Title: Oil's Wandering Paths – ROV Challenge Stations

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

Theme: 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.

Duration: 3-6 hours (depending on age level/time availability, can be split into 2-3 days)

Age Range: 6th-12th Grade

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
- "Oil Spill Response" point sheet
- "Oil Spill Challenge" diagram
- 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)
    - T connector (10)
    - Elbow (45°) connector (6)
    - + connector (2)
    - _ connector (2)
- Foam pipe insulation

- Zip ties
- Electrical tape
- Fishing weights
- Netting
- Clippers
- Pliers

Challenge Station Materials:

- Hula hoops (2/testing station)
- Medium sized rings (1/testing station)
- Weights for hoops and rings (3/testing station)
- Tethers (3/testing station)
- Square 1' PVC frames (1/testing station)
- bucket with lid (1/testing station)
- PVC arm (1.5' tall with 0.5' arm) (1/testing station)
- Beach balls (1/testing station)
- Ping pong balls (inside)
- Volunteers (1/group)

Background:

ROVs (remotely operated vehicles) have received a lot of attention recently because of their use in the *BP/Deepwater Horizon* Oil Spill. 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 in a pool or small water body to complete a series of oil spill response challenges. Oil's Wandering Paths – ROV Ocean Surface Challenge is an alternative lesson that takes place at a harbor or beach. 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:

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.

Determine number of groups in class (groups of 3-5 students) and divide the supplies for each group. Print 1 copy of "ROV Design and Oil Spill Response" worksheet for each student and 1 copy each of "ROV Frame Examples" and "Points to Ponder" for each group. Charge ROV batteries.

Decide upon your location for the challenge stations. Talk to the pool director and reserve pool time or determine an appropriate location at the beach or nearby lake.

Before the challenge stations, set up stations for each group to work through (see diagram). Each station will consist of:

- 1 hula hoop submerged vertical in pool at depth
- 1 medium sized weighted ring submerged vertical in pool at depth
- 1 hula hoop horizontal floating on surface
- 1 1'x1' square vertical in pool at depth
- 1 ring hook/weighted bucket
- 1 beach ball
- Ping pong balls
- 1 "human seal" who is in water and can retrieve/reset challenge materials, untangle ROVs, etc (with appropriate gear if in ocean or lake)

Use weights and tethers to set up one hula hoop submerged vertically in the pool. Place another hoop, beach ball, and group of ping pong balls floating on the surface in different areas of the pool. Tape or zip-tie weights onto the bottom of a medium sized ring to get it to stay submerged and upright in the pool. Tape or zip-tie weights to the bottom of the 1' x 1' square so it will float upright above the bottom of the pool. Finally, create a ring hook by attaching an arm made of wire or PVC to a 5-gallon bucket. Then place weights in the bucket it and set it on the bottom of the pool.

Introduction:

Hand out 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.

Divide the class into companies of 3-5 students. Hand out "ROV Frame Examples" and "Points to Ponder" to each group. 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 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.

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.

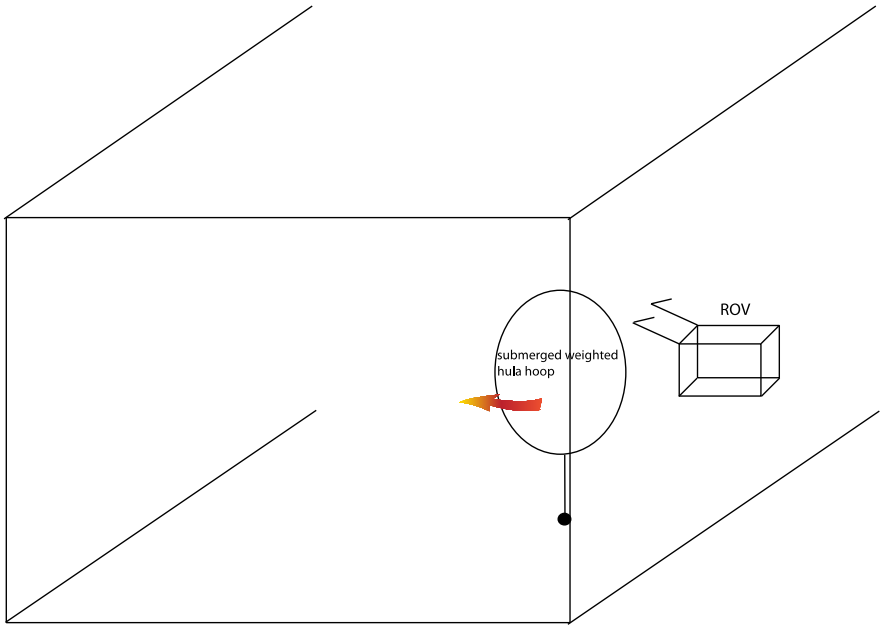
After initial frames have been built, demonstrate to each group how to attach the motors with zip-ties. Explain that teams must inspect the motor rotation and decide on a configuration for motors, based on the "Points to Ponder." Guide students towards the correct placement for each motor in order to achieve the desired configuration; students secure the motors to their frame.

Once the motors are attached, groups should attach netting if desired and foam for buoyancy. While teams are building and adjusting their ROV, rotate through groups to check for teamwork. Remind students to keep the "Points to Ponder" in mind. When some progress has been made, ask each group 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.

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. Review the course and explain the point break down to students.

Perform a float check. Student teams 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.

Next, begin the station challenge activities. Each group should proceed to a water challenge testing station. Each station needs an adult leader to keep track of points and monitor students. Students should take turns driving, at least 2 minutes each or the completion of one challenge activity (teams are given points based on working as a team). Teams may request that the volunteer "seal" reset their obstacle course (retrieve floating beach ball, reset hooks and rings) and untangle their ROVs from one another.



alls from the water's surface

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 which challenges 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?

Evaluation:

Assess student groups based on their successful completion of the challenge stations and final points awarded.

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