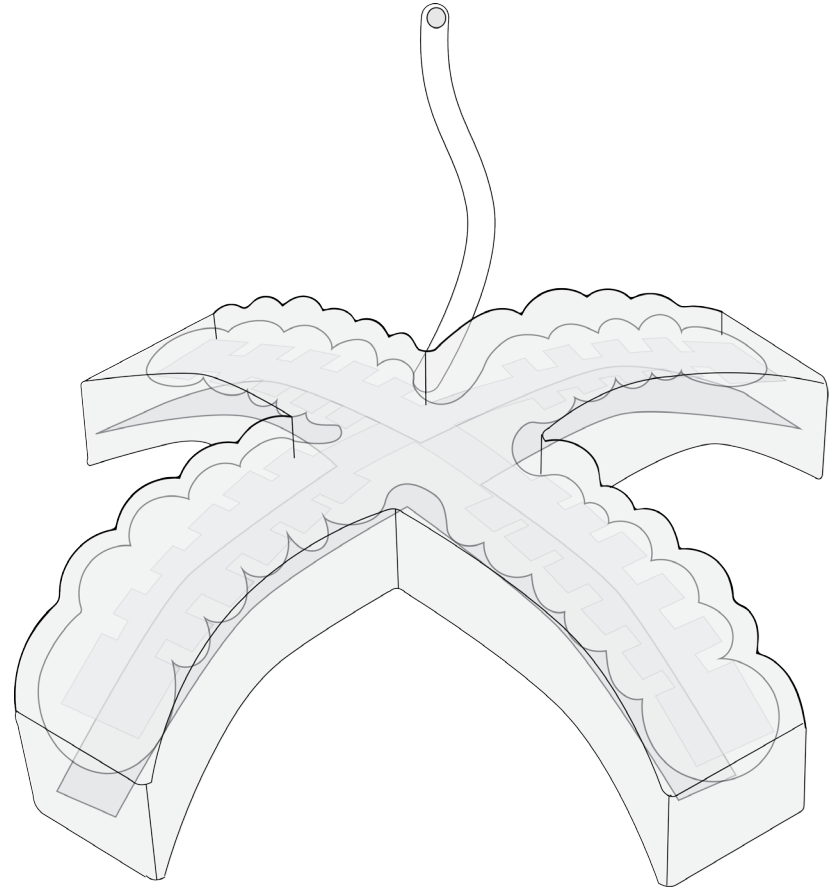


SOFT GRIPPER

An Educator's Guide
Soft Robotics Toolkit, 2017
www.softroboticstoolkit.com



SUPPLIES

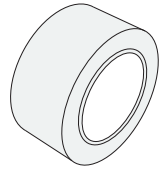
GLUE STICKS



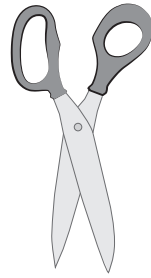
MIXING STICK



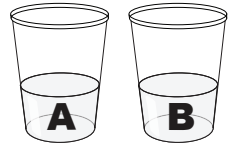
GLUE GUN



CLEAR TAPE



SCISSORS



ECOFLEX 00-30



PASTE GLUE



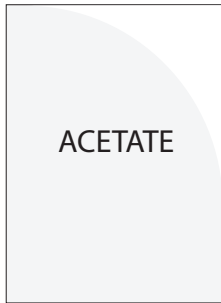
PIN



SYRINGE



FABRIC



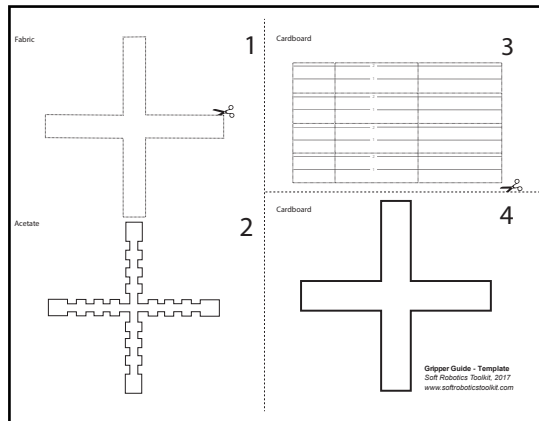
ACETATE



SHARPIE



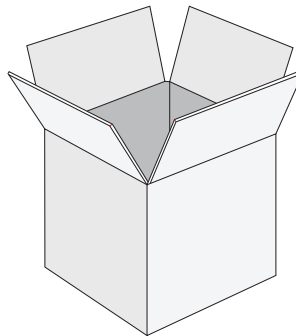
BOX CUTTER



TEMPLATES 1 - 4



TUBING



CARDBOARD

A more detailed supply list for this activity is located in the Bill of Materials document that was 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.

Glue Sticks: 2-3 per mold is recommended.

Glue Gun: For assembling the cardboard mold

Mixing Stick: For mixing the silicone parts together

Clear Tape: For laminating the inside of the mold. Clear packing tape is often most useful.

Scissors: For cutting the paper template, fabric, and acetate. They may also be used for cutting the cardboard.

Eco Flex 00-30: Silicone elastomer for the body of the robot.

