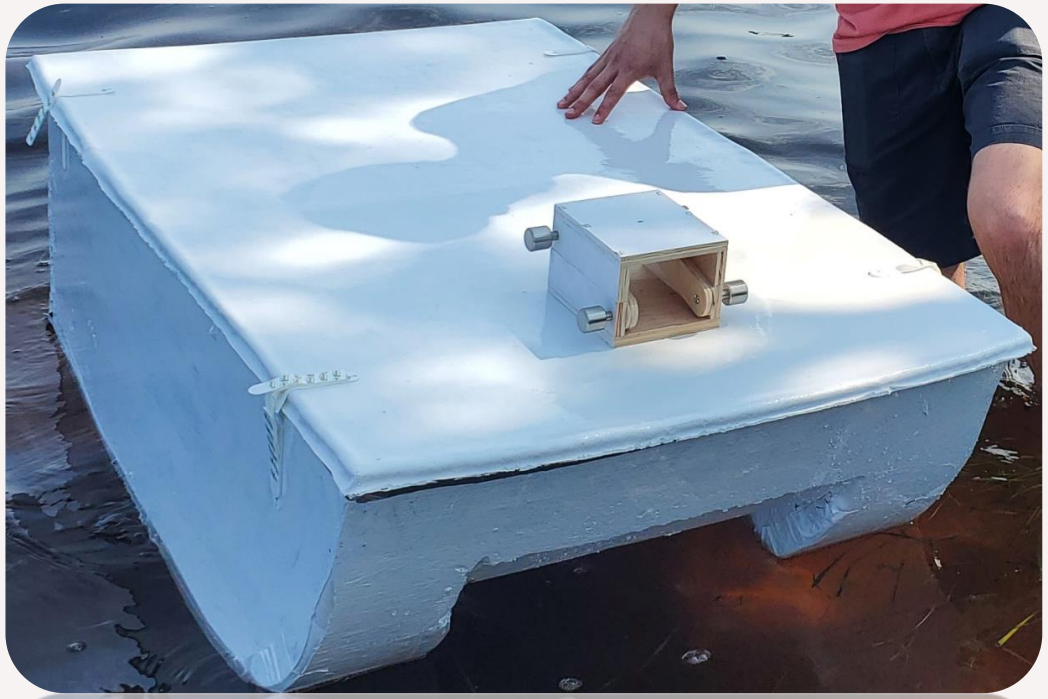
Final Presentation
Team 524PC
RoboBoat Pt. 1



By: Tamara McCaskill, Joseph Earnest, Manning Owens, Steven Harrington, Bryson Potts

Bryson Potts
Design Engineer

Joseph Earnest
Design Engineer

Manning Owens
Design Engineer

Tamara McCaskill
Design Engineer

Steven Harrington
Design Engineer

The Team

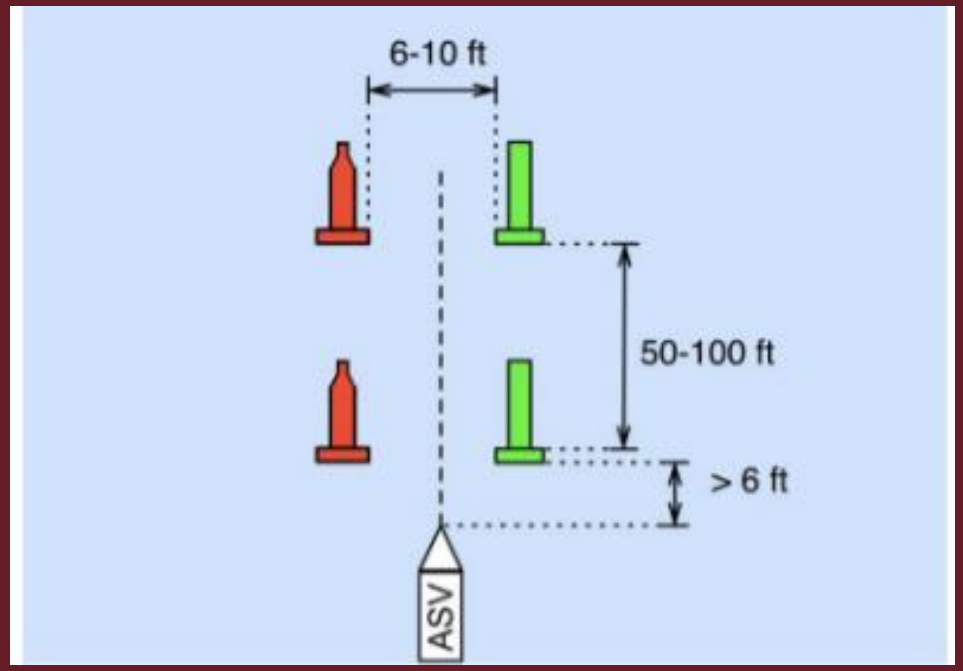
Project Overview

This project aims to demonstrate the skills acquired through our mechanical engineering program by designing and constructing a ship with autonomous functions that can complete the course objectives of the 2021 RoboBoat competition.

