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TRYEngineering



# Fun with Speedboats

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## Lesson Focus

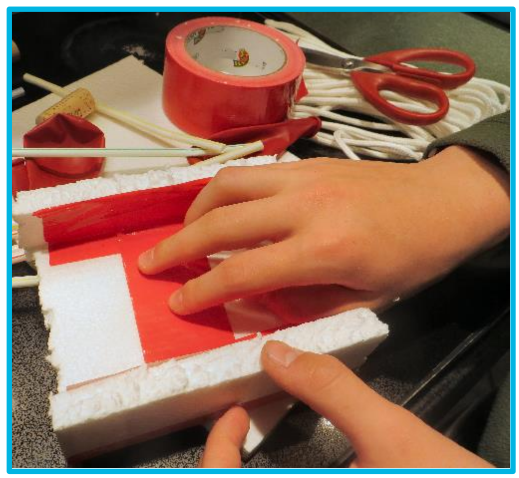
Lesson focuses on how engineers and ship designers have developed boats with a goal of breaking a water speed record. Students work in teams to develop a boat out of everyday materials that will prove to be the fastest in the classroom covering a distance of 5 ft or 150 cm along a classroom trough.  Students design, build, and test their speedboats; evaluate their designs and those of classmates; and share observations with their class.

## Lesson Synopsis

The Fun with Speedboats lesson explores how boats are engineered to achieve speed. Student teams consider and develop a design, build their speedboat out of everyday items, and test their boat against those developed by other student "engineering" teams. They reflect on the challenge and present their findings to the group.

## Age Levels

11-18.



## Objectives

- Learn about engineering design.
- Learn about ship design and engineering.
- Learn about world records.
- Learn about teamwork and working in groups.

## Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- naval engineering and marine architecture
- engineering testing
- problem solving
- teamwork

## Lesson Activities

Student teams learn how engineers have competed in a race for water speed and then design their own speedboat out of everyday items, considering the fastest and most stable propulsion system they can create. They design their speedboat first on paper, build their boat, test and time it against those of other student teams, reflect on the challenge, and present to their class.

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## Resources/Materials

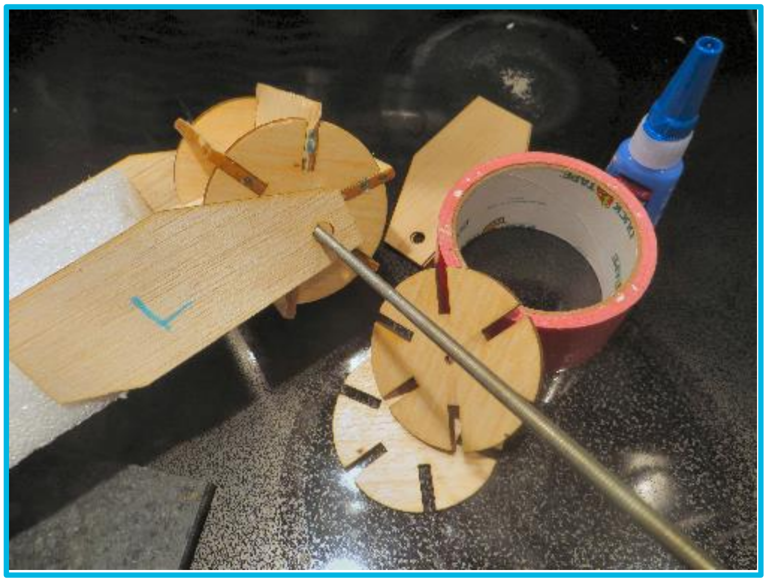
- Teacher Resource Documents (attached)
- Student Worksheets (attached)
- Student Resource Sheets (attached)

## Alignment to Curriculum Frameworks

See curriculum alignment sheet at end of lesson.

## Internet Connections

- TryEngineering (www.tryengineering.org)
- Guinness World Records (www.guinnessworldrecords.com)



## Recommended Reading

- Extreme Machines (ISBN: 978-0789454171)
- Cutwater: Speedboats and Launches from the Golden Days of Boating (ISBN: 978-1879301047)
- Boatbuilding: A Complete Handbook of Wooden Boat Construction (ISBN: 978-0393035544)

## Optional Writing Activity

- Write a paragraph or essay describing how engineering has impacted the attainable speed of another transportation vehicle such as a train, car, or spaceship.

## Extension Idea

- Require student boats to carry a load (candy, a golf ball) -- and add this variable half way through the challenge so students will have to adapt their designs.

