



Oil's Wandering Paths: ROV Ocean Surface Challenge

Grade Level: 6-12
Length: 3-6 Hours (can be split into 2-3 days)
www.pwsrcac.org/lessons

By Prince William Sound Science Center, <http://pwssc.org/> with funding from the Oil Spill Recovery Institute

NGSS Standards

MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Crosscutting Concepts

Systems and System Models

A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Related Resources

Supporting Materials ROV Design and Oil Spill Response Slide Show; ROV Design and Oil Spill Response Worksheet; Points to Ponder when Designing ROVs Handout; ROV Frame Examples Handout

Websites

- <http://www.pwssc.org>
- <http://www.mbari.org/education/rov/default.htm>

Pair With Popcorn Spill Lesson; Preparation & Prevention Lesson

Overview

It is challenging to clean up oil once it has been spilled.

Objectives

- Students will work cooperatively to design and build an ROV (remotely operated vehicle) in response to a mock oil spill.
- Students will demonstrate how to operate equipment similar to real-life oil response equipment.

Materials

ROV Build Materials (all available through PWSSC)

- “ROV Design and Oil Spill Response” Power Point Presentation
- “ROV Design and Oil Spill Response” Worksheet
- “Points to Ponder When Designing ROVs” Handout
- “ROV Frame Examples” Handout
- ROV Motors (3/team)
- Control Box and Umbilical (1/team)
- ROV Power Source (battery or wall adapter) and Connection Harness (1/team)
- PVC Pipe Cut into Various Lengths (total 10 to 20 feet for each ROV) and Drilled Through to Allow Water to Drain
- PVC Connectors
 - 12” PVC (4)
 - 6” PVC (10)
 - 4” PVC (8)
 - 3” PVC (10)
 - L (90°) Connector (10)
 - Elbow (45°) Connector (6)
 - + Connector (2)
 - _ Connector (2)

Notes

Materials (continued)

- Foam Pipe Insulation
- Zip Ties
- Electrical Tape
- Fishing Weights
- Netting
- Clippers
- Pliers

Ocean Surface Challenge Materials:

- Boom constructed from:
 - Nylon rope
 - Foam floats or bits of foam
 - Netter
 - Large metal washers
- Popcorn
- Handheld Strainers

Background

ROVs (remotely operated vehicles) received a lot of attention because of their use in the BP/Deepwater Horizon oil spill. New applications of ROV technology for oil spill prevention and recovery are regularly featured in news articles. They were used both to record the amount of oil entering the water and in attempts to cap the well. Although ROVs were not used in the Exxon Valdez oil spill clean-up, they are now a valuable technology in oil exploration, oil spill prevention through monitoring of oil extraction and transportation, and oil spill response. ROVs can go where it is too dangerous or expensive to send people and can be used to perform tasks or gather data and important information.

In this exciting activity, students work in teams to design a functional ROV and then deploy it at the beach or harbor to complete a series of oil spill response challenges. Oil's Wandering Paths ROV Challenge Stations is an alternative lesson that takes place in a pool or small body of water. These lessons can be combined, if you have access to both a harbor/beach and pool/pond. The process of creating the ROVs is the same in both lessons; only the final tests differ.

Preparation

1. The worksheets, handouts, power point, and most of the build materials for this lesson are available from the Prince William Sound Science Center. Contact the Prince William Sound Science Center (<http://www.pwssc.org> or info@pwssc.org) to request the ROV Teaching Kit well in advance of your lesson. The PWSSC lesson materials focus on an arctic environment but can be adapted to other environments if you so choose.
2. Determine number of groups in class (groups of 3-5 students) and divide the supplies for each group. Print one copy of “ROV Design and Oil Spill Response” worksheet for each student and one copy each of “ROV Frame Examples” and “Points to Ponder” for each group. Charge ROV batteries.
3. Decide upon your location for the ocean surface challenge. Talk to the harbor master to arrange a time to conduct the ocean surface challenge in the harbor or identify a good beach location. A swimming pool can also be used, substituting a retrievable object such as ping pong balls for the popcorn.
4. Create model boom by stringing or attaching foam to the nylon rope (to make it float) and attaching the netting below, with washers to weight it down. Before the ocean surface challenge, place netting or extra boom at the end of the boat slip in the harbor. If you are at a beach location, it is ideal, but not necessary, to set up this netting around the area where the “spill” will take place.

Introducing the Lesson

Handout the “ROV Design and Oil Spill Response” worksheet to each student. Give “ROV Design and Oil Spill Response” presentation to the class and work through the worksheet questions. Provide students with plenty of opportunities to ask questions and provide suggestions about designing an ROV and responding to the challenges.

