FAMU-FSU College of Engineering

NSWC - RoboBoat
Team 521

February 29, 2024 | Virtual Design Review 5

Team Introductions (ME)

Ivanna Caballero
Materials Engineer

Andly Jean
Mechatronic Engineer

Nicholas Norwood
Mechanical Systems Engineer

Makenzie Wiggins
Design Engineer

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Team Introductions (EE)

Sophia Barron
Electrical Systems Engineer

Michael Fitzsimmons
Electronics Engineer

Lucca Meyer
Test Engineer

Sponsor and Advisor

<u>Engineering Mentor/Sponsor</u>
Dr. Damion Dunlap
Navy Surface Warfare Center

<u>Academic Advisor</u>
Dr. Shayne McConomy
Senior Design Coordinator

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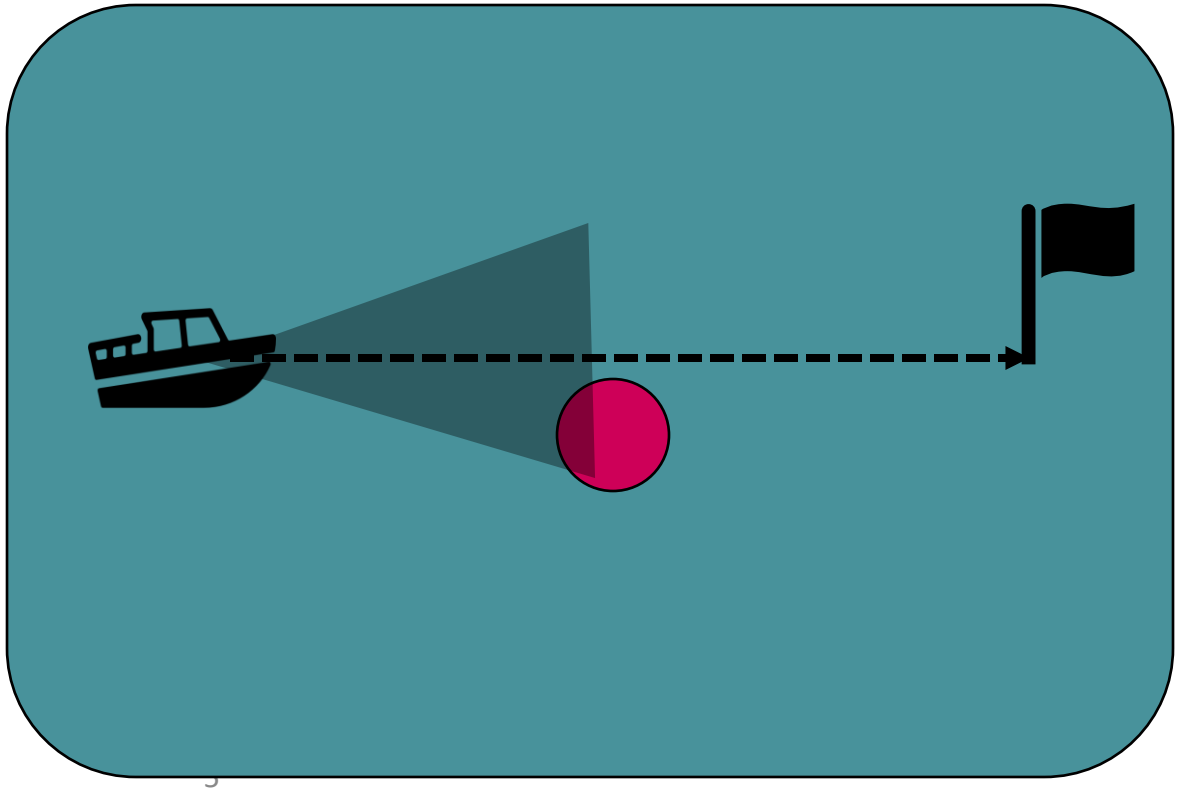
Nicholas
Norwood

Project Objective

The objective of this project is to design, build and program an autonomous surface vehicle capable of completing several tasks in the following categories:

- Navigation
- Detection
- Object avoidance



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Norwood

Background

RoboBoat

- Program at RoboNation
- An international student competition
- Design autonomous, robotic boats to navigate through a challenge course
- Tackle tasks that mimic real-world challenges

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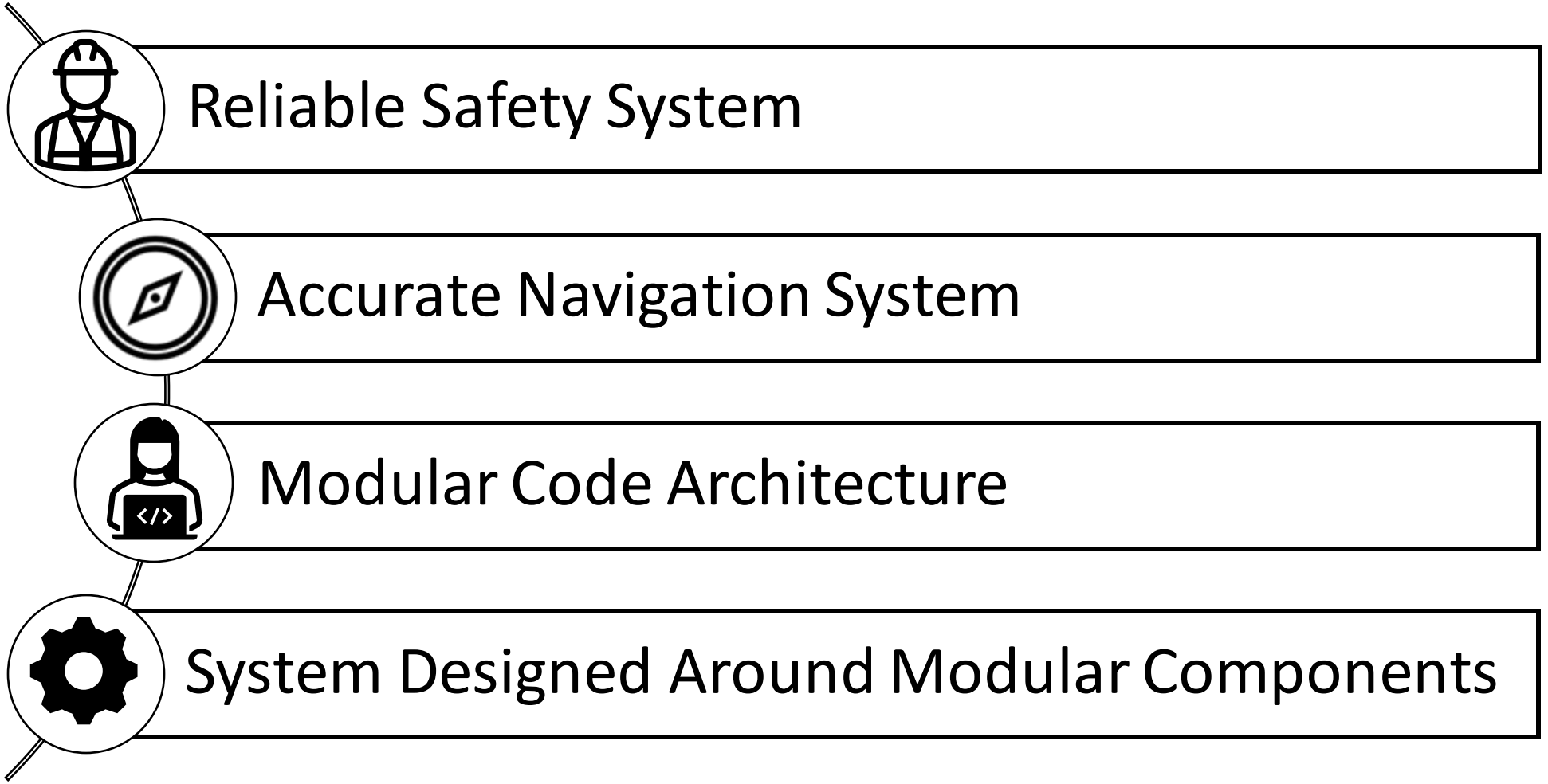
Customer Needs



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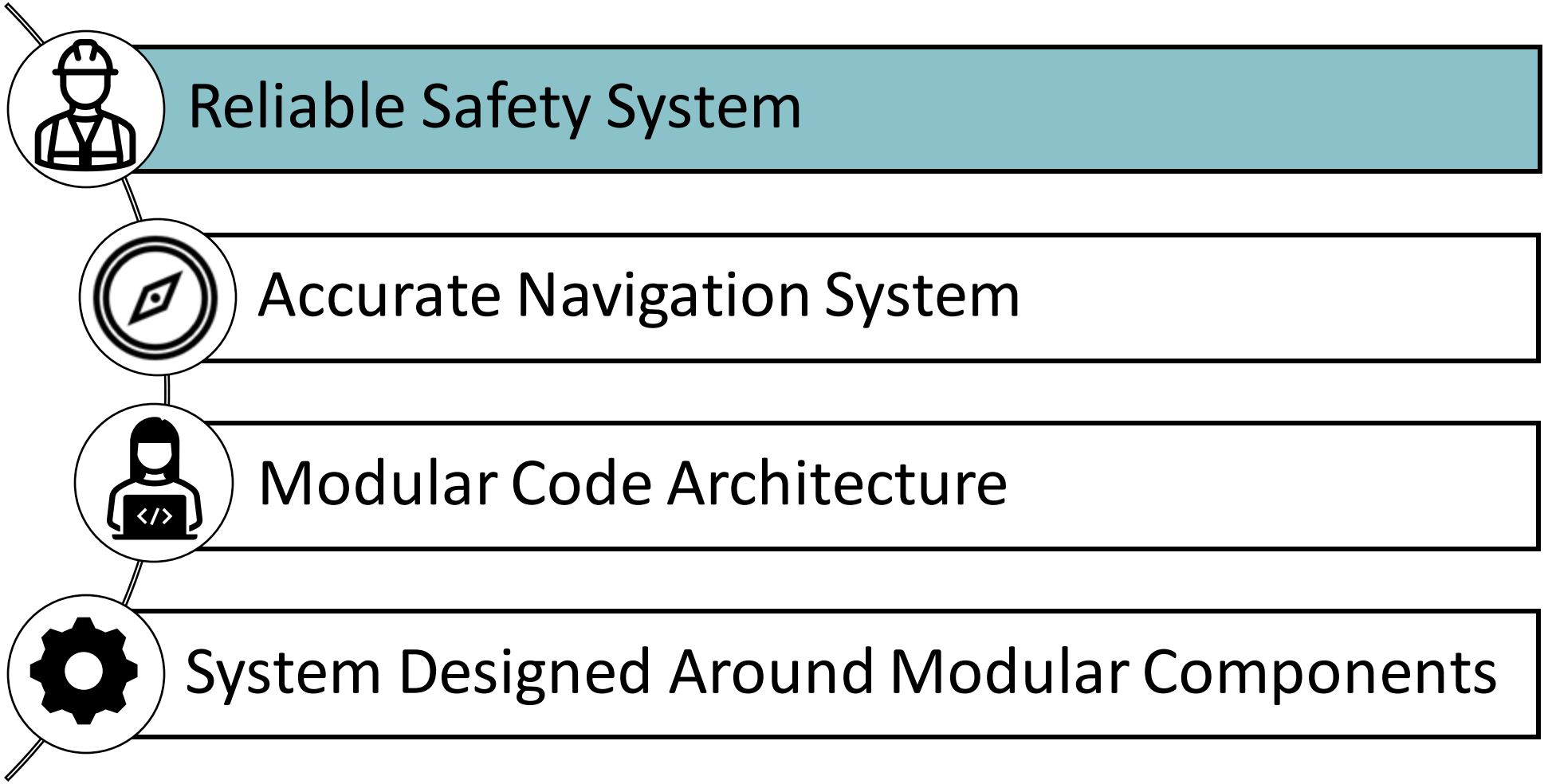
Customer Needs



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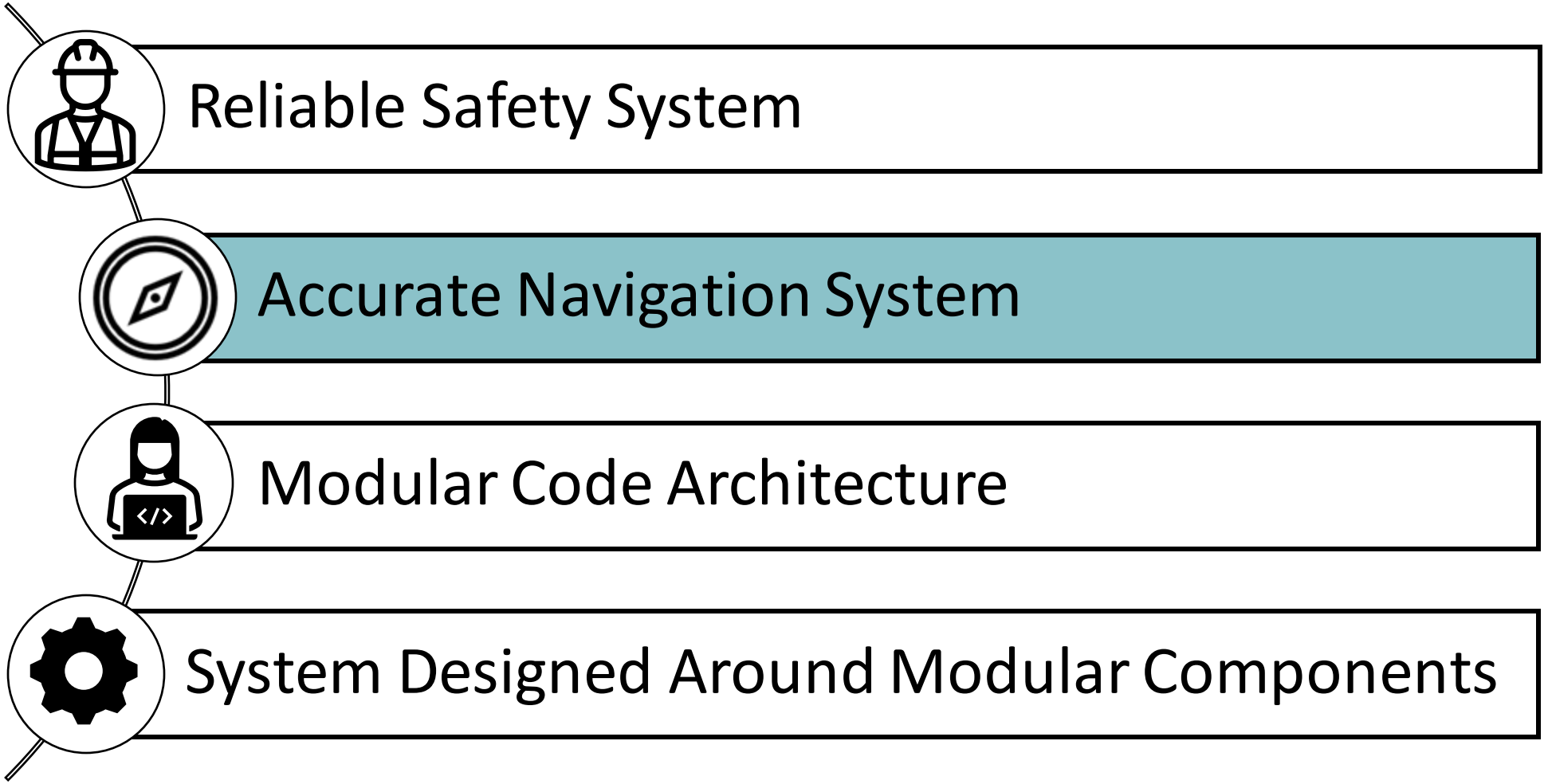