Paste Glue: Used to adhere templates onto cardboard.

Pin: For poking a small hole in the gripper to insert tubing.

Syringe: For inflating the gripper upon completion. You may also use a bike or hand pump.

Fabric: Basic non-stretch fabric. Muslin fabric is most often cheap and available.

Acetate: Placed between mold castings to create a channel within the gripper.

Permanent Marker: For tracing onto the acetate

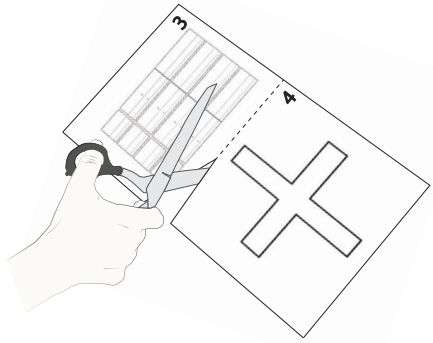
Box Cutter: For cutting the cardboard pieces. You may use

Templates 1-4: For the acetate, fabric and parts of the mold.

Tubing: Completes the pneumatic connection.

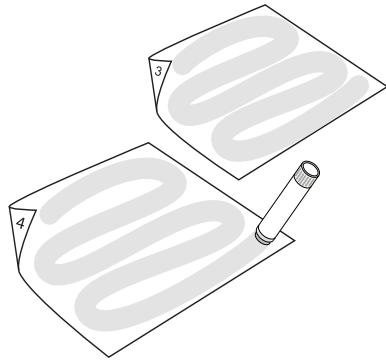
Cardboard: For constructing the walls of the mold. If from recycling this cardboard should be as clean and flat as possible.

01



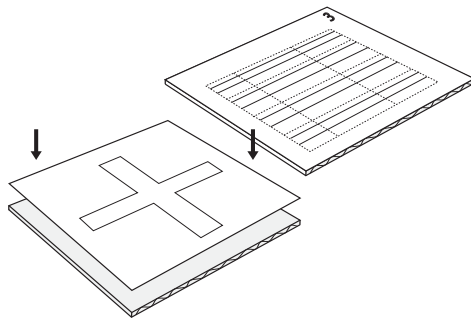
Cut along the dotted line to separate templates 1-4. Part 1 is the template for the fabric layer. Part 2 is the template for the acetate layer. Part 3 is the template for the sides of the gripper mold. Part 4 is the template for the gripper mold base.

02



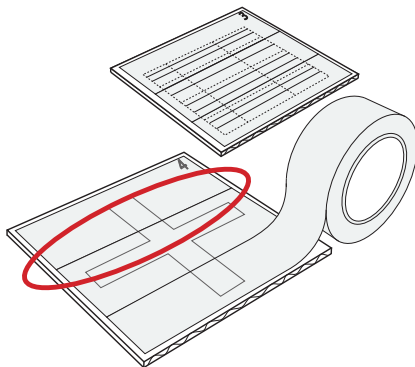
Spread paste glue across the entire backs of templates 3 and 4.

