LESSON 4:
PING PONG PICK UP

SUPPLIES

MAIN BIN

- Paper Clips (50)
- Rubber Bands (25)
- String (2 rolls)
- Masking tape (1)

HANDOUTS FOLDER

- Paper - (50)

PENCIL BOX

- Ping Pong Balls - (6)
- Pencils
- Rulers
- Scissors
- Tape Measure
- Tape

OBJECTIVES

- ☑ To engineer a creative way to pick up materials without our hands
- ☑ To understand why we might need to grab objects without our hands, and how designing a solution could be helpful

HOOK

2-3 min

Ask students:

- What are some situations where you have to grab something without using your hands?

Potential answers:

- Picking up trash from the side of the road
- Retrieving keys from a sewer grate
- Retrieving something that fell under your couch
- Using a claw machine
- Holding something dangerous, like a hot pan or a sharp object

INTRODUCTION

3-5 min

Sometimes an engineer is asked to design and create a tool that makes a difficult task a little bit easier! A grabber is a good example.

Tools like grabbers are mechanical, and help humans in a variety of situations where it might not be practical (or safe!) to pick something up using our hands. A grabber can be used to pick up something that is too far away for us to reach, or something that would hurt our hands.

Grabbers come in many different forms. As we will see today, the same task--picking up a ping pong ball--can be accomplished using many different tools. Every different design might be better for a particular situation. Trying to find mechanical solutions to different challenges might result in some completely different grabbers!

PING PONG PICK UP

DISCUSSION

3-5 min

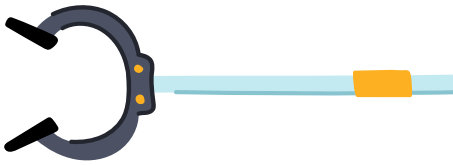
Tell the students that today we are going to design grabbers! We will use our grabbers to pick up ping pong balls. In order to be effective tools, grabbers must have the following features:

- Lightweight
  - Light enough to be easily moved around
- Strong
  - Strong enough to carry an object without bending or breaking
- Secure
  - Be able to secure the object so that it doesn't fall while being moved

DESIGN & BUILD

25 min

1. Divide students into groups of 3 and pass out materials. Each group should receive:
   - 10 sheets of paper
   - 10 paper clips
   - 5 rubber bands
   - 1 roll of masking tape
   - 1 ping pong ball



   The students will have to share two rolls of string between all the groups.

2. On the next page, there are three versions of the Ping Pong Pick Up challenge. You can choose the version of the challenge that best fits your students' ability levels. Explain the rules.

3. Give students 15 minutes to complete the challenge. When time is up, test each group's grabber. Use masking tape on the floor to mark a start and end point. Each group can send a representative to try and move a ping pong ball between the start and end point using their grabber.

EVALUATE & REDESIGN

3-5 min

After they've tested their grabbers, tell students to reflect on the features you discussed earlier in class.

- Was the grabber lightweight enough for you to move the ping pong ball easily?
- Was the grabber strong enough to pick up the ping pong ball without breaking?
- Once the ping pong ball was picked up, did it stay secure?

If all groups completed the challenge, have them complete a harder version of the challenge or do the extension activity.

PING PONG PICK UP

CHALLENGE #1
For very young students

Create a tool that can move a ping pong ball 1 foot.

Rules:

- You cannot touch the ping pong ball with your hands
- The ball cannot be secured to the tool using tape
- Neither the tool nor the ping pong ball can touch the ground while it is being moved

CHALLENGE #2
For younger students

Create a tool that can move a ping pong ball 2 feet.