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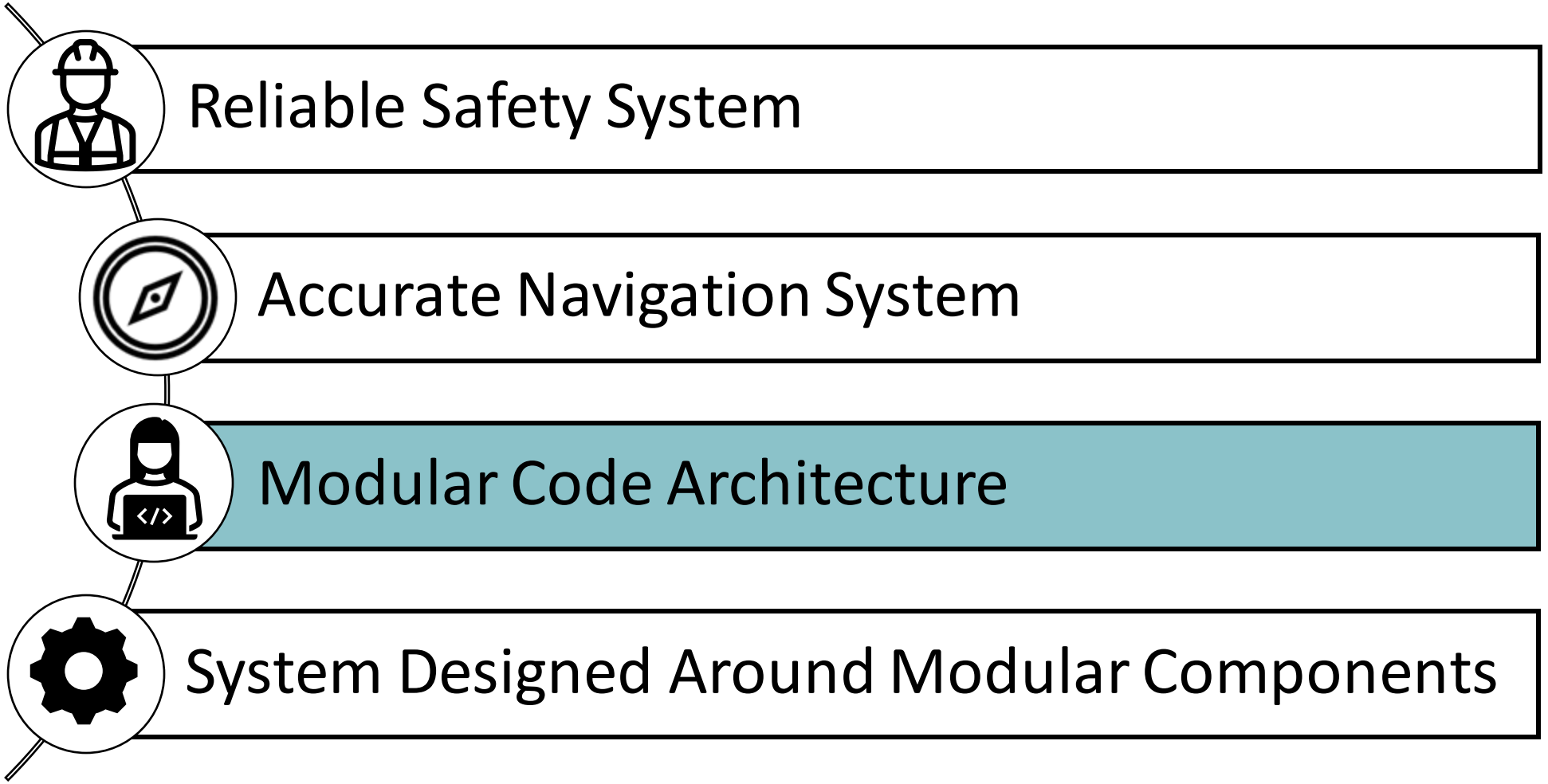

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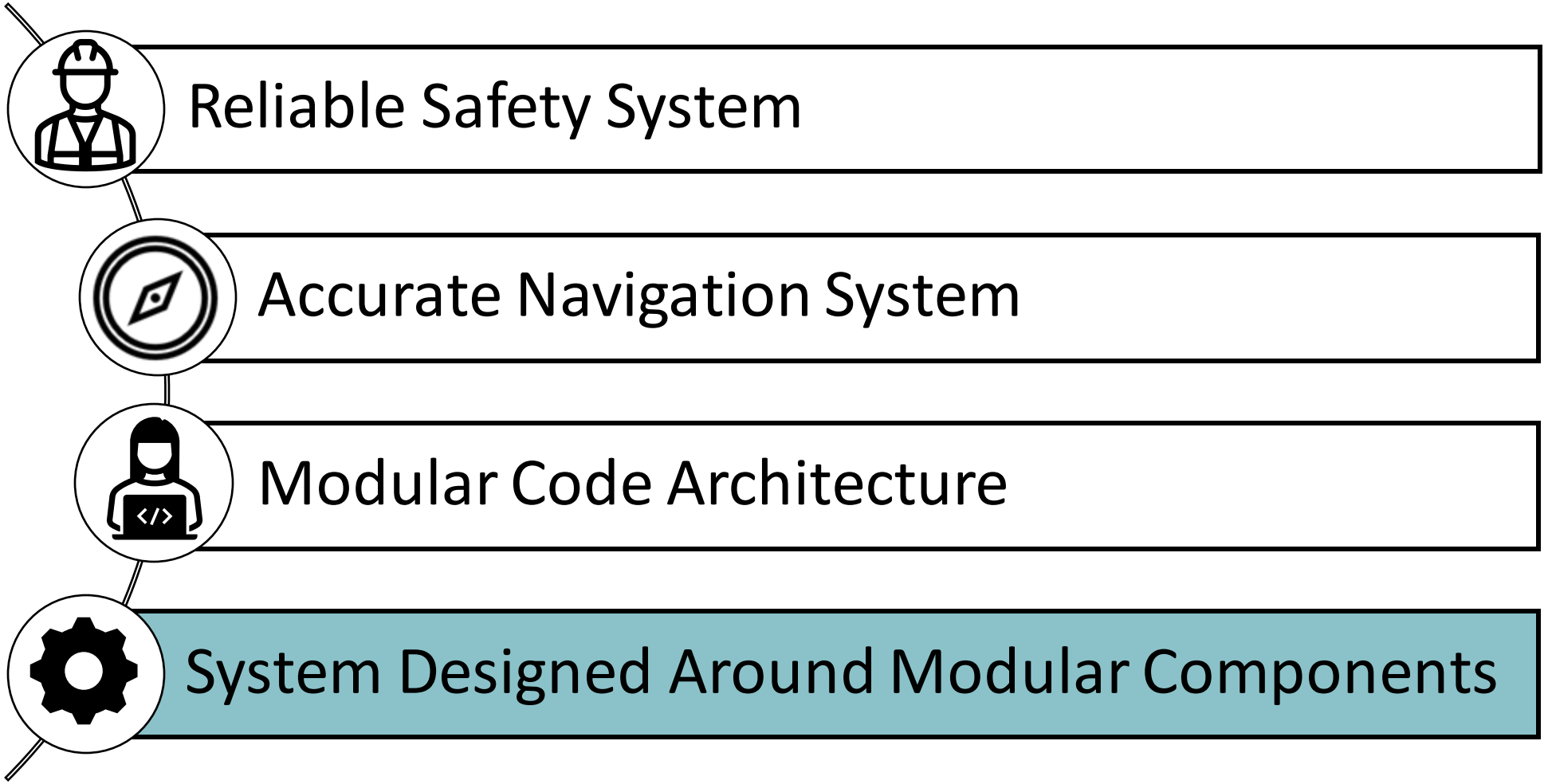
Customer Needs



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Fitzsimmons

Critical Targets

Size:
≤ 6 ft x 3 ft x 3ft

Weight:
≤ 140 lbs

Battery Life:
> 30 min

Autonomous Navigation:
True

Kill Switch Integration:
True

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Concept Generation

Biomimicry

Anti-Problem

Crap Shoot

Forced Analogy

Morphological Charts

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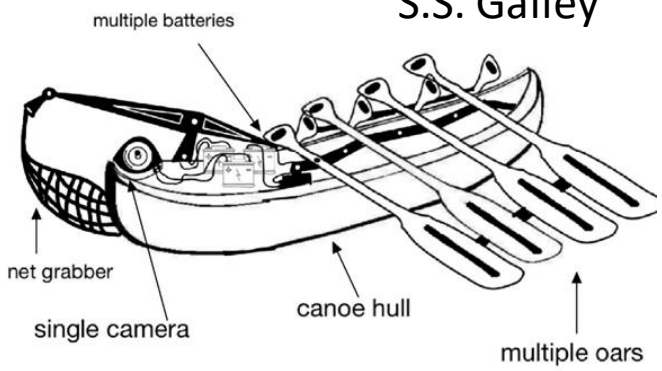
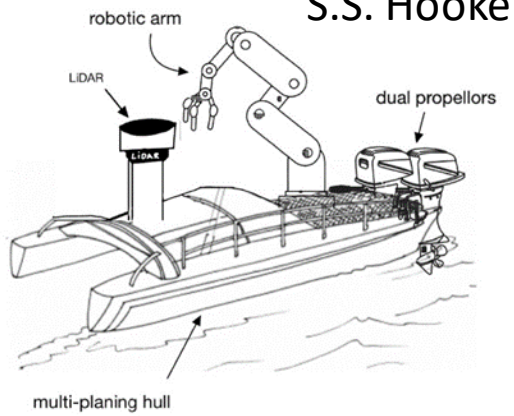
5 Medium Fidelity Concepts

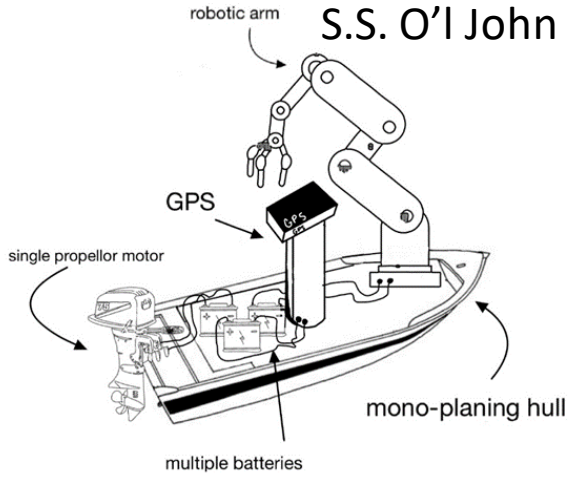
S.S. Galley



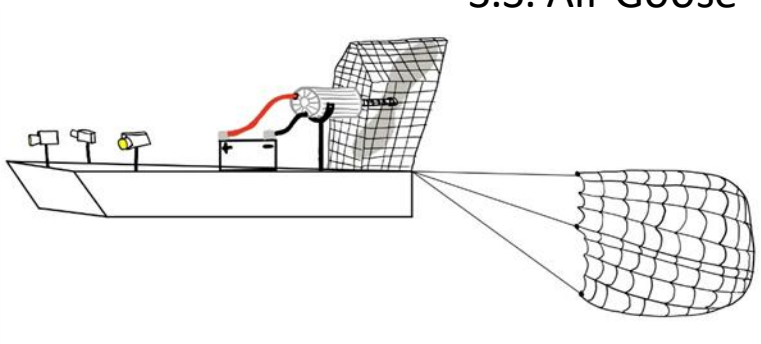
S.S. Hooker



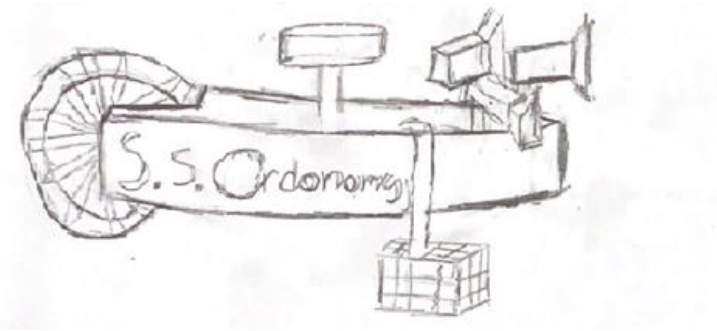
S.S. O'l John



S.S. Air Goose



S.S. Ordonomy



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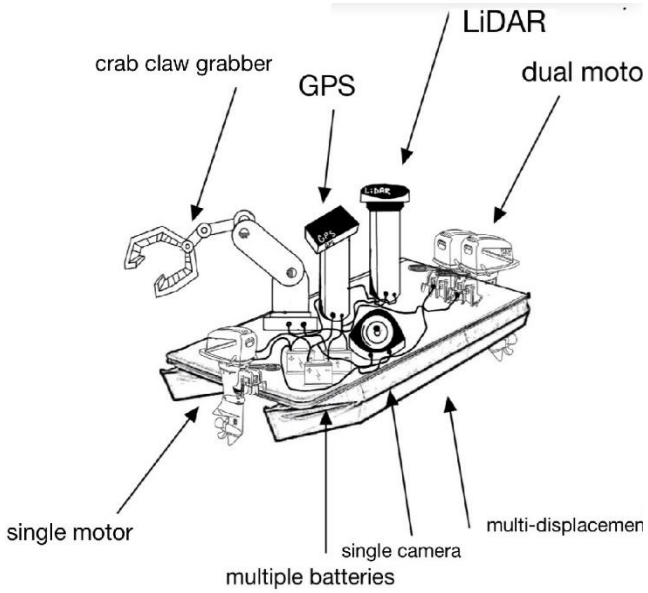
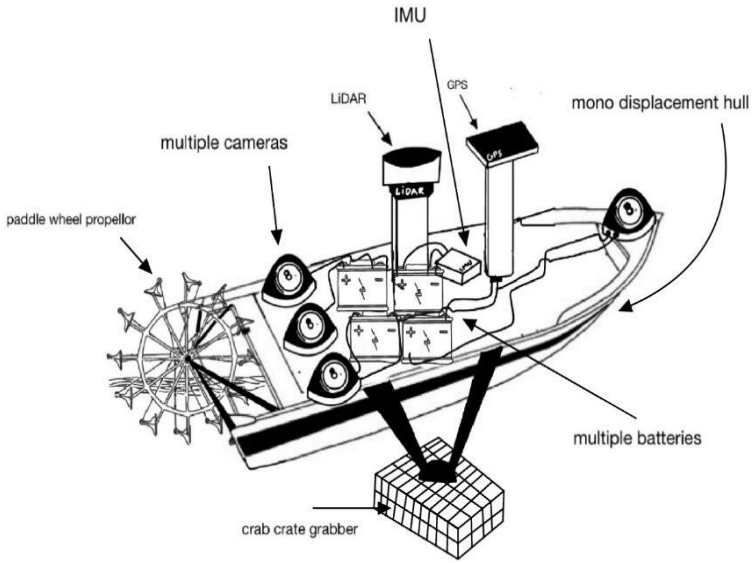
3 High Fidelity Concepts

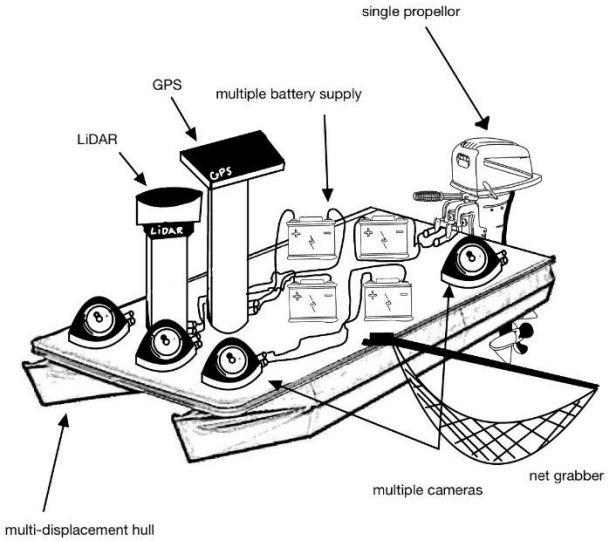
S.S. Hooker



S.S. Hooker



S.S. Slow and Steady



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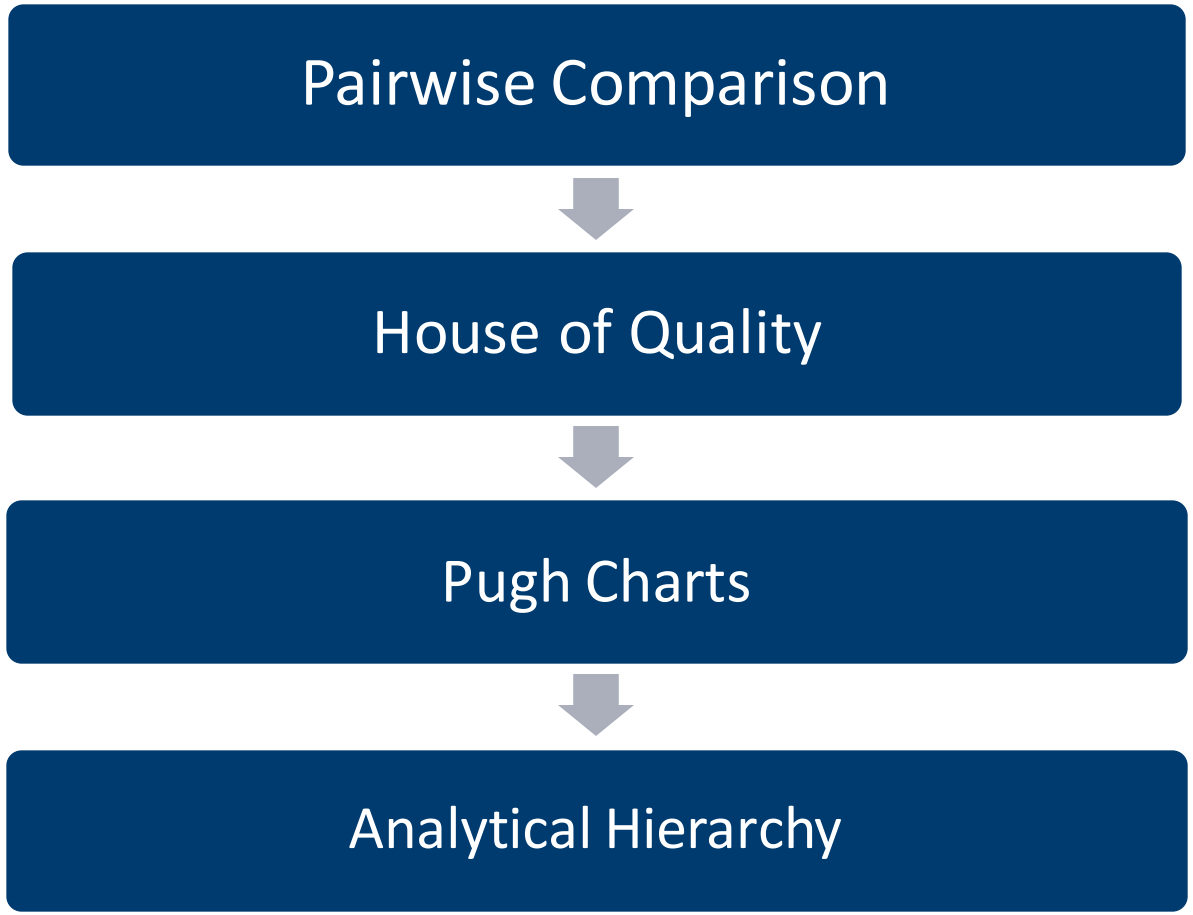
Concept Selection



