

# Capstone Project: RoboBoat Design Review 2

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# Presentation Overview

Design 1 Recap.....

Target and Metrics.....

Concept Generation.....

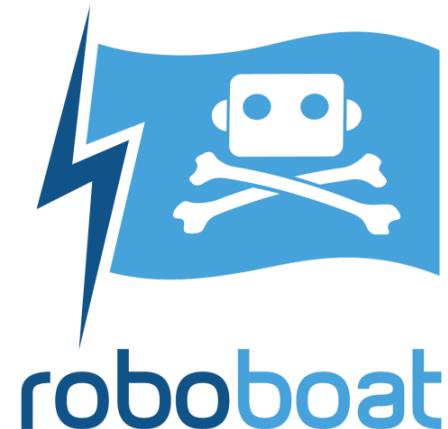
Concept Selection.....

Next Steps.....

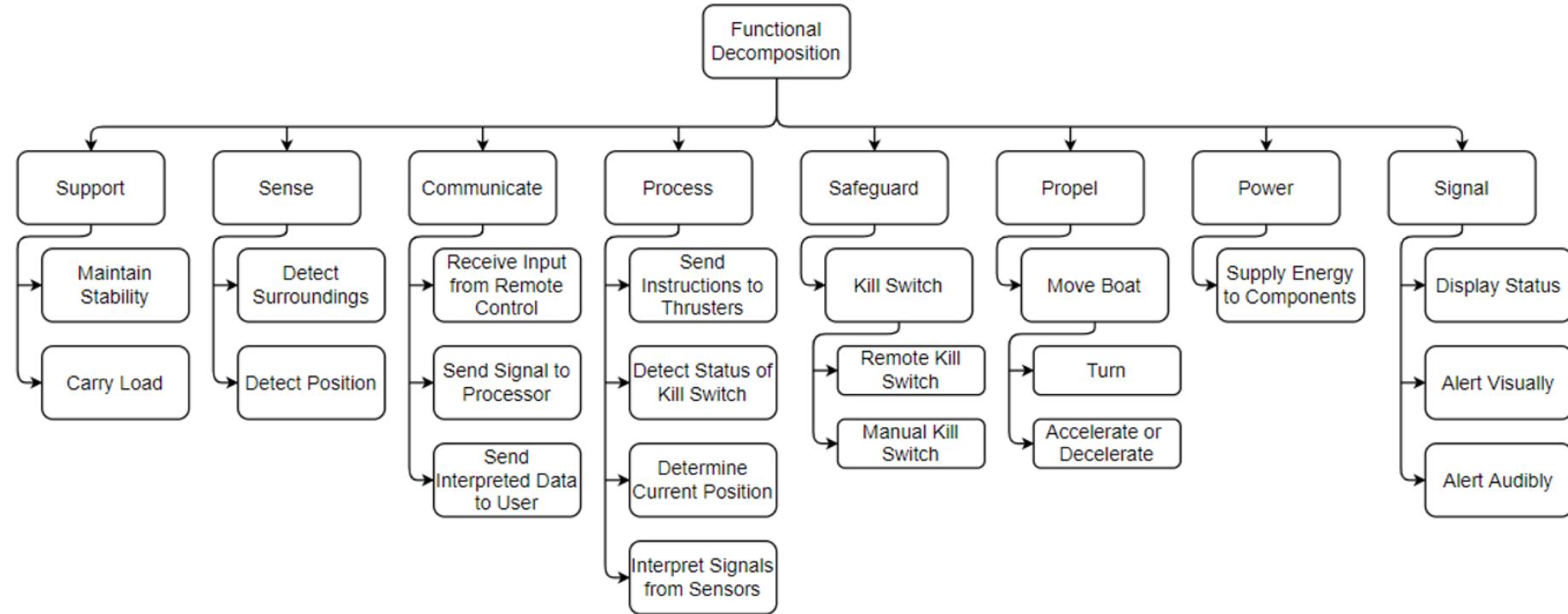


# So far, we have covered.....

- ✓ Who we are
- ✓ RoboBoat Competition
- ✓ Customer Needs
- ✓ Functional Decomposition



# Derivation of Targets and Metrics

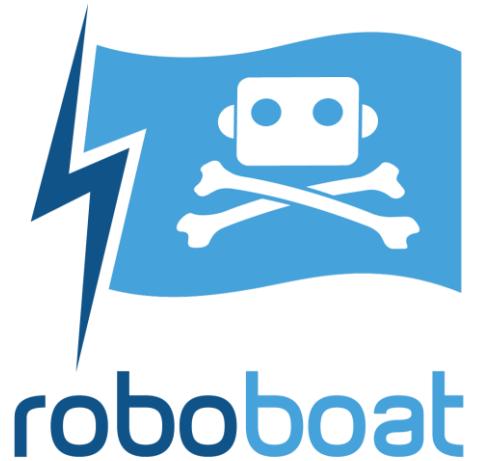


# Critical Targets and Metrics

Function	Metric	Target
Maintain Stability	Buoyancy	Positive buoyancy for >= 30 minutes
	Weight Distribution	Center of Gravity below Center of Buoyancy
Detect Surroundings	Sensor Range	6 meters
	Sensing Speed	Value from spec sheet
Process	Object Detection	Same as Sensing Speed
Move Boat	Thrust	13-18 lbs