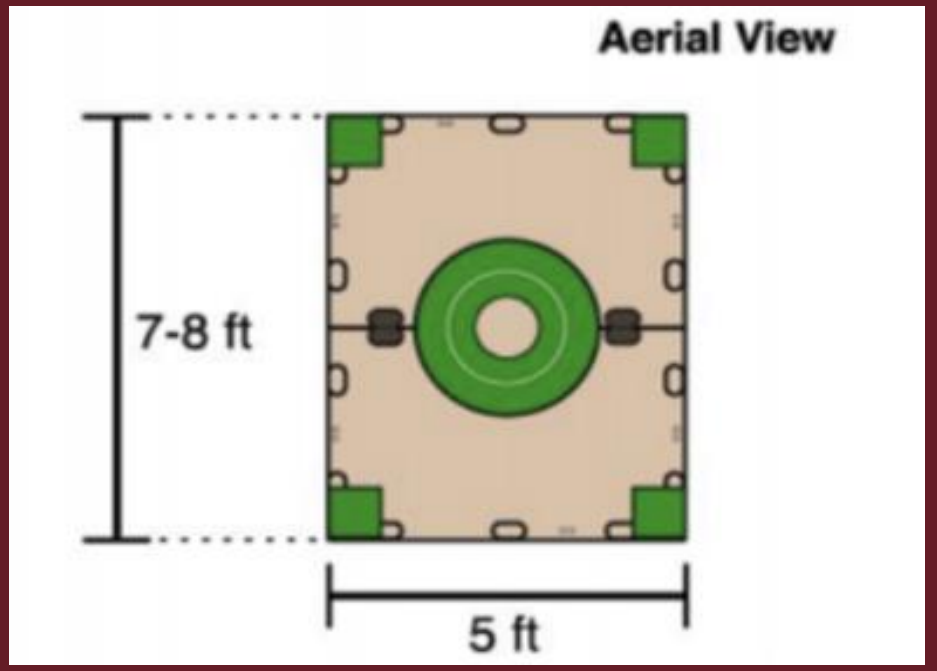
Competition Background

- ➔RoboBoat is an international competition hosted by RoboNation in Daytona, Florida.
- ➔Competitors create autonomous surface vehicles (ASVs) to complete simplified tasks.
- ➔These tasks simulate real-world challenges in the maritime industry, such as surveillance, object delivery, and navigation.

Example Tasks…..



Navigation Challenge



Object Delivery Challenge

Previous Overall Competition Winners

VANTEK 2020

Institut Teknologi Sepuluh Nopember 2019

Embry Riddle 2014

Due to COVID….

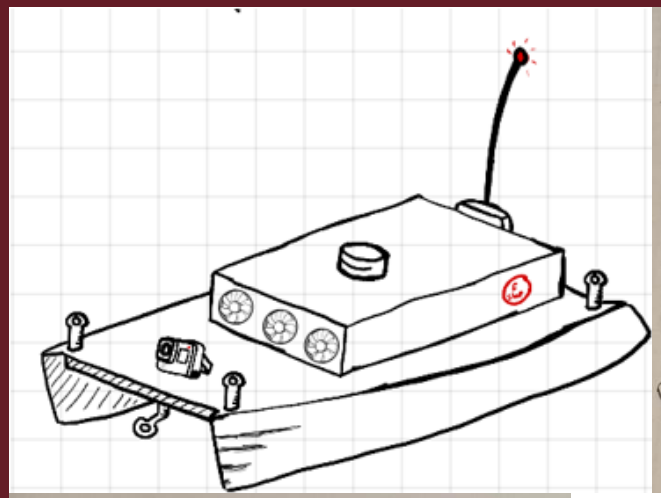
This year’s RoboBoat 2021 competition was held online.

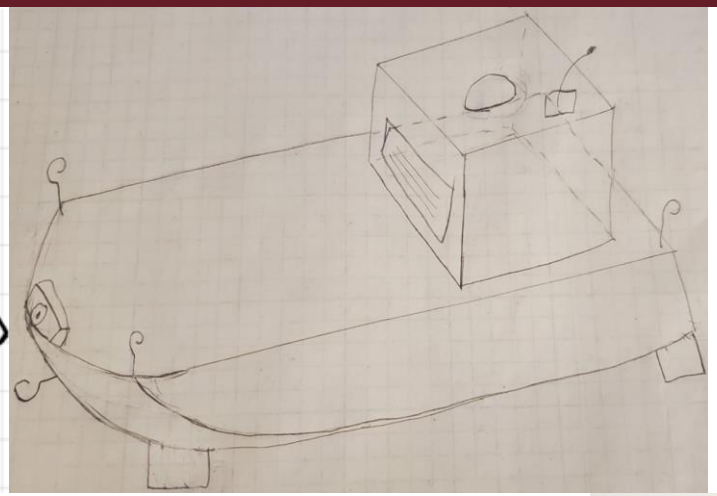
Required Deliverables Included:

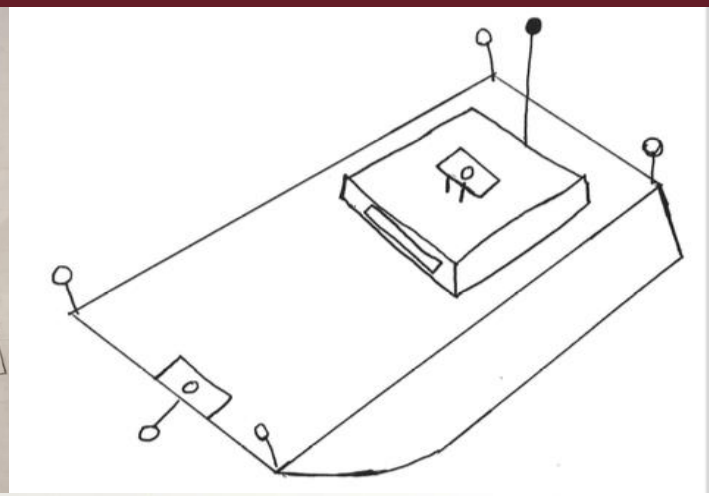
- ➔ Short Skills Video
- ➔ Detailed Technical Report
- ➔ Team Website Page