## *For Teachers:*
## *Teacher Resource*

### ◆ Lesson Goal

The Fun with Speedboats lesson explores how boats are engineered to achieve speed. Student teams consider and develop a design, build their speedboat out of everyday items, and test their boat against those developed by other student "engineering" teams. They reflect on the challenge and present their findings to the group.

### ◆ Lesson Objectives

- Learn about engineering design.
- Learn about ship design and engineering.
- Learn about world records.
- Learn about teamwork and working in groups.

### ◆ Materials

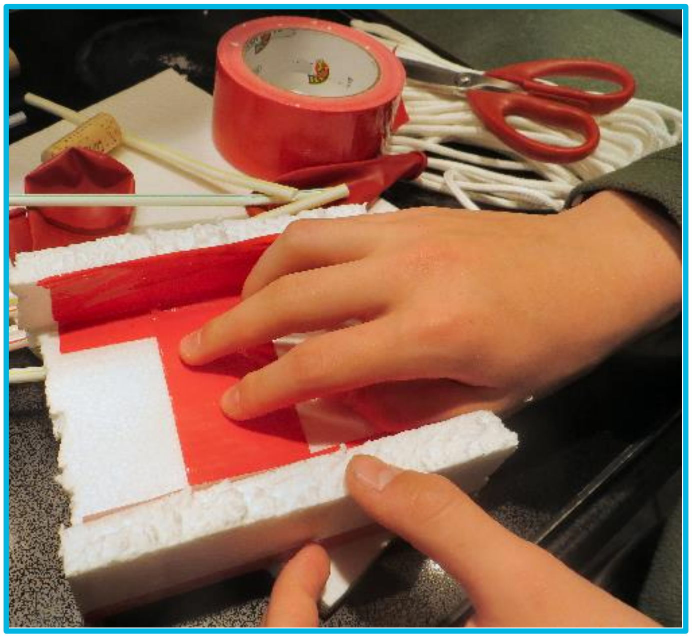
- Student Resource Sheet
- Student Worksheets
- Classroom Materials: water, towels, canal (long waterproof container such as a planter, or gutter section with end pieces attached), stopwatch or other speed measuring device. Gutters are usually sold in 4" or 125 mm x 7 foot/2.2 metre length sections -- with end caps this works well and allows for a water depth of about 3" or 90 mm. Whatever size trough you select will have to be provided to students so their boats fit.
- Student Materials: rubber bands, measuring tape, cardboard, fasteners, blocks or sheets of Styrofoam, duct tape, toothpicks, paper, foil, glue, pencils, straws, gears, paper cups, wax, balloons, string, springs, cork, motors, etc. -- or students can gather their own parts outside of class.

### ◆ Procedure

1. Show students the various Student Reference Sheets. These may be read in class, or provided as reading material for the prior night's homework. Divide students into groups of 2-3 students, providing a set of materials per group.  Give each team a name or number that will appear on their speed boat for easy identification.
2. Explain that students are now an "engineering" team that must develop a boat that can fit into the testing trough and prove to be the fastest in the class.  (Note: be sure to measure the trough you are using and guide students to design their boats so that they are a narrower than the width of the trough.  Boats also cannot be longer than 10 inches or 25 cm). The boat must remain in the water at all times during testing….and also has to be built from scratch, although younger students may use plastic boat toys though if building is too difficult.
3. Students meet and develop a plan for their speed boat which they will sketch on paper, including a list of parts.

## *For Teachers:*
## *Teacher Resource*

### ◆ Procedure (continued)



4. Student teams next present their plans to the class and review all the speedboat designs of other teams.
5. Next, students build their speedboat. They have an opportunity to view the boats built by other teams and make a prediction of the speed at which their own boat and the other team boats each will travel.
6. Teams test their boats -- each team can test their boat three times…and take the best speed. Note: The teacher should set up the waterway; only one is needed for all testing. Add water to a trough or sealed gutter section and tape the starting line and finish line. Teachers should time the tests for fair reporting. Students record the results of each test, noting distance spanned and stability.
7. Each student group compares their speed predictions with actual results, completes an evaluation/reflection worksheet, and presents their findings to the class.

### ◆ Time Needed

Two to four 45 minute sessions

### ◆ Extension Ideas

Advanced or older students could be challenged with developing a computerized sensor for measuring the time it takes for a boat to cross the "finish line."

### ◆ Tips

- Testing could be conducted outside to reduce water issues in a classroom setting.