# Concept Generation

- Observation of existing systems
- Morphological Chart
- 5 medium fidelity concepts
- Included previous RoboBoat



# Previous RoboBoat Designs

## Previous Overall Competition Winners



VANTEK 2020

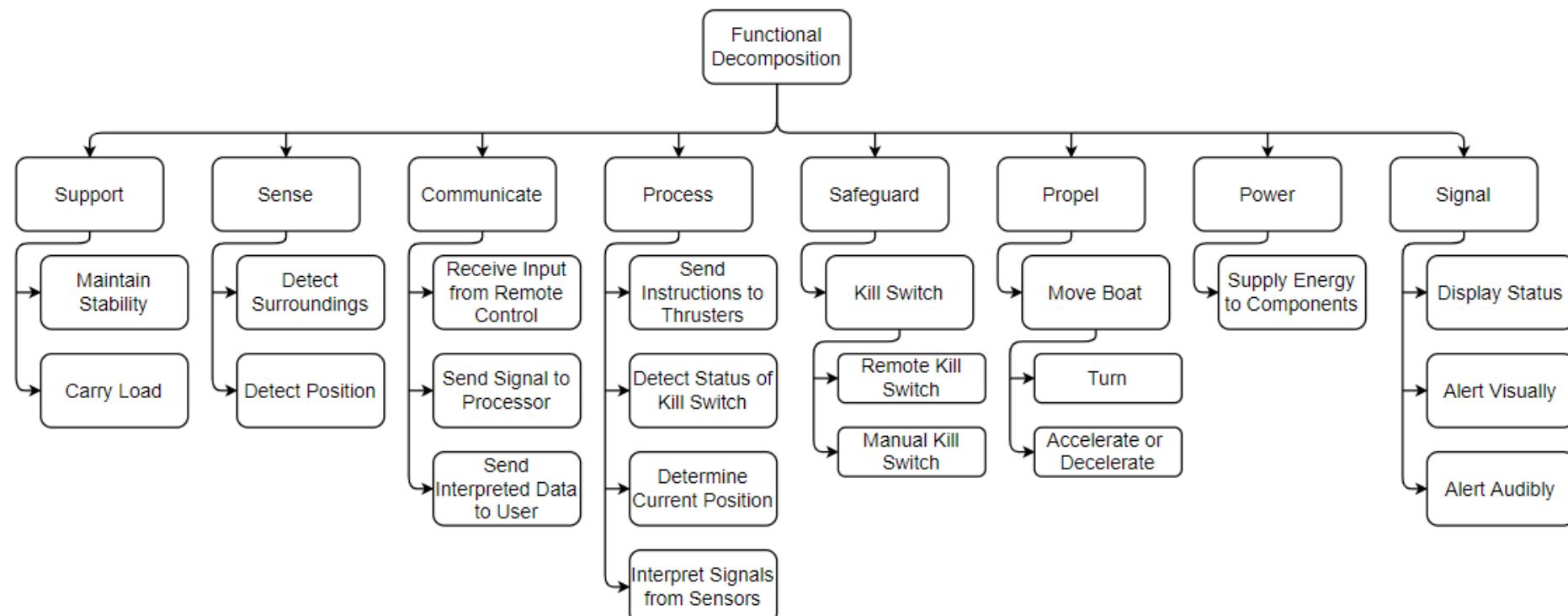


Institut Teknologi Sepuluh Nopember  
2019



Embry Riddle 2014

# Functional Decomposition



# Morphological Chart

Hull Shape	Hull Material	Propulsion	Propulsion Amount	Object Detection Sensor	Localization	Electronics Enclosure	Cooling System
Displacement Hulls	Carbon-Fiber	Inboard Propeller	1 Propulsor	Ultrasonic	GPS	Yeti Enclosure	Fans (active intake) + Fan (active outtake)
Planing Hulls	Fiber-Glass	Outboard Propeller	2 Propulsors	InfraRed	Odometer & Gyroscope	Wooden Acrylic	Vents (passive intake) + Fan (active outtake)
Flat Bottom	Aluminum	Fan	3 Propulsors	LiDAR	Triangulation	Carboard Box	Fans (active intake) + Vent (passive outtake)
V-Bottom	Stainless Steel	Sailboat	4 Propulsors	Time of Flight		Carbon-Fiber Box	Liquid Cooling
Tri-Hull (Tunnel Hull)	Rubber	Rowing	Differential Propulsor	Camera/Image Processing		Plastic Box (PLA)	Mineral Water
Pontoon	Plastic (PLA)		2 Differential Propulsors			Plastic box (ABS)	
Semi-Displacement Hulls	Plastic (ABS)		2 Differential Propulsors + 1 Propulsor				
Multi-Hulls	Wood		2 Differential Propulsors + 2 Propulsors				
Catamarans	Titanium		4 Differential Propulsors				
Trimarans	PVC Pipe						
	Ferro-Cement						
	Polyethylene Foam						
	Flex-Tape						
	Flex-Seal						
	Aero-Gel						

