deSTEMber
SCIENCE ★ TECHNOLOGY ★ ENGINEERING ★ MATH

PRESENTED BY: girlstart

Robot Arm

Are you ready to be a robotics engineer?! Examine your arm, wrist, and hand, and brainstorm how you could reverse engineer these body parts to design your own robot arm prototype. Reverse engineering is when engineers design an object based on an existing object. Compare your "robot arm" to your arm and note their similarities and differences.

TEKS:

7.6A Demonstrate basic relationships between force and motion using simple machines, including pulleys and levers.
7.12B Identify the main functions of the systems of the human organism, including the circulatory, respiratory, skeletal, muscular, digestive, excretory, reproductive, integumentary, nervous and endocrine systems.

How To:

1. Before you begin, go to http://pbskids.org/designsquad/parentseducators/guides/mission_robo_arm.html and watch the *Robo Arm* video. In *Robo Arm*, kids substitute a mechanical system for bones, joints, and muscles. In your prototype, you're going to substitute cardboard for bones, a brad for a joint, and string for muscles.
2. Place the pieces of cardboard in an "L" shape so that the holes line up in the corner of the "L." Attach the pieces of cardboard with a brass fastener at this "joint."
3. Tape straw pieces at intervals along the back of each cardboard strip. The straw pieces should be centered on each strip and run length-wise. You can add as many or as few straw pieces as you like.

Materials:

- 1 large strip of corrugated cardboard (2"x 8" or 5cm x 20 cm) with a hole punched in one corner
- 1 small strip of corrugated cardboard (2"x 4" or 5cm x 10cm) with a hole punched in one corner
- One 1-inch brad or brass fastener
- 1 straw, cut into 1 inch (2.5cm) lengths
- 39 inches (100 cm) of smooth string (e.g. kite string)
- 2 large paperclips
- One 3 oz. paper cup
- Small, somewhat heavy items such as pennies, washers, or paperclips
- Tape

How To (continued):

4. Run your string through all of the straw pieces. At the top (by the nonattached end of the larger strip of cardboard), knot your string multiple times so that it doesn't slide back through the straws.
5. Take a paperclip and bend it so that it makes an "S." Tie it to the bottom of your arm (by the nonattached end of the shorter strip of cardboard). Secure the string and paperclip to the shorter piece of cardboard, with the paperclip extending beyond the edge like a hook.
6. Test your arm by pulling on the string at the top. You should see the shorter piece of cardboard pivoting upward like your forearm does when you pick up a cup.
7. To give your arm a challenge, completely unfold the second paperclip and curve it so that it looks like a handle. Tape it to the top of the paper cup so it resembles a bucket, then fill the cup with small, somewhat heavy items like pennies or washers. Loop the handle of the cup through the paperclip at the end of your cardboard arm and pull the string to see how much your arm can lift!

The STEM Explanation:

When engineers design an object based off an existing object it is called reverse engineering. *How do you think making our robot arm is an example of reverse engineering?* Hopefully, you thought about how your arm and hands work to build your mechanical version, your robot arm. If you compare your robot (cardboard) arm to your own arm you will notice both have flexible parts (string and muscles) to move rigid parts (cardboard and bone). When you pull on the string or flex your muscles they are directed by a guide (the straws and your tendons), and the guide's position affects the arm's efficiency. Finally, the brass fasteners mirror our joints. Another example of joints is a lever system. A lever converts a little effort into a lot of force. *What part of your robot arm acts as the fulcrum, which is the point at which a lever pivots?* The brass fastener is the fulcrum and the cardboard is the lever arm. Changes will alter the force required to move the lever.

Career Connection:

A *robotics engineer* creates robots and robotic systems that are able to perform duties that humans are either unable or prefer not to perform. At NASA, a robotics engineer designs and builds humanoid robots to work alongside astronauts. The robots have impressive dexterity, strength, and intelligence. These robots are useful because they can accomplish tasks and function in conditions that humans cannot withstand, as well as complete tasks that would otherwise be unsafe for humans to perform.

Resources:

- www.pbskids.org/designsquad
- www.pbskids.org/designsquad/links/solarsystem