Cardboard Robotics Hand Student Copy

Name:

Objective: Students will learn that robotic hands “effectors” are shaped in different ways depending on their intended function.

Challenge:

1. Students will construct a mechanical end effector “robotic hand” and test it with a variety of tasks.
2. After completion of the task students will design a new end effector by modifying the hand to perform a new function that a real hand can do.

https://youtu.be/24SVNOBgk-w

Materials:

1. Cardboard
2. Scissors
3. Hot glue gun and glue
4. 5 beads can also possibly use (small safety pins or fishing leader connector)
5. 5 lengths of string (length from arm to shoulder)
6. 1-2 plastic straws
7. 5 zip ties (optional: can just tie loops with string or possibly use rubber bands)
8. Sharpie marker
9. Ruler (smaller ruler may work better than standard size)

What you need to know:

In robotics, an **end effector** is the part of the robot that interacts with the environment. The three most common types of end effector are **1. mechanical, 2. magnetic and 3. vacuum**. End effectors are designed very differently depending on the task they are intended to perform. Industrial grippers come in many different forms. Some physically grasp the object to be manipulated, like the “hand” the students will build, while others puncture objects with needles, or suck them up with a vacuum, or grip the object with glue. Some use electromagnets to pick up and drop magnetic objects. Effectors can also be tools like drills, screwdrivers or welding torches.

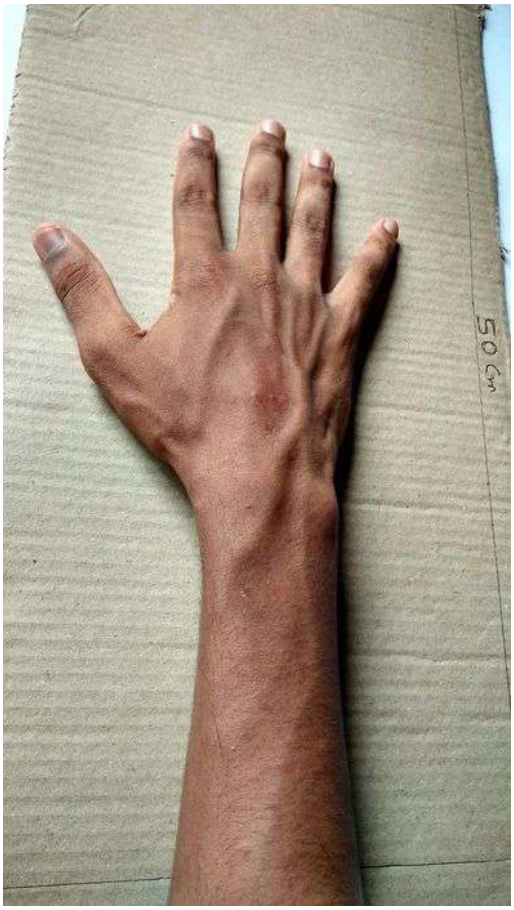
What you already know about robotics:

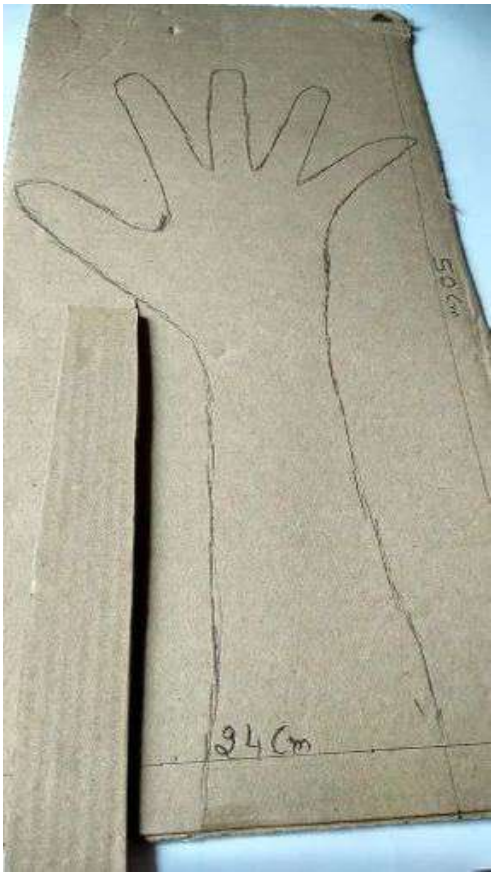
1. What types of robots have you seen before?

