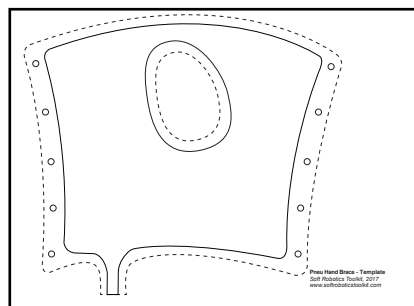
TUBING



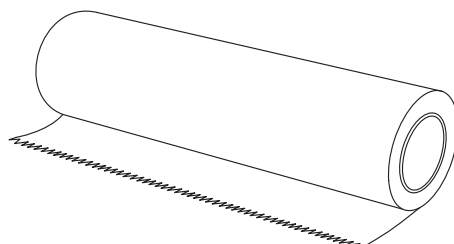
HEAT-WELDABLE FABRIC (P1)



IRON



TEMPLATE



PARCHMENT PAPER (P2)

A more detailed supply list for this activity is located in the Bill of Materials document within the fabrication guide package. Please be advised that if the supply list calls for box cutters, irons or scissors it is under the discretion of the educator to decide if their group is able to use these tools as part of the activity or substitute as needed.

**Flexible Glue:** This flexible glue will provide reinforcement to the tubing when inserted into the brace.

**Hole Punch:** 1/8 inch hole punch to match the size of the cord.

**Scissors:** For cutting the paper template, parchment paper and fabric. These should be sharp enough to create a clean cut in the coated fabric.

**Cord Lock:** This cinching device allows the brace's cords to be tightened and loosened for sizing.

**Elastic Cord:** A stretchy cord that will be used as lacing for the brace.

**Zip-Ties:** Zip-ties allow for a quick method to secure the tubing to the brace body. For smaller hands a zip-tie gun may be useful. This is listed in the bill of materials document.

**Permanent Marker:** Depending on the color of the heat-weldable fabric. Marker shows up best on lighter colors. Pencils work well for darker fabrics.

**Hand Pump:** For inflating the brace upon completion. Bike pumps could also be used.

**Tubing:** Completes the pneumatic connection.

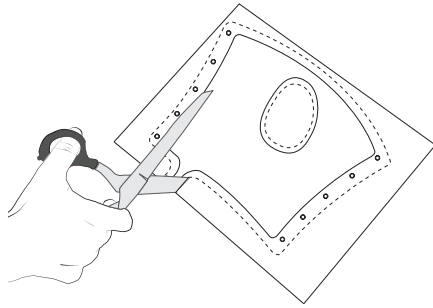
**Heat-Weldable Fabric:** Coated nylon fabric. Noted as P1 within the guide.

**Iron:** For welding the sides of the brace.

**Template:** For construction of the brace.

**Parchment Paper:** To place between the fabric layers to create an air channel in the brace. Referred to as P2 within the guide.

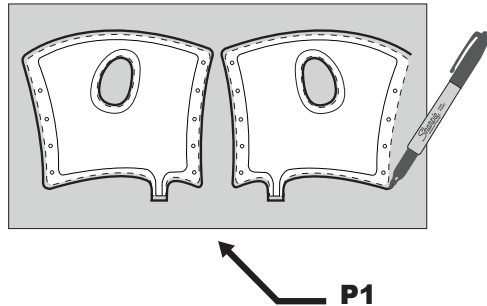
**01**



Cut the paper template along the DOTTED line, including the thumb-hole in the middle. This will be the template for the fabric bladder.

**NOTE:** Make sure that students do not cut the template further to the solid line at this step.

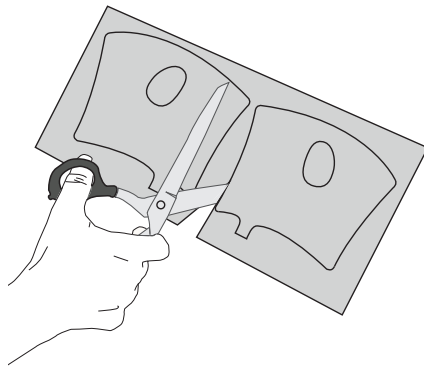
**02**



Trace the template onto one side of the heat-weldable fabric. Flip the template over only and trace it a second time onto another area of the fabric such as in the picture. Students must have two opposite pieces of fabric in order to successfully iron them together.

**NOTE:** It is easier to trace onto the woven side of the fabric, rather than the coated side. If the fabric is black, students can use graphite pencils to trace the template as a black permanent marker will not show up as well.

