Engineering Project

Boat Building Challenge

Most boats and ships have the same basic shape and design. They are longer than they are wide, and typically they taper to a point in front. The pointed front acts like a wedge. It pushes the water to the side as the boat moves forward. If a boat were flat in the front, like the blade of a bulldozer, then water would build up against the front of the boat and slow it down.

Suppose you are a nautical engineer working for a ship building company. Your company supplies ships to other companies that transport goods across the ocean. Your clients have said that they need ships that can travel across the ocean more quickly and that can carry more cargo than their older ships. How can the design of a boat be changed to increase its speed or the weight it carries? In this project you will investigate answers to these questions.

To carry out this investigation, you will design, build, and test a model boat from a set of simple materials. Here are the rules for the project:

- You may use only the materials that the teacher provides. If you want to use additional materials, the teacher must approve them.
- The force to move the boat will come from an inflated balloon. Your teacher will provide the balloons. You will inflate and install the balloon before launching the boat, and then let the balloon deflate.
- After the boat is launched, you may not touch the boat or influence its motion in any way.

Points will be awarded in three performance categories:

1. the boat's speed and the distance that it travels
2. the straightness of the boat's path
3. the amount of weight that the boat can carry

Suggested Materials (per pair or group)
For building the boat:
- a box of pencils (unsharpened)
- balloon
- drinking straw
- rubber band
- disposable aluminum baking pan or pie pan
- aluminum foil
- duct tape or glue
- clothespins

Additional materials:
- meter stick or measuring tape
- scissors
- 5 or 6 waterproof weights, such as sealed plastic bags containing 10 to 20 dried beans
- sink or bucket, filled with water
- science notebook or journal for each student
- calculator
- balance or scale
- stopwatch
- pool or tank (per class)

Procedure
Part 1: Building the Boat

1. Review the materials for building the model boat. With your partners, discuss how you could assemble the materials. You may wish to view videos or consult reference sources to help you identify the parts of a boat and their functions.

2. With your partners, discuss ideas for meeting one or more of the performance categories of this project. You may decide to try to outdo classmates in gaining points in only one category. Or you may try for points in all three categories. To help develop your ideas, try joining the materials temporarily in different ways. Make drawings and sketches, too.

3. Be sure to include a mechanism to hold an inflated balloon in place and to release it. For example, the mouth of the balloon could be tied to the drinking straw, then the balloon could be taped or pinned into the boat. You could use a clothespin like a valve to let the air out of the balloon.

4. Agree on a design for your boat, and complete a drawing of it. The drawing should serve as a guide for building the boat. The drawing should also include the forces that affect the motion of the boat, including its weight (a downward force), thrust (the forward force from the balloon), buoyancy (the upward force from the water), and drag (a backward force due to resistance from the water).

5. Follow your design and build the boat. You may need to revise the design as you proceed.

Part 2: Testing the Boat

Before completing the tests, assign a role to each group member. Roles include preparing the added weight for the boat, inflating and installing the balloon, timing the boat, measuring the distance of travel, recording data, and supervising all aspects of the investigation.

Be sure to record all data. You may copy or tape the Data Table into your journal or notebook.

6. Test whether the boat will float. You may test it in a sink or a large bucket filled with water.

7. Measure the weight of the boat, as well as the weights of the standard weights. Place the boat in water, and then add weights to the boat to find out how much weight it will hold before sinking.

8. Now test your boat in the tank or pool that the teacher provides. Determine a starting point and finish line, and measure the distance between them. Then launch the boat, and measure its time and distance of travel. Repeat the test with added weights inside the boat. Conduct as many trials as time allows. Record the results of each trial in the Data Table shown below.

9. After all boats have been tested, your teacher will award points.

Data Sheet

Weight of the boat without extra load: ____________

Maximum extra weight (load) that boat will hold without sinking: __________

Maximum travel distance (from starting point to finish line): __________

Data Table for Testing the Performance of a Model Boat

Trial	Weight of the boat and load	Distance of travel	Travel time	Speed of travel (distance/time)	Path (straight, curved, zigzag)	Other observations
1						
2						
3						
4						
5						
6						
7						
8						

Analysis

1. Describe the forces that affect the motion of a boat. Include a drawing to show the forces.

2. What problems did you encounter in designing and testing your model boat? How did you address these problems?

3. **Analyze** Review the data you recorded in the Data Table. Make a graph of weight versus speed. How did the total weight of the boat and its load affect the speed? Did the total weight also affect the distance traveled and the straightness of the path?

4. **Analyze** Compare your test results to other groups' results.
   a) Which boat was fastest? Which features do you think helped maximize its speed? How do these features affect other factors of a boat's performance?

b) Which boat carried the most weight without sinking? Which design features helped maximize the weight a boat could carry? How do these features affect other factors of a boat's performance?

c) Which boat traveled in the straightest path? Which features helped stabilize the boat? How do these features affect other factors of a boat's performance?

5. Explain What are the advantages of using aluminum as the building material for a boat?

6. Evaluate Think about the experimental design of the tests you performed on the boat. Were you able to control all of the variables? How easy or difficult was it to make your measurements? How should the investigation be improved to make sure the results are meaningful?

7. Apply Think about a report you would write to the managers of the ship-building company. What design changes would you recommend to make a ship faster and able to carry a heavier load?