Build a Droid Arm

Objective:
Can you make a droid arm that could pick up a cup?
In the Star Wars universe, Droids are machines, but so much more! Droids do many functions that are too dangerous for organic beings to do, from being exposed to the conditions of deep space to serving in battles. Even droids that are designed to be diplomats, like C-3PO, can sometimes get damaged, and need a new arm.

Learn a little bit about mechanical physics with this activity, making your own droid arm. Then think about how you could improve this design.

Difficulty Level:
Medium with help (ages 12-14)/Challenging (ages 8-12)

Materials:

- 1 piece of 10 x 17 inch thin cardboard
- Pencil
- Scissors
- Ruler
- String
- Two bendy straws
- Double sided tape
- Masking tape
- Hot glue (optional -- be sure an adult says it's okay to use)
- Gold or red paint (optional)
- Gold Sharpie (optional)
- Black Sharpie (optional)

Procedure:

1. Trace your hand and arm onto the cardboard, using the pencil. In our example we made a Battle Droid arm, which only has three fingers.

2. Cut out the tracing of your hand along with two extra strips of cardboard. The extra strips should measure 1.5 x 12.5 inches and 1.5 x 13.5 inches.

3. Is your droid left-handed, or right handed? Decide which hand you want to operate your droid arm with. Next, glue or tape the 1.5 x 12.5 inch cardboard strip to the back of the cut out—this will help support your model and keep it standing up.

4. Turn the arm over, and use tape or glue to attach the 1.5 x 13.5 inch strip of cardboard around the arm's widest part, leaving enough space to slide your hand through.

5. Use a ruler to help you bend each cardboard finger and thumb down. You will bend three folds into each finger and one fold into the thumb.

6. Cut one straw into sections. Each section should be about half an inch, and you will need one section between each finger and thumb joint. Use hot glue, or strips strong tape over the straw, to hold them in place.

7. Cut three one-inch sections from the other straw. Use hot glue, or wider strips of strong tape over the top, to attach these to the palm of your droid arm, spaced out so that you could draw a straight line between the small straw piece and the larger one.

8. Use a pencil or hole punch to make a hole beneath the last joint of the thumb. Cut the folding part of a bendy straw, so that the total piece of straw is about two inches long, and push it through the hole, so the bendy part is on the back of the arm.

9. Use hot glue or strong tape to attach the bendy straw bit, making sure you leave a small piece of the straight part of the straw sticking out the palm side of your droid arm.

10. Measure and cut three lengths of thread, each about 16 inches long. Attach the thread firmly to the tips of the fingers and thumb, by wrapping over them with strong tape, or using hot glue.

11. Thread the lengths of thread through each straw, including the one at the base of the thumb.

12. Attach two cut lengths of straw to the back of the droid arm, between the thumb and the arm grip. Then cut and attach a longer piece of straw, with the bendy section still attached, to the back of the horizontal strip where you will slip your hand through.

13. Pull the thumb thread through the short bendy straw bit on the back of the arm. Then pass it through the two short sections on the front, and finally, through the long bendy straw part.

14. Turn the arm over, palm side up. Make a loop in each string that you can fit your fingers and thumb through. Then, knot the thread, leaving the loop open.

To operate your droid arm: Slip your hand through the cardboard hand grip, and slide your fingers and thumb through the string loops that are attached to the droid's thumb and fingers. Bend your fingers and thumb -- are your droid's fingers and thumb moving? See if you can pick up a pen or straw with your droid arm.

Think about what you could change or modify your droid arm. Is there something that isn't working the way you like? What will you change?

If you want a bigger challenge, how would you modify this design to make a prosthetic hand, like Darth Vadar or Luke Skywalker's?

What's the Science?

This model works a little bit like your own hand works. Under your skin, you have a network of muscles and tendons that work together whenever you flex or relax your fingers and thumb. The strong flexor tendons attach muscles to bones, and allow you to open and close your hand, so you can pick things up, hang onto a pull up bar, or climb a tree.

Which parts of your droid arm act as the tendons? Open and close the droid arm, and watch which parts work with the straw ‘bones’ to move the cardboard ‘muscles’.

Explore More:

Scientists are working to develop more effective prosthetics for people who have injuries or disabilities.

Right now, there are artificial tendons made from polyethylene (a type of plastic), and attached to artificial bones made of metal, composite materials, or even 3-D printed plastic. The prosthetics can be powered by small servo motors or compressed air.

Benjamin Tee, assistant professor at the university of Singapore, recalls being fascinated watching *The Empire Strikes Back*, and seeing Luke Skywalker’s cybernetic prosthetic hand. This memory stayed with him as he grew up and studied biotechnology and the crossroads between humans and machines.

Luke’s cybernetic hand was able to react to sensations and to feel. Most prosthetics now can’t do that, but Dr.Tee is working on an artificial nervous system, and artificial skin, called e-skin, that can respond to touch.

If you’re interested in biomechanics and robotics, there are lots of great books and activities you can try, to learn more.

Star Wars Connection:

Droid arms and parts can be interchangeable. The comic *Star Wars Special C 3PO #1* from Marvel brings readers along on the nervous protocol droid’s adventures, explaining how he wound up with a red arm in *The Force Awakens*.

Many other characters also have prosthetic replacements for damaged limbs in the Star Wars universe, including Anakin and Luke Skywalker.

References:

This project was inspired by a project in the book *Star Wars Maker Lab: 20 Crafts and Science Projects*, by Liz Lee Heinecke and Cole Horton.

The information about prosthetics is from “How Luke Skywalker’s robotic hand inspired the prosthetics of tomorrow,” Justin Solomon, Zeena Saifi, and Tom Page, CNN Health, March 21, 2018.
https://www.cnn.com/2018/03/21/health/benjamin-tee-tomorrows-hero/index.html

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