Engineering & Robotics: Hovercraft Design

Legacy SeaPerch Resource www.seaperch.org

Grade Level: 3rd – 9th grade

Length of Lesson: 1-2 class periods

Goals:

- Understand that friction slows moving objects, but also allows them to be controlled
- Predict characteristics of surfaces that might influence the amount of friction
- Create a hovercraft and understand how it moves and why it hovers
- Modify the hovercraft to improve speed, distance, and/or maneuverability
- Understand the importance of friction for engineers designing movable objects

National Science Standards:

- PS2.A: Forces and Motion
- PS3.A: Definitions of Energy
- PS3.C: Relationship between Energy and Forces
- ETS1.A: Defining and Delimiting an Engineering Problem
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

Materials:

- Large Styrofoam plate OR compact disc (CD)
- Film canister
- Ballpoint pen, stylus, or other sharp object to poke holes
- 12” wide balloon
- Poster putty
- Various classrooms materials for modifications

Background:

Friction is a force that arises when things rub against each other. Friction can slow things down and eventually make the surfaces wear down. Different objects have different amount of friction when they rub together. However, when surfaces do not rub against each other, there is no friction between them. The best way to reduce friction between two surfaces is to arrange them so that they do not touch!

Boat engineers and builders know that friction between a boat and water is one thing that slows the boat down. Over the years, they have been figuring out ways to design boats so that they do not touch water very much, but still float. In 1877, a British engineer named Sir John Thornycroft patented a method to design boats to ride on a cushion of air. Basically, his method was to use a large fan powered by a motor to force air down under the craft. Eventually, the air pressure was large enough to lift the vehicle off the surface.

Lesson credit: Dene D., PBS Kids

Engineers took this idea and built upon it, designing "flying boats" and other airplanes that can lift off of a water surface. Finally, in the early 1950s, British, American and Swiss engineers began to think of new ways to use Sir Thornycroft's air cushion idea. In 1955, a British man named Christopher Cockerell tested a new kind of craft and patented his idea for the first real hovercraft — a vehicle that can travel on a cushion of air over water, ice, dirt, pavement and other surfaces. Hovercrafts are so versatile that the Ford Motor Company even made a "hovercar" called the Glideair in 1959. Now, hovercrafts are used for rescue work on rapidly moving rivers and thin ice, cargo transport and ferrying work (such as across the English Channel), and by the military to transport troops and equipment from boats to the shore.

Lesson: LAUNCH

1. Have students take a plain Styrofoam plate or CD and push it across the surface of a table. Discuss with students why the plate/CD does not go very far and why it meets resistance (due to friction). Ask students how it might be possible to reduce the friction on the plate or CD.
2. Show students an example of a hovercraft. Many short videos are available on YouTube, for example, this video of a hovering golf cart.
3. With students, discuss the uses of hovercrafts (some are shown in the video). They can be used for rescue missions as well as the just-for-fun golf cart, and in the 1800s they were tested as a way to reduce friction on large sea-going ships (see Background section). There are even hovercraft tanks in limited use today.

Lesson: INVESTIGATE

1. Put the students into teams of two. Hand out one set of materials per team.
2. Students should poke a small hole in the film canister. If using the plate, they should also poke a hole in the center of the plate. For younger grades, teachers/facilitators may wish to complete this step themselves to avoid student injury.
3. Put some poster putty around the bottom of the film canister, making sure not to cover up the hole. Stick the canister to the plate or CD, lining up the holes as much as possible. If using a CD, the side with the label or printing should be facing down (away from the canister).
4. Blow up a balloon and twist the end shut. Students should work together in their partner groups to put the balloon over the open end of the film canister, keeping the balloon twisted so that no air escapes.
5. When all students are ready, place hovercrafts on a smooth, flat surface such as a table or floor. Let go of the balloons and gently tap the side of the plate or CD in the direction you wish the hovercraft to go.
6. Ask students to write a short paragraph describing what happened to their hovercrafts. Make sure they mention friction. This step can be modified to a class discussion as appropriate for younger students.

Lesson credit: Dene D., PBS Kids

Lesson: PRACTICE

1. The following steps are optional additions to the lesson.
2. In their partner groups, ask students to discuss the success of their hovercrafts. Students should pick one area they wish to improve on their hovercrafts: speed, distance traveled, or consistency of path (how straight the hovercraft moves after the first push).
3. Students should brainstorm a modification they might make to their hovercraft in order to improve in the area chosen. Give them time to come up with possible modifications.
4. Give students access to additional materials (glue, paper, balloons, weights, string, etc). Let them have 15-20 minutes to modify their hovercrafts and test them.
5. Once all students have modified their hovercrafts, hold a hovercraft race. Discuss with students what modifications worked, which did not, and why. It may be helpful to mention that while less friction usually improves speed and distance, it normally decreases control and maneuverability.

Lesson credit: Dene D., PBS Kids