## *Student Resource:*
## *Naval Architecture and Marine Engineering*

### ◆ What do Marine Engineers and Naval Architects Do?

Marine engineers and naval architects are involved in the design, construction, and maintenance of ships, boats, and related equipment. They design and supervise the construction of everything from aircraft carriers to submarines, and from speedboats to tankers. Naval architects work on the basic design of ships, including hull form and stability. Marine engineers work on the propulsion, steering, and other systems of ships. Marine engineers and naval architects apply knowledge from a range of fields to the entire design and production process of all water vehicles.

### ◆ Type of Vessels

There are a wide range of vessels that are designed and tested by marine engineers and naval architects including:

- Merchant Ships - oil/gas tankers, cargo ships, bulk carrier, container ships
- Passenger/vehicle ferries, cruise ships
- Warships - frigates, destroyers, aircraft carriers, amphibious ships, etc.
- Submarines and underwater vehicles
- Icebreakers
- Offshore drilling platforms, semi-submersibles
- High Speed Craft - hovercraft, multi-hull ships, hydrofoil craft, etc.
- Workboats - fishing boat, platform supply vessel, tug boat, pilot vessels, rescue craft, etc.
- Yachts, power boats, and other recreational craft.

### ◆ How Important is Testing?

Scientists and engineers use testing systems to evaluate the performance of equipment of all types before construction.  Testing can take a variety of forms including wind tunnels, computer simulation, model making, and prototype fabrication.

## Student Resource: How Fast is Fast?

### ◆ What is a Speed Boat?

A full size motorboat (or speedboat) is a boat which is powered by an engine. In this lesson, you'll be building a boat that is much smaller and can be propelled using lots of different methods! Some motorboats are fitted with inboard engines, others have an outboard motor installed on the back of the boat that contains an internal combustion engine, a gearbox and the propeller in one unit.

### ◆ What is a World Record?

A world record (or world best) is usually the best global performance ever recorded and verified in a specific skill or sport. The book Guinness World Records collates and publishes notable records of all types, from first and best to worst human achievements, to extremes in the natural world and beyond. A number of high-profile records are broken on a regular basis, such as the record for the oldest person in the world. At the moment, with the most Guinness World Records is Mr Ashrita Furman, who holds the records for, among many others, long-distance pogo-stick jumping, most glasses balanced on the chin, and most hop-scotch games in 24 hours.

### ◆ World Water Speed Record

The official world water speed record is 275.97 knots (511.11 km./h, or 317.58 mph) by Ken Warby in the unlimited-class jet-powered hydroplane Spirit of Australia on Blowering Dam Lake, New South Wales, Australia, on 8 October 1978. Warby's record still stands today, and there have only been two official attempts to break it -- both ending in the death of the challengers.  It is a good lesson that going fast isn't necessarily safe!

The Spirit of Australia was powered by a Westinghouse J34 jet engine. The engine was developed by the Westinghouse Electric Company in the late 1940s and was used for jet fighters and other aircraft. The Spirit of Australia is displayed permanently at the Australian National Maritime Museum.

Warby was fascinated with the idea of breaking the world speed record from a young age. As a child he built his own models and powercraft to race on water, setting the scene for his eventual world record attempts. With most of his engineering experience learnt on the job, he designed a wooden 3-point hydroplane which, at record breaking speeds, would make little contact with the water.

## Student Worksheet: Design and Testing

You are a team of engineers who have been given the challenge of developing a boat that can travel down a small canal faster than boats designed by other student "engineering" teams. There are a few rules:

1. Your boat must touch the water at all times during its journey.
2. Boats cannot be longer than 10 inches or 25 cm.
3. Boats also cannot be wider than 3 inches or 90 mm -- but check with your teacher as the width of the canal he/she is preparing may have a different width requirement.
4. You must make your boat from scratch (no premade plastic boats allowed, unless your teacher approves).
5. The method you develop for propelling your boat has to be part of the boat, so you cannot for example toss a ball at it to make it go.

### ◆ Research/Preparation Phase

1. Review the various Student Reference Sheets.

### ◆ Planning as a Team

Meet as a team and develop a drawing on the other side of this paper showing the design of your speed boat. Be sure to list all the items you think you will need to build it in the box below.

| Parts List: |
| --- |
| |

## Student Worksheet:
## Hull Engineering and Testing (continued)

### ◆ Construction Phase
1. Build your boat using your planned materials…you may find you need to add materials or change the design during this phase. It is ok to trade materials with other teams, or request additional materials from the teacher. In some situations, your team may build your boat outside of school and gather materials as needed outside the classroom.

