Sail Through Engineering Post-Workshop Activity

Thank you for participating in the Sail Through Engineering Workshop. We hope you and your students enjoyed your time at the MIT Museum. This post-workshop activity is designed to help students continue the iterative engineering process.

If students would like to continue to explore nautical objects including half-hull models, boat designs, and navigational charts, the MIT Museum’s Nautical Collection can now be accessed online with new and expanded content: [https://mitmuseum.mit.edu/explore/collections](https://mitmuseum.mit.edu/explore/collections).

Materials
- Sail Through Engineering worksheets from the MIT Museum
- One post-activity worksheet per pair of students
- Pencils
- Scissors
- Plastic straws
- Cardstock
- Hot glue
- Several varieties of tape
- Computers (with access to the internet)
- Printer
- MIT Museum Boat Cross-Section Online Application: [http://webmuseum.mit.edu/herreshoff/](http://webmuseum.mit.edu/herreshoff/)
- Fluid Dynamic Simulator: [https://physics.weber.edu/schroeder/fluids/](https://physics.weber.edu/schroeder/fluids/)
- Tubs of water
- Newton-meter
- Gram cubes

Setup
1. Set up a supply station with hot glue, cardstock, and tape.
2. Fill 1-4 tubs with water for testing of the new boat models.

Activity
1. Hand out one post-activity worksheet per pair of students. Make sure that each group has access to the internet on a computer or other device.
2. Students should have the worksheets from the MIT Museum’s Sail Through Engineering workshop with them.
3. Review the engineering cycle with the students. Ask them to describe how they carried out each step during the workshop at the MIT Museum.
4. Reiterate the importance of the original challenge question and definition of the criteria of success. Students should write down their original challenge (boat type) and criteria for success on the post-workshop worksheet.
5. Students will then work through the post-workshop worksheet in order to improve upon their original boat hull design from the workshop.
Sail Through Engineering Post-Workshop Activity Worksheet

Engineering is an iterative process. This means that solutions to problems are tested and then modified based on data collected in experiments. The following procedure will guide you through the process of using the data you collected at the MIT Museum to improve upon your boat design.

The Engineering Cycle

1. Define the Challenge
2. Background Research
3. Define your Constraints
4. Prototyping
5. Testing your Design
6. Learn from your Data

1. Look at your criteria for success and data collected during the workshop at the MIT Museum. In what ways was your boat successful? Support your answer using data from your experiments.

2. Look at your criteria for success and data collected during the workshop. In what ways was your boat not successful? Support your answer using data from your experiments.
3. Before you build your next boat hull model, you will test the design using a computer simulation. Go the following website: https://physics.weber.edu/schroeder/fluids/ to use a computer simulation that lets you draw a top-down view of your boat and observe how water will flow around it. The simulation also lets you study the force of drag (the force with which the water pushes backwards on your boat as it moves).

- This simulation shows fluid flowing from left to right as viewed from above. (Initially, a straight barrier is shown.) Click “start” to see how the barrier diverts the fluid around it.
- Change the shape of the barrier by pressing pause. Click “clear barriers” and then click and drag on the green simulation box to draw your boat.
- Click the checkbox next to “Show: Force on barriers” to show the force exerted by the fluid on your boat hull.

4. After trying multiple boat designs in the simulation, draw your final design below. Briefly describe why you chose this design. In your sketch, draw five vertical lines to indicate the cross-sections that you will create for your boat.
5. Complete the table below by describing up to three changes that you will make to your first boat model regarding size, drag, capacity, or other factors:

<table>
<thead>
<tr>
<th>What will you change from your first boat model?</th>
<th>Why did you make this change?</th>
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6. Go to the following link to access the CAD software that you used during the MIT Museum workshop: [http://webmuseum.mit.edu/herreshoff/](http://webmuseum.mit.edu/herreshoff/)
   - Change your x and y values in order to create the cross-sections of the new boat hull that you drew in question #9.
   - When finished, export and print the file that has been downloaded.
7. Follow the directions below in order to build your new boat hull model with the printed cross-sections.

- Use scissors to cut out your five slices.
- Trace your slices onto a piece of cardstock.
- Cut out the cardstock pieces (Picture A).
- Cut a drinking straw into four equal pieces.
- Use hot glue to attach the straws to your slices (Picture B).
- Glue plastic wrap to the bottom of your boat for waterproofing (Picture C).
- Select the type of tape that you are going to use for the outside of your hull and seal your boat hull with the material (Picture D).
8. Carry out the four tests with your boat that you did in the workshop at the MIT Museum (tracking, drag, weigh capacity and stability tests) and report your data below. Refer to your data sheet from the workshop for instructions. Feel free to design your own new experiments as well.

9. Look back to your original challenge and criteria for success. In what ways is your new boat better than your previous boat?

10. If you carried out another iteration of boat design, what would you change based on your new data?