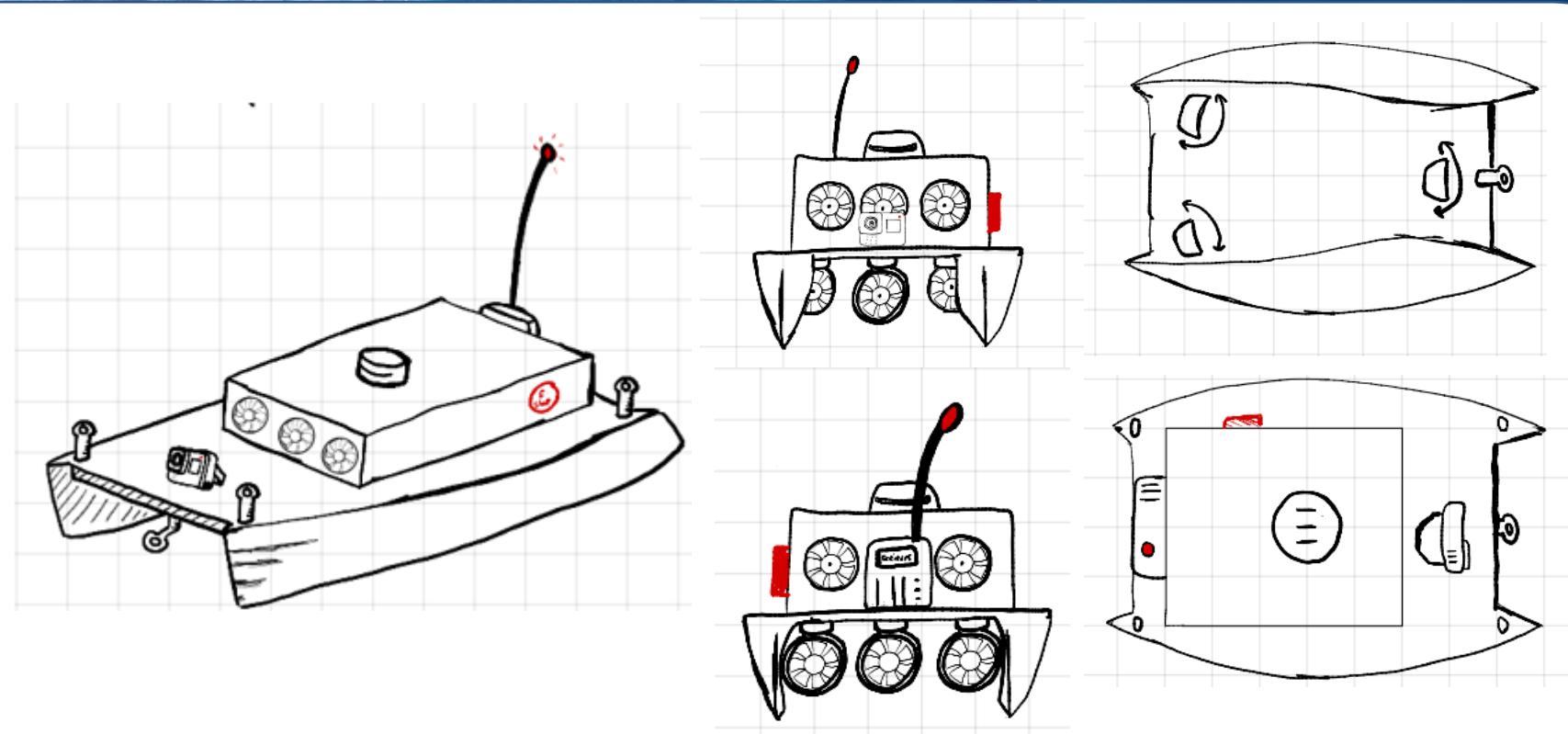
# Morphological Chart

- Concept 1
- Concept 2
- Concept 3
- Concept 4
- Concept 5

Hull Shape	Hull Material	Propulsion	Propulsion Amount	Object Detection Sensor	Localization	Electronics Enclosure	Cooling System
Displacement Hulls	Carbon-Fiber	Inboard Propeller	1 Propulsor	Ultrasonic	GPS	Yeti Enclosure	Fans (active intake) + Fan (active outtake)
Planing Hulls	Fiber-Glass	Outboard Propeller	2 Propulsors	InfraRed	Odometer & Gyroscope	Wooden	Vents (passive intake) + Vents (passive outtake)
Flat Bottom	Aluminum	Fan	3 Propulsors	LiDAR	Triangulation	Carboard Box	Vents (passive intake) + Fan (active outtake)
V-Bottom	Stainless Steel	Sailboat	4 Propulsors	Time of Flight		Carbon-Fiber Box	Fans (active intake) + Vent (passive outtake)
Tri-Hull (Tunnel Hull)	Rubber	Rowing	Differential Propulsor	Camera/Image Processing		Plastic Box (PLA)	Liquid Cooling
Pontoon	Plastic (PLA)		2 Differential Propulsors			Plastic box (ABS)	Mineral Water
Semi-Displacement Hulls	Plastic (ABS)		3 Differential Propulsors			Acrylic	
Multi-Hulls	Wood		2 Differential Propulsors + 1 Propulsor				
Catamarans	Titanium		2 Differential Propulsors + 2 Propulsors				
Trimarans	PVC Pipe		4 Differential Propulsors				
	Ferro-Cement						
	Polyethylene Foam						
	Flex-Tape						
	Flex-Seal						
	Aero-Gel						

