Teach Science and Engineering Concepts Using LEGO® Underwater Robots

WaterBotics® Curriculum Developed by
The Center for Innovation in Engineering and Science Education
Stevens Institute of Technology
What is WaterBotics?

- Underwater ROVs (Remotely Operated Vehicles) created with LEGO materials
- Approximately 20-26 hour curriculum aimed at middle and high school classes as well as summer camps and after-school programs
- Developed, piloted, and implemented with thousands of students in U.S. through National Science Foundation funding
Why Underwater Robotics?

- Presents unique, complex design challenges not found in land-based projects (e.g. buoyancy, control in 3-D)
- Exposure to science concepts like propulsion, drag, buoyancy and stability, gearing, torque, speed, and thrust
- Awareness of careers that involve STEM skills
Why LEGO's?

- Familiarity with LEGO's
- Ease of use and durability
- Variety of pieces
- Rapid prototyping, testing, and redesign (tweak friendly)
- Can leverage prior purchases of LEGO equipment
Project Challenge

Using LEGO® components and related components, create an ROV that will be able to:

- Dive under the water
- Move around in 3 dimensions in a fully controlled manner
- Pick up weighted wiffle balls and deposit them in sunken bins
Mission 1: Rescue!

• Use a single motor to build a robot that can travel in a straight line—both forward and backward—on the surface of the water

• Use the robot to save a “drowning swimmer”

• Optimize gearing to improve speed and/or control
Mission 1

Example Achievements

- **SUCCESSFUL SAVE**
  Perform a complete rescue

- **RAPID RESCUE**
  Perform a complete rescue in 20 seconds or less

- **CHEETAH OF THE SEA**
  Perform a complete rescue in 10 seconds or less

- **ROOM FOR MORE**
  Rescue 5 or more ping-pong balls in one trip

- **ALL ABOARD**
  Rescue 10 or more ping-pong balls in one trip

- **HEAVY LIFT**
  Rescue 1 “elephant” (a heavy wiffle ball)

- **PACHYDERM PACKING**
  Rescue 2 “elephants”
Mission 2: Clean Up!

• Use a second motor to enable steering and two-dimensional movement

• Maneuver the robot on the surface of the water to clean up a spill of “hazardous pollutants”
Mission 3: Mine Sweep!

• Use a third motor to dive under the water

• Combine high-density and low-density materials to achieve good buoyancy and stability, making the robot controllable underwater

• Detonate or disable underwater “mines” to make a shipping lane safe
Mission 4: Collect!

- Combine the products of previous missions to produce a vehicle that can collect samples from a “sunken ship” and deposit them in various underwater collection bins.

- A fourth motor may be used to create a mechanism to grab and release the balls.
Programming a Custom Remote
### Key Concepts and Skills

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Next Generation Science Stds

SCIENCE
• PS2.A: Forces and Motion
• PS2.C: Stability and Instability in Physical Systems

ENGINEERING
• ETS1.A: Defining and Delimiting Engineering Problems
• ETS1.B: Developing Possible Solutions
• ETS1.C: Optimizing the Design Solution
WaterBots in Action

On the surface and underwater
For More Information

Website:  www.waterbotics.org
Facebook:  www.facebook.com/waterbotics
YouTube:  www.youtube.com/waterbotics