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Activity Idea

Cardboard Robot Arm

Recommended for Ages 12 - 18

Constructing a design on an existing object is called reverse engineering. Making a robot arm is an example of reverse engineering because you are starting with something familiar (your hands and arms) and building a mechanical version. Let us reverse engineer our own version of a robot arm by creating it with cardboard.

Materials:

- Cardboard
- Tape and strong glue
- 3 drinking straws
- String
- Scissors
- Pencil
- Ruler

Preparation for your Robotic Arm:

1. Cut a cardboard rectangle, make sure that your rectangle is equal to the length of your hand and forearm. (Piece A)
2. Measure the width of the palm of your hand and cut a cardboard rectangle 3 times that size in length and 3 inches in width. (Piece B)
3. Cut 20 pieces of straw ½ inch in length.
4. Cut 4 pieces of straw 1 ½ inches in length.
5. Cut 5 strings of 18 inches in length (the length might be longer than you will need).

Instructions:

1. Place your hand on the cardboard piece A with your fingers slightly stretched. Trace your whole hand leaving about 1/8 to ½ an inch of extra measurement between your fingers. Trace all the way to your forearm (you can have someone help you trace it).
2. Cut out along the lines you made.
3. Place your hand back on the cardboard and make small marks at the three bends of your fingers (thumb has two bends only), you want to mimic how your hand moves. Think about how your hand bends and how you might make your robotic hand bend. Look at how your hand grabs things and make the appropriate marks on your cardboard.
4. Plan the string (muscles) path

   a. Decide where you will attach the string (muscles) to the cardboard (bones) to make the hand move.
   b. Lay the string along the cardboard. Make light pencil marks where you think your string might go.
5. Plan the straw guides (tendons)
   a. Decide how you will use the straws (tendons) as guides for the string. The string will pass through the straws which will be attached to the cardboard hand.
   b. Lay the straws on the cardboard where you think they should go and then review your placement choices. Make pencil marks where you will later glue your straws.
6. Take your ruler and place it at each finger bend and crease your cardboard. Bend your cardboard creases and see if it mimics your hand when you move your fingers.
7. Take cardboard piece B, bend it around your hand and adjust it to size. This part will be the trigger mechanism for your hand movement so make sure it is not too loose around your palm.
8. Glue the trigger mechanism to be back side of the cardboard, not the front, at the end of your cardboard forearm.
9. Make a small hole in the cardboard at the base of the thumb.
10. Place a dab of glue in this hole and insert a ½ inch piece of straw.
11. Turn your cardboard arm over and draw a straight line from this hole down the arm, stop right at the beginning of the cardboard trigger. Place and glue 3 pieces of straw 1 ½ inches apart on this line. These straws will be on the front of the hand. All others will be on the palm.
12. Turn your cardboard arm over so the palm is facing up and place one ½ straw piece at the thumb marking and one ½ inch piece of straw at each finger marking. All fingers should have 3 pieces of straw glued at each joint marking, except the thumb which should have 2.
13. Place 4 of the 1 ½ inch straw pieces close to the base of the hand before the wrist crease, each should be in line with the shorter straws of one finger. Tape these guides in place (you will glue them later on).
14. Connect the string (muscles)
   a. Take your string and insert it into a piece of straw, then knot it in place. Tape the straw on a horizontal position to the top of the fingers.
   b. Thread the string through the straw guides.
   c. Position and tape the string end to the hand section. Tape everything first and once you are satisfied with how well the position works, you can glue them in place.
   d. For the thumb, since the string is on the front, take an additional piece of straw and glue it to the side of the trigger. Insert the string through this straw so all strings will now be pulled from the palm side.