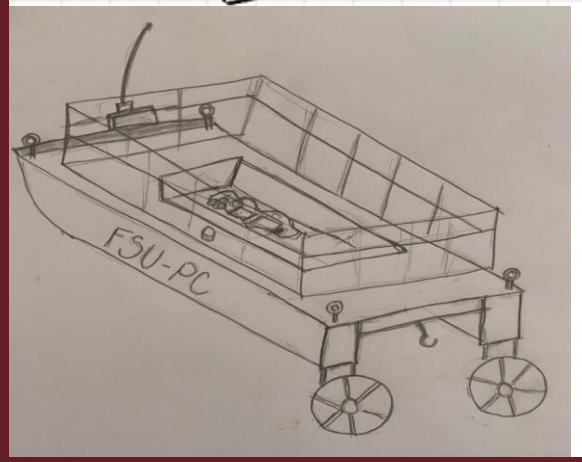
  https://pcspear.org/the-2020-2021-team/

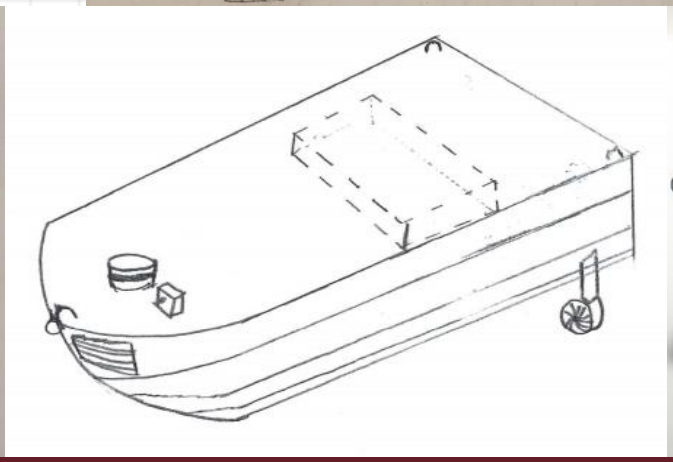
Preliminary Designs

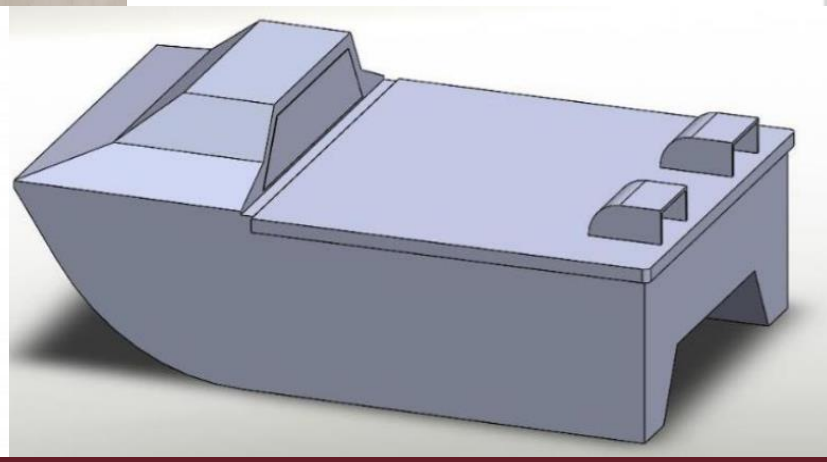












Concept Selection – Binary Comparison

	1	2	3	4	5	6	7	Total
1. Weight	-	1	0	0	0	1	0	2
2. Size	0	-	0	0	0	1	1	2
3. Buoyancy	1	1	-	1	1	1	1	6
4. Stability	1	1	0	-	0	0	1	3
5. Sensing	1	1	0	1	-	1	1	5
6. Maneuvering	0	0	0	1	0	-	1	2
7. Safety	1	0	0	0	0	0	-	1
Total	4	4	0	3	1	4	5	n-1=6

Concept Selection – House of Quality

House of Quality		Engineering Characteristics								
Improvement Direction		↑	↑	↑	↓	↓	↓	↑		↓
Units		N	M	MHz	cm	cm	kg/m3		N/A	N
Customer Requirements	Importance Factor	Thrust	Sensing Distance	Processing Speed	Center of Gravity	Localization Accuracy	Material Density	Strength/Density	Coating/Seal	Drag Force
Weight	2	3			9		9	9	1	3
Size	2	1	1		3	3	3			9
Buoyancy	6				9		9	1	3	1
Stability	3	3			9		3	3		1
Sensing	5		9	9		9				
Maneuverability	2	9	3	3	3	3	1			9
Safety	1	1	1	1		1	1	9	3	
Raw Score (517)		36	54	52	111	58	90	23	51	42
Relative Weight %		7	10.4	10.1	21.5	11.22	17.6	4.5	9.9	8.1
Rank Order		8	4	5	1	3	2	9	6	7

Concept Selection – Pugh Chart

Selection Criteria	Baseline		Concepts				
	RoboBoat 2020 DATUM		1	2	3	4	5
Material			+	S	-	-	S
Center of Gravity			-	S	-	S	+
Thrust			+	+	S	+	S
Drag Force			+	-	-	S	S
Cost			-	S	-	-	S
	Total:	# of plus	3	1	0	1	1
		# of minus	2	1	4	2	0
		# of same	0	3	1	2	4