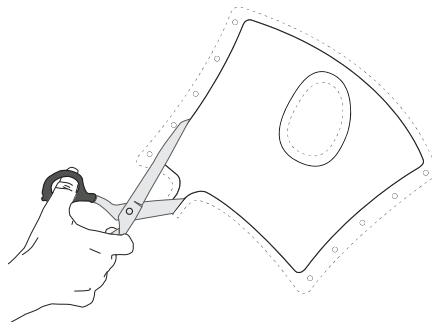
**03**



Cut the fabric along the traced lines.

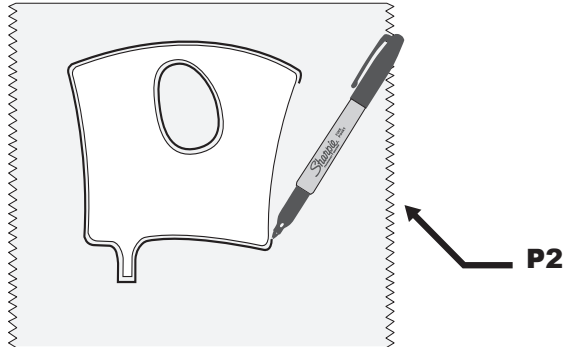
**NOTE:** Later, you will weld these two pieces together, so they must be somewhat neatly cut and as close in size as possible.

**04**



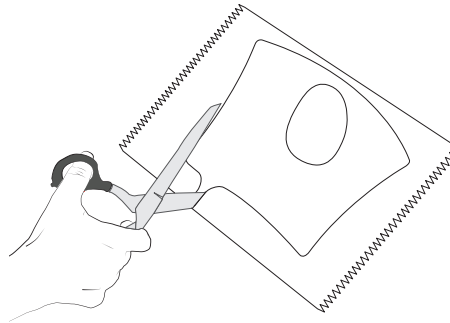
Cut the paper template again, but this time along the SOLID line, also including the thumb-hole. This will be the template for the parchment paper spacer inside of the brace.

05



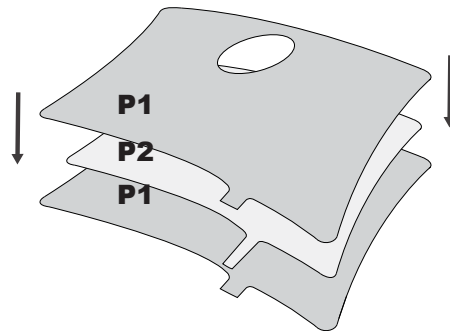
Trace the inner template with a permanent marker onto the parchment paper. Students only need to do this once unlike with the heat-weldable fabric. This piece will be sandwiched between the two fabric pieces.

06



Cut the template from the parchment paper, including the thumb-hole.

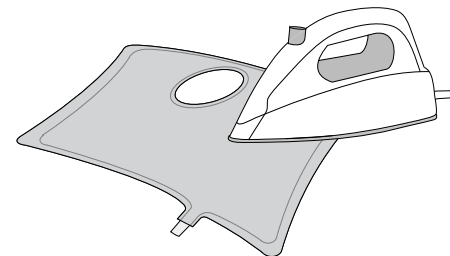
07



Align the three pieces (2 heat-weldable fabric and 1 parchment paper) so that the fabric is on either side of the parchment paper. The coated sides of the fabric **MUST** face inwards, towards the parchment paper. When the pieces are ironed together in the next step, the laminated sides will fuse together to seal the wrist brace.

**NOTE:** If students have trouble keeping the pieces aligned is difficult, you can tape the pieces down while ironing.

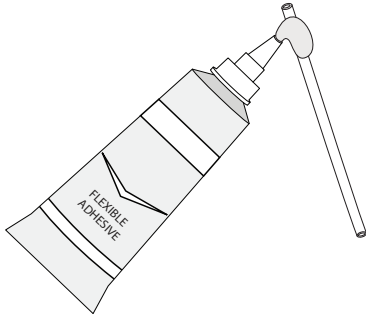
08



Iron the three pieces together. The outer edges of the heat-weldable fabric will not be protected by the parchment paper and will fuse together. The parchment paper will keep the fabric separated in the middle of the bladder, creating room for the air to fill the brace.

**NOTE:** It is essential that the parchment paper sticks out of the opening completely where the tubing will later be inserted such as in the image. This will ensure that the opening is not fused shut by the fabric.

