M1-18

# HYDRODYNAMICS

The Study Of Efficient Designs For Water Vessels

# QUESTION

How does the design of a boat's body affect its water resistance?

# PURPOSE

If the boat designs were not hydrodynamic, then everyday boats would not be efficient while sailing.

# ABSTRACT

My question was how the design of a boat's body affects its water resistance. I asked this because if the boat designs were not hydrodynamic, then our everyday boats would not be efficient while sailing. I think my experiment will help me understand why boats are shaped the way they are. I hope to find a design that is more hydrodynamic and I hope these hydrodynamic designs are in use within the shipbuilding community. The more hydrodynamic the boat is, the better it is for everyone, as it saves in shipping costs and the usage of natural resources. For this experiment, I used a pool, string, a fan, and 3 foil boats, each with a different nose shape. I recorded the time that it took for each boat, with the same wind speed from the fan, to reach an ending point marked with string. After recording the time, I have learned that the shape of a boat does affect it's hydrodynamics. The more pointed the shape is, the more hydrodynamic it will be. This is because water is easily able to move around the boat, which decreases friction.

# HYPOTHESIS

The testable question is how does the design of a boat's body affect its hydrodynamics?  My hypothesis is that if the boat's body design is pointier, the boat will be more hydrodynamic. This is because the boat doesn't have to push through as much water, allowing it to move faster with less force needed.  In previous experiments, I learned that when a larger object pushes through a lot of air it causes more air resistance. I think this will also apply to water and boats. I want to focus on boat body designs and hydrodynamics for this experiment.

# PROCEDURES

1. Gather the project's materials
2. Build 3 different boat designs using aluminum foil: one that is rounded, one that is squared, and one that is cone-shaped.
3. Measure the weight of each boat design when you are done building. The boat that has the largest weight is what you will make the others weigh. (Ex. If one boat is 420 g and the other 410 g, add 10 g to the one that is 410 g)
4. Place a piece of tape to mark your boat's exact starting point.
5. Place the fan at one beginning of the pool, facing perpendicular to the finish marking
6. Place one of your three boats in the water at the marked starting point (procedure #4) in front of the fan.
7. Turn on the fan.
8. Allow the boat to be blown by the fan and watch for the boat to cross the finish line, timing this process with the stop watch.
9. After your boat has passed the finish line, record the time in the trial log.
10. Repeat steps 6 through 9 for a total of 20 times, using the same boat.
11. Repeat steps 6 through 10, two more times using each of the other two boat designs you made.
12. Analyze results.

# MATERIALS

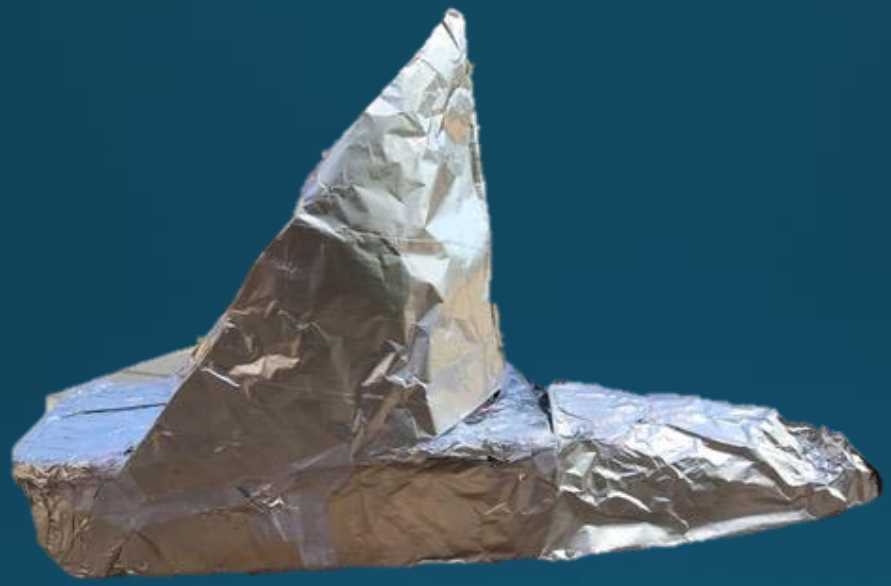
- Large Portable Tub or Pool (filled with water)
- Large portable Fan
- Plastic container (to be the boat's infrastructure)
- Aluminum Foil
- Small weights to make sure each boat has the same weight and distribution
- Scale to measure boat's weight
- String to mark the finish line
- Tape measure to measure distance