03



Paste templates 3 and 4 onto cardboard.

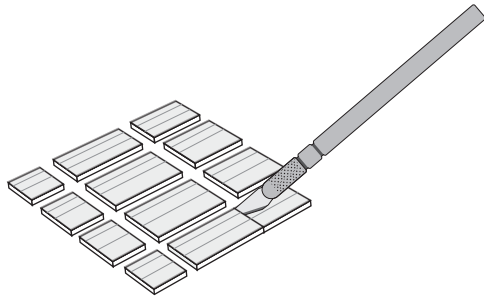
04



Use the clear packing tape to laminate the front sides of both 3 and 4.

NOTE: Overlap the edges of the tape to ensure that there are no gaps between the pieces of tape. The cardstock must be completely sealed to prevent leaking the EcoFlex in later steps.

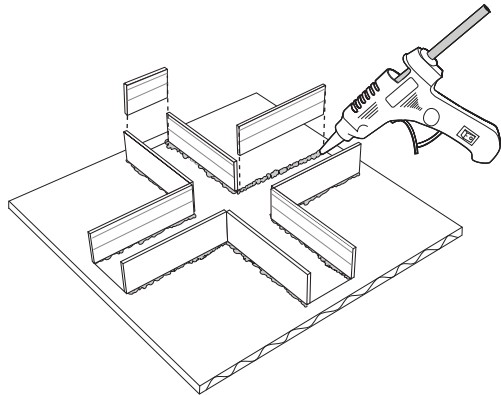
05



Use box cutter to cut template 3 apart into its smaller pieces. Cut along the black dotted lines. These pieces will be the sides of the mold.

NOTE: Students may need addition supervision at this stage. Some students may struggle to use the box cutter, in which case they may use scissors or the template can be scored by an adult to make it easier to cut.

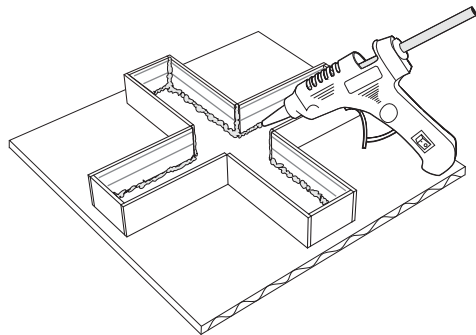
06



Use a hot glue gun to assemble the parts of 3 onto the gripper outline on part 4, forming the mold. Trace the base with hot glue and glue the pieces along the edges that correspond with their size. The pieces' laminated sides must face the interior of the gripper mold to protect the mold from leaking silicone.

NOTE: Students may place the pieces incorrectly however as long as the inside of the mold corresponds with part A's outline, and the mold is sealed it function correctly.

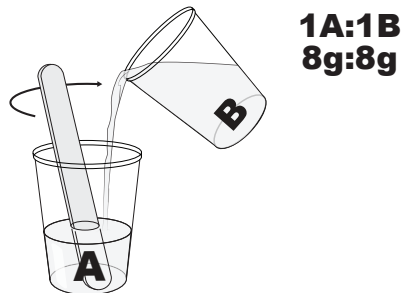
07



Secure the mold in place by outlining the entire structure in hot glue. Make sure to line all of the joints with hot glue, both inside AND outside of the mold.