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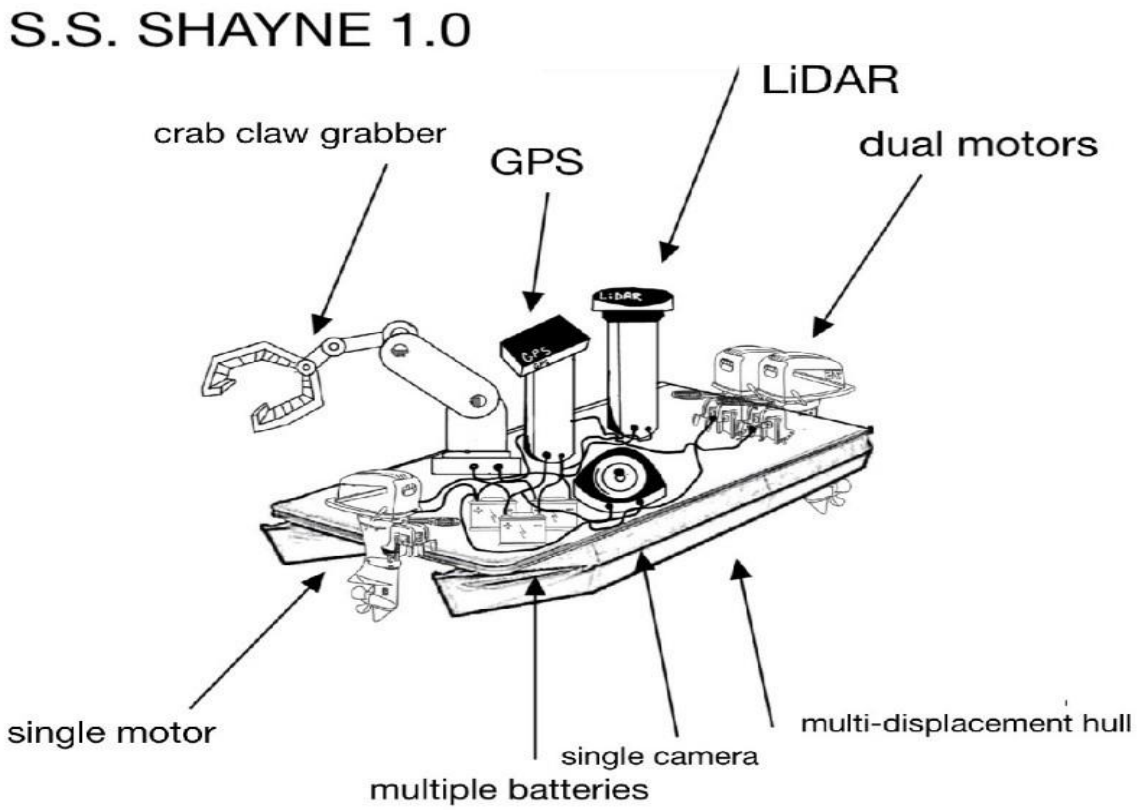
Selected Concept



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Current Work
Purchasing

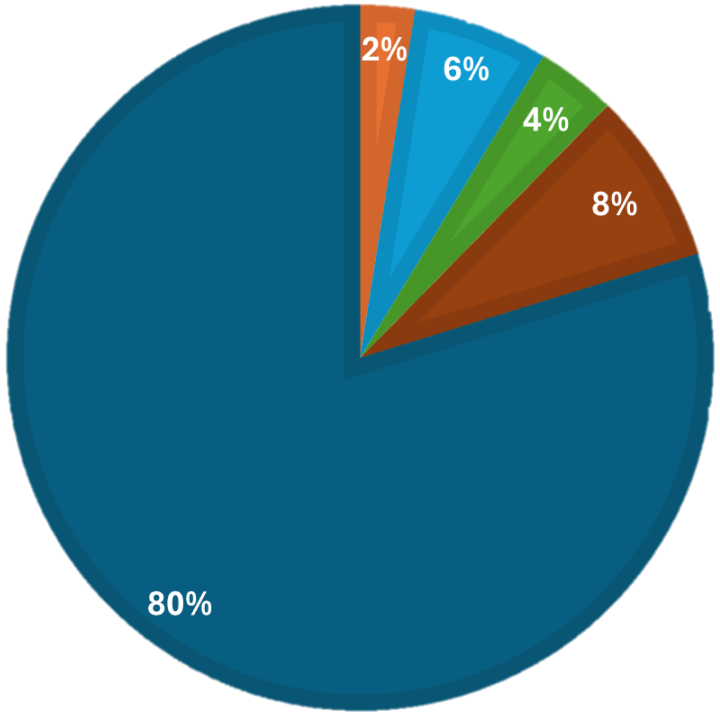
- Receiving list
  - Thrusters (x4)
  - Electronic Speed Controlling ESCs (x4)
  - Velodyne LiDAR (x1)
- Established Source of Funding
  - Derived priority order list

Current Work
Budget Breakdown

Total spent: $404.62

Remaining: $1595.48

- Navigation System:$50.05
- Power System:$123.57
- Hardware:$73.00
- Structure:$158.00



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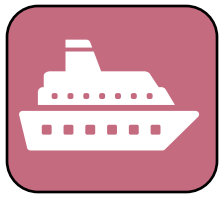
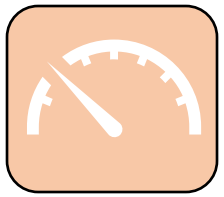
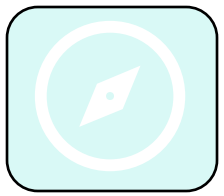
Current Work
Budget Breakdown

- Lidar: $4600.00
- GPS Module: $32.00
- Camera: $399.00
- Jetson: $3,000.00
- USB Port Hub: $19.99
- SD Card: $12.99
- Batteries: $169.99
- Voltage Regulators (9V): $49.98

Total
Amount Saved: **$8,284.94**

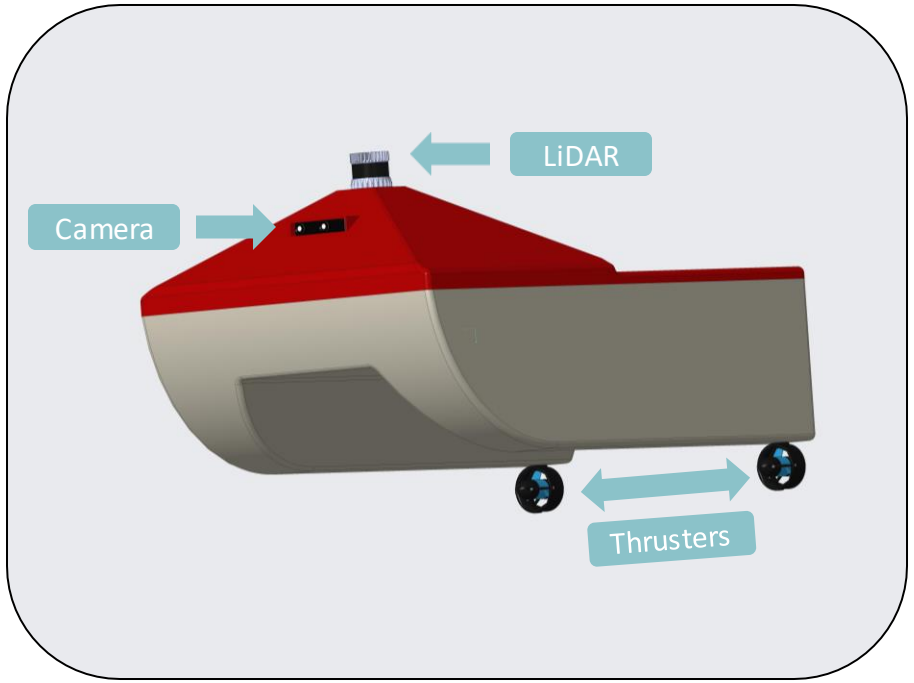





Current Work
Structure

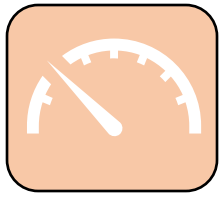
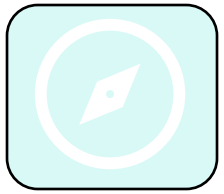
- Tested hull with 30 lbs. weight in water
  - Leaks
- Began reinforcing structure
- Selected Material
  - 1/10" Plexiglass

Current Work
Structure

- Designing mounts for LiDAR, thruster, and camera
- Cutting plexiglass lid to size
- Hinged lid



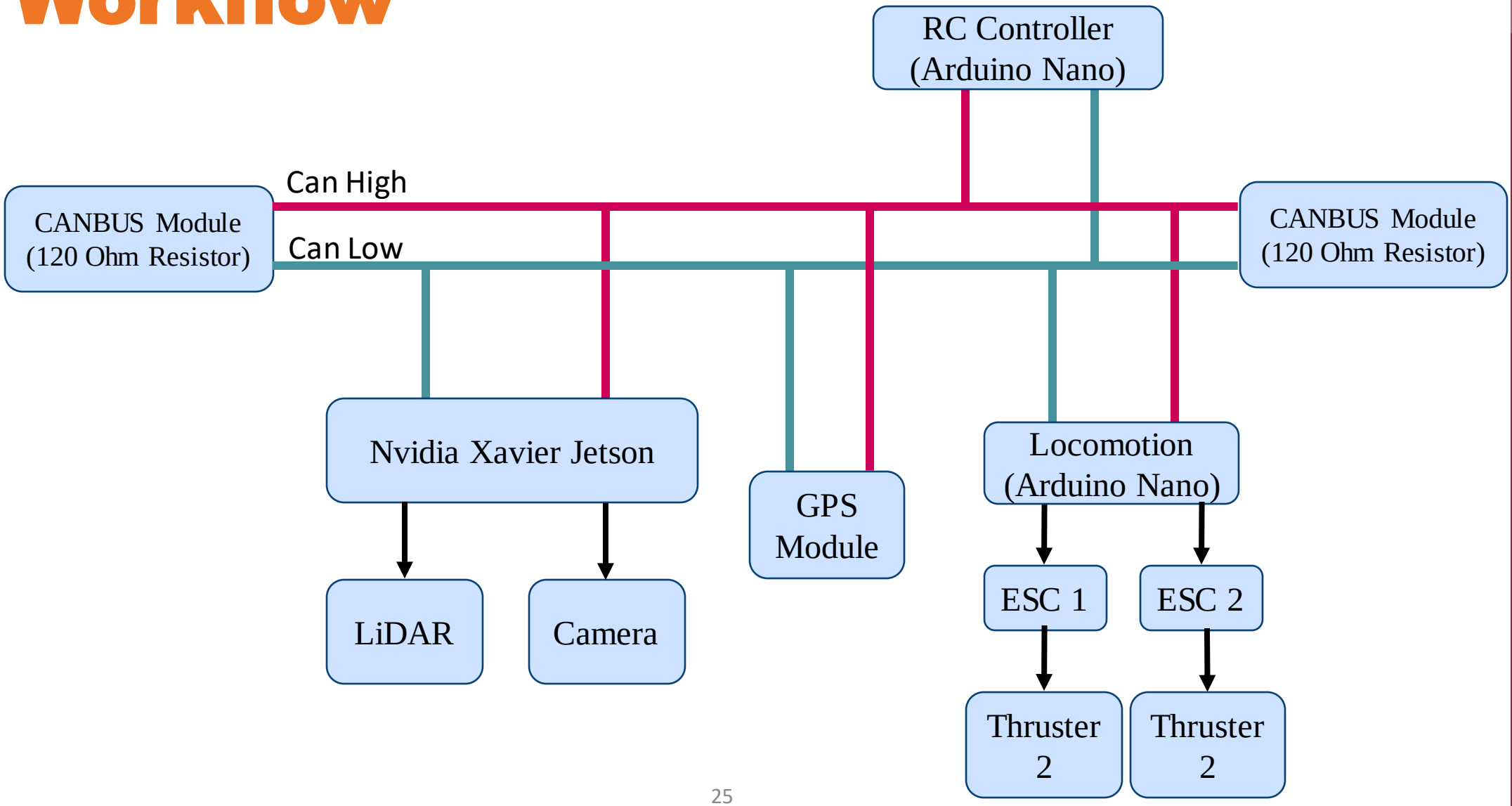


Current Work
Structure

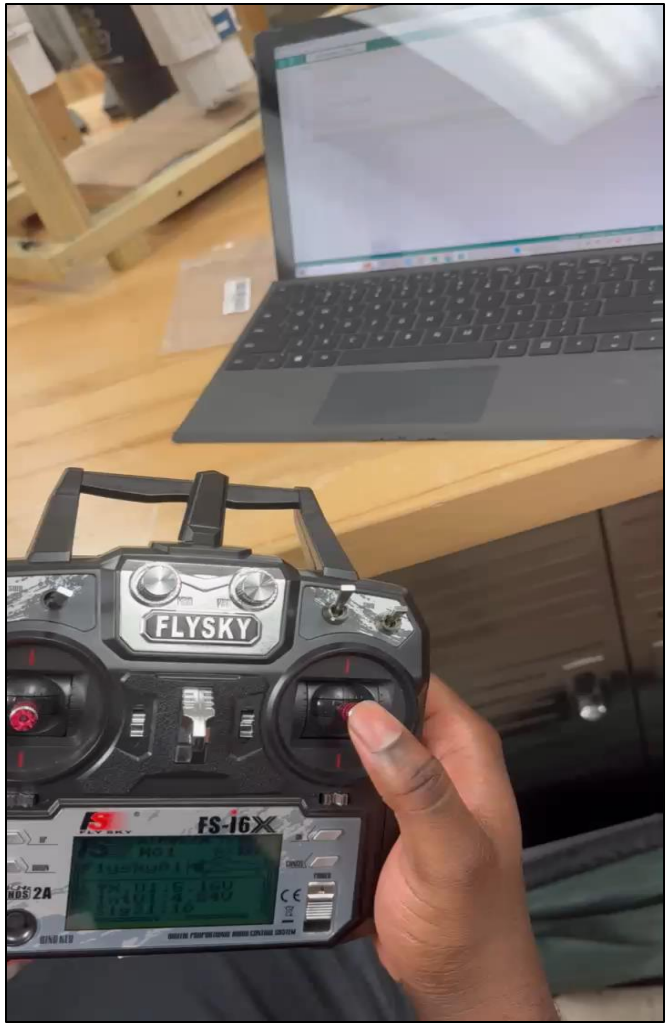
- Mount Thrusters to hull
- Finish reinforcing Hull
- Fiberglass
- Leak prevention

Workflow


RC Controller
(Arduino Nano)
Can High
Can Low
CANBUS Module
(120 Ohm Resistor)
CANBUS Module
(120 Ohm Resistor)
Nvidia Xavier Jetson
GPS
Module
Locomotion
(Arduino Nano)
LiDAR
Camera
ESC 1
ESC 2
Thruster
2
Thruster
2