2. What tasks did these robots perform?

Directions:

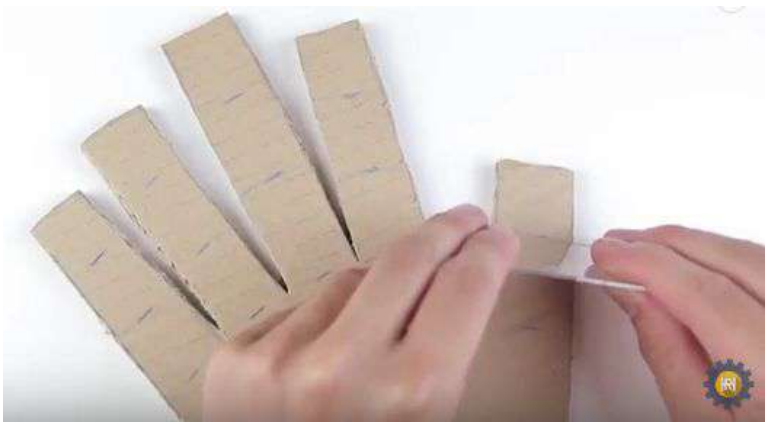
Step 1 Getting the Shape: Obtain a piece of cardboard that is long enough to contain your entire hand and half of your forearm. Then trace your arm and hand on the cardboard with the sharpie marker and cut out the shape with a scissors. *Please use caution and care while cutting through the thick cardboard.*

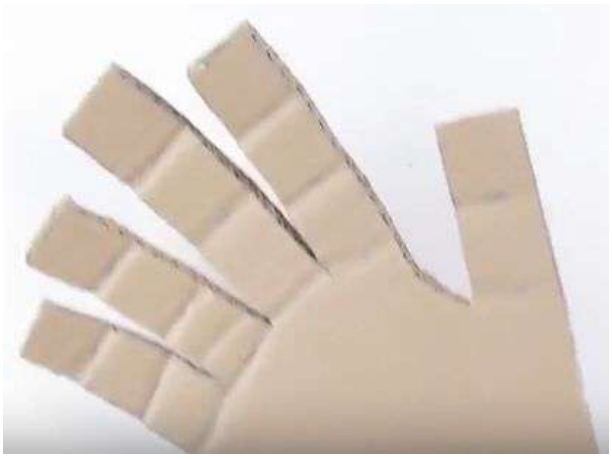




Step 2 Bending the Cardboard: When you make the bends in cardboard, use a ruler perpendicular to the cardboard to get a nice straight and crisp bend as seen in the image below.

- For each finger make three bends in the cardboard in the same places your fingers bend.
- Make two bends for your thumb.





Step 4 Building Links:

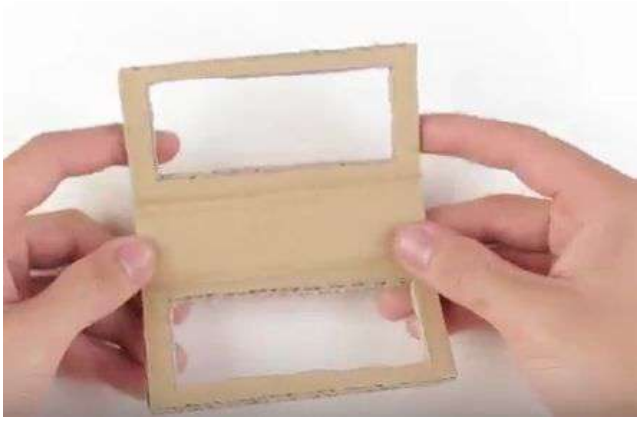
1. Cut the straw into 17 pieces each 1.0 cm long, and 5 pieces each 4 cm long.

