

Games Machines Play

Activity 2: Grades 5-8

Streamlined Design

In "[Superhuman Subs](#)", you observed how teams from around the world competed to produce the fastest human-powered submarine. The quickest submarines relied on a sleek hull shape that effectively parted the water as it moved through the tank. Without "slicing" through the water, a sub can encounter a pileup of fluid in front of the hull, slowing it down. To learn how to overcome this effect, designers must examine how different hull shapes behave as they move through water. Now it's your chance to design an effective hull shape. In this activity you'll observe how streamlining affects a vehicle as it is pulled through a water-filled trough.

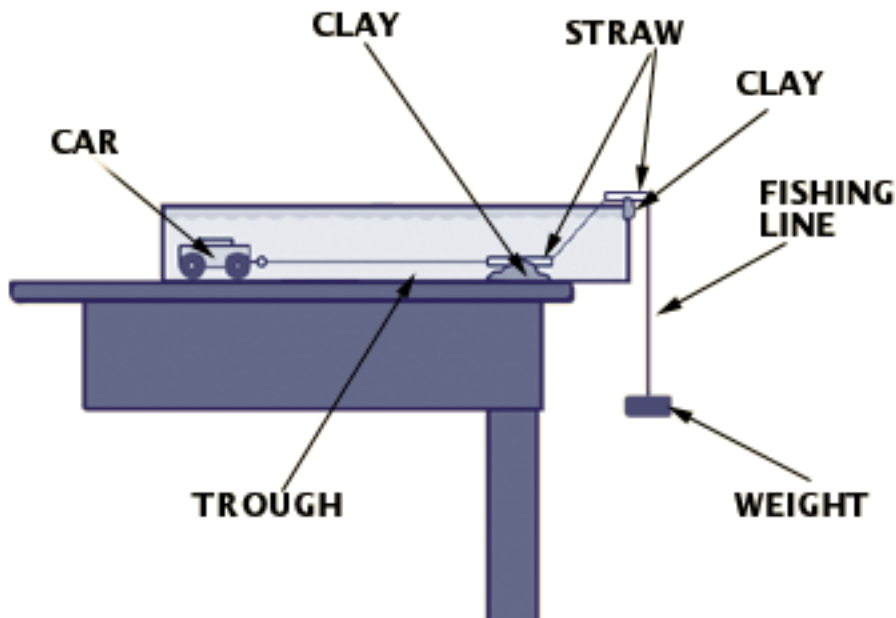


This activity page will offer:

- A hands-on experience in streamline design
- An opportunity to design, build, test, and improve design ideas
- A hands-on (and hands-wet) construction activity

MATERIALS

- Trough (a plastic gardening one will do)
- Waterproof tape
- Small toy car or similar toy
- Straw
- Scissors
- Waterproof clay
- Aluminum foil
- Weight
- Fishing line
- Stopwatch
- Water



PROCEDURE

1. Obtain a long, plastic trough. If necessary, use waterproof tape to seal up any drainage holes in the container.
2. Position the trough on a sturdy tabletop so that one end aligns with the edge of the table.
3. Use a scissors to cut two small segments of straw. These segments will be used as guides for the fishing line.
4. Place one segment in a small lump of waterproof clay. Set the clay at the bottom of the trough as shown in the diagram.
5. Place the other segment of the straw in another lump of clay. Position this lump on the edge of the trough as shown in the diagram.
6. Obtain a one-meter length of fishing line. Thread the line through both straws.
7. Tie one end of the line to a small weight. Use waterproof tape to attach the other end to a small car or similar toy.
8. Fill the trough with water so that the car is submerged.
9. Position the car at the far end of the trough with the weight raised.
10. Release the weight. Use a stopwatch to determine how long it takes for the car to travel across the trough.
11. Perform several trials to obtain an average time.
12. Use a small lump of clay to secure a deflection screen onto the front end of the car as shown here. The screen should be made of a piece aluminum foil.
13. Perform several trials to obtain an average time. Experiment by using different dimensions of this shield. How does this effect the pull-time?

14. Use two pieces of aluminum foil to create a plow-like blade that can be added to the front of the vehicle.
15. Perform several trials to obtain an average time.