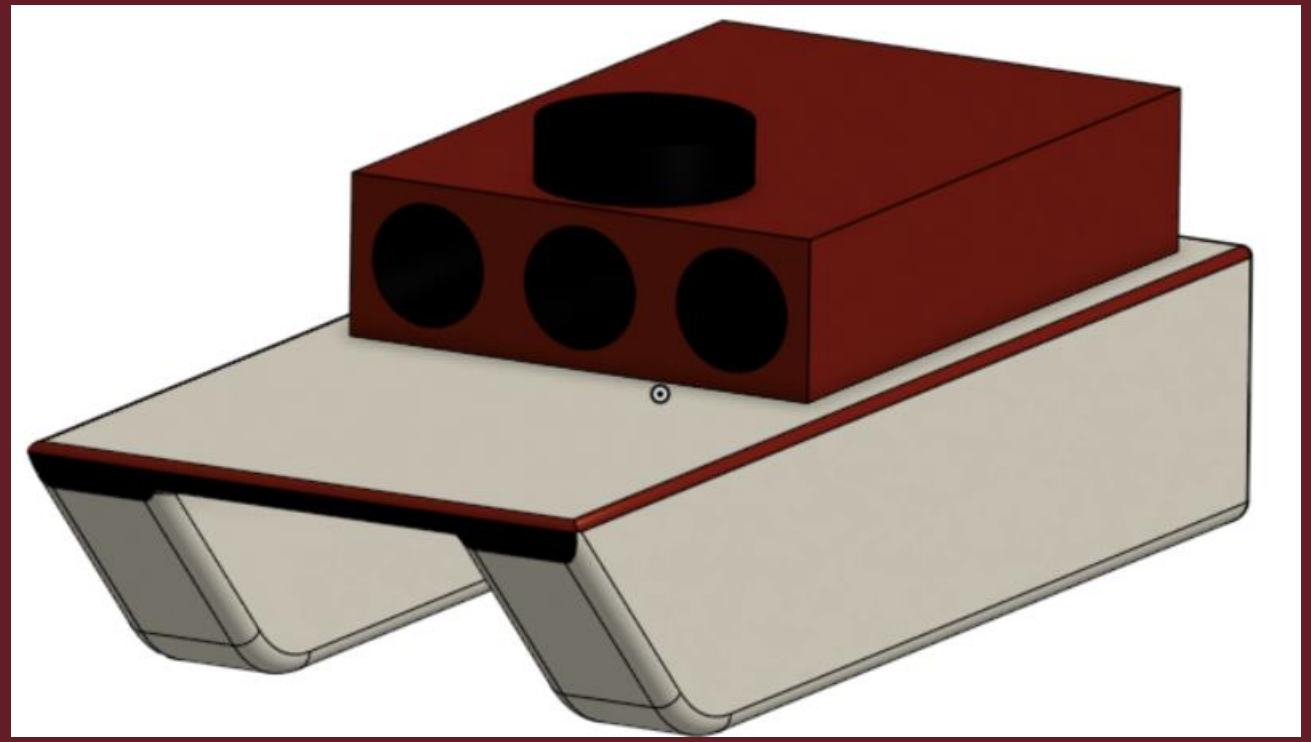
Concept Selection – Characteristic Comparison

Material Characteristic Comparison	Density (g/cm^3)	Cost ($/Kg)	Tensile Strength (Gpa)	Strength Ratio (GPa/(g/cm^3))	Cost/Strength Ratio
Carbon Fiber	0.9721	21.5	3.8	3.91	5.66
Fiber Glass	0.7869	5.51	1.02	1.298	5.402
Aluminum Alloy	2.7	15.98	0.339	0.1256	47.14
Wood	0.75	4.5	0.047	0.0627	95.74

Concept Selection – Decision Matrix

Decision Matrix	Importance Weight Factor	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
Aesthetics	1	3	3	3	3	3
Component Space	3	3	1	9	3	3
Stability	9	9	3	3	9	3
Manufacturability	9	3	1	9	3	3
Total	198	120	42	138	120	66