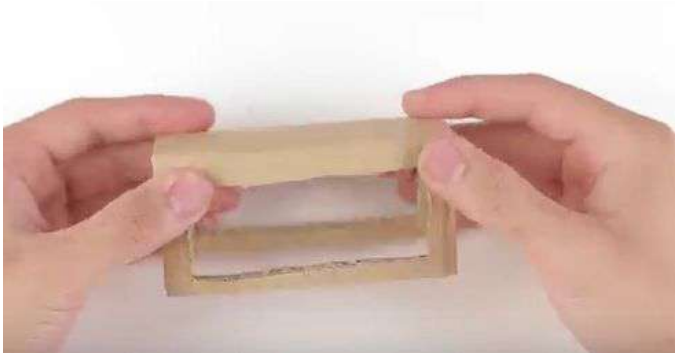
2. Using a hot glue gun, glue each 1.0 cm link between each joint on the finger excluding the tips of the fingers, and just below the finger on the upper palm of your hand as shown in the picture below.

Step 5 Building Finger Support System:

1. Take a square or rectangle piece (approximately 14 cm by 14 cm) making sure it as long as the width of your cardboard hand and fold it into 3 folds using the straight edge of a ruler. The left and right folds should be equal and a little larger than the middle fold.

2. Cut a window in the left and right side wide enough to fit your four fingers through it





3. Hot glue the bottom left and right sides to the wrist of your cardboard cut out.

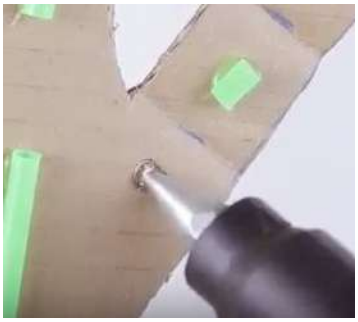
4. Once the glue has dried you should be able to fit your 4 fingers through the window.

5. Add some support by gluing in cardboard squares to fit the left and right sides.

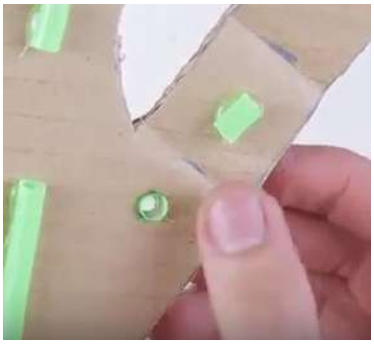

Step 6 Building the support to make your thumb mobile:

1. Go to the hammer station and using only 1 tap, make a hole below the thumb as seen in the picture below. We are not using a drill for this station.

2. Add some hot glue to the hole you just created.



3. Put a small piece of straw through the hole and glue to create a tunnel.



4. Flip your hand over and glue three small pieces of straw to the back side of the hand going along the thumb down toward the cardboard wrist and finger support structure you built .

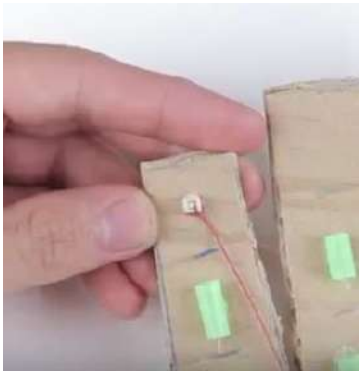
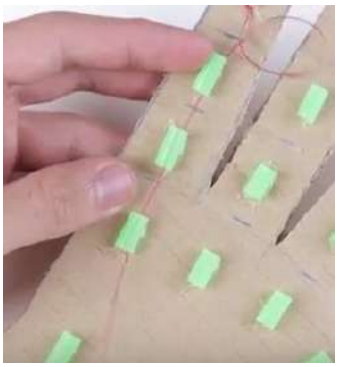
5. On the thumb side of the finger support structure, add some glue.

6. Add a medium piece of straw 3-4 cm long to the glue on the thumb side of the finger support system.

7. Add a strip of hot glue on the back of the hand down to the wrist, and then attach a rectangle piece of cardboard for support.