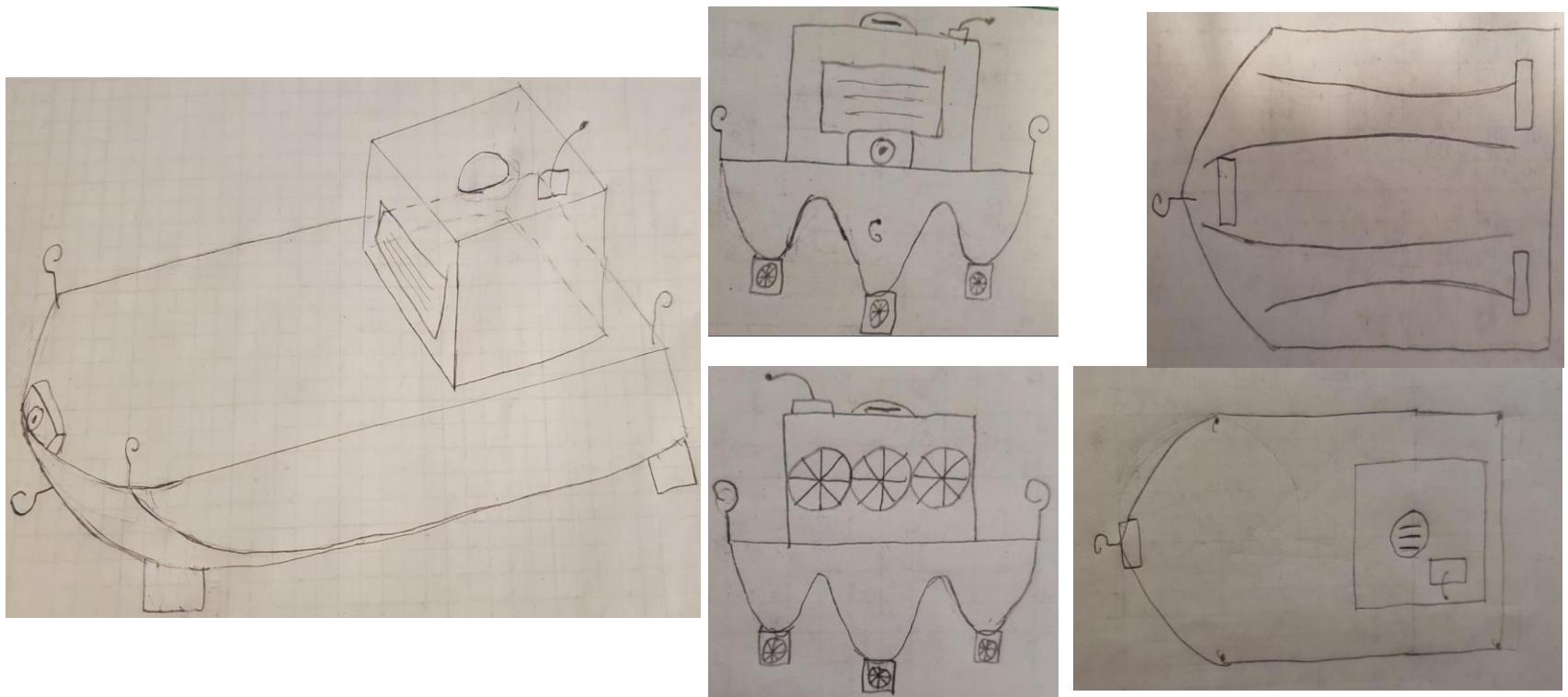
# Concept 1

- Catamaran
- Carbon-Fiber
- Outboard Propellers
- 2 Differential+1 Propulsors
- LiDAR
- GPS
- Acrylic Enclosure
- Fan Intake + Fan Outtake



