Exploring Ocean Robots

A Classroom Activity for Ocean Gazing Episodes 13, 15, 24 & 49: Autonomous, enormous, ingenious; Gliding on Earth; The little sub that could; Slick of oil

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Grade Level: 6-12

Lesson Time: 45 min.

Materials Required

Large fish tank filled with fresh water, Stepstool, Towels, Sponges, Laptop with glider data and photos, or laminated color printouts of glider data, Balance, Small plastic spheres that snap shut (available from vending machines that dispense toys), Vegetable oil (optional), Corn Syrup (optional), Rubbing alcohol, Hot glue gun & glue, Kosher salt, Large (4 cup) measuring cup, Spatula for stirring, Glider models (60cc syringes (1 for each model), Plexiglas, Saw, Hot glue, Paint or electrical tape)

Summary

How does the glider move through the water without a propeller?

Lesson Overview

- ✓ Engage: This activity will help the students convey their understanding about robots and introduce them to the glider. 10 mins.
- ✓ Explore: This activity seeks to introduce density and buoyancy. Students will explore how density and buoyancy change when the mass of an object changes. 20 mins.
- ✓ Make sense: This activity allows students to apply their understanding of how density and buoyancy work by applying it to the movement of the glider. 20 mins.

Introduction

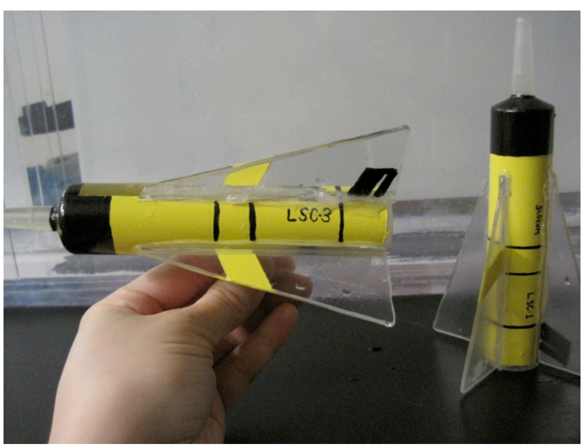
Slocum gliders are autonomous underwater vehicles (AUV) used to study ocean water. They are extremely energy efficient since they use small changes in buoyancy to move up and down in a water column instead of a traditional propulsion system. A battery powered piston moves seawater in and out of the glider to change the buoyancy of the craft. Small wings on the sides convert some of the up down motion into horizontal movement, creating a saw-tooth flight path. The scientists program the glider using mission files, which instruct the glider to dive and climb to a predetermined set of waypoints (latitudes and longitudes). Due to their energy efficiency these AUVs can be deployed for extended durations on the order of weeks to months, as well as covering extended distances, thousands of kilometers.

The glider was originally envisioned by

Henry Stommel in 1989, and engineered by Doug Webb. Gliders today are operated by many institutions to monitor the water throughout the world. Gliders can be equipped with a multitude of different sensors to measure temperature, salinity, depth, ocean color, etc. and provide a real time view of ocean conditions below the surface.

Construction

1. To assemble a glider, first, cut the plunger of a 60cc syringe so it is only about one inch long.
2. Cut off any of the excess plastic at the back of the syringe. This modified syringe will form the body of the model glider.
3. Next, form the glider wings by cutting Plexiglas into long right triangular shapes that are 4 to 4 ½ inches long and 1 ¼ inches high.
4. Even though actual slocum gliders only have 2 wings and a tail, for stability the model needs four of these triangular wings for each.



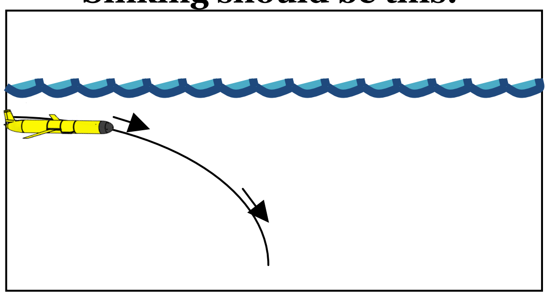
5. Hot glue the wings to the syringe body at 90° angles to the syringe and at the positions north, south, east, and west if you look directly down the length of the syringe tube. It is important to make sure that the fins are straight lengthwise on the tube, and as close as possible to a right angle to the syringe.
6. Lastly, use yellow and black electric tape or paint to create the shape of the real glider on the model. If using paint, seal with a waterproof clear spray-paint sealant before use.
7. For the "Buoyancy Bubbles", submerge both plastic halves in the liquid of choice in the large measuring cup (rubbing alcohol for less dense than water, salt water for more dense) and reclose. You may also choose to fill half with corn syrup and half with cooking oil, but as these will be messy if opened, try sealing them closed once filled with a bead of hot glue around where the hemispheres of the dome come together.

