Lesson Remotely Operated Vehicles

This lesson was developed by teachers from Jamestown High School located in Williamsburg, Virginia to assist teachers in instructing students on how to design and build remotely operated vehicles.

Concepts

1. Oceanography is the field that studies the world's oceans and how oceans affect life and the future of our planet.

2. Oceanography career opportunities include work as biologist, chemist, physicist, geologist, engineers and meteorologist. The skills and knowledge from each are important in our study of the oceans and their impact on earth.

3. Remotely controlled vehicles (ROVs) allow mankind to research water bodies, its life, and natural and artificial formations, while providing minimum impact to this ecosystem.

Performance Objectives

Students will following the engineering design process to research, design, build, and test their ROV
Students will work in teams comprising of engineering and oceanography experts.
Student will apply math, science, and machining skills to design, build, and test their ROV.

Anticipatory Set

When maneuvering around in a place that has the same atmospheric pressure as the surface of Venus, you might need a little help. You might let a few remotely operated vehicles (ROVs) do the walking - or the floating. The wreckage of the Titanic yielded its mysteries thanks to a system of deep sea work vehicles that go where no human without tentacles would dare to tread.

The Titanic expedition used ROV's to bring artifacts up, to take extensive photographic documentation of the wreckage, to set up a variety of scientific experiments, and to do forensic research on the disaster that claimed the Titanic. On hand is a modest armada of ROVs large and small, each with a support vessel. There's the Magellan, which is supported by the Ocean Voyager, dubbed the "sea-going studio" because of the state-of-the-art television production facilities aboard. There's also the ROV Abyssub, supported by the ship Abeille. These two are of a generic type of ROVs known as "work class ROVs" -- strong and capable of doing real work with their variety of robotic arms and tools. They're often used to find wreckage from shipwrecks and air crashes, or by undersea drilling operations.

Key Terms

Archimedes Principle – The relationship between buoyancy and displaced fluid. An immersed object is buoyed up by a force equal to the weight of the fluid it displaces

Boyle's Law – At a constant temperature, the volume of a given quantity of gas is inversely proportional to the pressure upon the gas.

Buoyancy – The apparent loss of weight of an object submerged in a fluid.

Buoyancy Force – The net upward force exerted by a fluid on a submerged object.

Density – A property of a substance, equal to the mass divided by the volume; commonly thought of as the lightness or heaviness of a substance.

Displaced – Term applied to fluid that is moved out of the way when an object is placed in the fluid. A completely submerged object displaces a volume of fluid equal to its own volume.

Equilibrium – A state of balance, e.g. the state of a body on which no net forces acts.

Fluid – Anything that flows; any liquid or gas.

Force – Any influence that tends to accelerate on an object; a push or a pull; force = mass x acceleration (Newton's 2^{nd} law), measured in Newton's (N).

Gravity – A pulling force exerted by any mass upon another; the Earth's gravitational force exerts an acceleration (g) of 9.8 m/s^2

Mass – A measure of the quantity of matter in a body; the amount of stuff in an object.

Neutrally Buoyant – A stated in which the forces of gravity and buoyancy are in equilibrium or balance.

Pressure – The force per unit of surface area; exerted perpendicular to the surface; measured in Pascals.

Principles of Flotation – A floating object displaces a quantity of fluid of weight equal to its own weight.

Volume – The amount of space occupied in three dimensions.

Weight – The force on a body due to the gravitational attraction of another body (usually Earth).

Tether – Wiring to the ROV allowing the electronic control of the ROV.

Polarity – The physical alignment of atoms. The term is often used to describe the positive and negative ends of batteries and magnets.

Key Questions

1. What are the benefits of using ROV technology?
2. How does ROV technology help mankind and the environment?
3. How does a structured design process help solve complex problems?
4. What are the advantages and disadvantages to working in teams?

Activities

Introduction/Statement of Problem:

- The teacher will introduce the key questions and assign a due date.
- The teacher will present an overview of the oceanography career field. http://video.google.com/videoplay?docid=-9867343287696141 28&q=Oceanography&hl=en
- The teacher will show Secrets of The Titanic (National Geographic 60 minutes)
- The teacher will show ROV "Stinky" video. Carl Hayden High School **ROV** Falcon RoboticsNightline2005.mpg
- Show ROV films on (PPT):
  - **http://www.seabotix.com/news/videos.htm**
  - http://video.google.com/videoplay?docid=-6524663821874014656&q=rov&hl=en
- The teacher will introduce the statement of the problem (see ppt).
- The students will create their teams.

- The teacher will assign the key terms and ask that student groups present definitions, sketches, and formulas for homework.

ROV Basics:

- The teacher will describe the key concepts and components of a ROV. (see ppt).
- The teacher will demonstrate calculating ballast. The student will calculate ballast for a small bobber and sinkers. The students will test calculations and record actual weights required.
- The teacher will present homework (Baggs problem).
- The teacher will identify materials on hand from PPT

Design Process:

- The teacher will review the engineering design steps. (PPT).
- The teacher will remind students to document their project with photo and video.
- The student will begin researching and brainstorming ideas for their ROV. Students submit preliminary design sketches.
- The student will begin designing ROV in inventor by creating part files and an assembly.
- The instructor will discuss mass and material density. The instructor will demonstrate creating material information
- The students will determine ROV weight using Inventor software.
- The student will calculate ballast requirements.
- The student will submit design for approval and bill of materials.

PVC Construction:

- The instructor will demonstrate how to cut PVC pipe to length using hacksaw.
- The instructor will demonstrate how to drill vent holes in PVC pipe
- The student will construct the ROV frame.

Electronics Construction

- The instructor will introduce electronics, motors and switching circuits .
- The students will assemble the control systems and test controls.

Testing and competition:

- The students will participate on a field trip to Nauticus for testing of ROV.
- The students will compete in the mid-Atlantic regional ROV competition

Presentations

- The students will present there design to a panel.
- The students will submit a written report.

Unit Assessments

1. Students will be assessed on the accuracy and completeness of term definitions and notes recorded in their lab notebooks.
2. Students will be assessed on the sketches and detailed drawings produced to solve the engineering problem.
3. Students will be evaluated on their oral presentation of their engineering research project according to the presentation rubric.

4. The students will be evaluated on their calculations.
5. Students will be evaluated on their written report on the engineering research project according to Written Report Rubric.
6. Students will be evaluated on their responses to essential and key questions.

Resources

ROV Project
Introduction to Design Process

Reference Sources

http://www.rov.org/student.cfm
http://monitor.noaa.gov
http://www.marinetech.org

Credit

If reproducing this lesson, please credit Roger Hunt, Career and Technical Studies Tech Ed. Teacher at Jamestown High School, in Williamsburg, VA for developing this lesson. Contact NOAA's *Monitor* National Marine Sanctuary (**http://monitor.noaa.gov**) for more information.