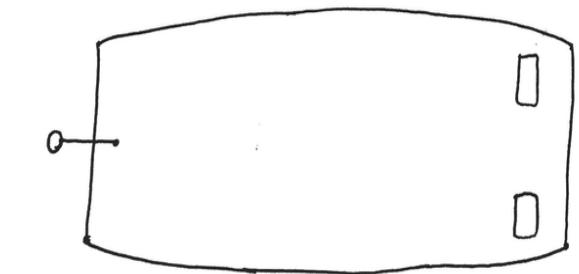
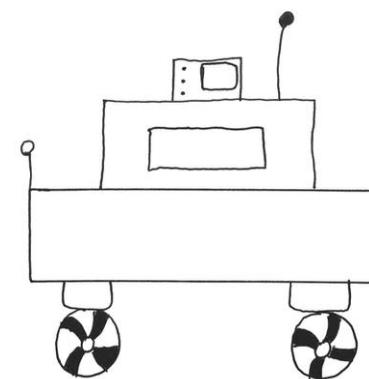
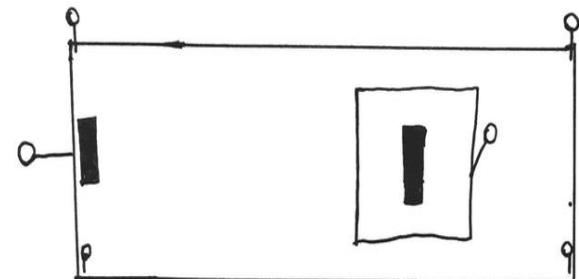
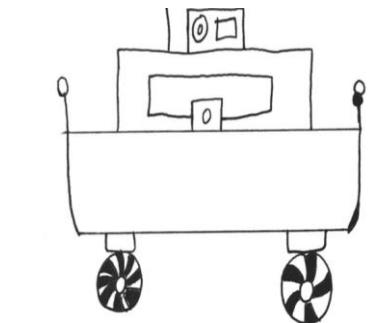
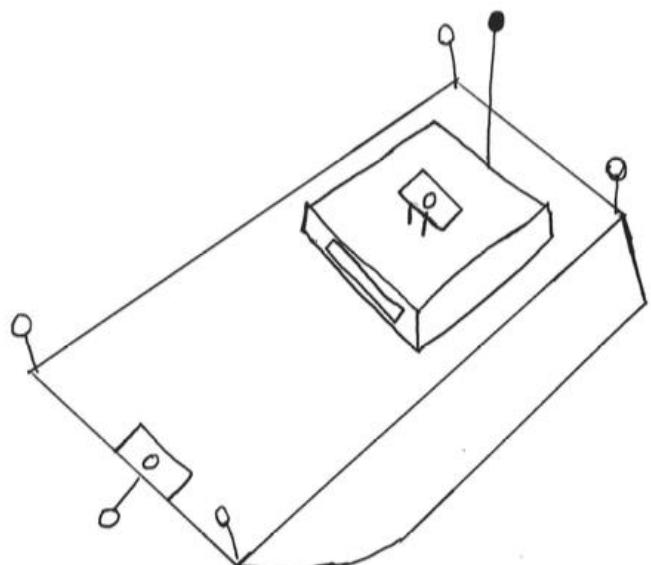
# Concept 2

- Tri-Hull
- Fiber Glass
- Outboard Propellors
- 2 Differential+1 Propulsors
- Ultrasonic
- GPS
- PLA Enclosure
- Vent Intake + Fan Outtake



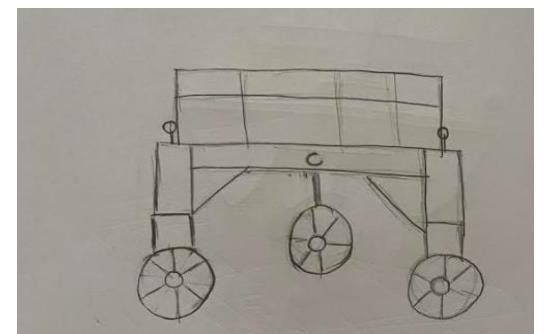
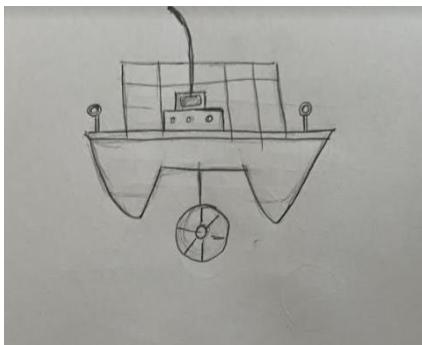
# Concept 3

- Flat-Bottom
- Aluminum
- Inboard Propeller
- 2 Differential Propulsors
- LiDAR
- GPS
- Wooden Enclosure
- Vent Intake + Vent Outtake