Concept Selection – Final Concept



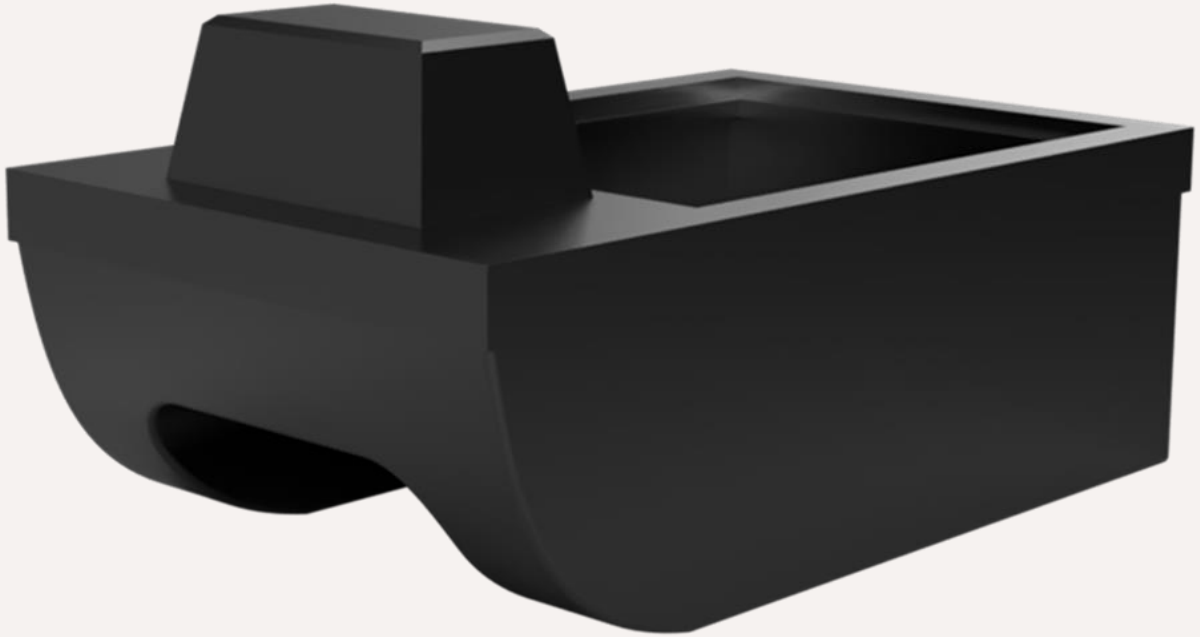
Prototyping and Test Readiness

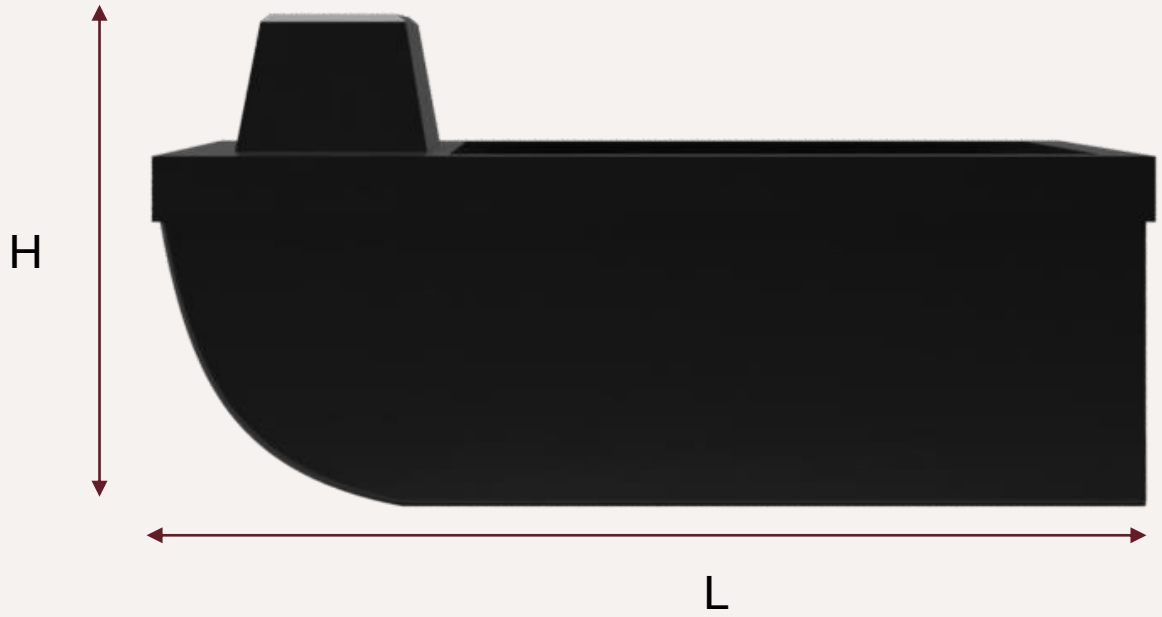
Prototypes

- The Hull
- The Lid
- The Tilt Mechanism
- Propulsor Hot-Swap

Test Readiness

- The Assessment Plan
- Description of Tests
- Safety Plan





B.O.A.T

- Length is 1.2 meters
- Height is 0.7 meters
- Material of construction is E6 Fiberglass
- Weight estimate of Hull + Lid is 13.26 Kg or 29 lbs. (SolidWorks material estimate)

Prototypes

Hull

- Finalize a model to construct
- 3D print said model
- Observe how it sits in water