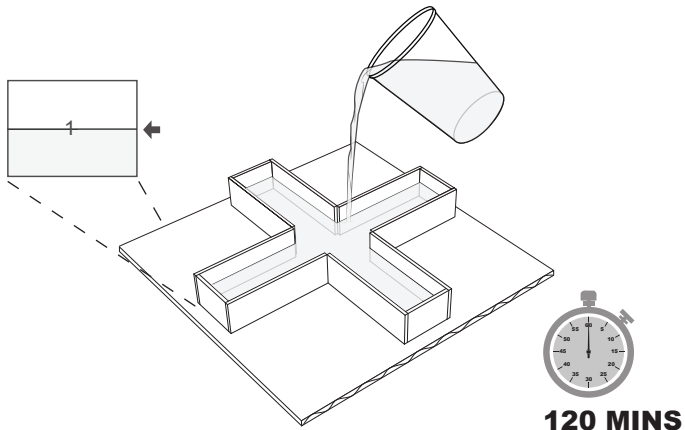
NOTE: Take special care to fill all of the exposed cardboard edges on the interior of the mold. The edges of the cardboard are corrugated and hollow which will allow the EcoFlex 00-30 to seep inside if they are not sealed shut.

08



Using a mass scale, measure out a 1:1 ratio of parts A and B of EcoFlex 00-30. 8 g of part A and 8 g of part B is recommended. Mix the silicone completely with mixing sticks for 30 seconds, or until completely mixed.

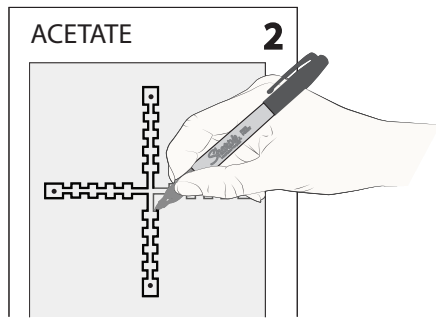
09



Fill the mold with the ` 00-30 to the fill line on the mold's interior. The line is halfway up the mold and marked with a "1". Let the silicone cure for 2 hours in the open air.

NOTE: If you have access to an oven, you can cure the silicone much more quickly. Turn the oven to 70°C (140°F) and let it cure for 20 minutes.

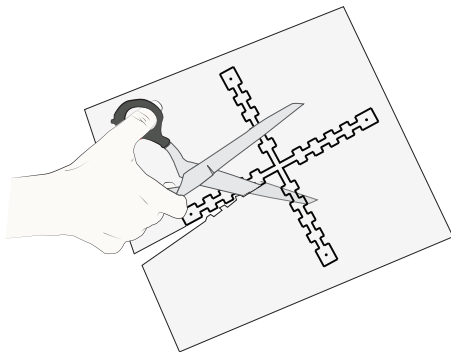
10



Place a square of acetate over template 2, marked "Acetate". Use a permanent marker to trace the template onto the acetate.

NOTE: If needed, tape the acetate to the template to keep the acetate from shifting around while tracing,

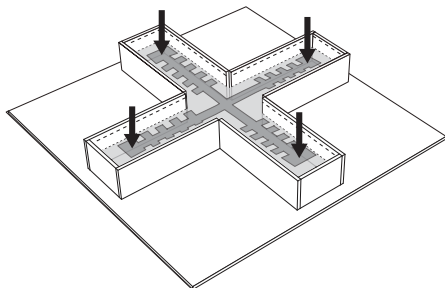
11



Use scissors to cut out the acetate layer. The grooves are very small, so allot extra time for the students to do this step correctly.

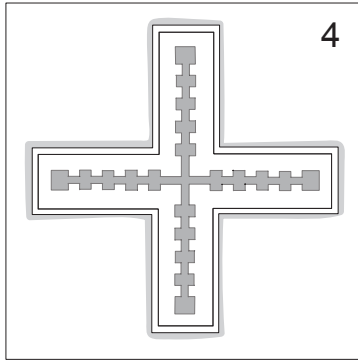
NOTE: Many students might find the scissors too difficult to maneuver along the small grooves. Students may also cut the acetate layer out with a box cutter if they find it easier.

12



Once the appropriate amount of time has passed, touch the silicone with a finger to test whether or not it has cured completely. If the silicone still feels "greasy" or "tacky", let it cure longer. If it feels "rubbery", then the silicone is ready. Place the acetate layer on top of the silicone layer.