### ◆ Competitive Analysis Phase
1. Take a good look at all the speedboats created by other "engineering" teams in your classroom. Notice the differences, and as a team, make predictions of the best speed you think your boat and the competition with achieve during testing. Later, you'll use this sheet to mark down the actual results after testing.

| Your team's prediction | Team: | Team: | Team: | Team: | Team: | Team: |
|---|---|---|---|---|---|---|
| Speed (Test 1) | | | | | | |
| Speed (Test 2) | | | | | | |
| Speed (Test 3) | | | | | | |

### ◆ Speed Race Testing
1. Observe as your team and other teams test their prototypes in your classroom waterway. Record your team's results in the box below, including points and observations.

| Actual Results | Team: | Team: | Team: | Team: | Team: | Team: |
|---|---|---|---|---|---|---|
| Speed (Test 1) | | | | | | |
| Speed (Test 2) | | | | | | |
| Speed (Test 3) | | | | | | |

## Student Worksheet: Evaluation

◆ Reflection

1. How did your speed boat perform compared to other teams in your classroom?

2. What do you think was the pivotal aspect of the design of the boat that helped it go the fastest?

3. If you had to do it all over again, how would your planned design change? Why?

4. Do you think that engineers often adapt their original plans during the manufacturing process? Why might they?

5. Did you find that there were many designs in your classroom that were very different and yet also very fast? What does this tell you about engineering plans?

6. Explain how working as team impacted (positively or negatively) your team performance on this project.

7. If you could have added a material to your boat that was unavailable, what would that have been? Why?

## *For Teachers:*
## *Alignment to Curriculum Frameworks*

**Note:** Lesson plans in this series are aligned to one or more of the following sets of standards:
- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

**◆National Science Education Standards Grades 5-8 (ages 10 - 14)**

**CONTENT STANDARD A: Science as Inquiry**

As a result of activities, all students should develop
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

**CONTENT STANDARD B: Physical Science**

As a result of their activities, all students should develop an understanding of
- Motions and forces
- Transfer of energy

**CONTENT STANDARD E: Science and Technology**

As a result of activities in grades 5-8, all students should develop
- Abilities of technological design
- Understandings about science and technology

**CONTENT STANDARD F: Science in Personal and Social Perspectives**

As a result of activities, all students should develop understanding of
- Science and technology in society

**CONTENT STANDARD G: History and Nature of Science**

As a result of activities, all students should develop understanding of
- Science as a human endeavor

**◆National Science Education Standards Grades 9-12 (ages 14-18)**

**CONTENT STANDARD A: Science as Inquiry**

As a result of activities, all students should develop
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

**CONTENT STANDARD B: Physical Science**

As a result of their activities, all students should develop understanding of
- Motions and forces
- Interactions of energy and matter

**CONTENT STANDARD E: Science and Technology**

As a result of activities, all students should develop
- Abilities of technological design
- Understandings about science and technology

**CONTENT STANDARD F: Science in Personal and Social Perspectives**

As a result of activities, all students should develop understanding of
- Science and technology in local, national, and global challenges

## *For Teachers:*
## *Alignment to Curriculum Frameworks*

◆**National Science Education Standards Grades 9-12 (ages 14-18)**

**CONTENT STANDARD G: History and Nature of Science**

As a result of activities, all students should develop understanding of

- Science as a human endeavor

◆**Next Generation Science Standards Grades 3-5 (Ages 8-11)**

**Motion and Stability: Forces and Interactions**

Students who demonstrate understanding can:

- 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

**Energy**

Students who demonstrate understanding can:

- 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.

Students who demonstrate understanding can:

- 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

**Engineering Design**

Students who demonstrate understanding can:

- 3-5-ETS1-1.Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2.Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 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.

◆**Next Generation Science Standards Grades 6-8 (Ages 11-14)**

**Engineering Design**

Students who demonstrate understanding can:

- MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

## *For Teachers:*
## *Alignment to Curriculum Frameworks*

◆**Standards for Technological Literacy - All Ages**

**The Nature of Technology**
- Standard 1: Students will develop an understanding of the characteristics and scope of technology.
- Standard 2: Students will develop an understanding of the core concepts of technology.
- Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

**Technology and Society**
- Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 7: Students will develop an understanding of the influence of technology on history.

**Design**
- Standard 8: Students will develop an understanding of the attributes of design.
- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

**Abilities for a Technological World**
- Standard 11: Students will develop abilities to apply the design process.

**The Designed World**
- Standard 18: Students will develop an understanding of and be able to select and use transportation technologies.