Lid

- Determine LiDAR tower size
- Finalize hatch size

LiDAR Tilt Mechanism

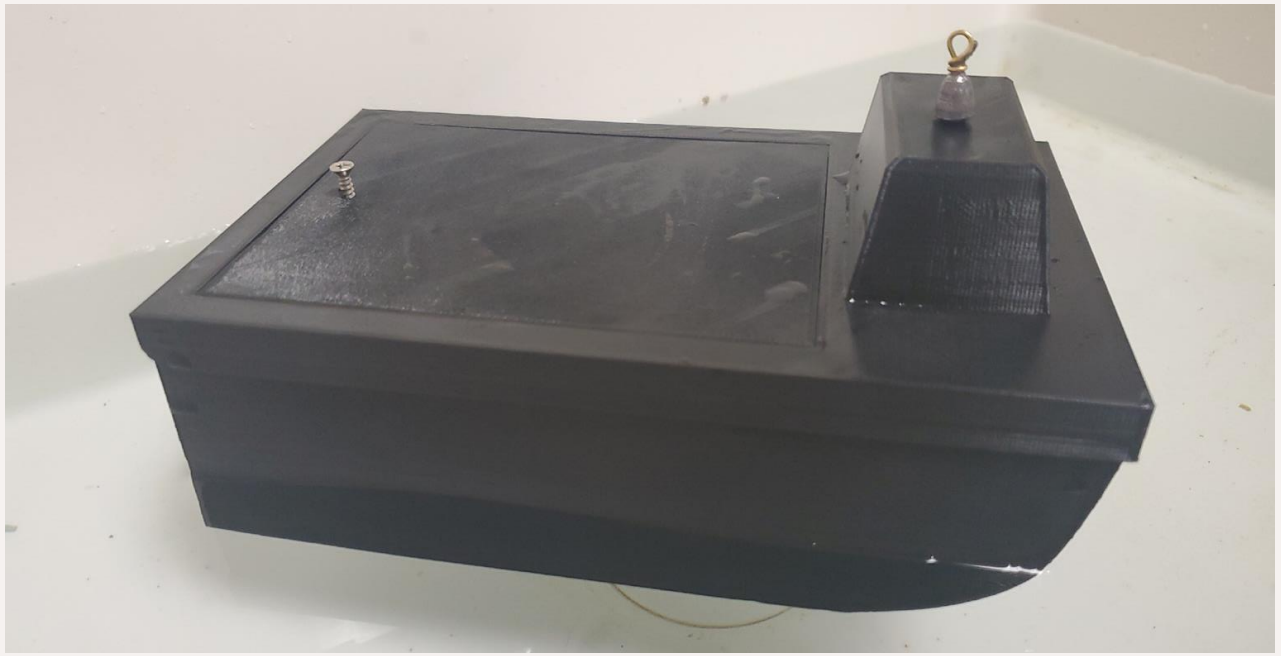
- Create test mechanism

Propulsor Hot-Swap

- Test making more propulsor hot-swaps

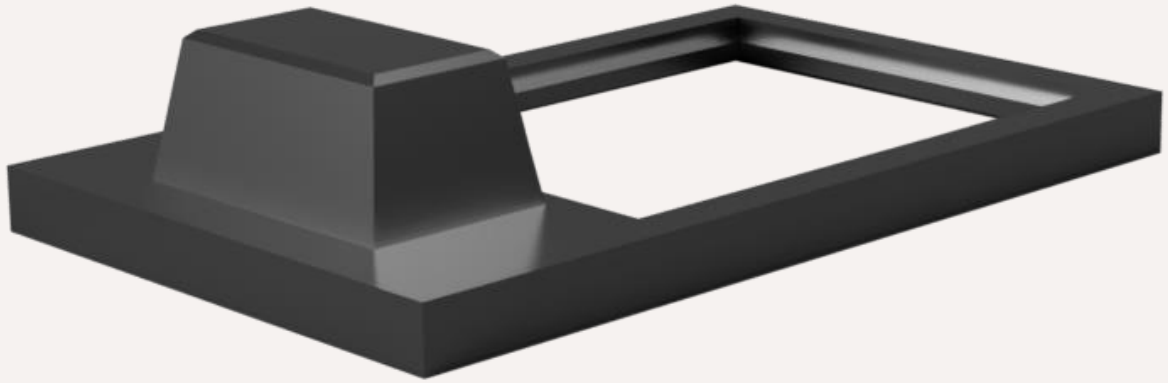
RoboBoat 2021

Scale Factor 1/92.85	Original Weight (g)	Scaled Weight (g)
Hull	6,500	70
Hull Lid	1,000	10.76923077
LiDar	447	4.813846154
Camera	72	0.775384615
GPS	250	2.692307692
Thruster (x4)	624	6.72
Computer	200	2.153846154
Battery (x2)	1450	15.61538461
Total Weight	10,543	113.54
Total Weight (lbs)	23.24335526	0.250313057



The Hull

- 3D modeled in Fusion 360 for FDM 3D printing (1/16 volume scale)
- Printed in Hatchbox PLA filament
- Lead fishing weights used as the scaled components