Preparation (15 mins)

1. Write the motivating question on the board or a large piece of paper:
   Q: How does the glider moves through the water without a propeller?
2. Construct the bubbles and gliders as above.
3. Fill the tank with fresh water to about four inches from the top.
4. Fill the large measuring cup about halfway with fresh water and add a handful or two of kosher salt. Stir well.
5. Use the syringe to fill one or two model gliders with the saltwater mixture. Hold them upright and press up on the plunger with your finger to remove any air bubbles.
6. Have another one or two model gliders empty or with a small amount of air inside them.
7. Test fly all gliders by placing each model horizontal in the tank (at the surface if it is water filled or near the bottom if empty/air filled) and giving

a slight forward push before release. Adjust the amount of salt water/air to get a good flight path. The glider should sink nose first, not tail first.

Sinking should be this:



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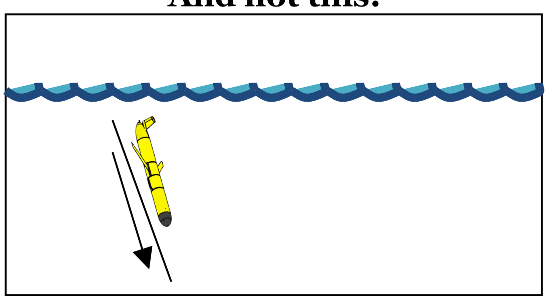
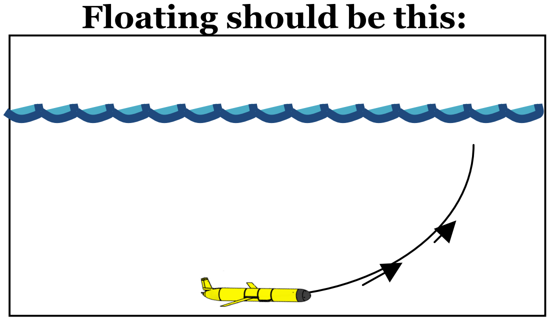


Floating should be this:



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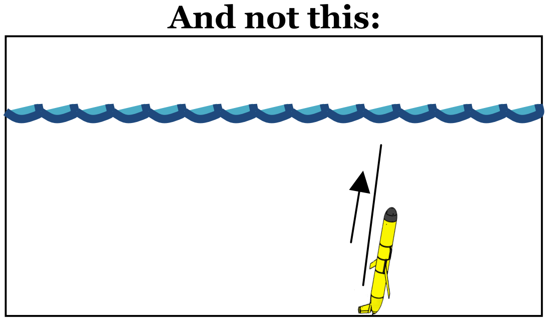


8. Fill one or two plastic "bubbles" with fresh water from the tank.
9. Set up a laptop with glider data and photos ready.

Engage (10 mins)

1. Think: Ask students what they think of when they think about robots. If you like, have students jot down their thoughts in a notebook.
2. Pair: Ask students to turn to the person next to them and come up with a definition of a robot. What are its traits?
3. Share: Have a few pairs share their thoughts with the group. Record all their responses on flip-chart paper, but be careful not to correct or comment on the students' answers.
4. Give a brief definition of a robot: A machine that can move by itself or by computer control. Point out a photo or model of a glider to explain that it is a robot submarine.[1] Its job is to measure the ocean for scientists. Typically they measure temperature, salinity, and density. Many also measure light and chlorophyll (plants).
5. Point to the motivating question and explain that today's experiments they will investigate:
   Q: How does the glider moves through the water without a propeller?