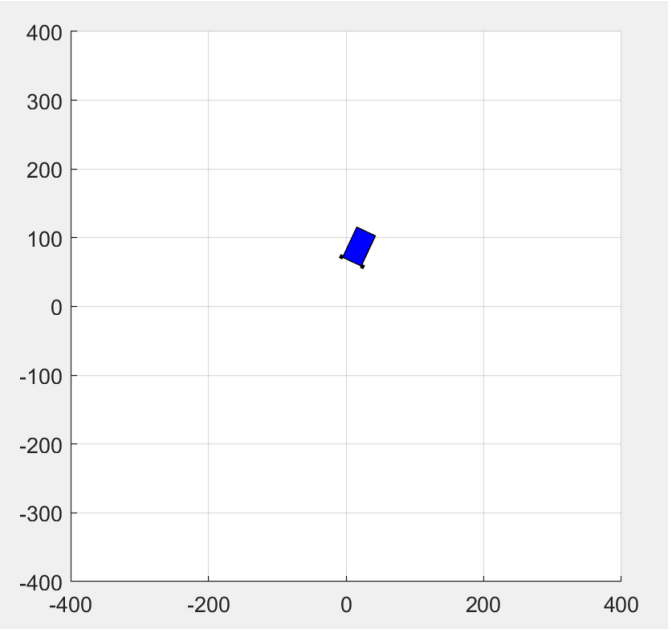
Current Work
Locomotion

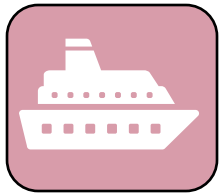
- Thrusters
  - Repaired broken ESC
  - 2 Thrusters connected and paired to RC Controller
- Can Bus Line
  - Communication logic written and formatted
  - Work out can line layout within boat

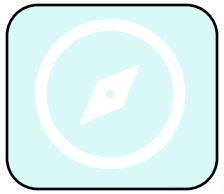


Current Work
Locomotion

- Controls
  - Matlab Simulation
    - Boat Kinematics
    - Waypoint following in progress
- Relationship between PWM signal and RPM
  - Equation provided by manufacturer
    - 12 and 16 Volts
    - 14 Volts*



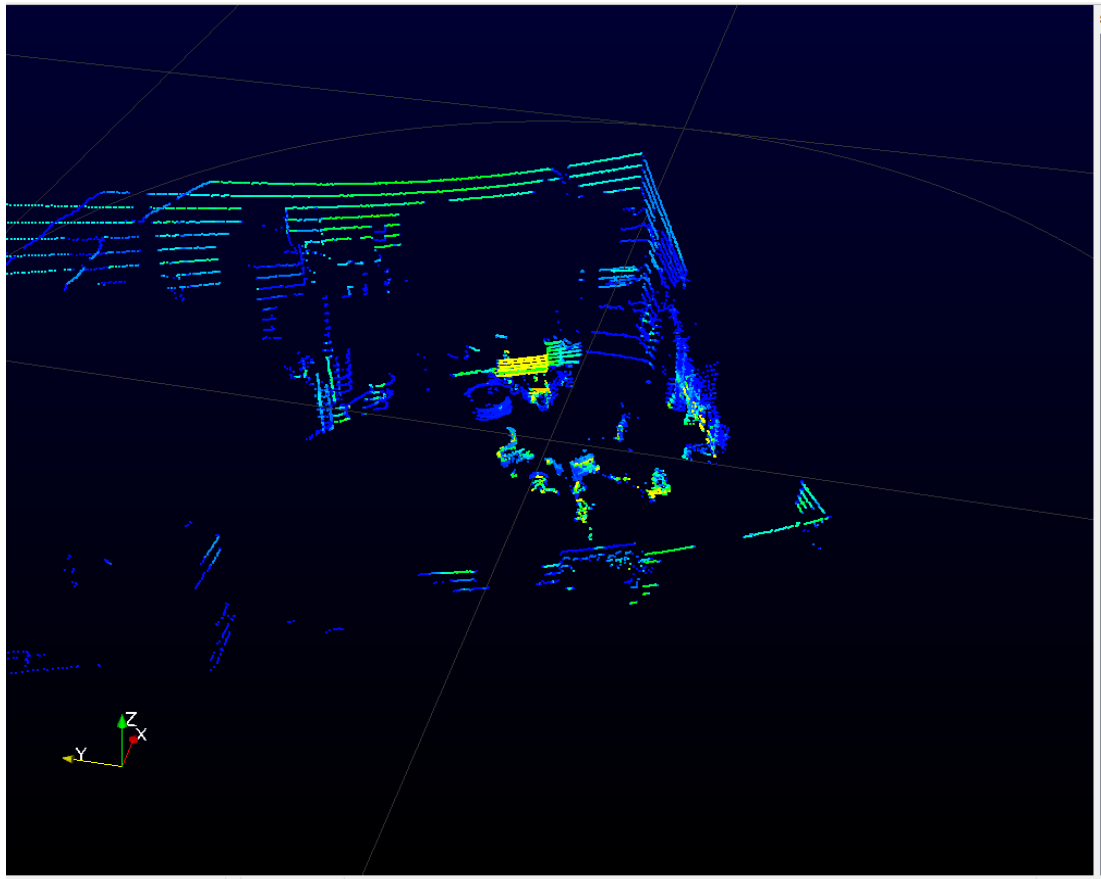




Current Work
Navigation

- Velodyne LiDAR
  - Panama City Campus
  - Internal IMU
  - Output example on next page
- Nvidia Xavier
  - Figured out and stored device password
  - Began software installs/upgrades
    - Error with update from Ubuntu 18.04 to Ubuntu 20.04

Current Work
Navigation



Showing Data Attribute: Point Data Precision: 3

	Point ID	X	Y	Z
976	976	1.587	6.596	1.818
977	977	0.854	3.528	-0.973
978	978	0.946	3.908	0.070
979	979	0.838	3.460	-0.822
980	980	1.790	7.384	0.398
981	981	0.716	2.952	-0.590
982	982	1.983	8.173	0.736
983	983	0.718	2.958	-0.482
984	984	1.987	8.175	1.033
985	985	0.894	3.676	-0.465
986	986	1.985	8.161	1.330
987	987	0.899	3.694	-0.333
988	988	1.986	8.154	1.631
989	989	0.899	3.689	-0.199
990	990	1.838	7.533	1.790
991	991	0.846	3.464	-0.062
992	992	1.606	6.580	1.815
993	993	0.853	3.471	-0.958
994	994	0.946	3.849	0.069
995	995	0.846	3.438	-0.817
996	996	2.003	8.136	0.439
997	997	0.722	2.934	-0.587
998	998	2.004	8.135	0.733
999	999	0.728	2.952	-0.482
1000	1000	2.008	8.139	1.029
1001	1001	0.911	3.689	-0.467

Live sensor stream (Port:2368) Frame: 7533 Factory Field 1: 55 (hex: 0x37) STRONGEST RETURN | Factory Field 2: 34 (hex: 0x22) VLP-16

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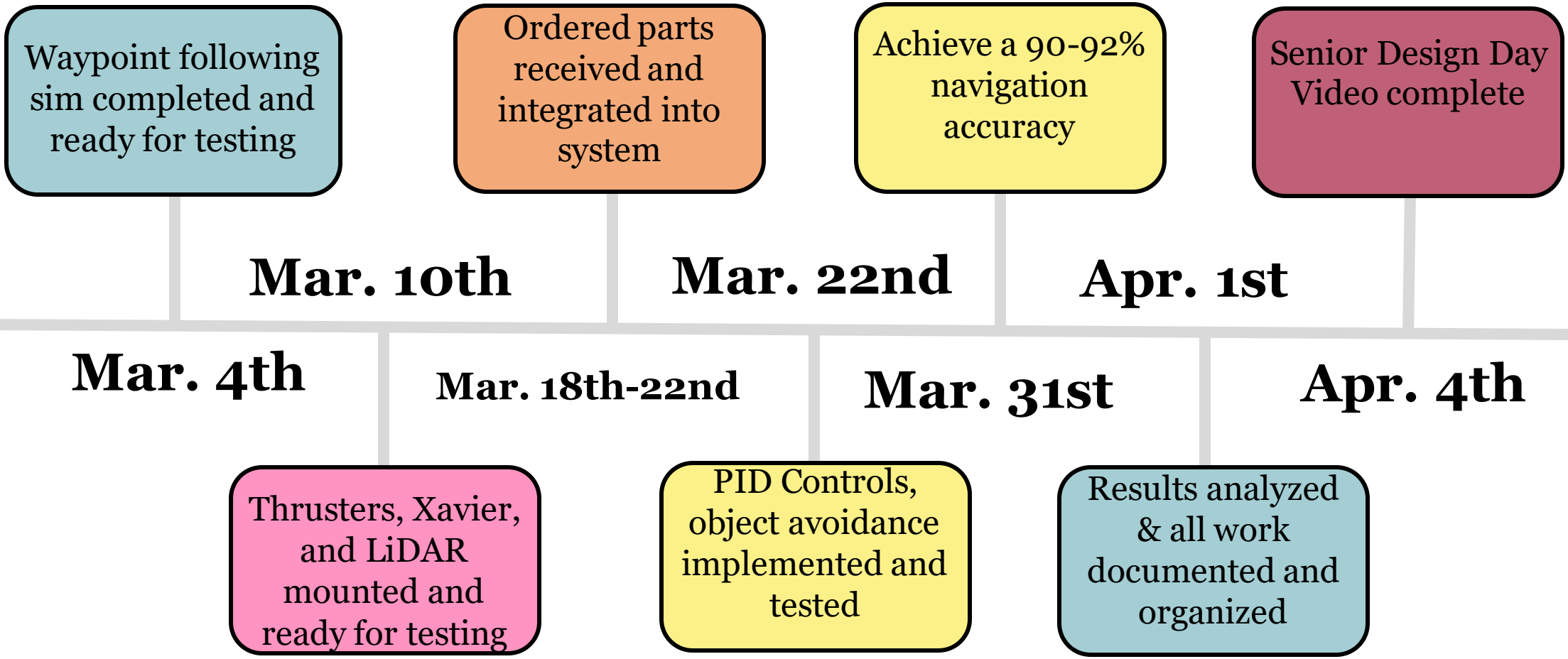
Future Work and Timeline



Thank You

Thank You

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References

About. RoboBoat. (2021, March 13).
https://roboboat.org/about/

Past programs. RoboBoat. (2019, September 27).
https://roboboat.org/past-programs/

RoboBoat 2024. RoboBoat. (2023, October 13).
https://roboboat.org/programs/2024/

Tel Aviv Competition Strategy Video. (2022, May 16).
https://www.youtube.com/watch?v=qss0lyN3KJ8

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Backup Slides

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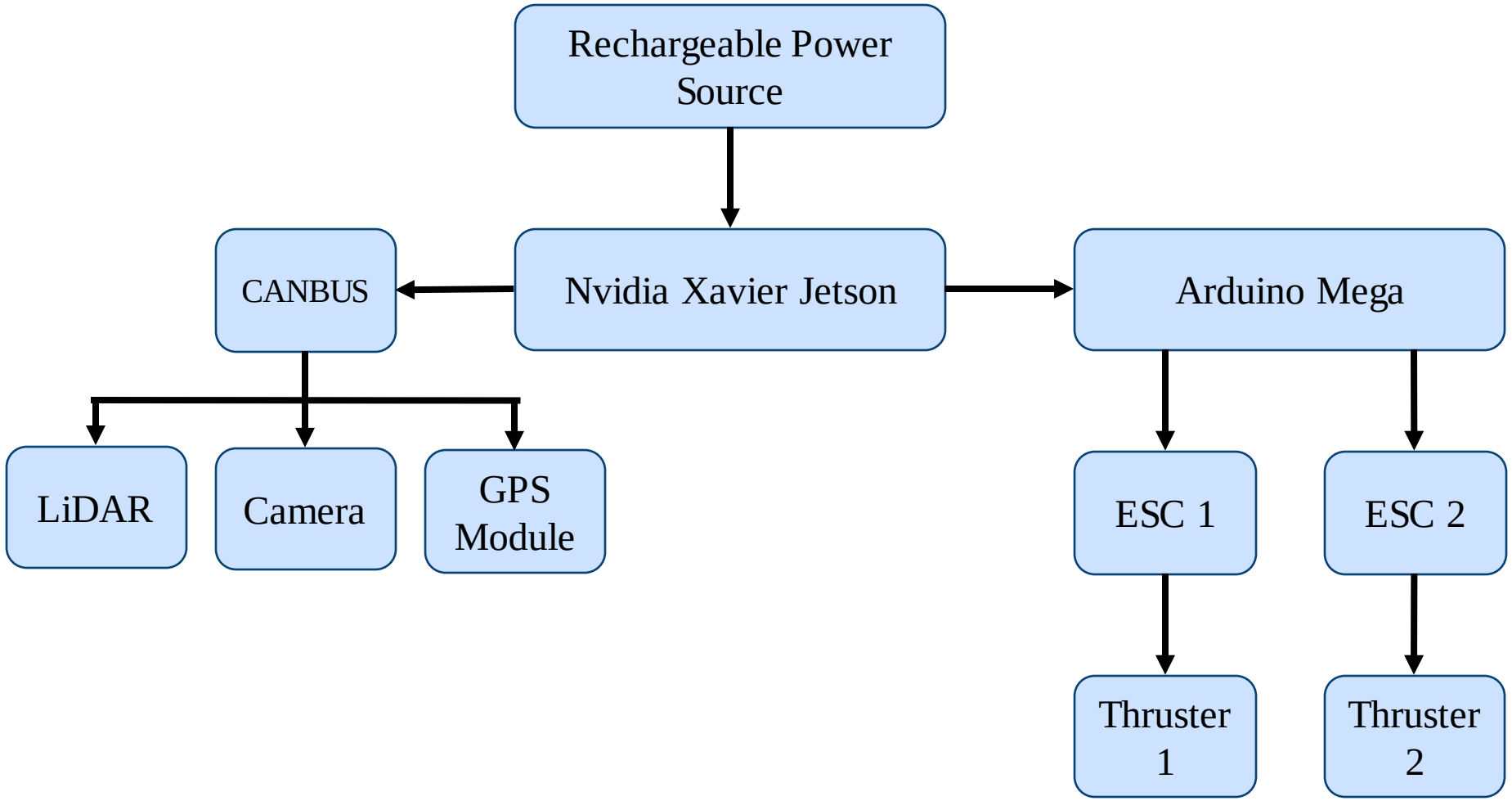
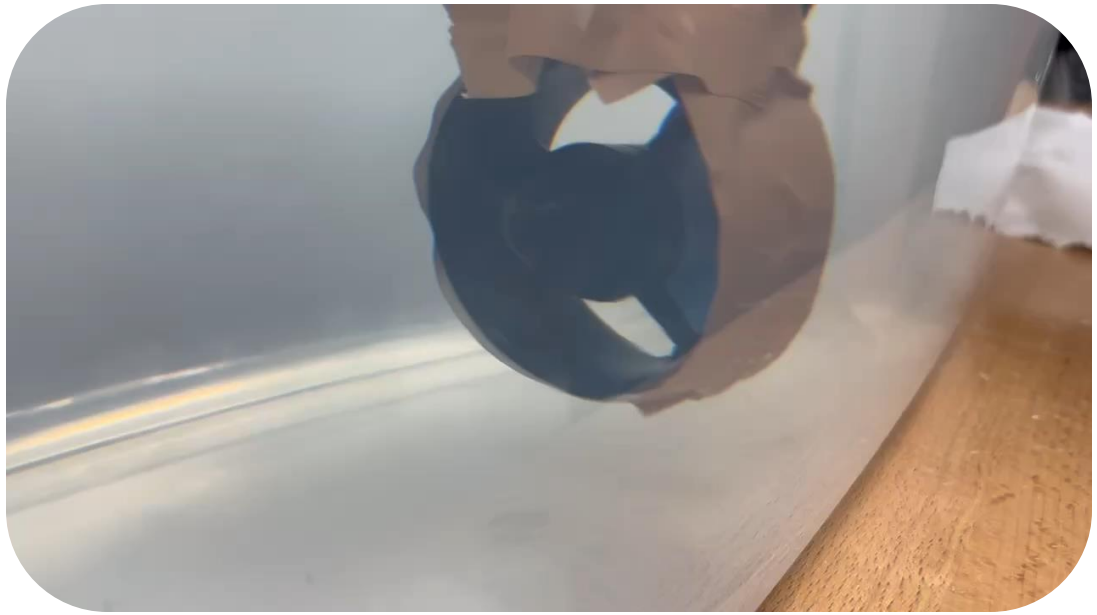
Workflow Chart



Makenzie
Wiggins

Current Work
Locomotion

- One fully functional thruster with ESC
  - Need new ESC (speed controller)
  - Thruster for rear of the boat



Ivanna
Caballero

Customer Needs

- Navigation System
- Safety System
- Power/Battery System
- Weight/Size Restraint
- One Major Task