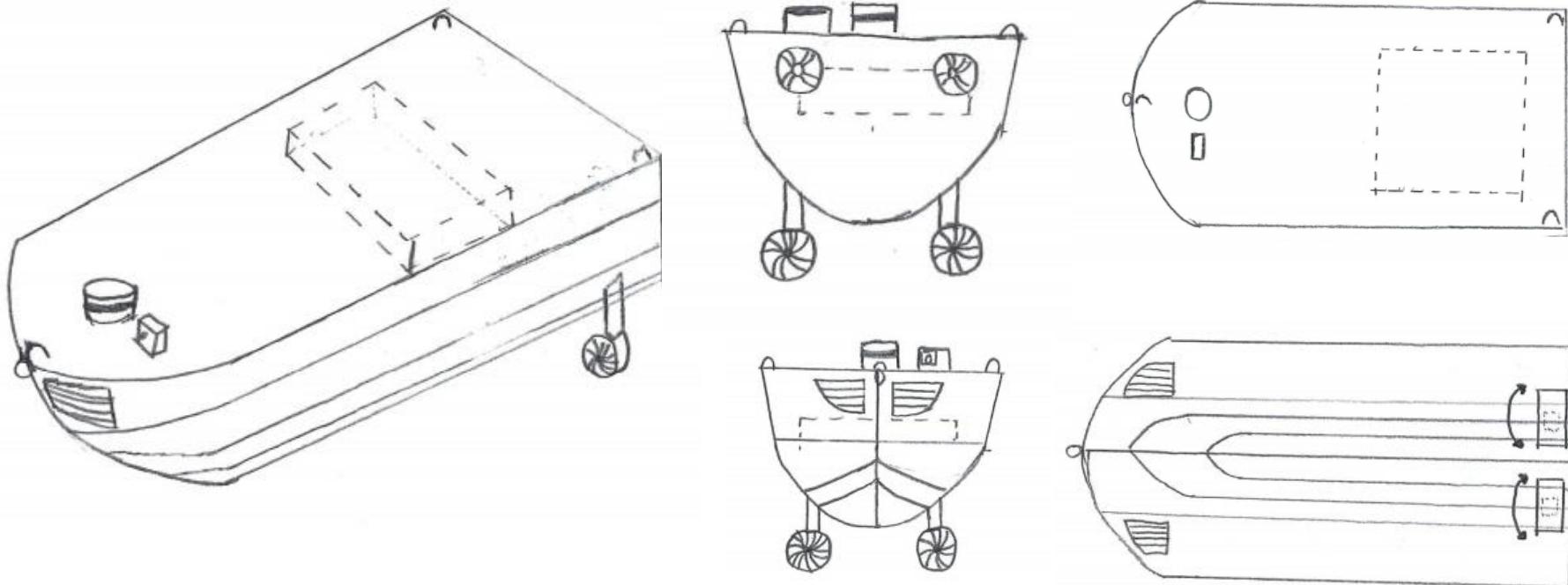
# Concept 4

- Pontoon
- Wood
- Outboard Propeller
- 3 Propulsors
- LiDAR
- GPS
- Plastic (ABS) Enclosure
- Vent Intake + Vent Outtake

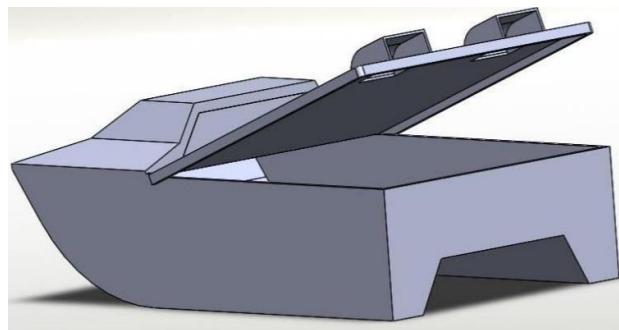
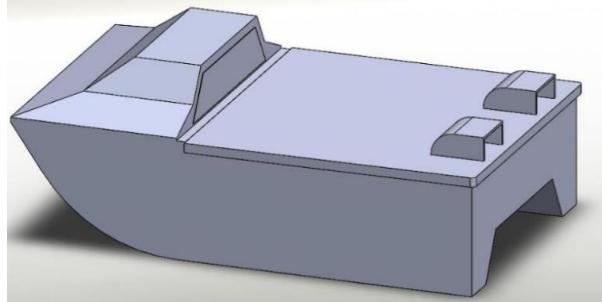
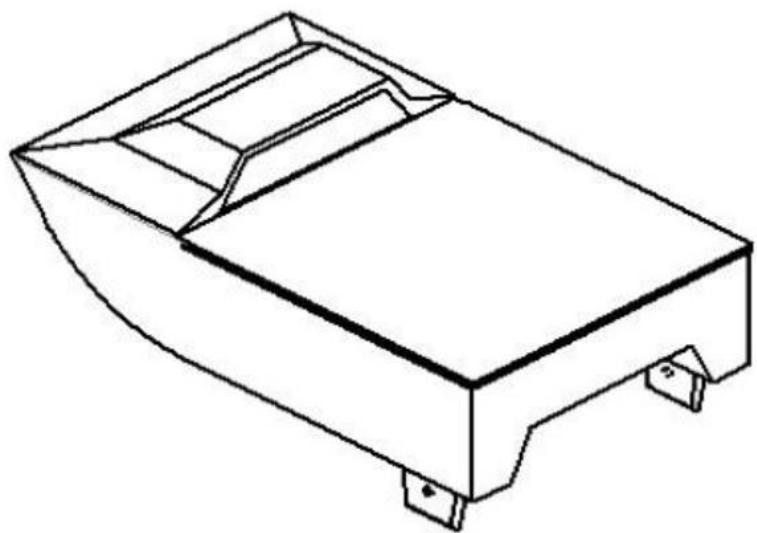


