Design and Build a Polar Ice Drifter

Oregon State University

Levels: Grades 3rd - 5th

Lesson Time: 1-2 50-minute class periods

Next Generation Science Standards:

Performance Expectations

3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Contact:

SMILE Program

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Description

Students will take part in a hypothetical engineering and design challenge that will help them to better understand sea ice and how research is carried out on sea ice.

Objectives

Students will:

- Understand what sea ice is, where it is located, and how it moves
- Understand why scientists use remote sensing to study sea ice
- Design a drifter that meets criteria similar to current sea ice drifters that sense various aspects of the polar environment
- Go through the engineering and design process to design, build, test and improve their sea ice sensor

Guiding Questions

Why is remote sensing and autonomous measurement important when studying sea ice?

How do you engineer equipment to survive harsh environments?

Background Information

Sea ice is frozen seawater. It only forms on seas when temperatures are cold enough to cool the surface water to 28°F. The freezing point of seawater is lower that fresh water because it contains salt and other impurities. In these regions winters can be very cold. The Arctic and Southern Oceans are remote and difficult to travel in, hence autonomous drifters (which may also be called buoys because they drift with the ocean) with a variety of sensors are used to study these regions. These drifters are placed on ice and drift across the ocean with the ice.

Drifters are quite diverse in the data they collect. For example some drifters have thermistors to measure snow, ice, ocean and air temperature. The salinity of ice and water can be estimated by measuring conductivity of the ice or water. Barometers measure air pressure. Anemometers measure wind speed. We can even measure pressure inside the ice pack with particular gauges that change size when pressure is applied.

Drifters need to provide data to scientists and the public in the comfort of their homes or offices. This is achieved by relaying data through a satellite link. The drifters must track their position accurately, which is achieved with the global positioning system (GPS). GPS works by timing a signal sent from a satellite and received by a GPS receiver. As distance is equal to speed divided by time, and we know the signal is moving at the speed of light, we can calculate distance. By calculating distance to many satellites the position of the GPS receiver can be found by triangulation.

Designing drifters to withstand the environment they are deployed in and perform the tasks scientists requires consideration of specific design requirements that will ensure the drifter can perform its job. In this lesson students decide on these design criteria, use them to guide their design, test that design and iterate the design in the same way a polar engineer would. Some real world engineering criteria are specific to the polar environment, such as ability to power instruments at -40°F. Other criteria may be specific to the task the drifter is designed to do. Perhaps the buoy needs to measure ice temperature internally in the ice pack, and it must be easily deployed to do this. You could imagine a drifter that provides detailed weather data and photographs of the environment, which must stay in a particular orientation even in heavy wind. Or how about an ocean profiler that first sinks into the ocean and then must float to the surface to transmit data?

Activity Introduction

Show students the introductory PowerPoint presentation on sea ice, sea ice drifters, remote sensing, and sea ice research. After the presentation ask students to think about the different characteristics needed for sea ice drifters and the sensing they do. Remind them to think about the pictures of the drifters and environment that they just saw in the presentation.

- What were the drifters in the presentation sensing?
- What are you trying to sense/study? What data do you want to collect?
- Why do the drifters look different?
- What types of conditions/environments do these drifters have to withstand?

After students have had time to think, have them pair share with a student or group of students sitting close to them. Next have the groups share out. Write on the board the characteristics that the students share, taking the time to discuss them with the class to make sure the entire class understands sea ice sensors. This is important to do before the student groups work independently

Materials

Found or easily sourced materials; encourage students to bring in found or recycled materials to use with this project similar to the ones below:

- *Materials for building:* Aluminum foil, craft sticks, cardboard, small nails or tacks, string, small wood pieces, index cards, paper clips, tape, hot glue, foam board, straws, Dixie cups, corks, recycled paper, small metal pieces.
- *Materials for testing:* Box fan, tubs for water, Styrofoam pieces (ice), towels.

during the design and building phase. By the end of this introduction the class should have a list of characteristics to consider as they begin designing their sea ice drifter with a set of sensors to sense any aspect of the polar environment.

Activity

Break the students into groups of 2-3 students and provide the students the following.

Engineering criteria:

- Drifter must be able to fit on the ice. (It is important that you provide students what size their sensor should be. However, water tubs will vary in size, as will the Styrofoam pieces that will act as the "sea ice". Provide students size criteria that works best with your materials.
- Drifter has to be stable on the ice. It must be able to withstand strong winds. (The wind will be tested by using the box fan.)
- Drifter must be able to either float or sink after the ice melts. (Students need to provide a reason why they choose the sensor to either float or sink.)
- The drifter needs to contain the following equipment: Sensor(s), GPS, battery, satellite communicator and antenna.
- Pick 1-3 criteria not already covered from the class list and include them as engineering criteria.

Other potential criteria:

- Has to blend into the surrounding environment or be easily identifiable on the ice.
- Has to have identifying marks or contact information so if it is found it can be returned.
- Has to be produced with biodegradable materials.
- A person with heavy polar clothing and big mittens puts the drifter in place.

Design

Provide student groups with scratch paper and have them diagram their drifter. Encourage students to work through this quickly focusing on making a number of designs and discussing these designs within their groups to see how it meets the engineering criteria above. When students have a final design have them label the parts of their sensor that will help guide them when they start building. If time allows have students participate in a gallery walk where they get a chance to see other group's designs.

Build

Provide students with found or easily sourced materials similar to the ones listed in the materials section. You may allow unlimited or limited access to the building materials. Limiting access to materials will make the activity more challenging for students, but it is more realistic to how sea ice sensors are made. Provide students a time frame for the building process that works for your class, but also allows for ample testing, redesigning and wrap-up time.

Test

There are two types of tests that students will do to evaluate their design:

1. *Surviving wind:* Have the students attach their sensor on the Styrofoam (ice). Place ice and sensor in the water bath in front of the box fan. Turn on the box fan and see if the sensor stays on the ice and does not tip over. Have the students talk about the outcome of the test. Even if the test is successful, ask the students what improvements they could make to their sensor to help withstand the wind.
2. *Float or sink:* Ask the students if they designed their sensor to float or sink and why. In a separate water tub from the wind test have the students place their sensor in the water. Have students talk about the outcome of the test. Even if the test is successful, ask the students what improvements they could make to their sensor to enhance its performance.

Redesign

An important part of the engineering and design process is analyzing data from testing and making improvements on its design. All sea ice sensors go through rigorous testing and redesign before they are deployed on the ice. Ask students why researchers go through this time-consuming process? Then have the students make at least two design improvements to their sea ice sensor. If time allows have students retest their sensor with the design improvements.

Wrap-up

Student groups take turns presenting their sea ice drifters to the rest of the class. Depending on time and class set up this can be done in a variety of ways such as individual presentations, gallery walk, or pair share. During this presentation have students share their initial diagram, the drifter itself, and design improvements they made based on testing. Encourage students to share the challenges they had through this process and how they could apply what they learned to solving other problems that are meaningful to them.