Make a Mechanical Hand

Student Instructions

Introduction

Engineers start by identifying the problem they are trying to solve and any constraints they need to consider.

Your challenge: How can you design and build a mechanical hand with fingers that bend and straighten like a human hand?

An engineering constraint is a limitation on your design. There are three constraints for this challenge:

- Use only the materials provided (but you don't have to use them all).
- The hand has to have four fingers and a thumb.
- The mechanical hand does not need to be the same size as a human hand.

Brainstorm Designs

- Take a minute to watch your hand as you make a fist and straighten your fingers and thumb out. Note where the joints are and how the thumb joint is different. Notice that your fingers have three joints that only bend and stretch in one direction, and your thumb has two joints. Which materials would make fingers with joints and a sturdy palm?
- To move a finger, muscles in our hands or forearms pull a tendon, which is like a long strong string. It pulls on a bone in our finger. When the muscle pulls, the finger bends at the joints. There are no muscles in our fingers and thumb! How can your materials work in the same way?



Materials

- Stuff to make the hand and fingers: cardboard and/or cardstock paper, regular or wide straws, toilet paper or paper towel rolls
- Stringy stuff representing tendons (the cords connecting muscle to bone): string, yarn, heavy-duty upholstery thread, twine
- Stuff to assemble the hand: tape, glue, staples
- scissors, craft knife, or similar cutting tool
- Paper hole punch
- Ruler
- Fine-tip marker
- Sketching materials
- Optional: transparent gloves for activity extension

Tips on selecting materials:

- The larger the straw or tube diameter, the easier it is to thread string through.
- The stiffer the stringy stuff, the easier it will be to thread through straws.

- Consider using hollow materials like straws or tubes to design your fingers and explore how cutting little notches in your tube helps it bend and straighten. How can you create a joint for your finger that bends only in one direction?
- What about making the tendons work? Since a tendon's job is to help your fingers bend and straighten, how might you use a piece of string to bend the fingers on your mechanical hand? And how will you attach the tendon—in this case, the string—to one end of your joint?

Build and Test

- Build your hand after doing some experimenting.
- To test it, pull on the tendons and see if the fingers and thumb bend. Will the fingers and thumb straighten out again when you release the tendons?
- If your tendons popped or your hand doesn't open and close properly, no worries. Engineers learn from what isn't working all the time.

Evaluate and Redesign

- What design elements worked the way you wanted them to? Think about the changes you'd like to make. Ask yourself:
- What's the best way to attach the tendon after you've threaded it through the tube you're using—making a knot on one end, or wrapping it over the end and taping it?
- What works better to make the finger bend and straighten, cutting little notches in the tube or cutting the tube into sections?

Make Changes and Try Again!

- See if you can improve your mechanical hand by making any weak points stronger.
- If this design challenge was easy, ramp it up. Can you make a hand that can pick up an object? What about putting a glove around it and stuffing it to make the hand more lifelike?

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