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Thruster Code

Michael Fitzsimmons

Boat_prototype §

```
#include <Servo.h>
#include <IBusBM.h>

const int xPin = A0;  //Analog Pin
const int yPin = A1;//Analog Pin

/****** RC Remote ********/
void joyS();       // Function for Joystick implementation
int potPin = A2;  // Analog pin for potentiometer
int buttPin = 50; // Digital pin for speed button
int revPin = 49;  // Digital pin for reverse button
int Thruster;     // Variable to control thruster speed
Servo servo;      // Thruster servo variable
byte servoPin = 9; // Pin to connect thruster to Arduino
int xAxis;        // variable for joystick axis
int State1 = 0;   //variable for reading Speed button
int State2 = 0;   //variable for Direction button
int state = 0;    // Variable for controlling thruster speed
int reverse = 0;  // Variable for controlling thruster Direction

int readChannel(int chanInput, int minLimit, int maxLimit, int defaultVal);

void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);  // Intialization for printing to Serial Monitor
  pinMode(xPin, INPUT);  // Initializing joystick pin
  pinMode(yPin, INPUT);  // Initializing joystick pin
  pinMode(potPin,INPUT);  // Intializing Potentiomemter pin
  pinMode(buttPin, INPUT); // Initalizing speed button pin
  pinMode(revPin, INPUT);  // Intializing direction button pin

  servo.attach(servoPin);        // Intialize Thruster
  servo.writeMicroseconds(1500); // Send signal to Initialize thruster
  delay(700);                    // Delay before starting loop to ensure thruster recognizes signal
}
```

Boat_prototype §

```
  delay(700);                    // Delay before starting loop to ensure thruster recognizes signal
}

void loop() {
//
//  Thruster = analogRead(potPin);
//  Thruster = map(Thruster, 0, 1023, 1100, 1900);

  State1 = digitalRead(revPin);   // read signal from button controlling direction
  if (State1 == HIGH)             // If button is pressed
    reverse = reverse + 1;        // Increase state of the direction
    reverse = reverse % 2;        // Mod 2, keeps direction between 0 and 1
                                  // 0 = forward, 1 = reverse

  State2 = digitalRead(buttPin); // read signal from button controlling speed
  if (State2 == HIGH) {           // If button is pressed
    state = state + 1;            // Increase state of the speed
    state = state%3;              // Mod 3, Keeps speed state 0, 1 or 2
                                  // 0 = off, 1 = slow, 2 = fast

  }
  Serial.print("reverse: ");      // Prints state of the direction variable to Serial monitor
  Serial.println(reverse);

  switch (state) {                          // Switch statement to control the speed of the thruster
    case 0: Serial.println("Off");            // Print state of speed to Serial monitor
            servo.writeMicroseconds(1500);    // 1500 microsends is the neutral value for the ESC thru
      break;
    case 1: Serial.println("Slow");           // Print state of speed to Serial monitor, SLOW setting
            if ( reverse == 0)                // If the direction state is 0 (Forward)
              servo.writeMicroseconds(1550);  // Set the ESC speed to 1550   (1500 + 50)
            else                              // If the direction state is 1 (Reverse)
              servo.writeMicroseconds(1450);  // Set the ESC speed to 1450   (1500 - 50)
      break;
    case 2: Serial.println("Fast");           // Print state of speed to Serial monitor, FAST setting
```


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Thruster Code

Boat_prototype §

```
    case 2: Serial.println("Fast");            // Print state of speed to Serial monitor, FAST setting
            if ( reverse == 0)                 // If the direction is 0 (Forward)
              servo.writeMicroseconds(1575);   // Set the ESC speed to 1575      (1500 + 75)
            else                               // If the direction is 1 (Reverse)
              servo.writeMicroseconds(1425);   // Set the ESC speed to 1425      (1500 - 75)
      break;
  }

  delay(400);
}

void joyS() {
  xAxis = analogRead(xPin);
  int yAxis = analogRead(yPin);

  static int range = 1900;
  static int center = 1500;
  static int thresh = range / 633  ;
  int x_Dist = xAxis - center;
  int y_Dist = yAxis - center;


  xAxis = map(xAxis, 0, 1023, 1100, 1900);
  yAxis = map(yAxis, 0, 1023, 1100, 1900);

  if (xAxis > 1495 && xAxis < 1505)
    xAxis = 1500;
}

int readChannel(int chanInput, int minLimit, int maxLimit, int defaultVal)
{
  int ch = pulseIn(chanInput, HIGH, 2500);
  if (ch < 100)
  {
    return defaultVal;
```

Michael Fitzsimmons

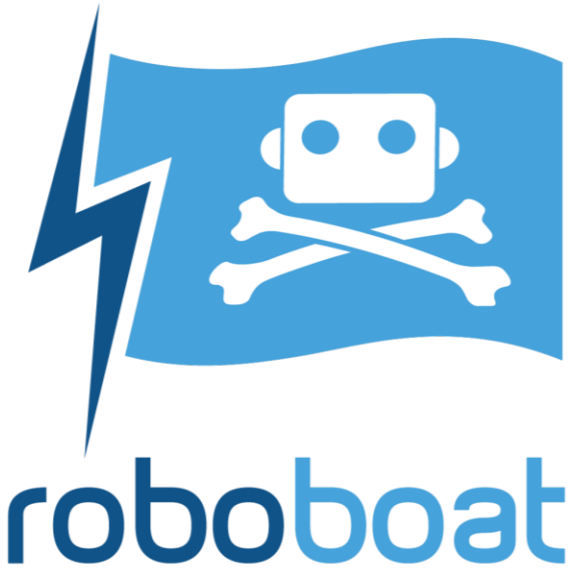
FAMU-FSU College of Engineering

Nicholas
Norwood

Project Objective

The objective of this project is to design, build and program an autonomous surface vehicle capable of completing several tasks in the following categories:

- Navigation
- Detection
- Object avoidance
- Conduct two-step behavior



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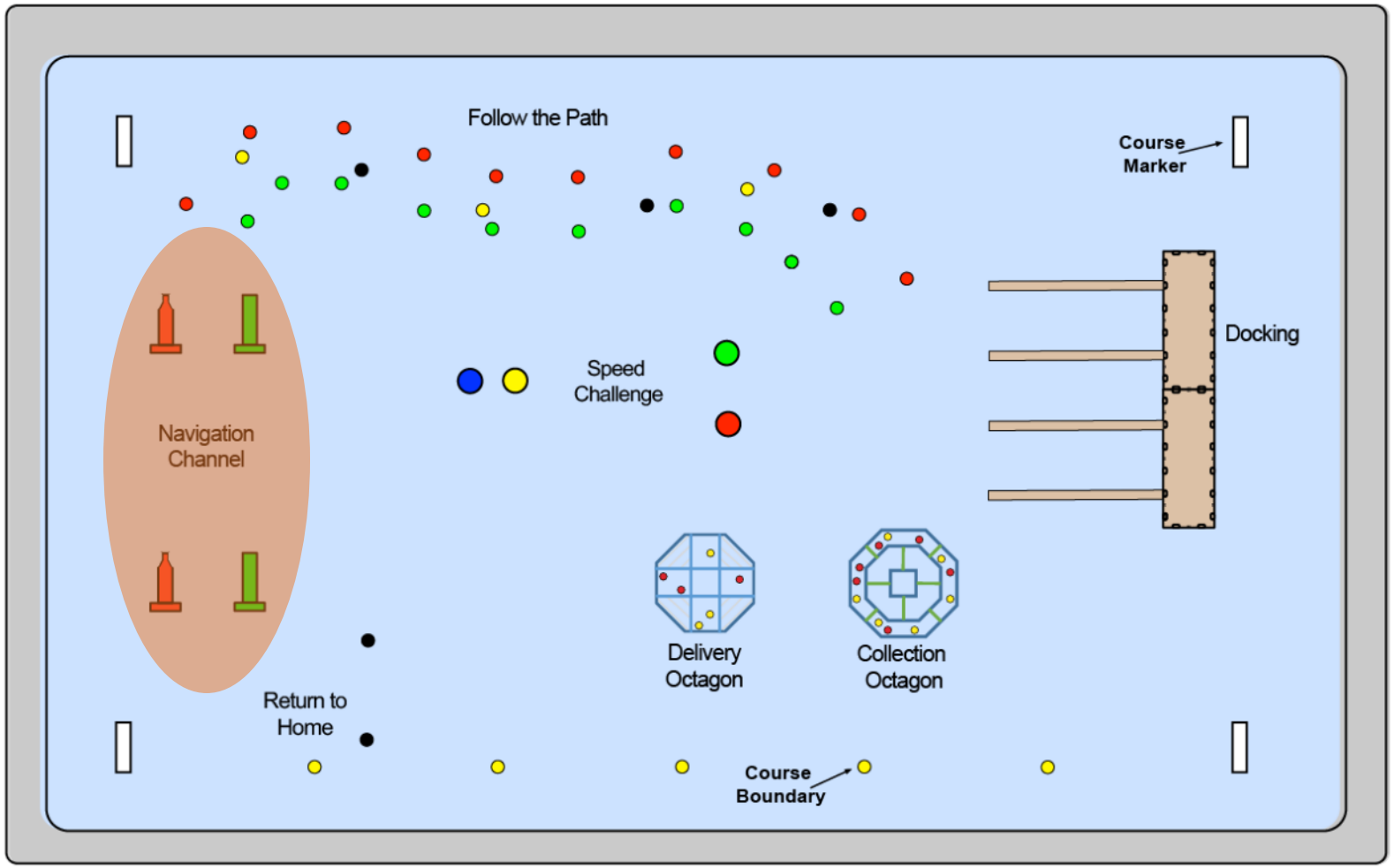
Makenzie
Wiggins

RoboBoat 2024 Course



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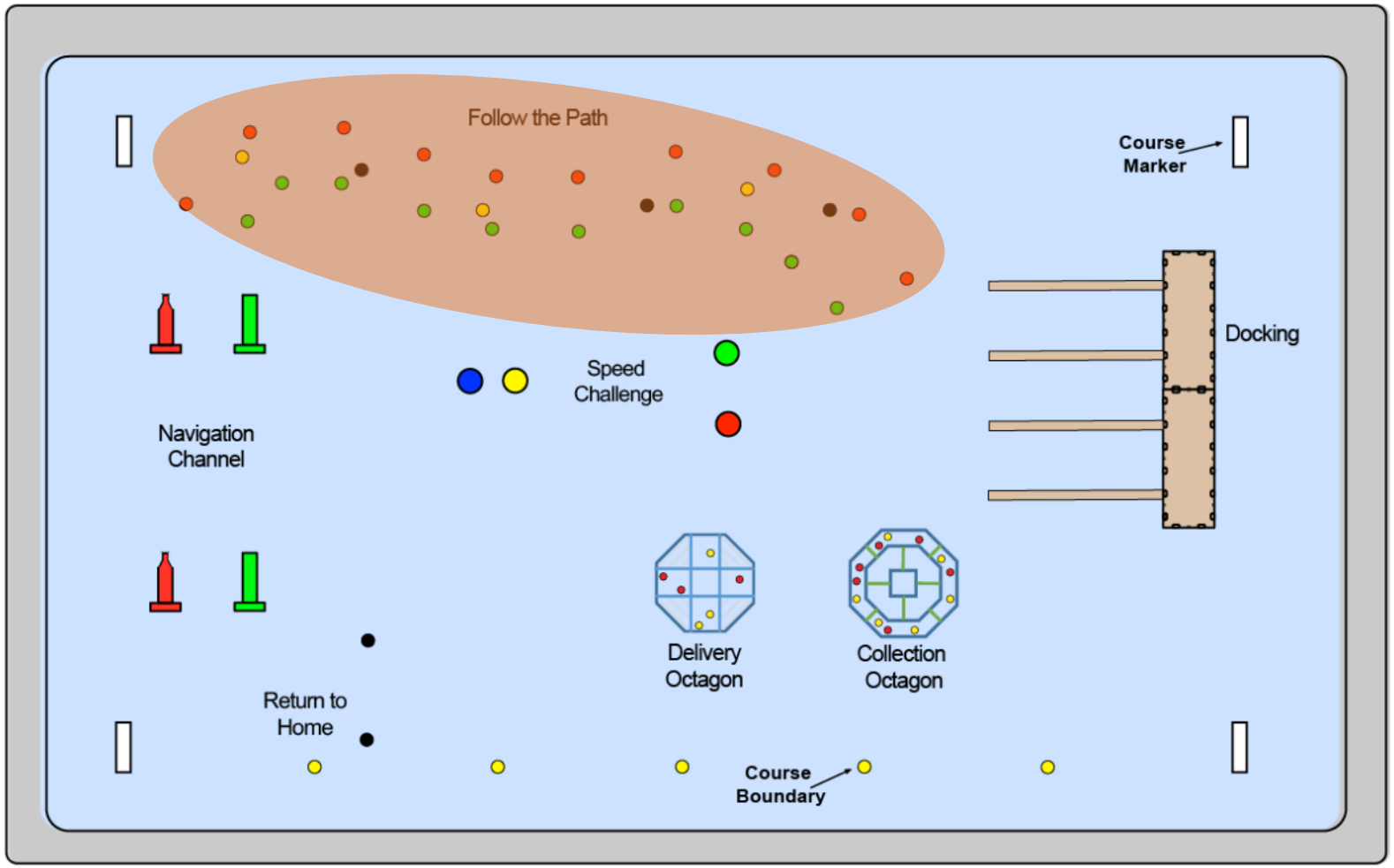

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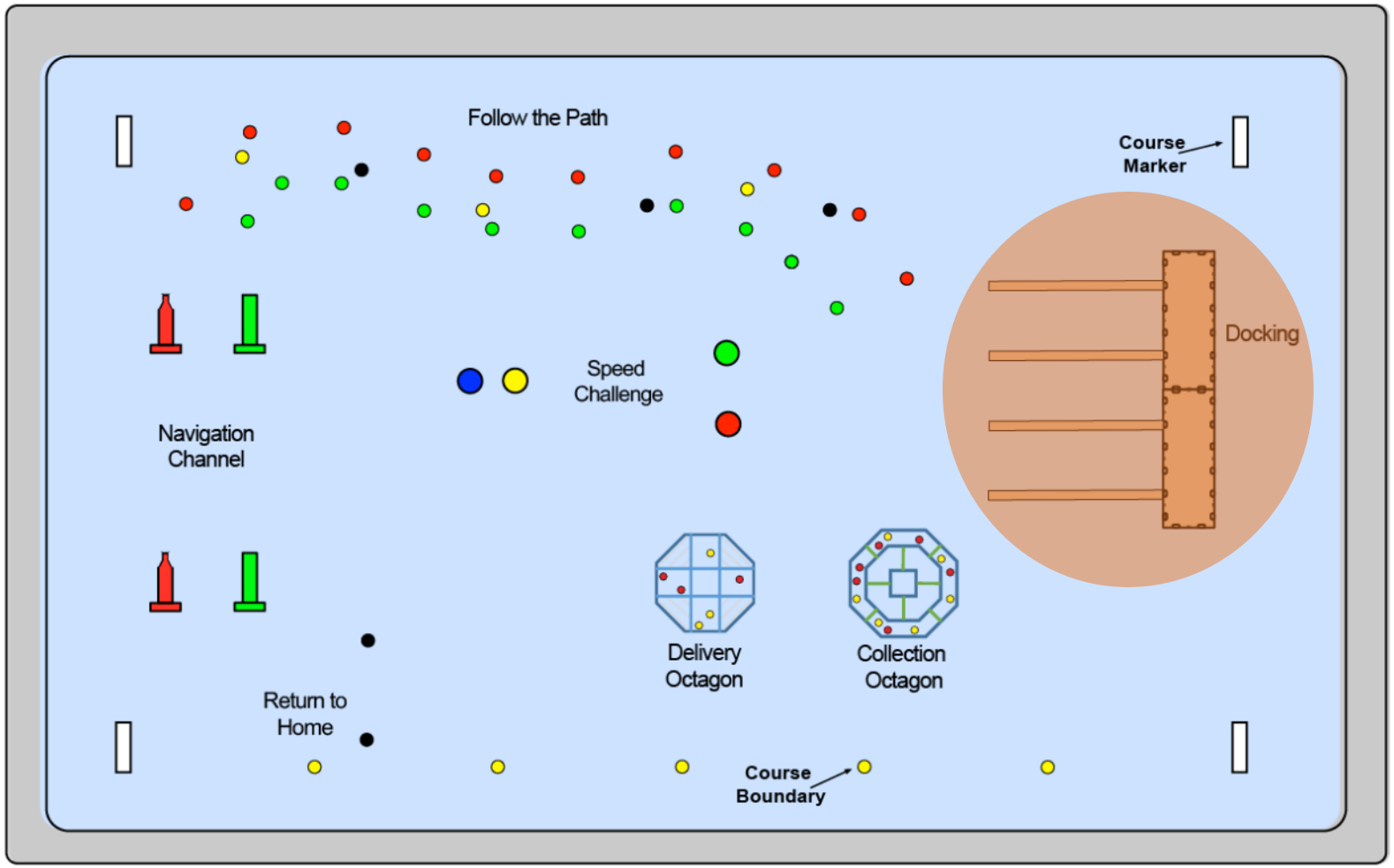