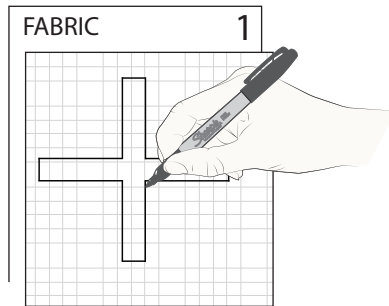
13



Align the acetate layer to be exactly in the middle of the mold.

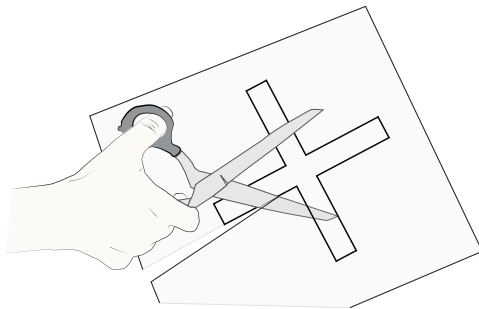
NOTE: The acetate layer should NOT touch the edges of the cardboard mold. If there is contact then the next silicone layer will not form around the acetate, causing a gap on the side of the gripper where air will escape.

14



Using scissors, cut out the fabric template from part 1. Trace the template onto fabric using a permanent marker.

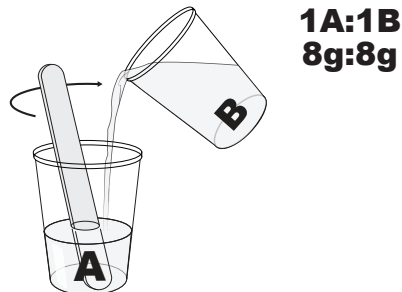
15



Using scissors again, cut out the fabric layer.

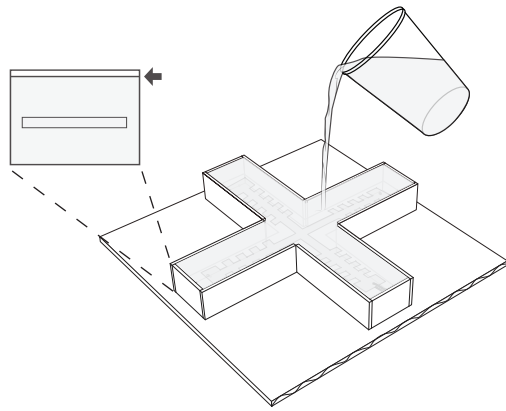
NOTE: Fabric scissors may cut more easily here if you have access to them.

16



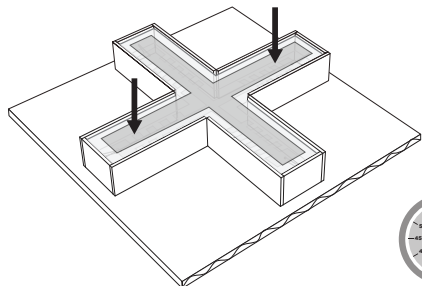
Using a mass scale, measure out a 1:1 ratio of parts A and B of EcoFlex 00-30. 8 g of part A and 8 g of part B is recommended. Mix the silicone completely with mixing sticks for 30 seconds, or until completely mixed.

17



Fill the rest of mold up with the EcoFlex 00-30 to the second line on the mold's interior. This is the line near the top of the mold marked with a "2".

18



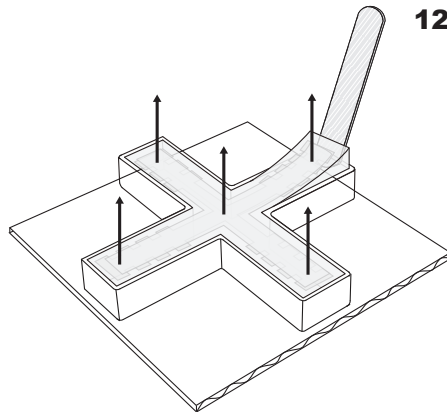
Place the fabric layer on top of this second silicone layer so that it is perfectly in the middle of the mold. Let the silicone cure for 2 hours in the open air.