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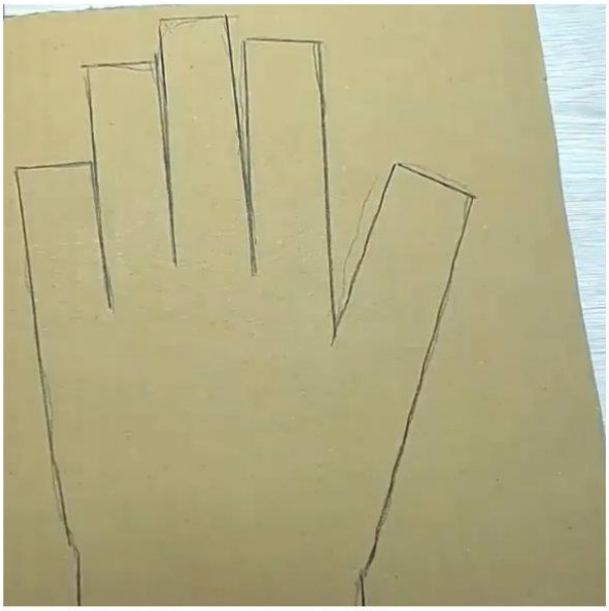
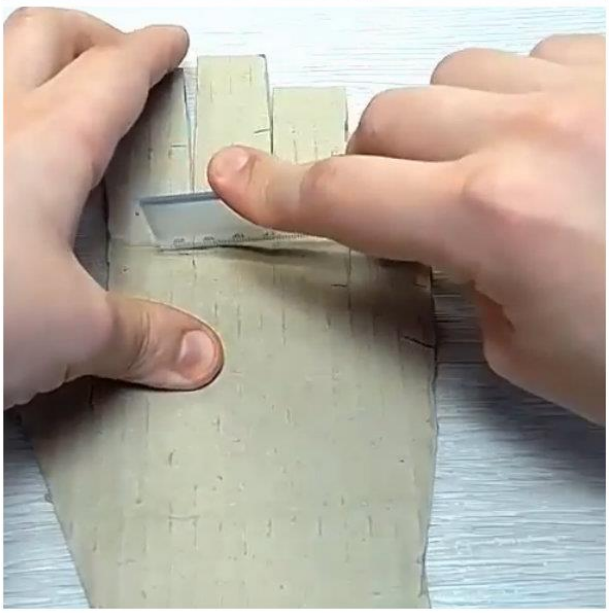
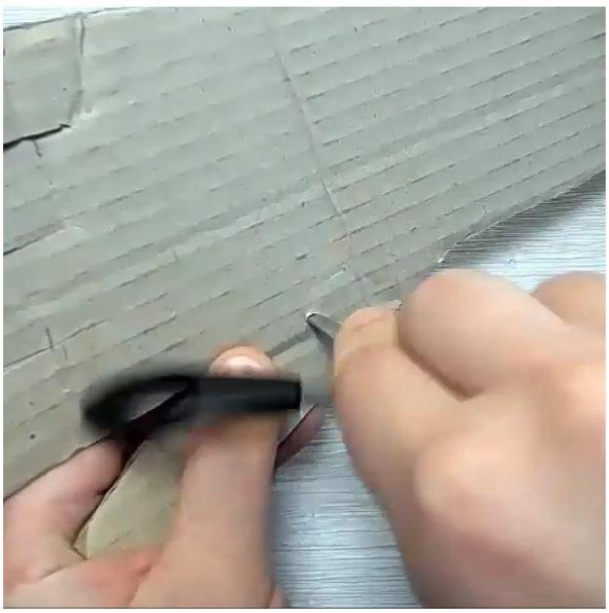
15. Test your robot arm.
    a. Make a loop at the end of each string and place your fingers through it. Pull the strings to make your hand move.

TIP: If the hand does not move in the direction it should, check where you taped the end of the strings to the cardboard. You might also check that the guides make the string pull in the right direction. The string's (muscle's) pull is directed by a straw guide (tendon). The position of each guide will affect the arm's movement.