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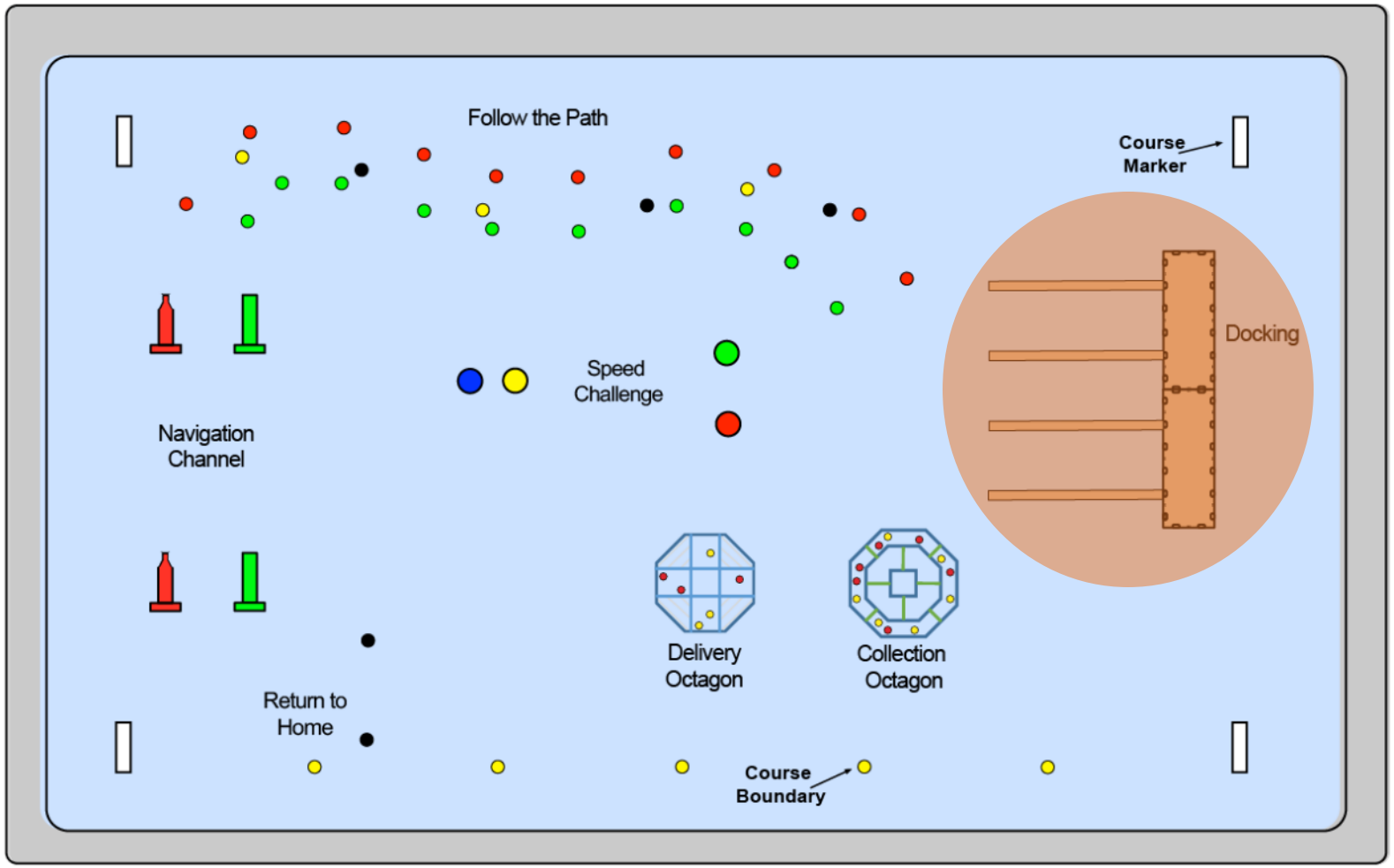

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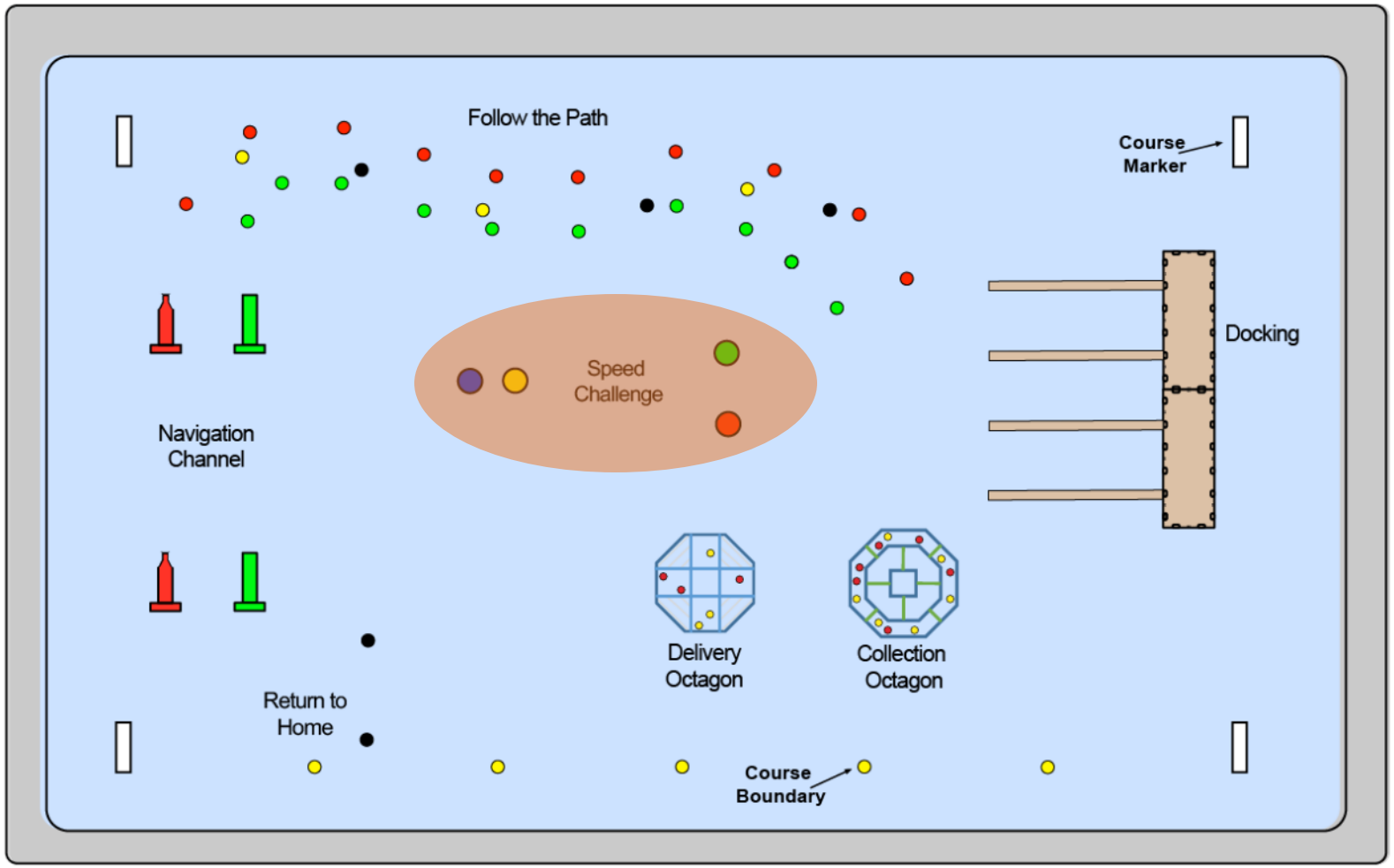

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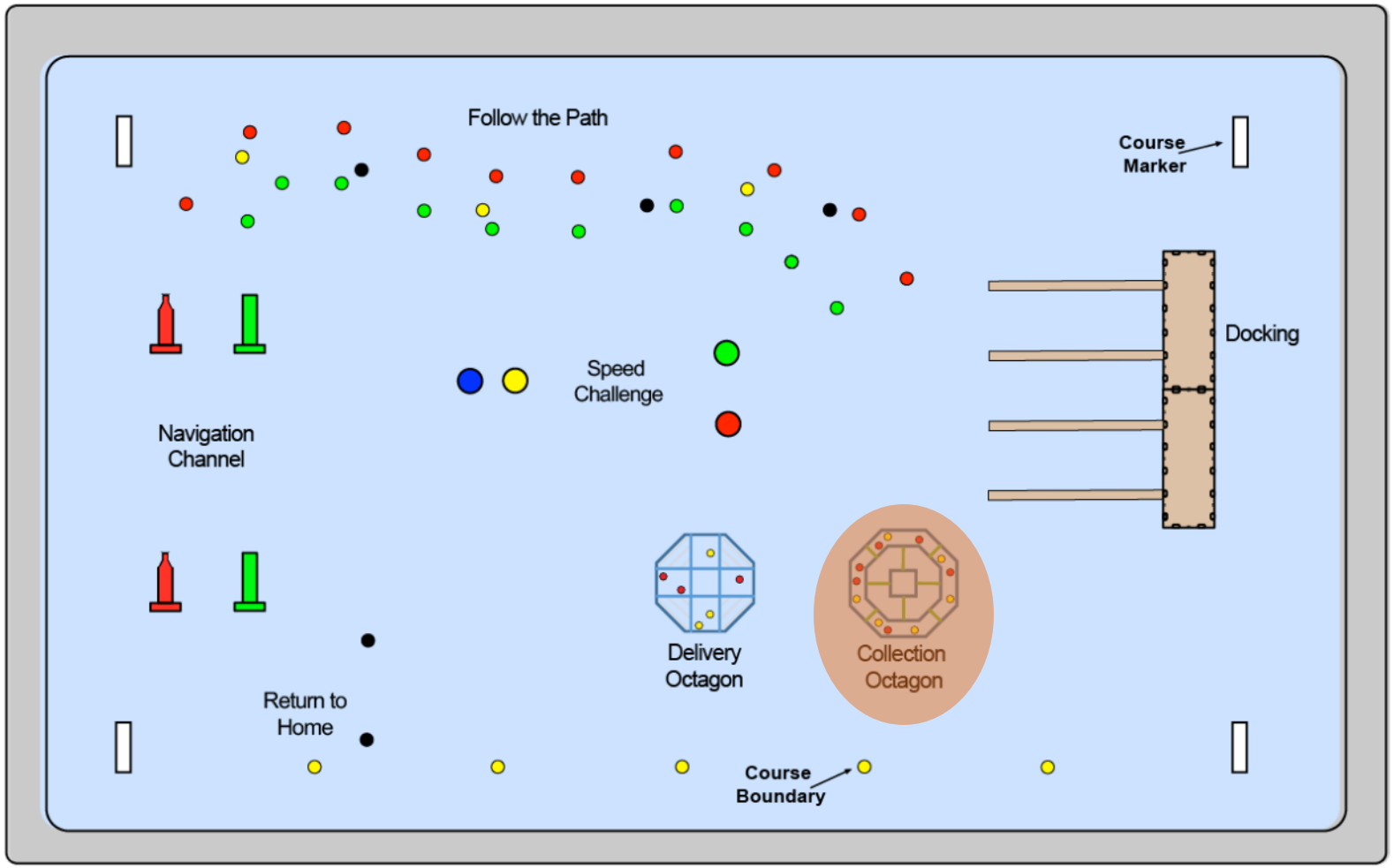

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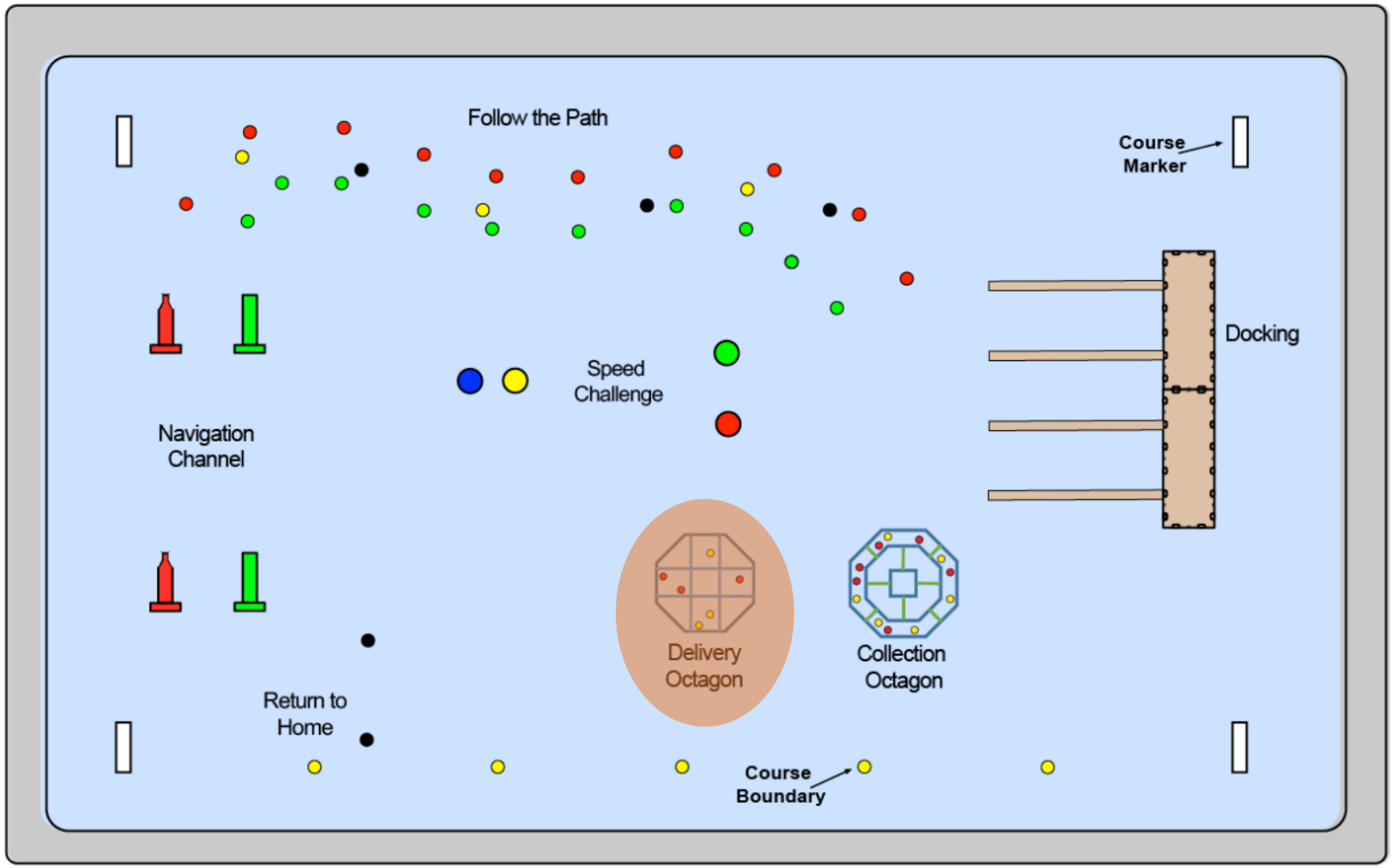