16. Try working a piece of waterproof clay into the shape of a bullet. Add this shape to the front of the car as shown below. Make sure that the clay does not interfere with the spin of the wheels.
17. Perform several trials to obtain an average time.



Questions

1. What force powered your underwater vehicle? Explain.
2. How did the shield you added to the car affect its original speed? How does the attachment point affect the performance?
3. How did adding a plow-like blade to the vehicle affect its movement? Why?
4. Did adding the extra weight of the clay improve or reduce the speed of the car? Explain.

Critical Thinking

Do you think that the car, without the plow-like blade, would have moved faster if it was moving through air instead of water? How would streamlining have affected the car in this case? Explain.

EXTENSIONS

Streamlined Shapes

How is streamlining applied to the shape of automobiles? Examine illustrations of different types of cars. Compare and contrast their shapes. More specifically, examine the shape of racecars with the shape of minivans. What are the advantages and disadvantages of each design? What characteristics identify a streamlined shape?

Announcing a Submarine Race

Work with a partner. Create a fictional script about a pair of radio personalities delivering commentary on a human-powered submarine race. Keep the dialog humorous, but integrate actual facts about the submarines.

Art Connection

Imagine designing your own human-powered submarine. What shape would the vehicle be? How would it be powered? Think about it. Then, draw a set of scale blueprints. Identify the parts of your vehicle and the mechanical actions essential to its movement and control.

WEB CONNECTION

Of Boats and Waves

<http://members.iinet.net.au/~bluep/wavedrag.html>

Information about the physics of hull design for surface ships.

Turtle: A Revolutionary Submarine

<http://www.geocities.com/Athens/Acropolis/4870/DrGeorgePCPage9Turtle.html>

Learn about the first US human-powered submarine.

Bibliography of Human-Powered Submarines Articles

<http://scilib.ucsd.edu/sio/indexes/subbibl.html>

Teaching Guide from the FRONTIERS Archive

http://www.pbs.org/safarchive/4_class/45_pguides/pguide_403/4543_sub.html

Check out these activities related to our earlier coverage of the human-powered submarine race.

The activities in this guide were contributed by Michael DiSpezio, a Massachusetts-based science writer and author of "Critical Thinking Puzzles" and "Awesome Experiments in Light & Sound" (Sterling Publishing Co., NY).

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ANSWERS

Questions

1. What force powered your underwater vehicle? Explain.
(Gravity. As the weight dropped, it pulled the car across the trough.)
2. How did the shield you added to the car affect its original speed? How does the attachment point affect the performance?
(It slowed the car down. The shield needs to be firmly attached or it may break loose from the resistance.)
3. How did adding a plow-like blade to the vehicle affect its movement? Why?
(It increased the speed by allowing the car shape to cut through the water more efficiently.)
4. Did adding the extra weight of the clay improve or reduce the speed of the car? Explain.
(Answers may vary, depending on the size of the lump of clay and the effectiveness of the bullet shape.)

Critical Thinking

Do you think that the car, without the plow-like blade, would have moved faster if it was moving through air instead of water? How would streamlining have affected the car in this case? Explain.

(Yes. Since air is less dense than water, it will present less resistance to movement and the car will move faster. Streamlining would increase the speed even further in air as well as water.)

CURRICULUM LINKS

Physical Science:

Water Resistance, Streamlining, Forces (Buoyant and Gravitational), Rate, Density

NATIONAL SCIENCE STANDARDS (Grades 5-8)

Science as Inquiry- Content Standard A

Students will develop descriptions, explanations, predictions and models using evidence collected.

Students will use the tool of mathematics to calculate averages and obtain data about speed.

Physical Science - Content Standard B

Students will explore the force of gravity and water resistance and how these two unbalance forces affect speed of an object.

Students will describe an objects motion by its speed.

Students will learn about the property of density and compare the resulting resistance of two substances with two different densities.

Science and Technology- Content Standard E

Students will communicate design ideas with blueprints.

Students will explore the modern technology of streamlining in automobiles and realize inherent constraints in air resistance, costs, and materials.

Students will observe and evaluate a design and implement proposed modifications.