# Concept 5

- V-Bottom Hull
- Wood
- Outboard Propeller
- 2 Differential Propulsors
- LiDAR
- GPS
- Plastic (PLA) Enclosure
- Vent Intake + Fan Outtake



# Previous RoboBoat



# Concept Selection - Assumptions

- All concepts use the same GPS, RC, and LiDAR systems
- Previous RoboBoat is used as datum for comparing concepts

# 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		↑	↑	↑	↓	↓	↓	↑			
Customer Requirements	Importance Factor	N	M	MHz	cm	cm	kg/m3	N/A	N		
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 - AHP

AHP	Hull Design	Hull Material	Reliability	Reparability	Speed	Maneuverability	Cost
Hull Design	1	3	0.3	0.3	7	1	3
Hull Material	0.3	1	0.2	0.3	5	0.2	1
Reliability	3	5	1	3	3	0.2	3
Reparability	3	3	0.3	1	3	0.3	3
Speed	0.14	0.2	0.3	0.3	1	0.14	0.2
Maneuverability	1	5	5	3	7	1	5
Cost	0.3	1	0.3	0.3	5	0.2	1
Sum	8.74	18.2	7.4	8.2	31	3.04	16.2

# Concept Selection – Normalized AHP

AHP	Hull Design	Hull Material	Reliability	Reparability	Speed	Maneuverability	Cost	Criteria Weight
Hull Design	0.114	0.165	0.041	0.037	0.226	0.329	0.18	0.157
Hull Material	0.034	0.055	0.027	0.037	0.161	0.066	0.062	0.063
Reliability	0.343	0.275	0.135	0.366	0.097	0.066	0.18	0.21
Reparability	0.343	0.165	0.041	0.122	0.097	0.099	0.185	0.15
Speed	0.016	0.011	0.041	0.037	0.032	0.046	0.012	0.03
Maneuverability	0.114	0.275	0.676	0.366	0.226	0.329	0.309	0.328
Cost	0.034	0.055	0.041	0.037	0.161	0.066	0.062	0.065
Sum	1	1	1	1	1	1	1	1

# Concept Selection – Pugh Chart

Selection Criteria	Baseline					Concepts				
	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	