Rules:

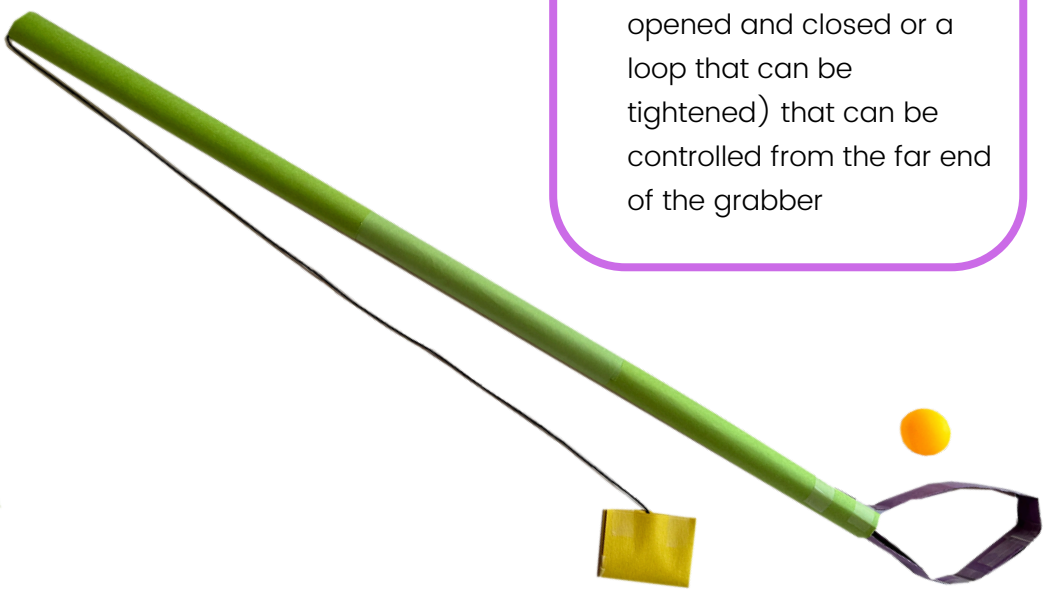
- You cannot touch the ping pong ball with your hands
- The ball cannot be secured to the tool using tape
- Neither the tool nor the ping pong ball can touch the ground while it is being moved
- Your hands must remain 1 foot or further from the ball while it is being moved (meaning the grabber tool must be at least 1 foot long)

CHALLENGE #3
For older students

Create a tool that can move a ping pong ball 10 feet.

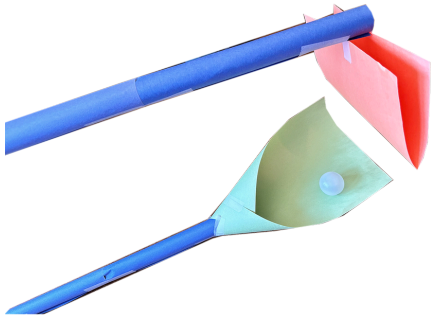
Rules:

- You cannot touch the ping pong ball with your hands
- The ball cannot be secured to the tool using tape
- Neither the tool nor the ping pong ball can touch the ground while it is being moved
- Your hands must remain 1 foot or further from the ball while it is being moved (meaning the grabber tool must be at least 1 foot long)
- The tool must include a mechanical element (like a hook that can be opened and closed or a loop that can be tightened) that can be controlled from the far end of the grabber



PING PONG PICK UP

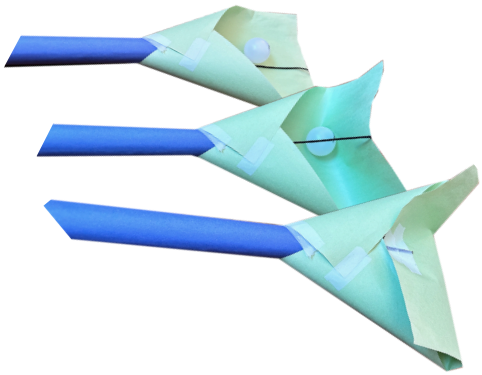
PING PONG GRABBER EXAMPLES



Dustpan Grabber

Engineering Concepts:

- Gravity - once the ball is in the dustpan, this version uses gravity to keep it secure. This wouldn't work if the grabber had to be used at different angles
- Materials - the dustpan is made of a single sheet of paper. It can support a ping pong ball, but would not work for heavier objects



Mechanical Dustpan Grabber

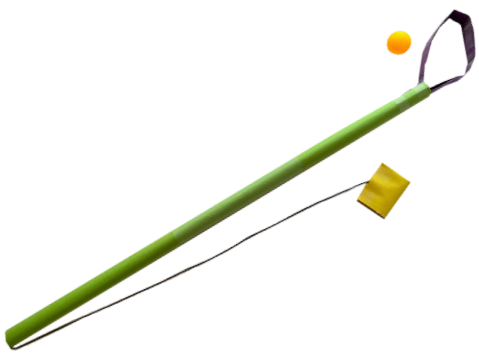
Engineering Concepts:

- Mechanics - this tool uses a string to close over the ping pong ball
- Tension - the tension from pulling on the string closes the lid, but when you let go of the string, the tension of the paper causes it to unfurl. This grabber can open and close, unlike the mechanical loop grabber, which cannot open easily
- Materials - the dustpan is made of a single sheet of paper. It can support a ping pong ball, but would not work for heavier objects

Loop Grabber

Engineering Concepts:

- Size - the loop is designed to fit the exact size of the ball.
- Friction - this grabber uses friction to keep the ball in place. It would not work with a differently sized object



Mechanical Loop Grabber

Engineering Concepts:

- Mechanics - this tool uses a loop, which can be tightened using a string, to grab the ping pong ball
- Size - this tool can be used to grab objects of various sizes
- Materials - the way the paper handle is rolled and the paper loop is folded makes this grabber very strong. If your class has done the paper tower or paper bridge experiment, connect this to concepts in those lessons

PING PONG PICK UP

REAL LIFE APPLICATION

A classic grabber relies on levers working together to move the claw. To picture this, think about scissors. Scissors are made from two levers. They are joined at the center by a fulcrum. When force from your hand is placed on the top lever, it pushes the bottom of the two levers together.

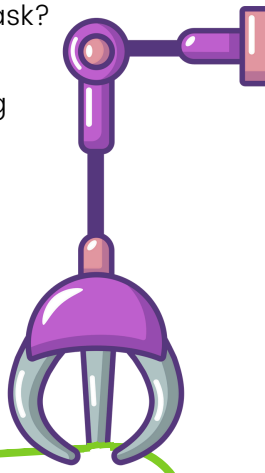
Many grabbers also have a coating of rubber on the claws. This helps to grip objects it is picking up.

OBSERVE & EXPLAIN

5-10 min

Discuss the following ideas as a class. Refer to the previous page for examples of grabber designs and how they connect to different engineering concepts.

- Did most groups make similar designs, or were the tools fairly different?
  - If they were different, which designs were most successful and why?
- Is your current design useful when it comes to picking up lots of different objects, or could it only be used for this specific task?
  - Could it easily pick up larger/smaller objects?
  - Could it be used at different angles (picking something
  - out of a tree instead of off the floor)?
- What are other tasks grabbers could be used for? How would your design change if it was being used for one of those other tasks?
- Where have you seen grabbers in the real world?



EXTENSION

Set up two rectangles of masking tape five feet apart.

In the starting rectangle, lay out multiple ping pong balls. You can add other classroom objects as well, such as balled up paper, glue sticks, pencils, books, water bottles, etc. If an object is particularly heavy, you can assign bonus points to it. Have each group send a representative to compete. One by one, give each representative one minute to move as many objects between the two rectangles as possible using their grabber. The group who successfully moves the most objects wins!

Exit Ticket

Ask each student the following question as they walk out the door.

- Q: Did your tool use a mechanical mechanism (a moving part you could control using a level, switch, string, etc.)? If so, how did it work?