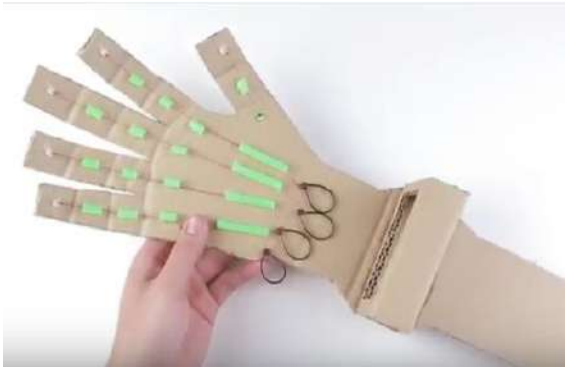
Step 7 Making your hand move:

1. Tie and knot a piece of string to a bead. Glue the bead to the cardboard tip of your finger. Then feed the string through the correct straw pieces as shown in the picture below and repeat for all your fingers.

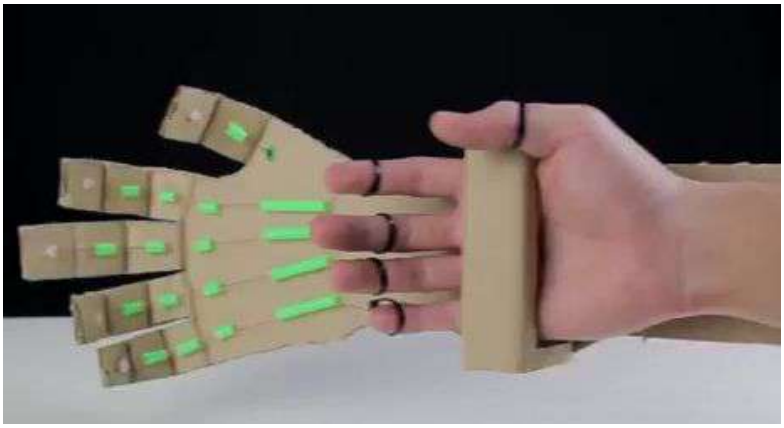




2. Tie a piece of string to a bead and glue the bead to the tip of the thumb. Feed the rest of the string through the straw pieces and the hole to the straw pieces on the backside of the hand.

3. Tie a knot at the end of the string big enough to fit you fingers and thumb through it.



Completed Build: feed your hand through the finger support system, and attach the loops to your finger and thumb. Now you are ready to test your robotic arm!



Testing Your Robotic Hand:

Perform the following tasks using your robotic hand. After each task, identify how long or how many attempts it took you to be successful at your task. Identify the challenges you faced using your robotics hand and what modifications you would need to make, or made to perform this task.

Task 1: Lift an empty plastic water bottle and hold it in your hand for 30 seconds.

# of attempts	Reflection of how your hand worked and identify any modifications you did or would make

Task 2: Move a full water bottle 1 meter using only your robotic arm.

# of attempts	Reflection of how your hand worked and identify any modifications you did or would make

Task 3:Stack the red solo cups 3 cups high using only your robotic arm.

# of attempts	Reflection of how your hand worked and identify any modifications you did or would make

Task 4: Catch a crumpled up piece of paper with your robotic arm that a partner underhand tossed to you.

# of attempts	Reflection of how your hand worked and identify any modifications you did or would make

Task 5: Complete a successful game of catch with a partner. Where each person tosses and catches one time using only your robotic arm.

# of attempts	Reflection of how your hand worked and identify any modifications you did or would make

Design Challenge
Challenge: After completion of the 5 tasks you need to design a new end effector by modifying the hand to perform a new function that a real hand can do. The new effector you will engineer for your robotic arm is to make the wrist 1. move up and down, or 2. side to side, or 3. rotate in a circle.
What new effector 1, 2, or 3 will you make for your robotic arm?

Brainstorm: 1. How will you make your arm move in this way? 2. What materials will you need to add to your arm. 3. How will you need to change your current arm?
1. 2. 3.
On a piece of scratch paper sketch out your new design and turn in this design in for approval conference with one of the teachers. You need to have your design approved before you start your construction.
After you engineered your new effector in your arm:
1. Explain what changed in your end design from your original approved sketch? Why did you make those changes?
2. What advice do you have for future engineers who are going to make robotic arms that you learned from doing this activity?