# VARIABLES

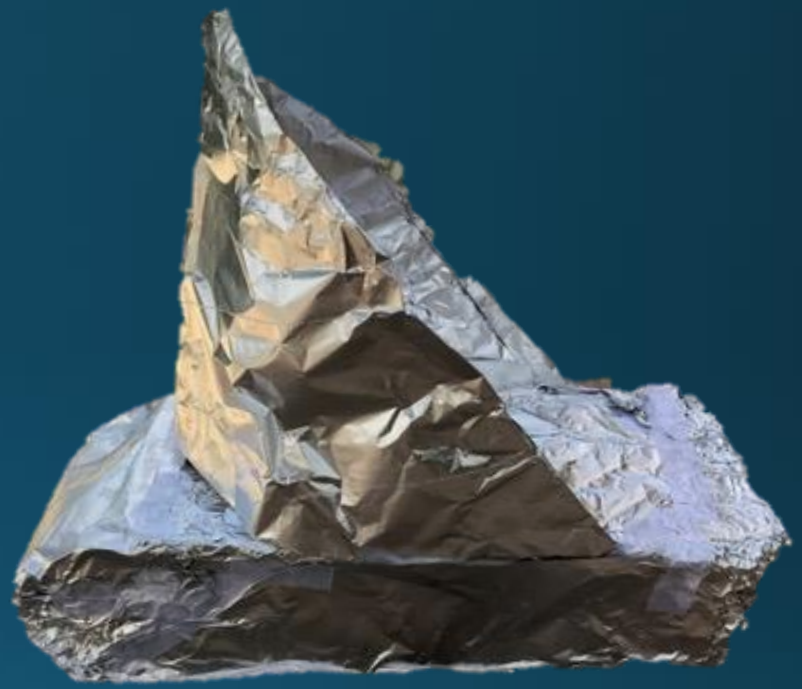
| CONTROLLS | DEPENDENT | INDEPENDENT |
| --- | --- | --- |
| Wind speed | How hydrodynamic the boat is | Body shape of boat |
| Material boat is made of | | |
| Weight of boats | | |