Activity

1. Divide the class into companies of 3-5 students. Hand out “ROV Frame Examples” and “Points to Ponder” to each group.
2. Explain to each group that they will be a company and have to come up with their name and an ROV design. Give companies approximately 20 minutes to design their ROVs. Companies must have their design approved before starting to build. The ROV

design may be modified or changed later, but students should have some direction when beginning. Frame design must meet challenge tasks. Students should have access to the PVC parts and other materials as they design their ROV but should not actually build anything.

3. Once companies are finished with their designs, they are given their build kit and can start to build their ROV frames using PVC piping and motor sets. Provide at least 45 minutes and up to 3 hours for this process. Students should review the “Points to Ponder” hand out as they construct their ROV.
4. After initial frames have been built, demonstrate to each company how to attach the motors with zip-ties. Explain that companies must inspect the motor rotation and decide on a configuration for motors, based on the “Points to Ponder.” Guide students towards the correct placement for each motor in order to achieve the desired configuration; students secure the motors to their frame.
5. Once the motors are attached, companies should attach netting if desired and foam for buoyancy. While companies are building and adjusting their ROV, rotate through companies to check for teamwork. Remind students to keep the “Points to Ponder” in mind.
6. When some progress has been made, ask each company to present their ROV design to their classmates and receive critical feedback about how their ROV will accomplish the required tasks. While students are completing their ROV frames, make sure each frame and motors are tightened so nothing falls off in the water.
7. Before moving on to the water challenge, review water safety procedures and remind students that there will be no swimming or wading. Remind students to keep batteries and control boxes away from water. When the ROV is being operated there must be always be a tether manager.
8. Review the challenge and explain the point break down to students.
9. Perform a float check. Student companies bring their ROV to water's edge and conduct a float test: does the ROV sink or float? Can it drive straight? Do ballast, floatation, or motor placement need to be adjusted? Provide students with 30 minutes to make any necessary adjustments.
10. Then begin the surface challenge. Divide the companies into 1-3 response teams so that each team has 3-4 ROVs and provide each response team with hand strainers and boom. Toss 6 cups of popcorn into the “spill area” and begin the timer.
11. The response team must wait 3 minutes before their ROVs can be deployed, but this time can be used to plan their response and attach boom and other tools to ROVs.

12. Instruct the response team that all popcorn must be removed to shore. Student on the response team cannot go in the water (in fact, no students may go in the water), but they can use strainers to remove popcorn from the water's edge. Explain that the following demerits will be added to their time:
 - Team member bickers, argues, or acts with disrespect (30 seconds)
 - Team member enters the water (30 seconds)
 - Team pulls tether to move ROV (30 seconds)
 - Clean up materials or ROV parts are lost (2 minutes)
13. You may choose to explain the following successful strategy to the response teams, or let them design their own response: 2 ROVs stretch boom between them to contain the popcorn while the other 1-2 ROVs scoop or push the popcorn to the water's edge where team members can scoop the popcorn out of the water with the strainer. When the first response team succeeds in removing all of their popcorn, stop the timer and remove all of the ROVs from the water. Record the time and add any time demerits to calculate their final time.
14. Repeat the process with response teams two and three, as necessary. The response team with the fastest final clean up time is the winner.

Wrap-up

Once all groups have completed the challenge, have student teams disassemble their ROVs and return all materials to kit. Students need to clean up all foam, zip ties, tape and other trash before leaving.

Debrief the experience with students. Review the essential properties of water that affect ROVs (pressure, density, buoyancy). Discuss what parts of the challenge were difficult or easy to complete. Review concepts of aquatic oil spills and how we can use technology to respond. Ask students why ROV's might prove useful in oil spill response. What are some of the challenges to using an ROV in oil spill response? What are some of the benefits?

Assessment

Evaluate student collaboration and cooperation during the ROV build and consideration of their peers' ideas during the project design and build process. After the challenge tasks, ask student groups to diagram their ROV and the ways in which 3-4 ROVs were deployed. Have them describe at least three changes they would make in order to optimize

their design/response. Direct them to include an explanation of how these modifications are based on data they collected/observations they made during the containment and clean up challenge. Students who successfully meet the performance expectation will demonstrate an understanding of the iterative process of design and how data from the tests can inform modifications.

Extension Activity

Allow student groups additional time to perform more modifications on their ROVs and attempt the containment and clean up challenge again.

Pair With: Popcorn Spill Lesson; Preparation and Prevention ROV Lesson Plan

Sources

Harry Bohm and Vickie Jensen, Build Your Own Underwater Robot and Other Wet Projects. Vancouver, B.C.: Westcoast Words, 1997.

“Build your own ROV,” Monterey Bay Aquarium Research Institute website. <http://www.mbari.org/education/rov/default.htm>