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Wiggins

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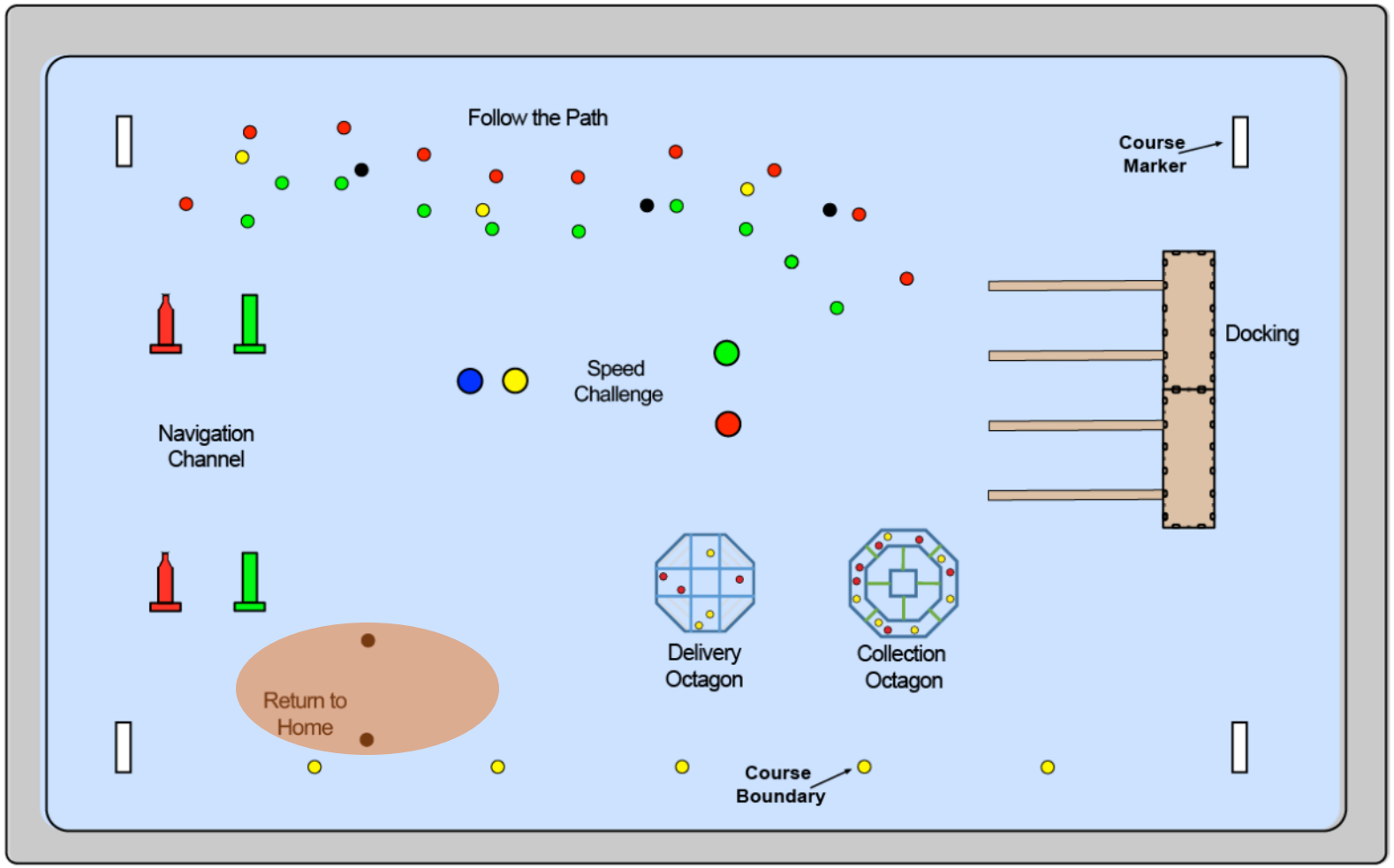

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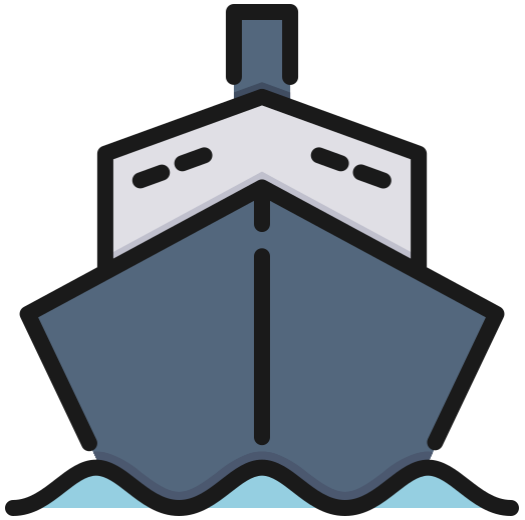
Ivanna
Caballero

System: Structure

Function	Target	Metric
Length	3.94(ft)	size
Width	2.58(ft)	size
Height	2.445(ft)	size
Weight	63.25(lbs)	weight
Buoyancy	300N	force
Deflection Angle	15 degrees	angle



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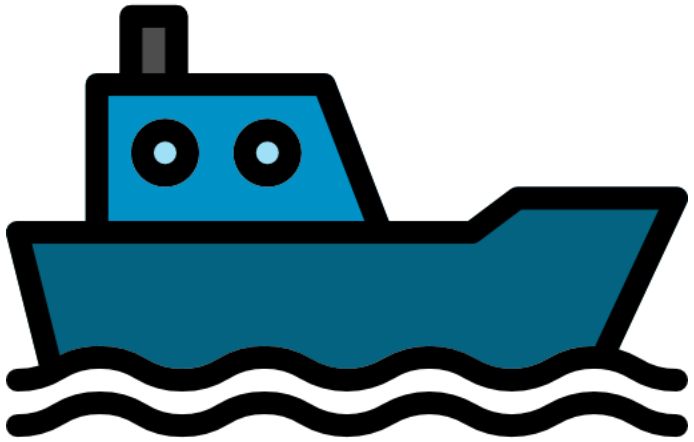
Caballero

System: Locomotion

Function	Target	Metric
Speed	>=1.515 (m/s)	velocity
Acceleration	0.25 (m/s)	acceleration
Thrust	14.6 (lbs)	force



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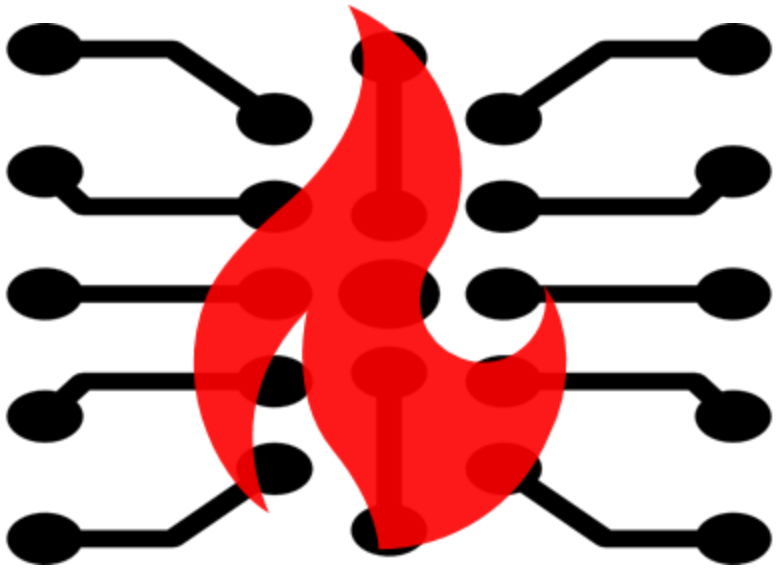
Caballero

System: Safety

Function	Target	Metric
Kill switch response time	0.25(s)	time
Manual-Remote kill switch integration	True	Boolean



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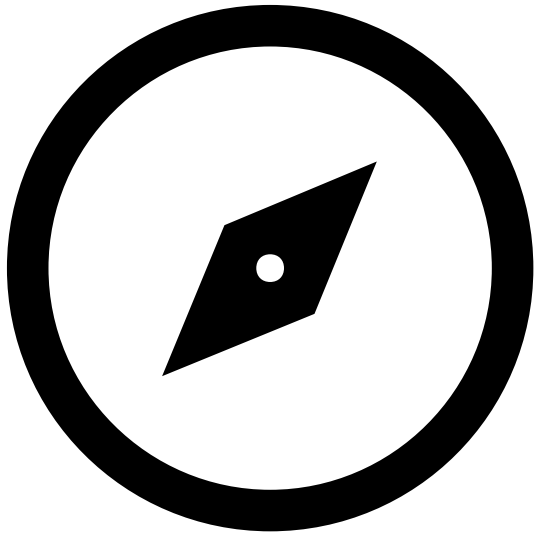
Caballero

System: Navigation

Function	Target	Metric
Cross-track error of navigating to a destination	2(m)	length
Boat localization error	< 5(m)	length



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System: Power Systems

Function	Target	Metric
Battery size	22000(mAh)	Charge capacity
Battery life	1 (hr)	Time
Capability of tracking battery life	True	Boolean

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System: Object Detection

Function	Target	Metric
Camera Resolution	1920x1080 (pixels)	Number of Pixels
Range of object detection	25(m)	Length
Accuracy of detecting color	95%	Percent Error
Capability of identifying different objects	Min. Of 6 objects	Number of objects

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Caballero

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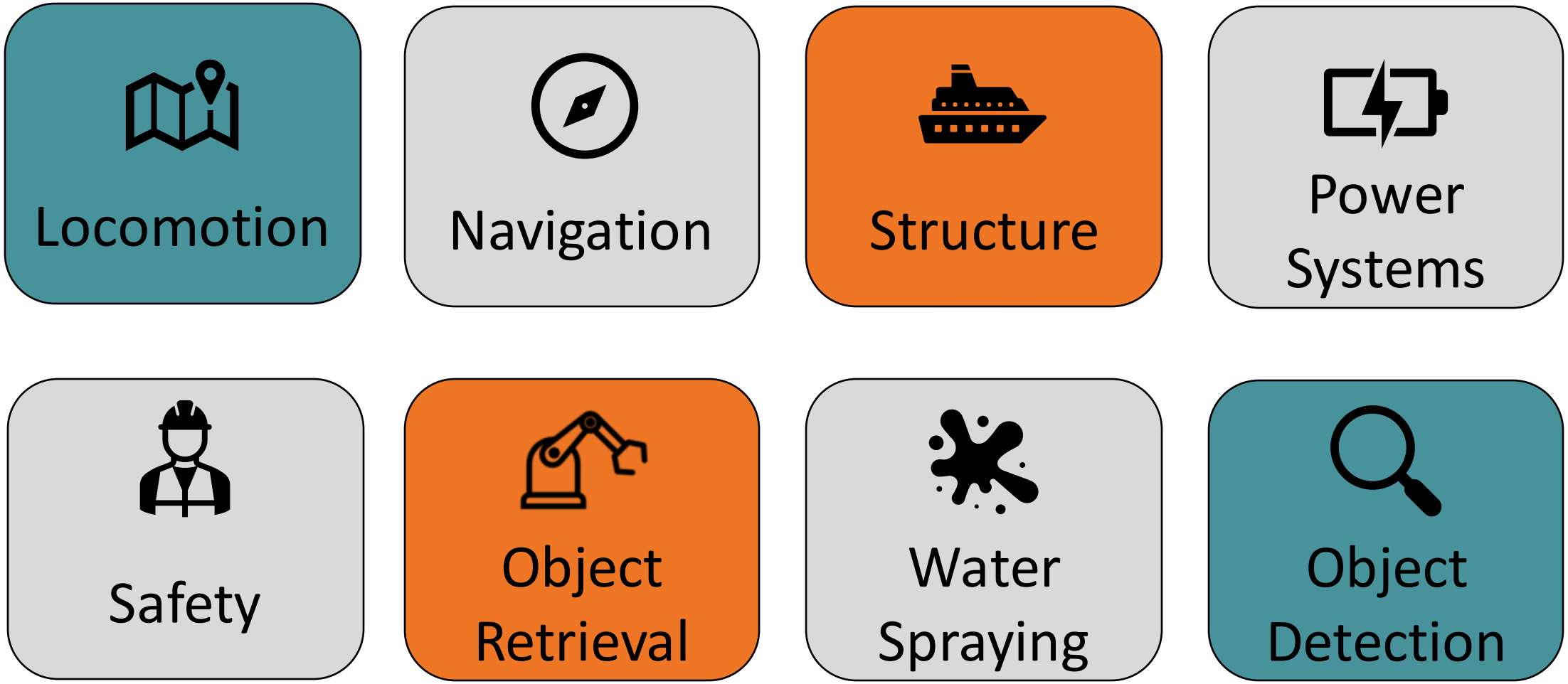
Functional Decomposition



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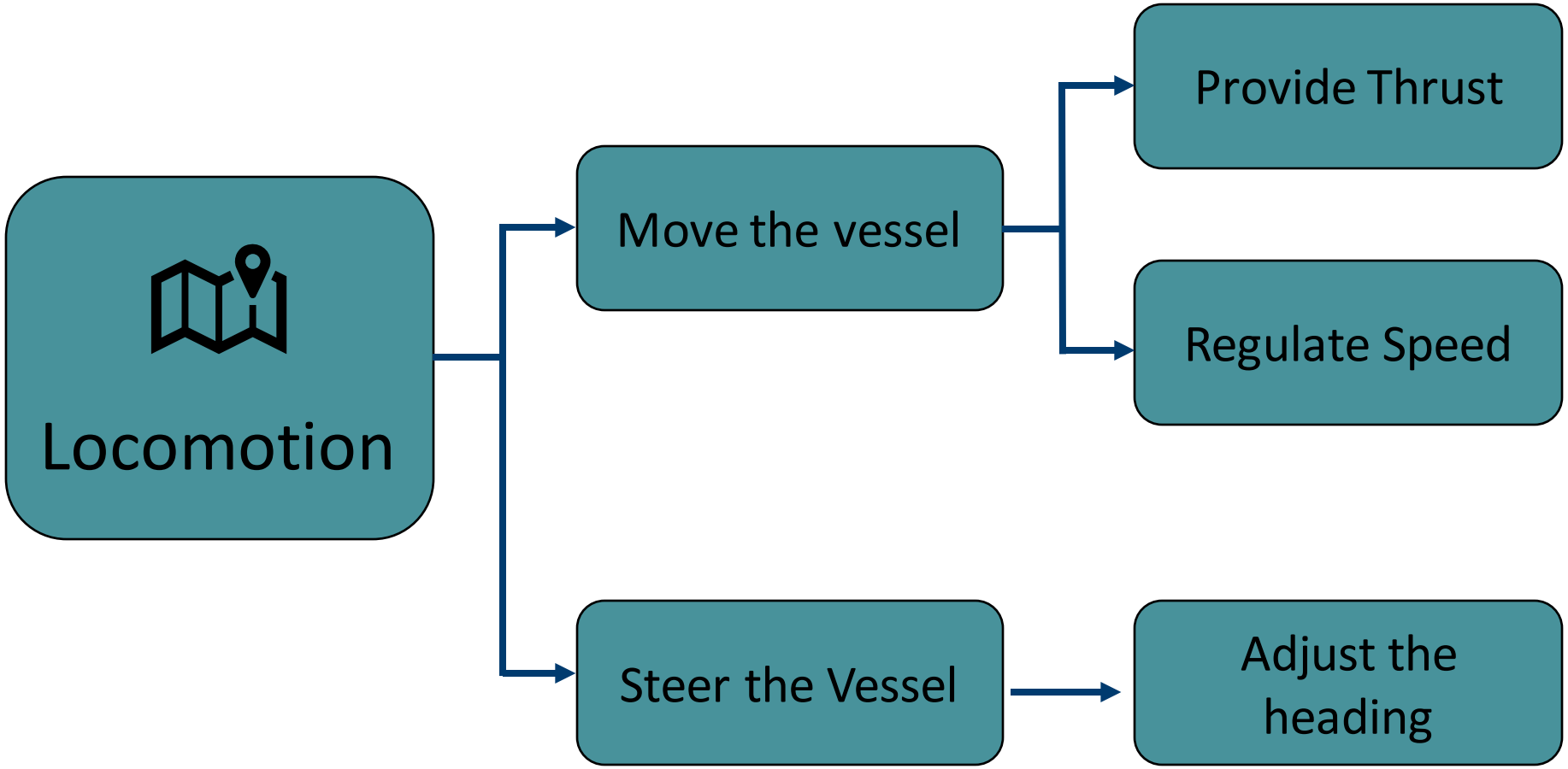
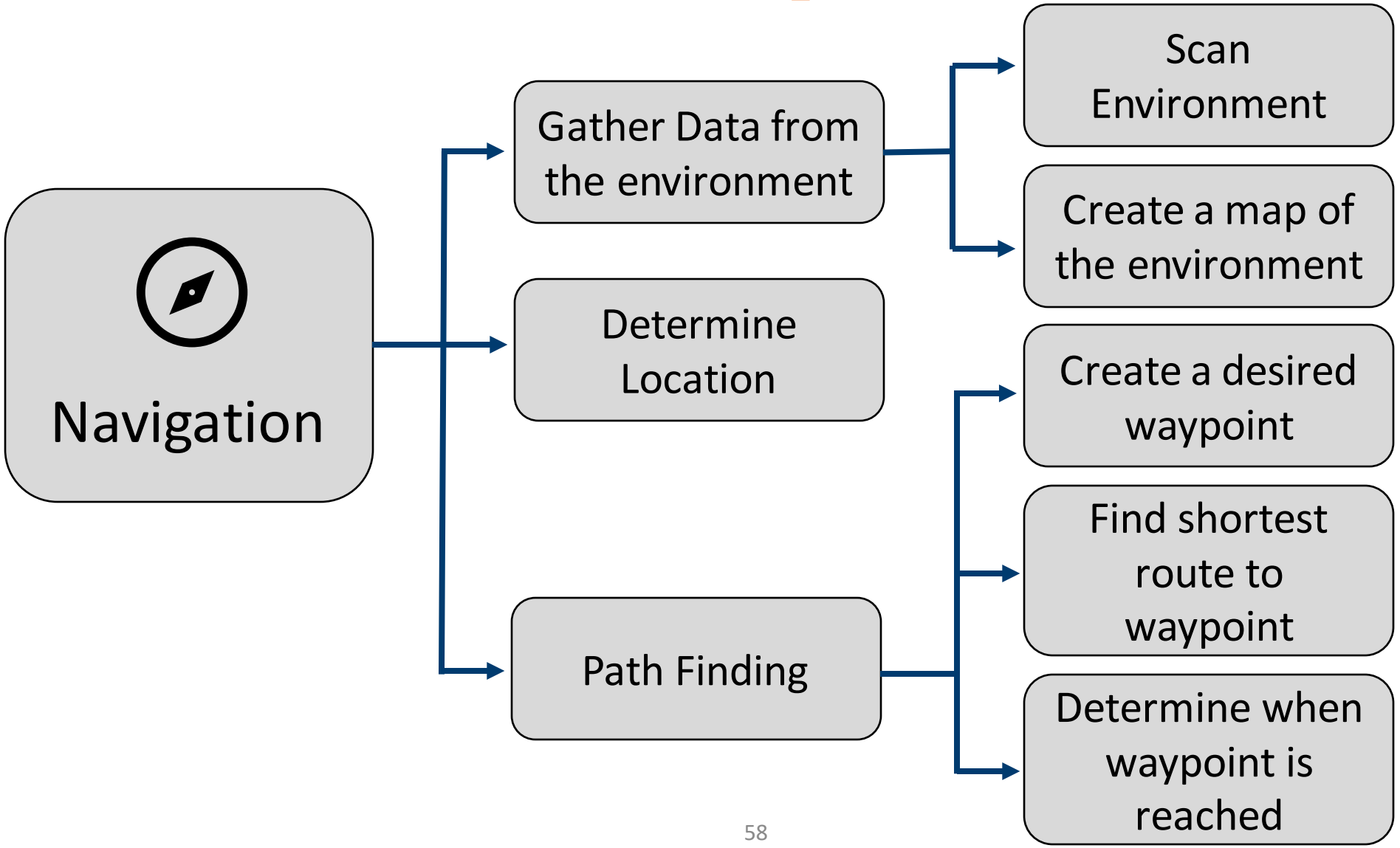