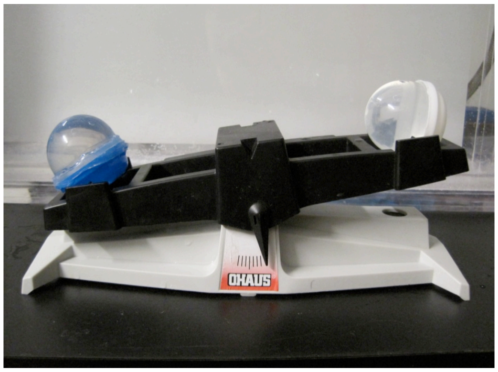
   Again, have students share their ideas about the question with a partner and then with the table group. Finally, ask volunteers to share the ideas from their table group with the entire room. Explain that they will be investigating this question.

Explore (20 mins)

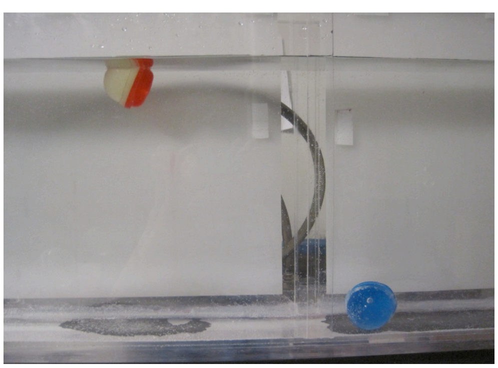
1. Ask the students to choose a buoyancy bubble and explain that

[1] http://rucool.marine.rutgers.edu is a great site for videos and pictures of the glider

each bubble is filled with different liquids.



2. Place the bubbles one at a time on the balance opposite a bubble filled with fresh water and have them write down whether their selected bubble is heavier or lighter than the same amount of water.
3. Ask the students the following questions:
   Q: What is density? (Point out that for each bubble, the volume is the same so we are comparing mass.)
   Q: Based on your observations, was the substance in their bubble more or less dense than water?
4. Based on the density of the bubble, have the students predict whether they think their bubble will sink or float.



5. Have the students test their prediction by placing their bubble in the tank and marking down on a paper which bubbles sink and which ones float.
6. Explain to the students that they have just tested the buoyancy of the bubbles and ask if they can define buoyancy.
7. Based on the students' responses provide them with some or all of the following information:
   - ✓ Buoyancy is the tendency to float in a liquid, or, whether an object floats.
   - ✓ It is also "the upward force that a fluid exerts on an object less dense than itself."

Make Sense (20 mins)

1. Show the students one model glider that is filled with water and one that is empty and ask the students to predict whether each will sink or float.
2. Invite the students to try placing the filled one in the water and releasing it to see what happens.
3. Demonstrate, or let them try placing the empty glider underwater and giving it a small push.
4. Ask the students whether the glider with water or without water was more dense. Which one demonstrated greater buoyancy?
5. Explain that these two models represent two halves of a glider's flight path.
6. Point to the motivating question and ask:
   Q: How does the glider moves through the water without a propeller?
7. Introduce the topic of climate change in Antarctica by viewing Act IV: A robot armada.

8. To emphasize the concepts, provide all or some of the following information:
    - ✓ The real gliders move by changing their density
    - ✓ They use a battery powered pump to bring seawater in or out to make themselves more or less dense
    - ✓ It also has GPS so it can let the scientists know where it is. Every six hours to every two days or so, the glider "calls home" to send back data it collected and check for new instructions on where to go
9. Based on time, show some data (computer or printout) from the gliders. Be sure to orient the students to what they are looking at. Show where depth is, and where distance along the line the glider traveled is. Point out that colors represent different number values the glider measured. It's easiest to do this for temperature – red for warmer water, blue for colder.

Resources

For more information on Slocum gliders, read: http://rucool.marine.rutgers.edu/index.php/COOL-Data/About-Slocum-Autonomous-Underwater-Gliders.html or http://www.webbresearch.com/slocumglider.aspx

To view real-time data generated from gliders deployed all over the world, access the Rutgers University Glider homepage at http://marine.rutgers.edu/cool/auvs. Note: If no glider missions are currently underway, please access the glider archives.

Trans-Atlantic glider FAQ: http://rucool.marine.rutgers.edu/atlantic/about_gliders.html

Sources

To access an online version of this activity, you can go to the following URL: http://coseenow.net/antarctica/Activity%204%20Exploring%20Ocean%20Robots.pdf

The related podcast episode for this activity can be found by going to the podcast section of www.oceangazing.org