Activity 2: Heavy Lifting

Introduction

You have probably seen cranes used to lift heavy materials. What if we could use cranes in our daily life? Imagine your grandparents or a differently-abled person living on the second floor, and imagine they need help carrying groceries to their apartment. Have you ever thought about how we can help people in these types of situations? The "Use it!" category focuses on inventions involving tangible consumer products where the end users are retail customers who would purchase the product for use in their daily life.

In this activity, you will experience one such invention project by creating and modeling a crane to help with heavy lifting. You will get to develop the hands-on skill of using common materials to create a crane. This activity should engage you for at least 45 minutes, or you can take as long as you want. Have fun learning!

Activity Guide

Materials

- Cardboard box (shoebox size or bigger)
- Paper clips
- Paper cup
- 3 pencils (1 sharpened for poking holes in cardboard)
- Scissors
- String (fishing line or kite string)
- 3 strips of corrugated cardboard (2" x 11" [5 x 28 cm]) (corrugated cardboard has grooves in the middle, like a cardboard shipping box)
- Tape
- Weights (marbles, pennies, or washers)
- Wooden spool

Design Instructions *(This is adapted from PBS Kids' Design Squad activity "Heavy Lifting")*

1. First, let's examine **what cranes are and how they work**. Cranes are huge machines that are used for moving heavy loads. They have a long arm called a beam that holds a strong wire or rope, called a cable, with a hook on the end. What do you notice when you see a crane? What materials do you see? Record your observation.

   Why do people use cranes? You can use cranes to lift heavy objects or to lift objects to high places. Are these cranes used only in the construction of high-rise

buildings? Where else do you think cranes are being used? How about cranes used in offshore drilling? How about space exploration? Did you know that cranes are used to move astronauts and heavy components around the exterior of the space stations? Read more on how NASA used heavy lifting to move the Space Shuttle.

2. **So, how does it work?** First and foremost, it needs to defy gravity. We all know that gravity is a force that pulls an object to the ground. Cranes have a long arm (called a beam) that holds the cable, which has a hook on the end. They use at least three simple machines: a lever that provides the leverage to lift things and move them around, a sheave (type of pulley) for the arm's cross pieces, and lastly, a wheel and axle as the take-up reel that is used for rolling up.

   Cranes also need a support structure (a strong pedestal and counterweights), which provides stability and support for the weight they carry. Overall, we have to ensure that the push and the pull force must be balanced so that cranes don't collapse at any point during movement.

3. Watch Nate for Hire: Heavy Lifting! This is a 5-minute video about how the PBS Kids Design Squad helps solve an engineering problem in an urban-space farm. They created this farm in an old paved lot that had been used to store old debris, including granite blocks from construction sites. Initially, they used the granite blocks to border planting beds, but it soon became a problem. The planting beds were pushing the granite blocks out of their place and the urban farmers wanted to move the granite blocks back into their original spots. Who knew cranes could help to solve these everyday problems? Watch the video to see how it was solved.

4. Next, let's examine the materials you've gathered to help us plan what we can do. We will try to model a crane's functionality using the materials we have. It's important that inventors know their materials! Look through the materials you have and consider these questions:

   a. What will you use as the pedestal (the body of the crane)? What materials will you use for the arm, the body, and the rope?

   b. How will you determine the length of the crane's arm? How will you keep the crane's arm from breaking off the pedestal when it lifts something heavy?

   c. How will you keep the arm balanced so that it doesn't drift left and right?

   d. How will you wind and unwind the rope so that the hook can go up and down? What materials will you use?

   e. How will you build the take-up reel? What materials will you use?

5. Draw your ideas for your crane. How would you like to build it?
6. Now let's build our crane. Click on this link and follow steps 6 through 15. If some parts are not working, make sure you take a look at the tips that are provided at the end of every step.
7. Test your model:
    a. Try your design to pull some weight. How much can it lift? Keep adding weights (marbles, pennies, or washers) to record your observations.
    b. Try substituting your weights with stones of different sizes, and test how much your crane can lift. Compare the results.
    c. You can also try picking up the load from the floor as your crane sits on the tabletop. Does it work? Why or why not?
    d. If not, revisit your design and see if you can make it work.
    e. Extend your challenge by modifying your take-up reel: add a hand crank.