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MAE 200 Boat Design Project

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Brainstorming Process

- Started with verbal ideas, then on paper, and eventually graduating to prototypes and testing
- Use a hot wire to cut the board in half widthwise
  - Don't cut it all the way so that we don't have to waste tape
- Maximize volume of water displaced
- Rip the tape in half/thirds
- Benefits of using a flat bottom versus a pointed bottom
  - Which is a better use of volume/materials
- Using other materials to build prototypes and picture design ideas
  - Testing the prototypes in water to see what changes to make

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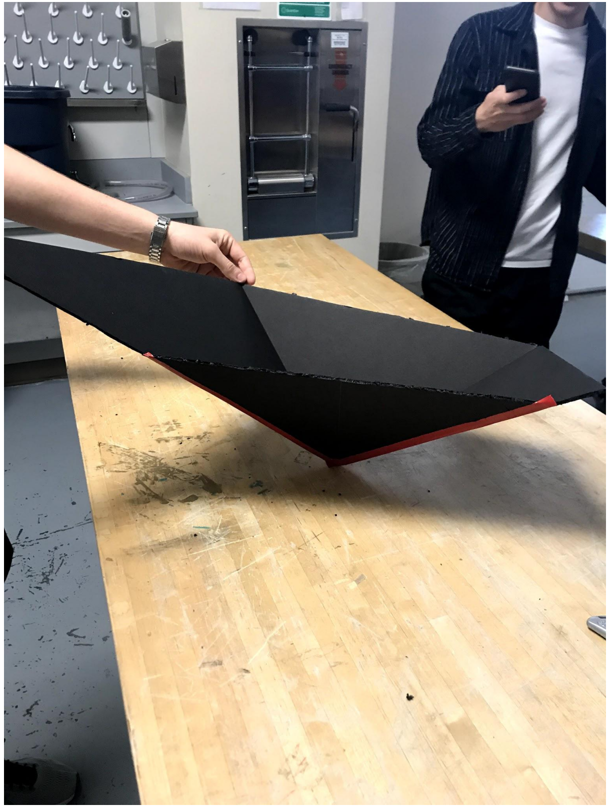
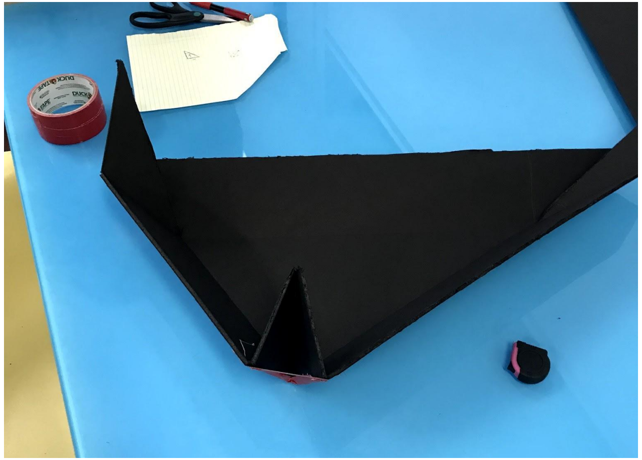
Testing Different Designs

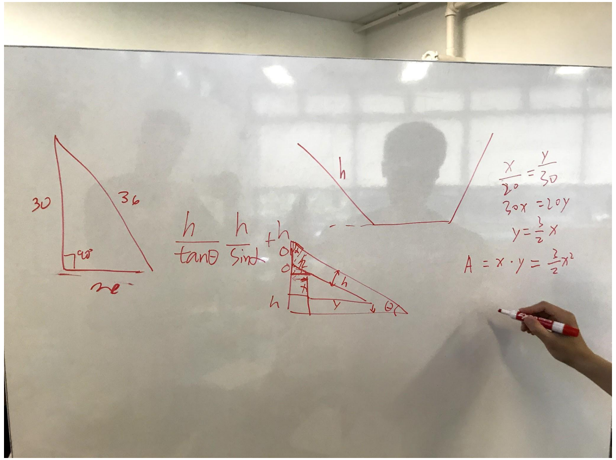
- First test: Pointed bottom boat
  - Worked better than we originally thought
  - No measurements involved - just testing an idea
  - The only major flaw was the point at the bottom letting in water
  - Held ~10 lbs



Testing (cont'd)

- Second Test: Flat bottom boat, edges at a right angle
  - Attempted at a volume maximization equation - we took the derivative of the buoyant force equation with respect to the height of the sides, however it proved to be wrong.
  - Fared far worse than we thought - sank almost immediately
  - Started off with an 8 lb weight, the maximum weight is unknown



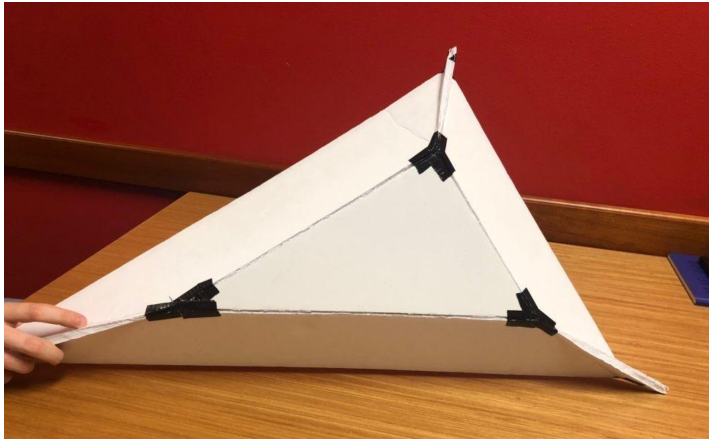


Testing (cont'd)

- Third test: design with flat bottom and slanted sides
  - Held ~13.2 lbs
  - Used maximization of volume to find the angle and height of sides
  - Found the angle to be 45°, and the height of the sides to be 4.099 in
  - A good compromise between the two original design ideas, still slanted while having a flat bottom to place the weights (or water bottles)

Final Design Decision

- We decided on a flat bottom boat with slanted sides
  - It held the most weight during tests
  - Best use of tape and materials (no material was discarded and all the tape was used)
  - We patched the corners, which was the most flawed part of our first design



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Final Design Prediction and Calculations

- We predict the weight to be around 11.66 lbs, based off of the volume given by our volume equation and a solidworks 3D model of the boat which gave us a volume of 322.69in^3. This is validated by our experimental boat which held 13.2lb but used a thicker material.
- Using the maximization of the buoyancy principle:
  We put the formula in terms of the height (h) of the sides, and took the derivative with respect to h. Then, setting it equal to zero to find the maximum and solving for h gave us the maximum that the sides could be, while maximizing the given volume. Using the second derivative of the equation let us check to make sure it was positive.
  We found h = 4.099 in.

Buoyant Force Formula

$$B = \rho_f V g$$

B – buoyant force in N

ρ_f – fluid density in kg/m^3

V – displaced body volume of liquid in kg/m^3

$g = 9.806\, m/s^2$ (standard gravity)