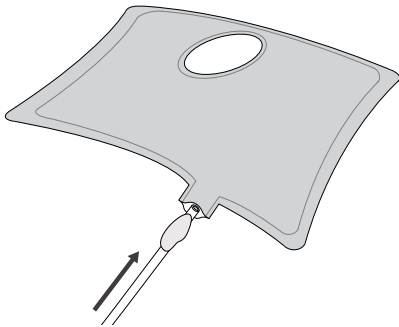
**09**



To complete the pneumatic component, cut about 1 ft of the clear plastic tubing to be inserted into the brace. Apply a generous amount of flexible adhesive around the outside of the tube.

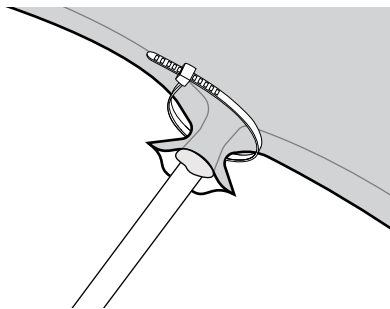
**NOTE:** Be careful to prevent students from sealing the end of the tube with the glue. Air should still flow freely through the tube.

**10**



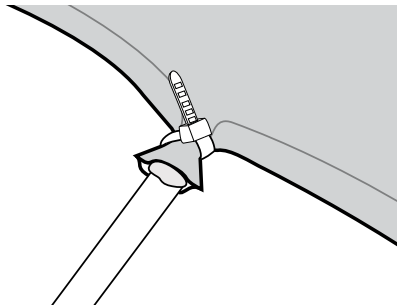
Insert the end of the tubing with the adhesive into the opening of the bladder. Ensure that the tubing is inserted far enough in so that it will not later fall out.

**11**



Arrange a zip tie around the opening of the bladder. It should surround the end of the tubing and the bladder's fabric. Wipe away any excess glue that may be forced out from the zip-tie.

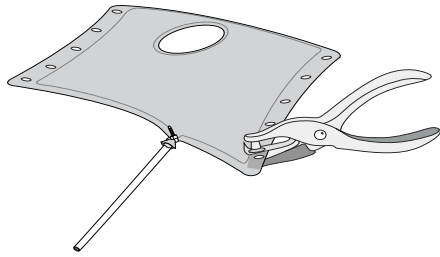
**12**



Fasten the zip tie as tightly as possible. The bladder's opening must be completely sealed around the tubing to ensure that no air will leak out, or the bladder will deflate.

**NOTE:** You may use a zip-tie gun here to ensure that the zip-tie is closed as tightly as possible. Students are often unable to apply enough pressure to create a complete seal and as such there are often leaks around this opening.

13



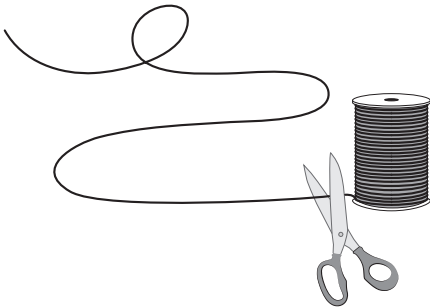
Use a hole punch to create 5 holes along the left and right sides of the bladder, where the fabric has been fused together. Elastic cord will later be laced through these holes to assemble the bladder into a brace.

**NOTE:** Use extra caution to ensure that students **ONLY** punch through the fused sides of the bladder, and do not accidentally puncture the middle of the bladder. This would cause a large air leak. After hole punching check the bladder for leaks by having students blow into the tubing. If the brace stays flat rather than inflating like a pillow, or makes a hissing noise, there is a leak and further sealing is needed.

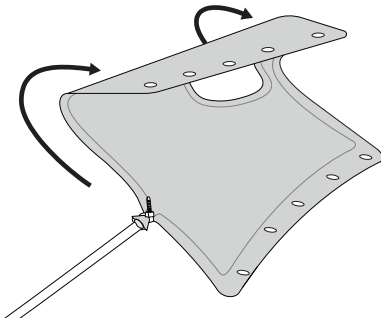
Cut about 2 ft of elastic cord to lace each bladder into a brace.

**NOTE:** The elastic may begin to unravel when cut, a small amount of tape at the ends will prevent this.

14

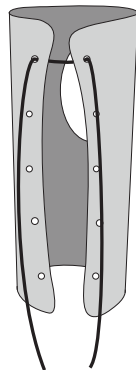


15



Loosely fold the bladder in half so that the edges with the holes meet. This will allow students to lace the bladder more easily.