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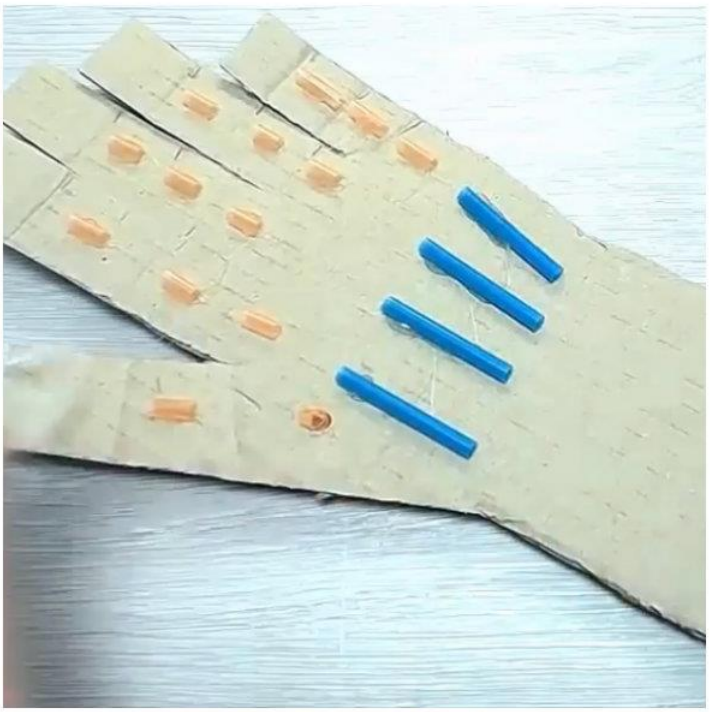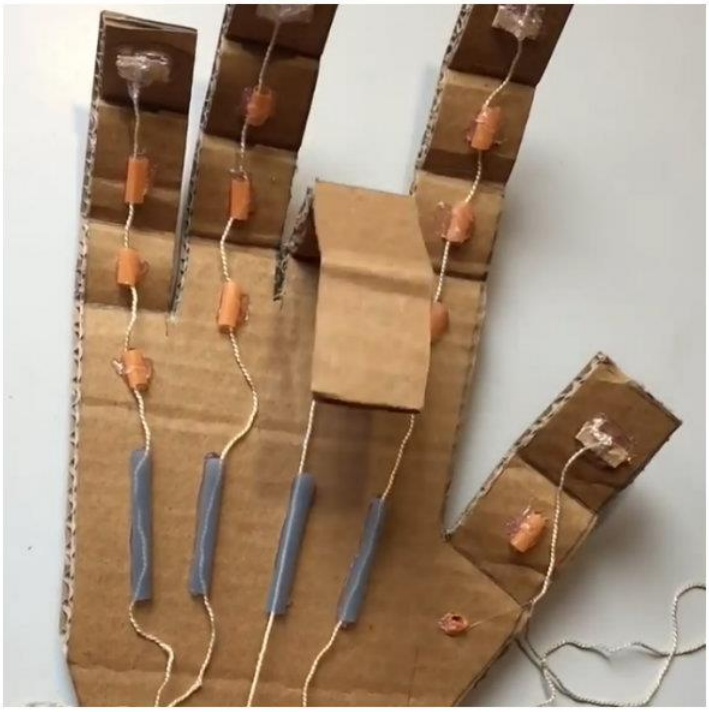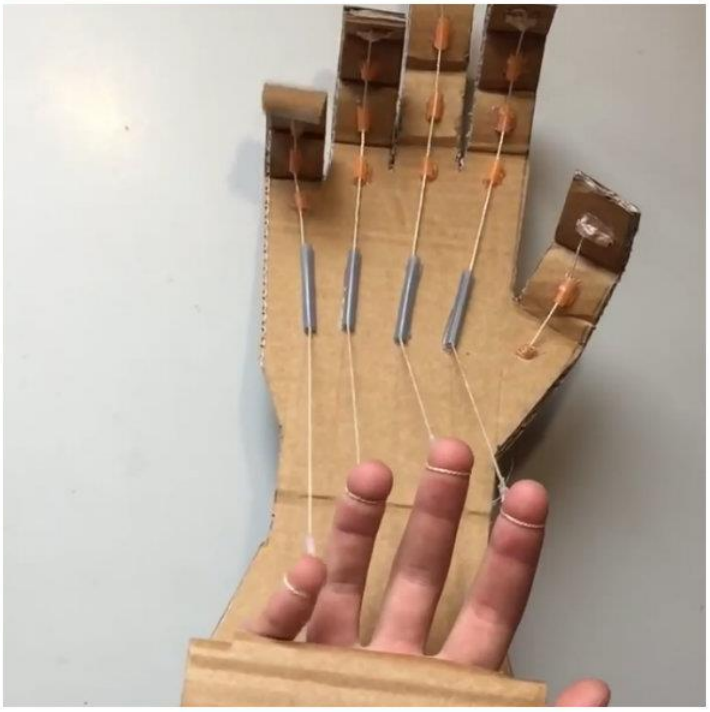
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