# BOAT BODY TYPES

SQUARED
SHAPE BODY



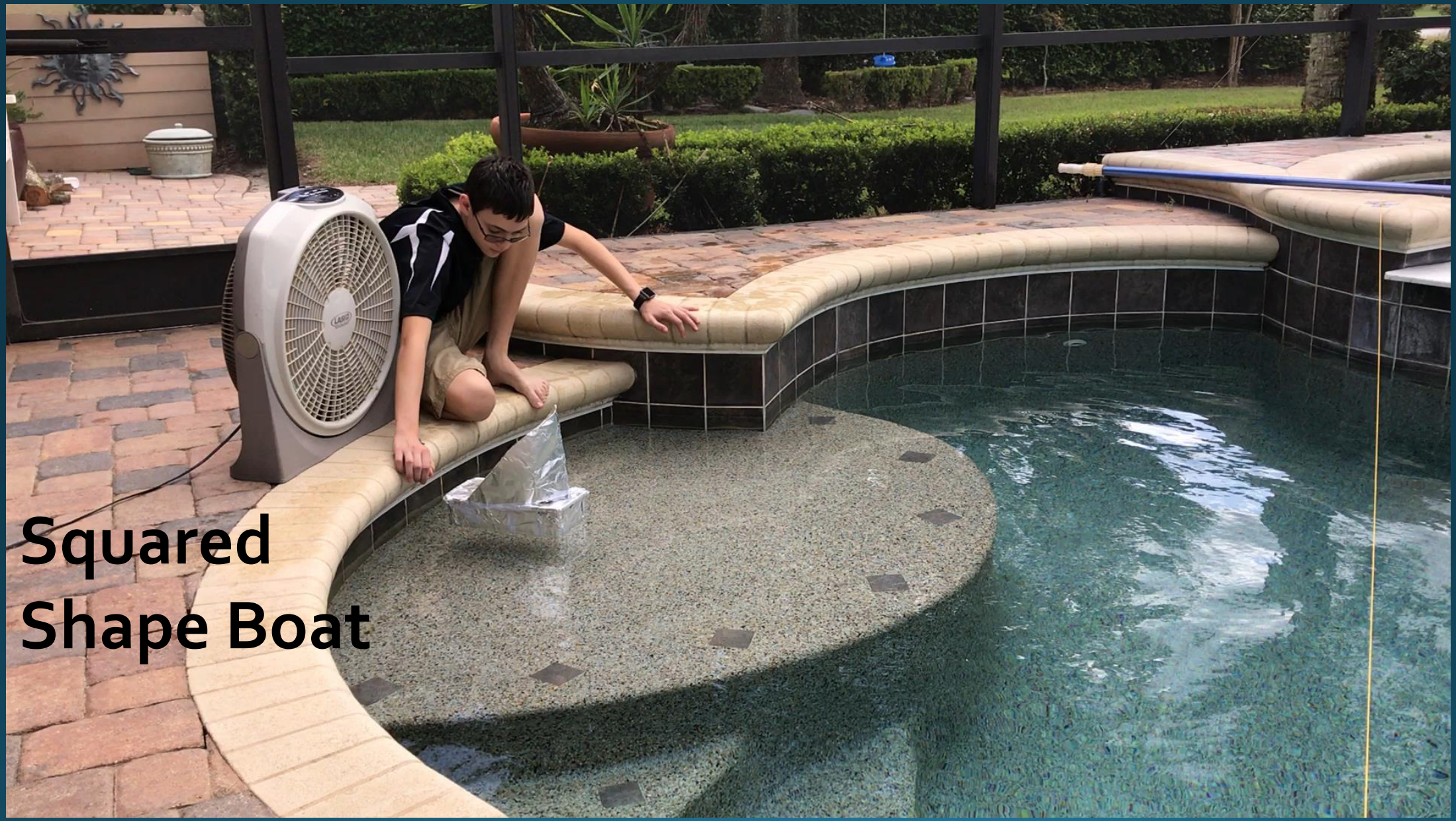
POINTED
SHAPE BODY

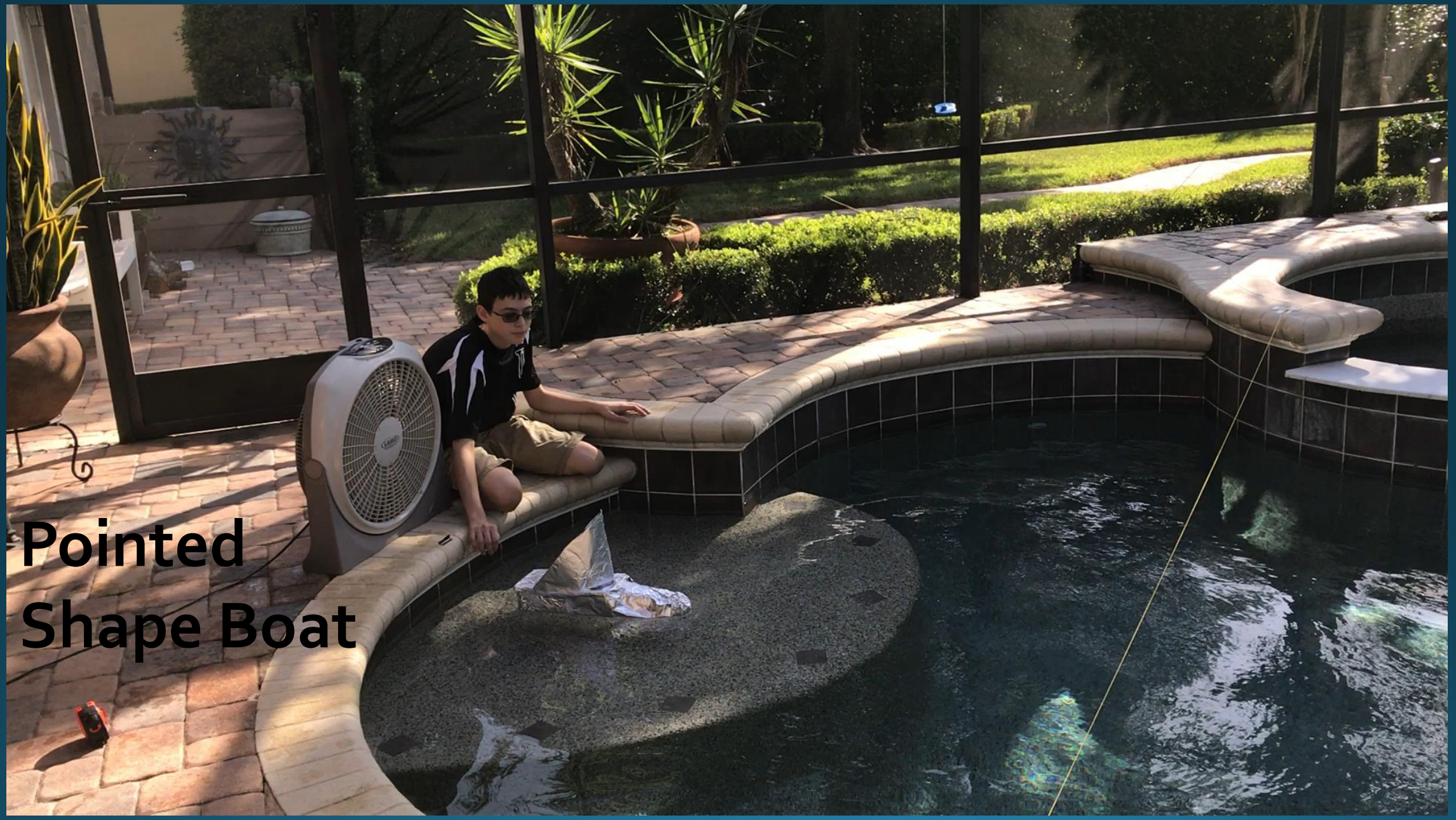


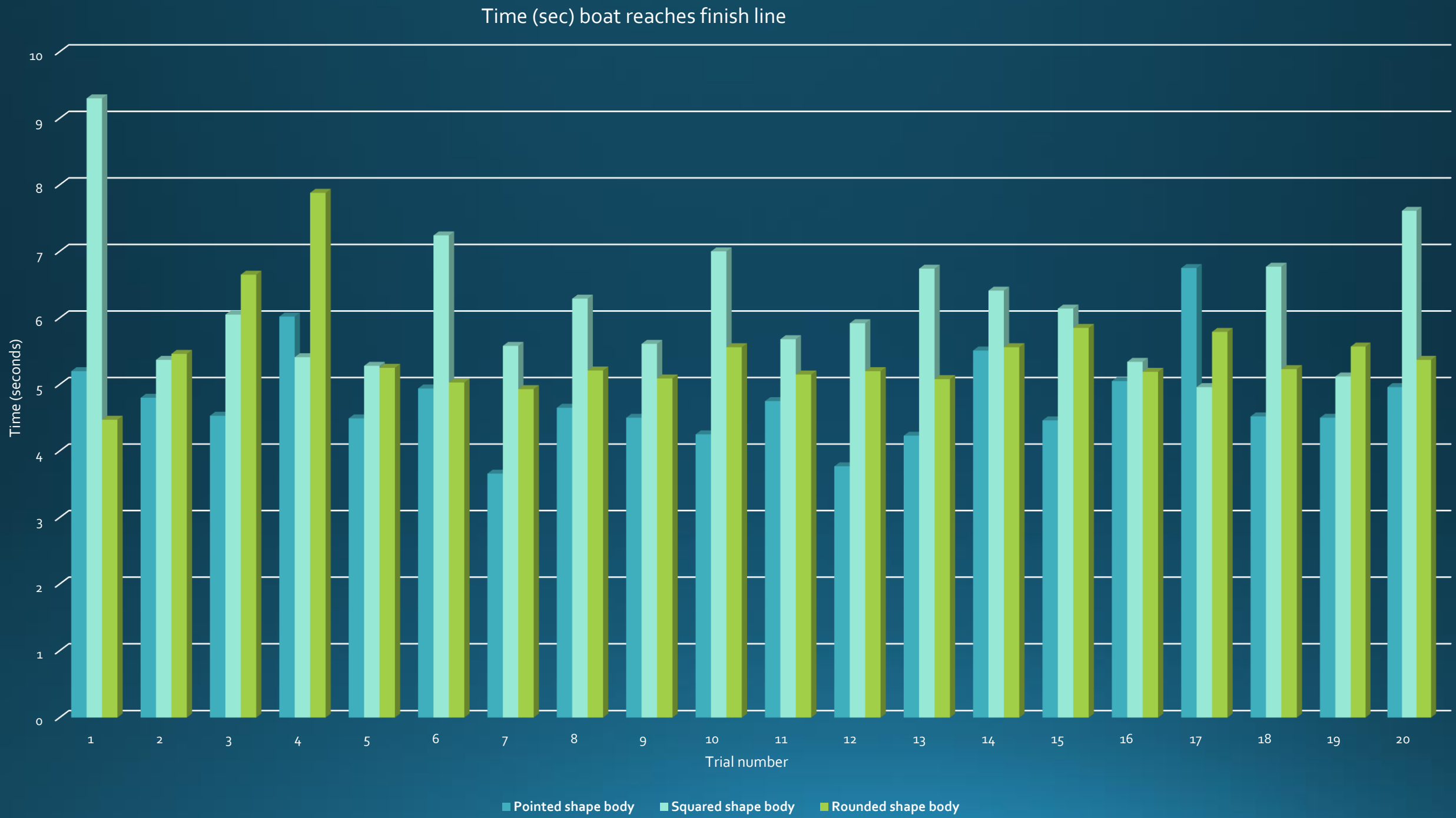
CURVED
SHAPE BODY

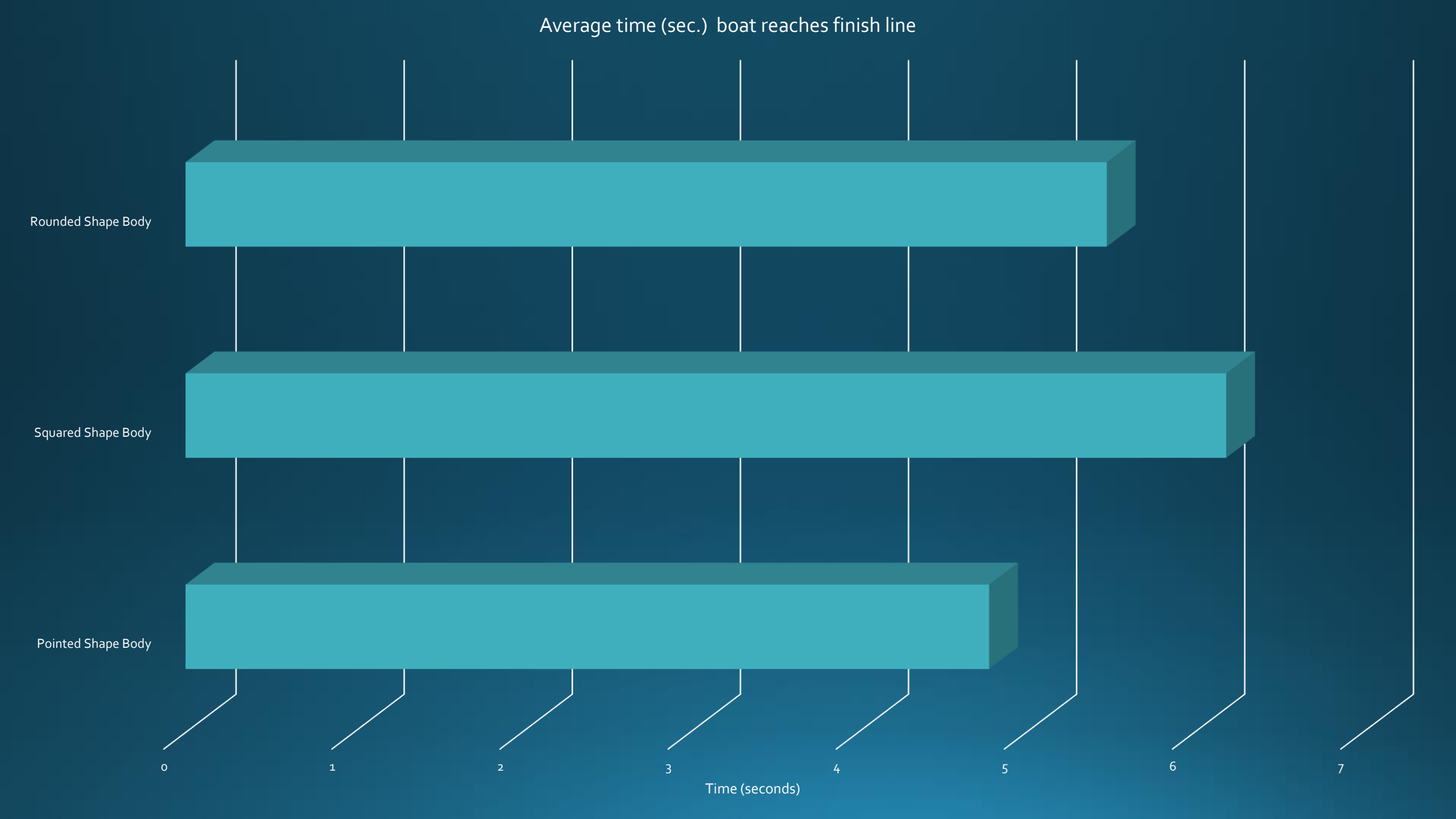

TESTING
VIDEOS


Rounded
Shape Boat


Squared
Shape Boat


Pointed
Shape Boat


Time (sec) boat reaches finish line
Time (seconds)
0
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Trial number
Pointed shape body
Squared shape body
Rounded shape body


Average time (sec.) boat reaches finish line
Rounded Shape Body
Squared Shape Body
Pointed Shape Body
0
1
2
3
4
5
6
7
Time (seconds)

# RESULTS

After the experiment and recording of the data, I found that the pointed shape boat had the most efficient hydrodynamics. This was because more water was easily able to flow around this design. The next most successful boat design was the rounded shaped design. The least efficient design was the squared shape.

# CONCLUSION

My hypothesis was that the pointier the body of the design, the more hydrodynamic the boat design would be. My data supports this hypothesis. The Pointed shape had an average time of 4.77 seconds to the finish line. The Squared shape body had an average time of 6.19 seconds. The Rounded shaped body had an average time of 5.47 seconds.