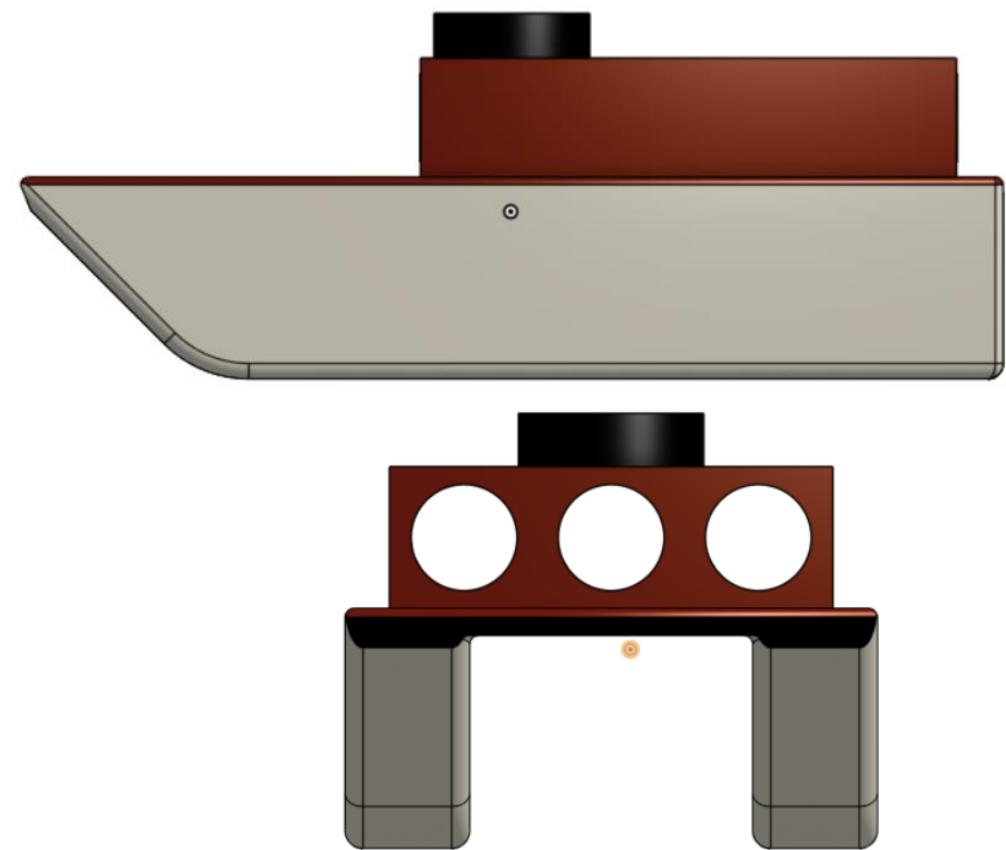
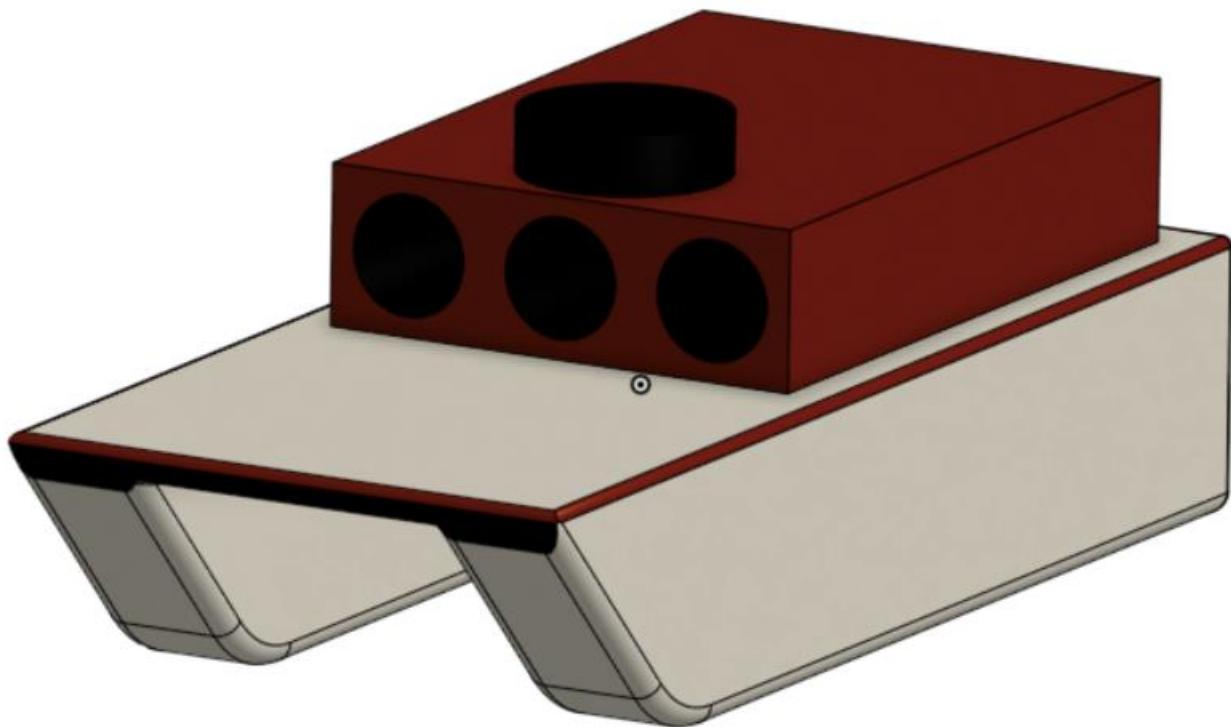
# Concept Selection – Characteristic Comparison

Material Characteristic Comparison	Density (g/cm <sup>3</sup> )	Cost (\$/Kg)	Tensile Strength (Gpa)	Strength Ratio (GPa/(g/cm <sup>3</sup> ))	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 Decision



# Looking Ahead

Phase 1	
Project Definition	Jan 6 - 29
Functional Decomposition	Jan 30 - Feb 4
Phase 1: Project Design Review	Feb 5 - 10
Phase 2	
Targets	Feb 10 - 17
Concept Generation	Feb 18 - 24
Concept Selection	Feb 25 - Mar 3
Phase 2: Design Review	Mar 4 - 10
Phase 3	
Component Selection	Mar 11 - 17
Prototype Assessment Plan	Mar 18 - 24
Risk Assessment	Mar 25 - 31
Summer Project Plan (WBS Update)	Apr 1 - 7
Phase 3: Design Review (Poster)	Apr 8 - 14

The Gantt chart illustrates the project timeline across three phases:

- Phase 1 • Jan 6 - Feb 10 • 36 days**
  - Project Definition (Jan 6 - 29)
  - Functional Decomposition (Jan 30 - Feb 4)
  - Phase 1: Project Design Review (Feb 5 - 10)
- Phase 2 • Feb 10 - Mar 10 • 29 days**
  - Targets (Feb 10 - 17)
  - Concept Generation (Feb 18 - 24)
  - Concept Selection (Feb 25 - Mar 3)
  - Phase 2: Design Review (Mar 4 - 10)
- Phase 3 • Mar 11 - Apr 14 • 35 days**
  - Component Selection (Mar 11 - 17)
  - Prototype Assessment Plan (Mar 18 - 24)
  - Risk Assessment (Mar 25 - 31)
  - Summer Project Plan (WBS Update) (Apr 1 - 7)
  - Phase 3: Design Review (Poster) (Apr 8 - 14)

# Phase 3



# Questions?