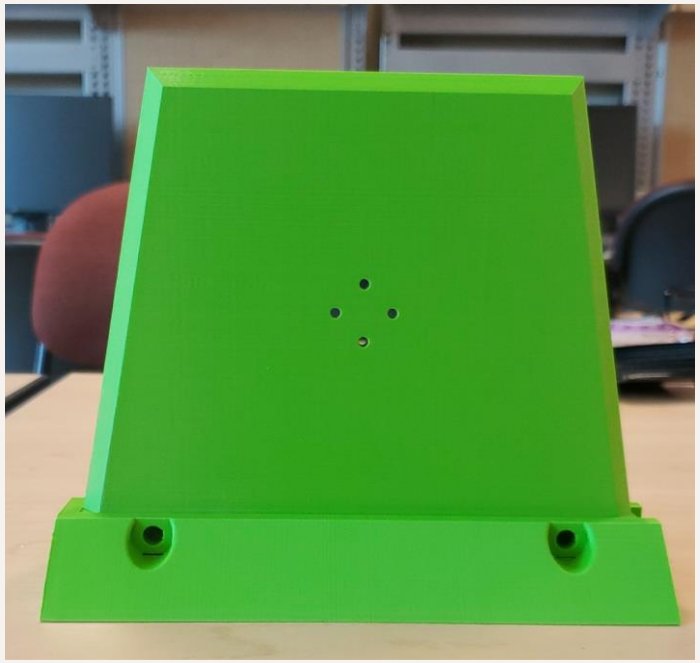


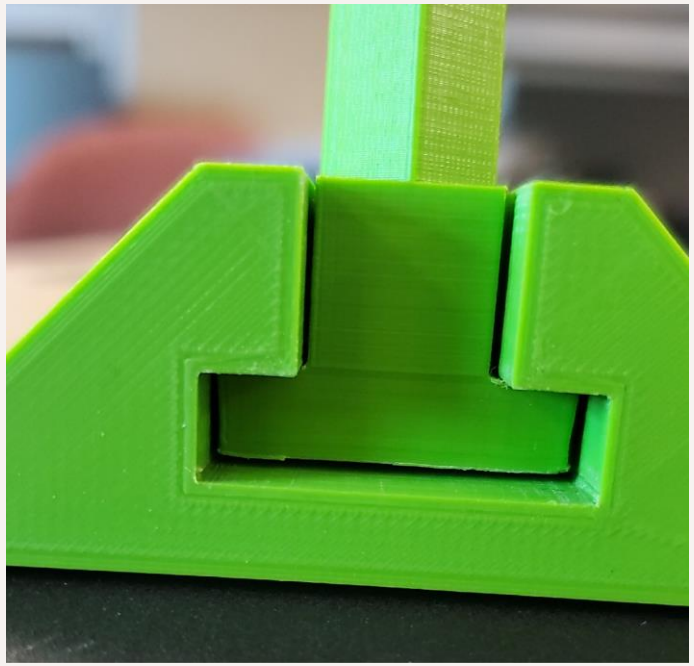
The Lid

- 3D modeled in Fusion 360 for FDM 3D printing (1/16 volume scale)
- Printed in Hatchbox PLA filament
- Spacious hatch for easy access to electrical components

The Tilt Mechanism

- Designed to adjust the angle at which the LiDAR will sit on the boat





The Propulsion Hot Swap

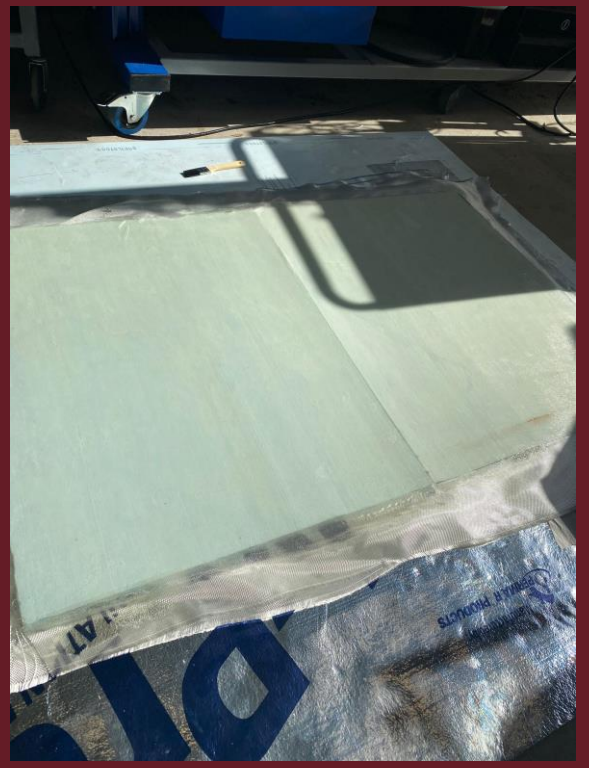
- Allows for quickly interchanging the propulsors
- Also allows the boat to sit on the ground without being supported by the propulsors
- Recreate the model on hand to be 3D printed

Fabrication Planning

- Initially planned to have the hull and lid manufactured at the HPMI in Tallahassee.
- Planned to have hull and lid manufactured at Gulf Coast State College.
- Hand lay-up was done to manufacture the hull and lid by team members in thermal lab space.

Manufacturing Process

- The tower on the lid was removed after observing that the LiDAR tilt mechanism would facilitate the purpose of the tower.
- A positive mold was made for lid fabrication. (Left)
- A negative mold was made for hull fabrication. (Right)



Manufacturing Process

- After conducting a float test, any holes and leaks were patched.
- Once cured the surface was sanded and painted.

Assessment Plan

Floatation

- Observe floatation capabilities
- Floats for at least 30 mins
- Floats at desirable stability

Stability

- Does it sit level?
- Does it flip when force is applied.

Sub-Systems

- Test the LiDar tilt mechanism
- Test the propulsor hot-swaps

Operation

- Does the boat work after EE integration?

Test	Target	Metric
Floatation	Float for at least 30 minutes	Time floating without taking on water
Stability	Sit level in the water	Use level to see stability in water
Sub-Systems	LiDar tilt mechanism works Propulsor hot swap works	LiDar scan has good visibility Propulsors can be easily swapped
Operation	Boat has all electronics implemented and functions	A combination of all the above metrics.

Floatation and Stability

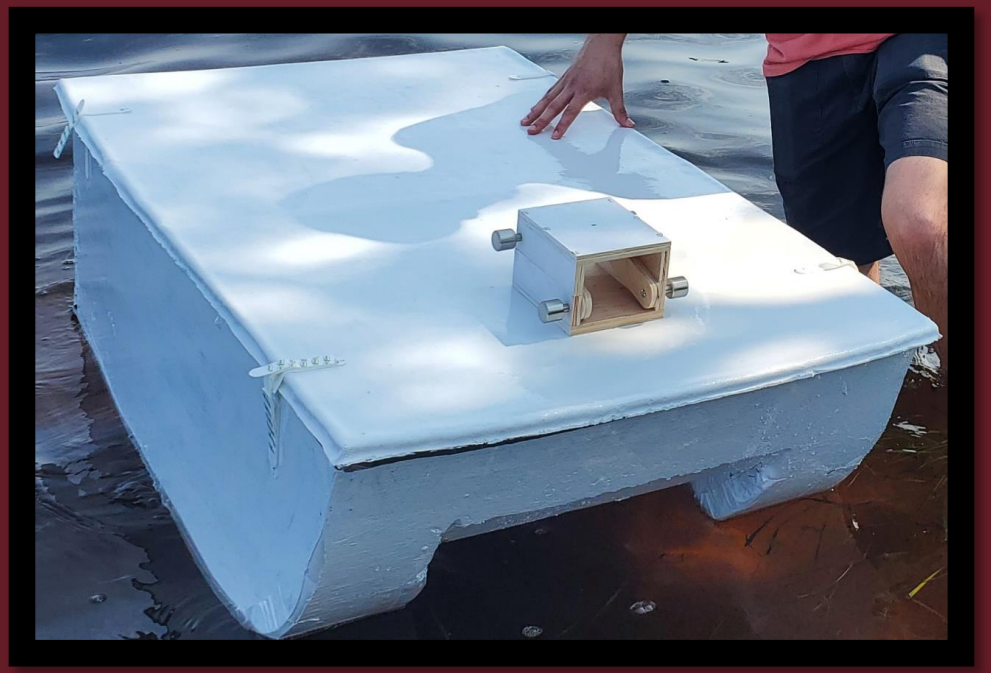
Possible locations to test the boat include:

- Gulf Coast Pool
- The Bay

Can test as early as the 19th of July depending on:

- Boat being manufactured
- Weather
- Authorization

Floatation and Stability



Sub-Systems and Operation

Sub-Systems consists of:

- The Propulsor Hot-Swaps
- The LiDar tilt mechanism

This testing can begin…

- EE has integrated their components

Safety Plan

Safety Concern	Safety Plan
Person falling in water	No running near water, also have floatation devices on hand
Boat flipping/sinking	Start at low power, move to high power.
Boat getting stranded in the middle of water	Ensure boat is fully charged, connections are secure.
Boat catching on fire	Have a fire extinguisher on hand
Collision between boat and obstacles	Clear unwanted obstacles from water

Roboboat Results

- As a result of the competition going to online/more conceptual, we did not have a hull made until the latter part of the semester
- With regards to the competition, we did not place or win any money

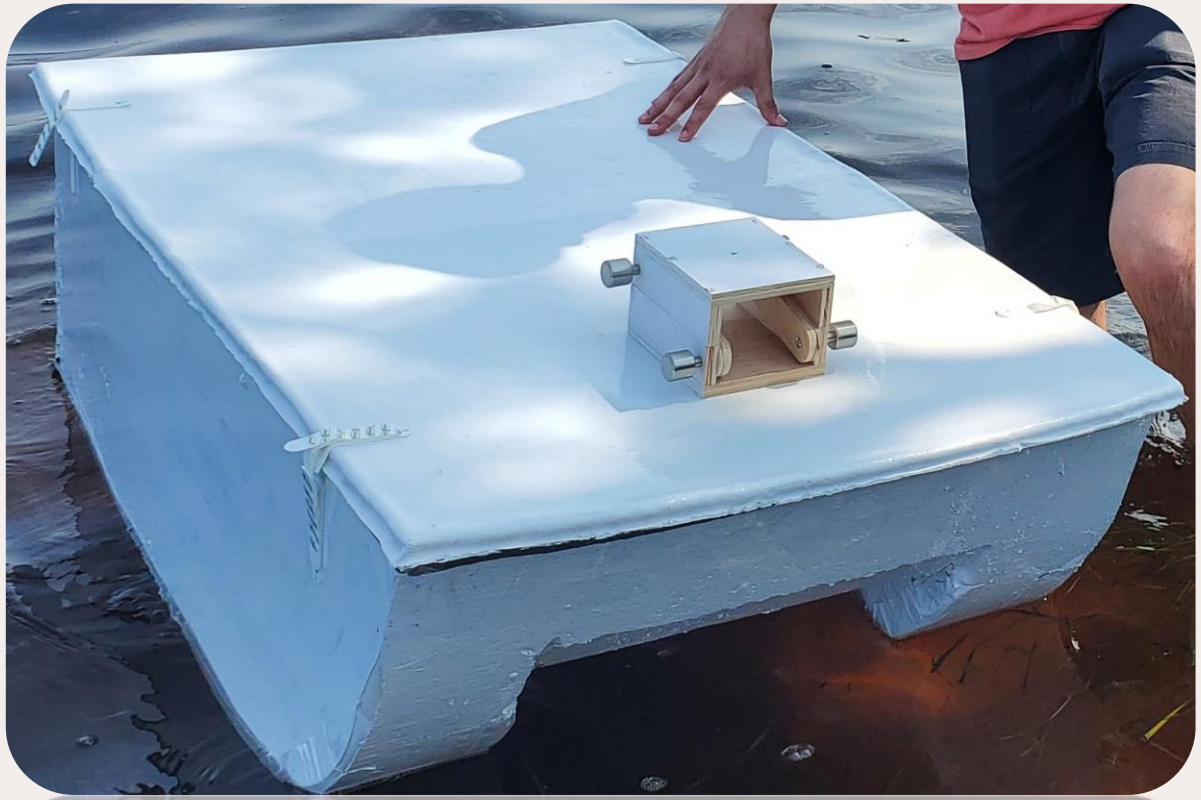
EE Integration

- The boat hull is finished
- The Electrical Engineering group will be able to implement all the hardware to be able to control this boat with a remote
- Our hull is strong and tough enough to be able to handle anything the EE’s put into it (within reason)

Advice for the Upcoming Groups

- Get it made professionally if possible
- Do not wait until the last minute!!
- Do a positive mold as opposed to a negative mold
- Flat-bottomed design?
- Budget willing, look into making the hull out of other materials

Questions?



B.O.A.T

(Best of All Time)