NOTE: If you have access to an oven, you can cure the silicone much more quickly. Turn the oven to 70°C (140°F) and let it cure for 20 minutes



120 MINS

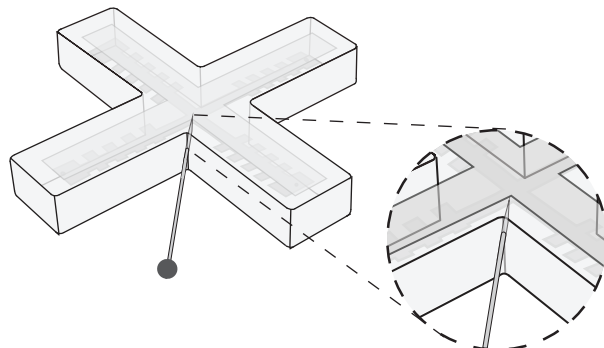
19



Touch the silicone with a finger to test whether or not it has cured completely. If the silicone still feels "greasy" or "tacky", let it cure longer. If it feels "rubbery", then the two-part silicone casting is complete. Use mixing sticks to peel the gripper out of the mold.

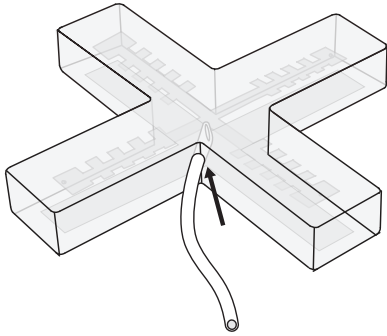
NOTE: The gripper may be hard to peel out. In that case, disassemble the mold and peel the cardboard pieces away from the silicone gripper.

20



Choose one of the joints in the mold and identify the acetate layer. Use a pin to poke a hole into the gripper just above the acetate layer. Tubing will be inserted into this hole.

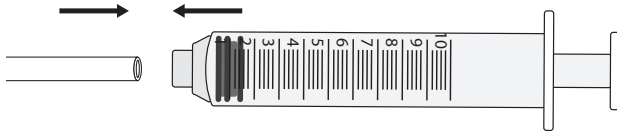
21



Cut 1 ft of plastic tubing for each student. Insert the tubing into the hole above the acetate. The tubing should be in contact with the acetate layer beneath it. This allows the air to separate the silicone from the acetate, creating an air channel through the gripper.

NOTE: Make sure that the tubing is inserted inside the gripper far enough so that the tubing will not fall out when inflating the gripper. The hole should create a tight fit around the tubing.

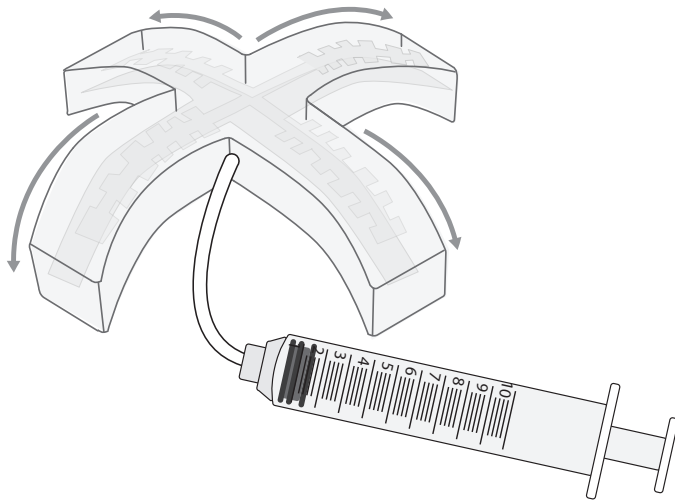
22



Insert the other end of the tubing into the syringe. The syringe will be used to pump the gripper with air.

NOTE: You may need to use the blue silicone tubing as a connector to the syringe.

23



Use the syringe to pump the gripper with air. The woven fabric layer on the bottom of the gripper is inextensible and will not stretch with the silicone as the gripper fills with air. As a result, the gripper will bend towards the fabric, causing it to curl.