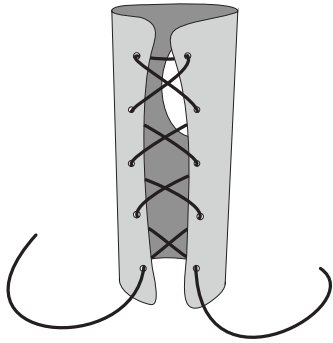
16



Lace the bladder together by threading the elastic cord through the holes on either side of the brace.

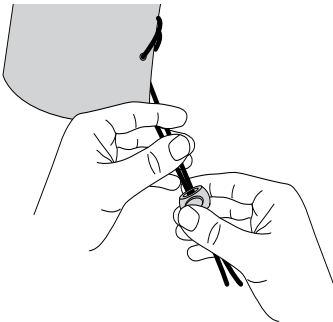
**NOTE:** If the elastic is too large to fit through the holes, use the hole puncher to widen the holes further again being cautious to avoid puncturing the air cavity.

17



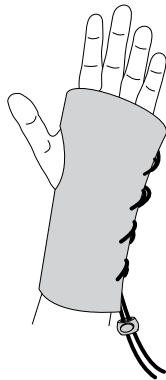
Continue lacing the elastic cord as you would a shoe lace along the entire length of the brace.

18



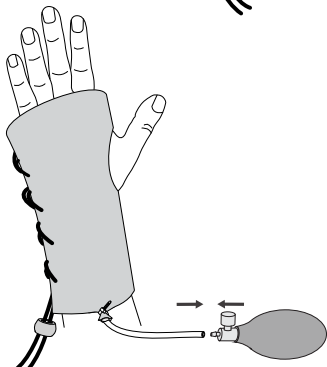
Thread a cord lock onto both free ends of the elastic cord to allow it to hold the ends together.

19



Have each student put on his or her brace. Then tighten the cord lock so that each brace fits its respective student hand and wrist size.

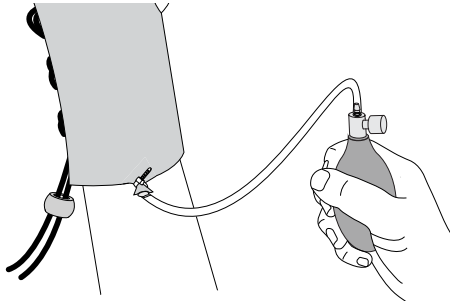
20



Insert the free end of the tubing around the hand pump nozzle.

**NOTE:** You may need to use the blue silicone rubber tubing listed in the bill of materials as a connector between the pump and the clear white tubing if the pumps nozzle is larger than the tubing. One or two inches of the blue tubing will work as a connector between the two.

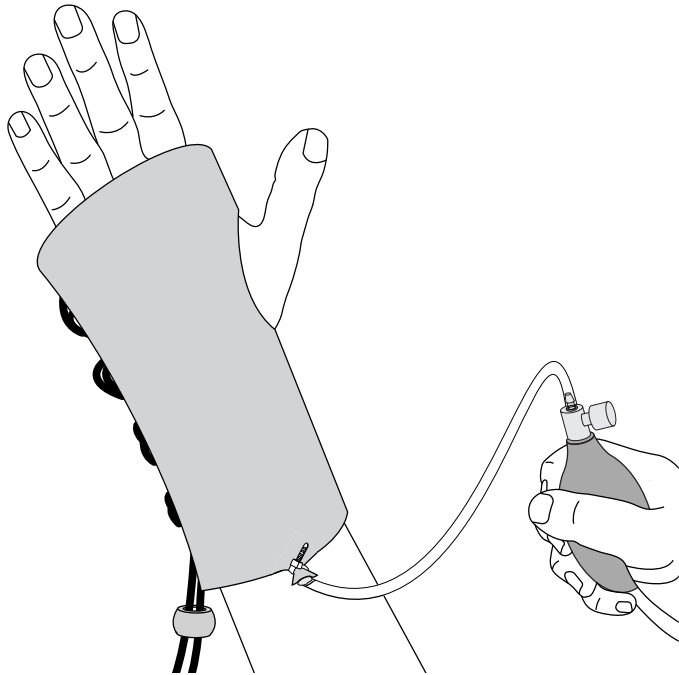
**21**



Squeeze the pump to fill the bladder with air completely. Make sure that the brace fills as firmly and has no leaks.

**NOTE:** Make sure that the knob on the pump is turned completely clockwise, to close the valve. This will keep air from escaping the brace.

**22**



You now have a complete wrist brace. Have students try their braces on, test its pressure, fit and comfort.