Sophia Barron

Sophia
Barron

Functional Decomposition



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Sophia
Barron

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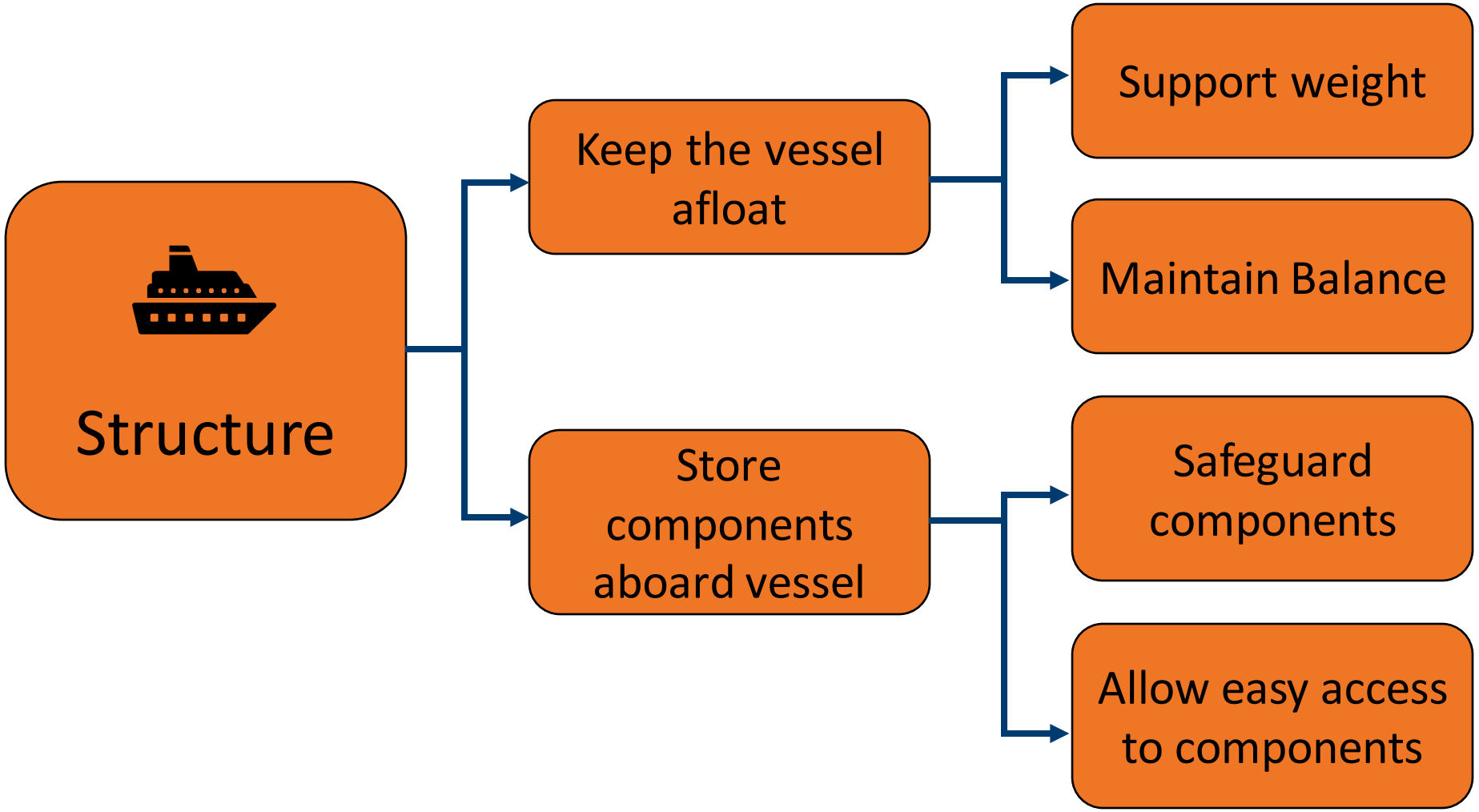

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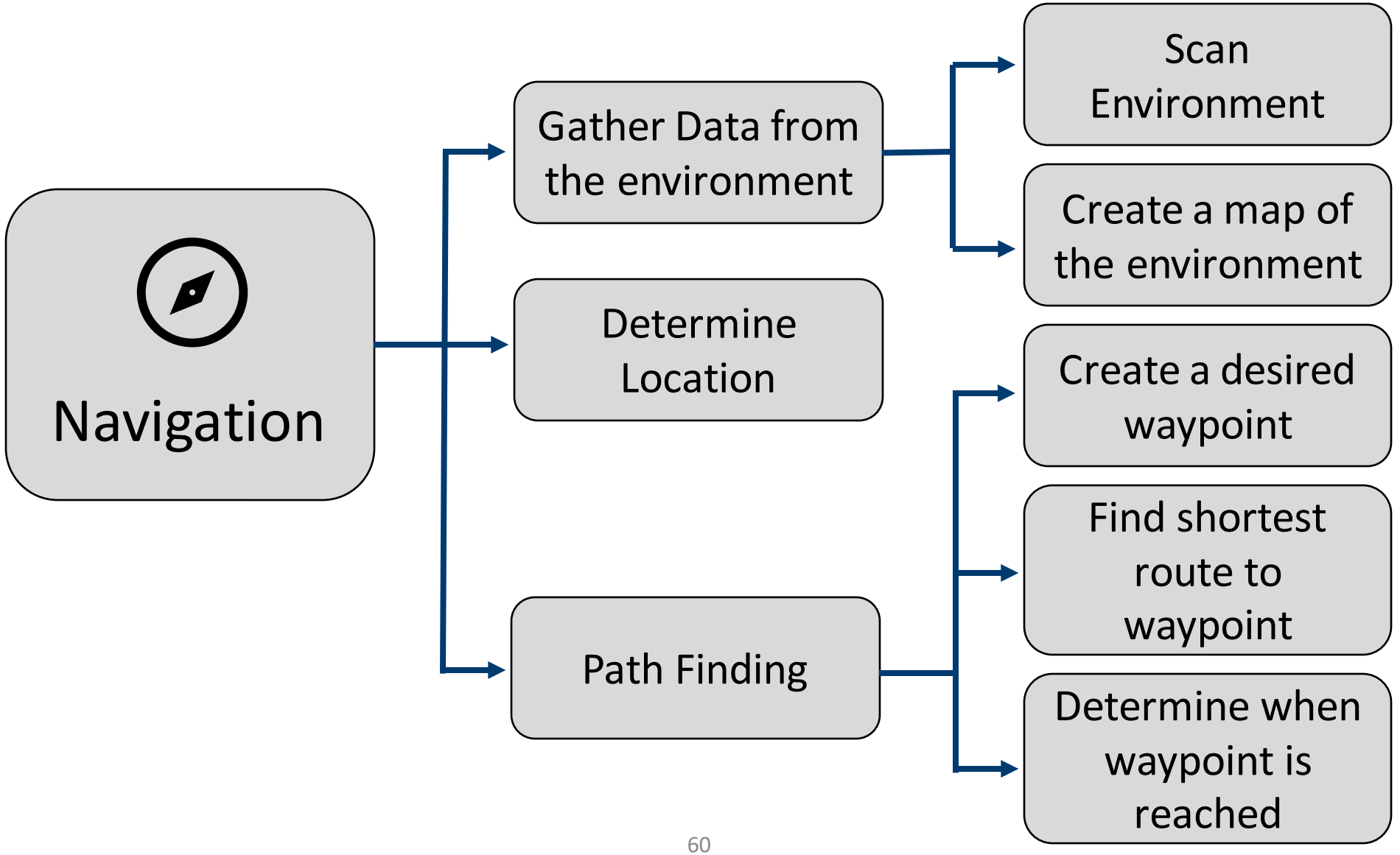

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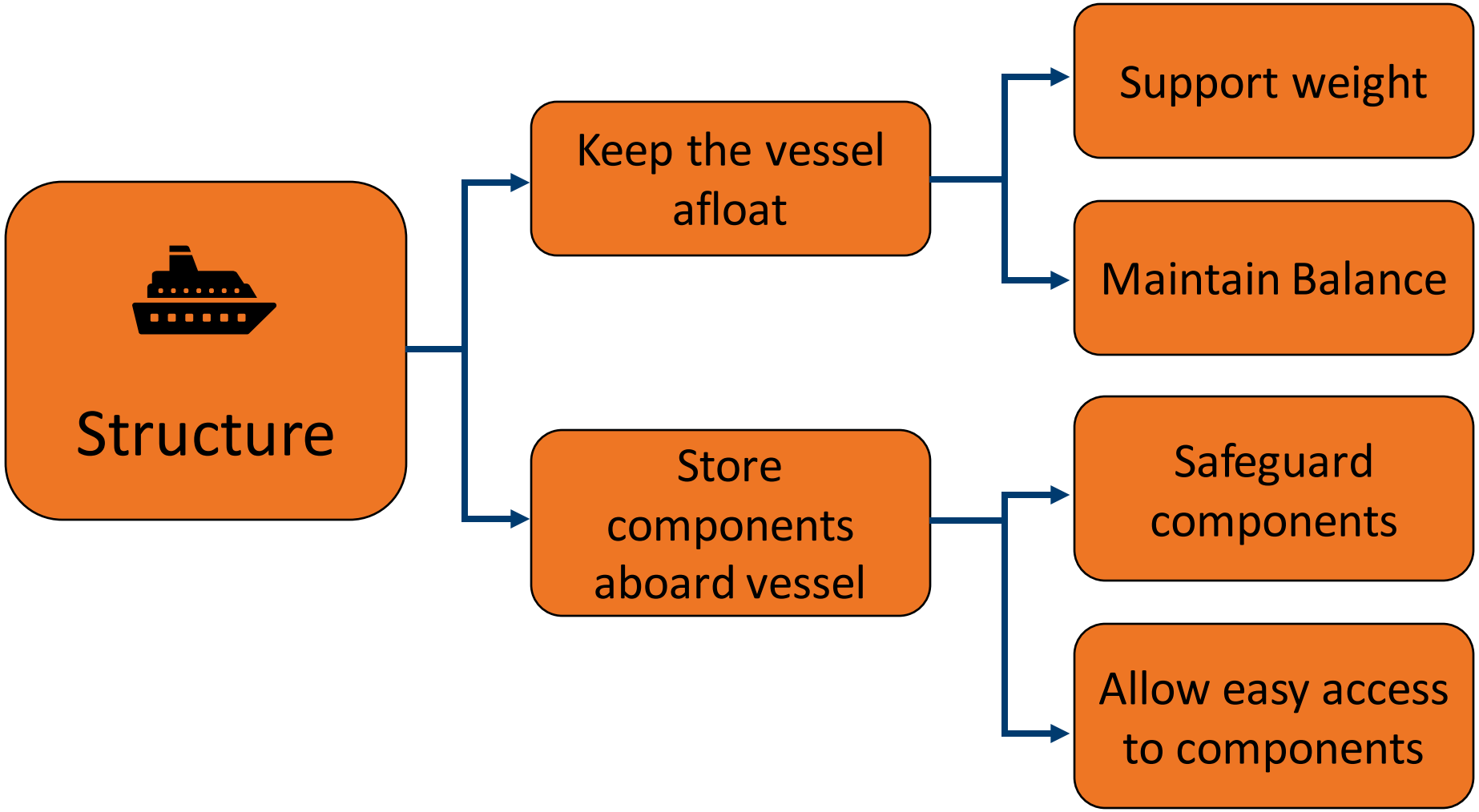

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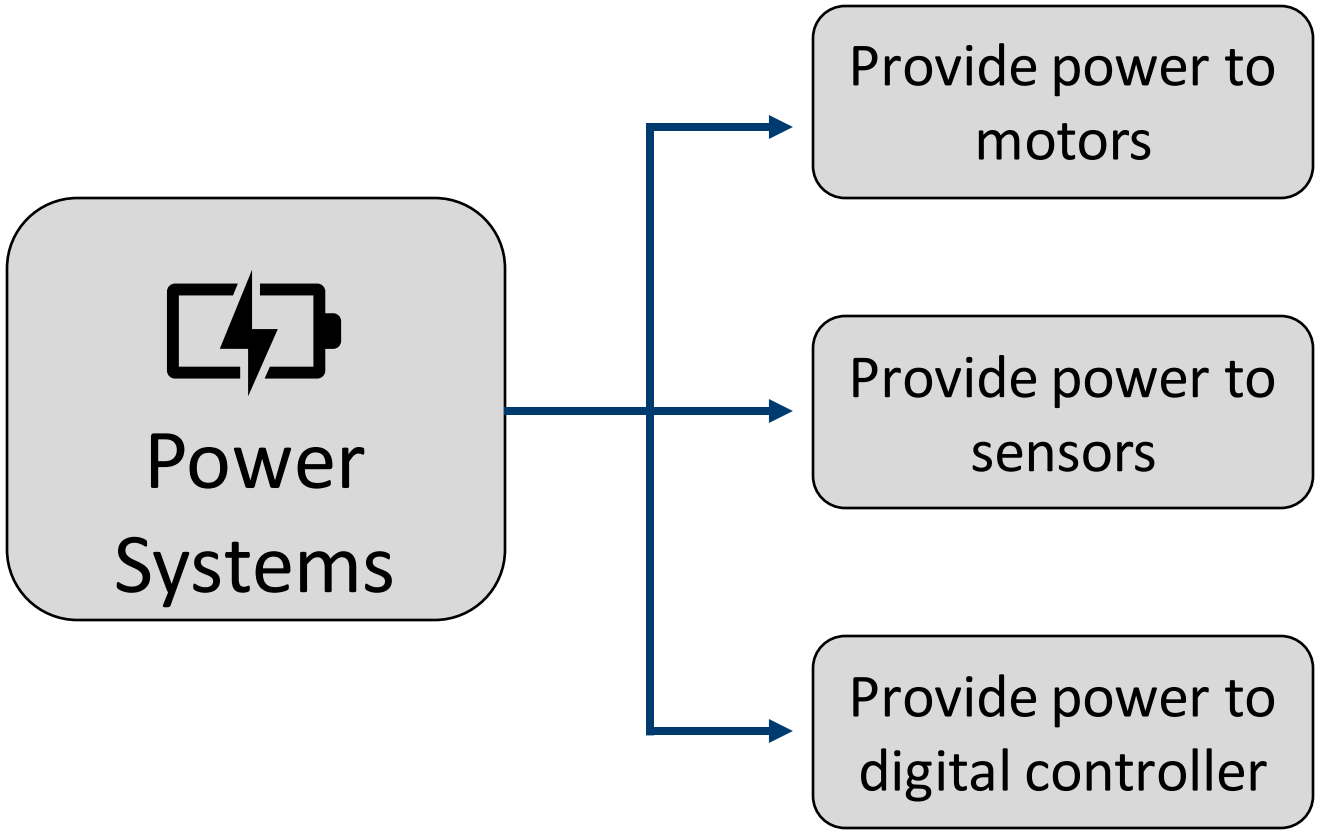
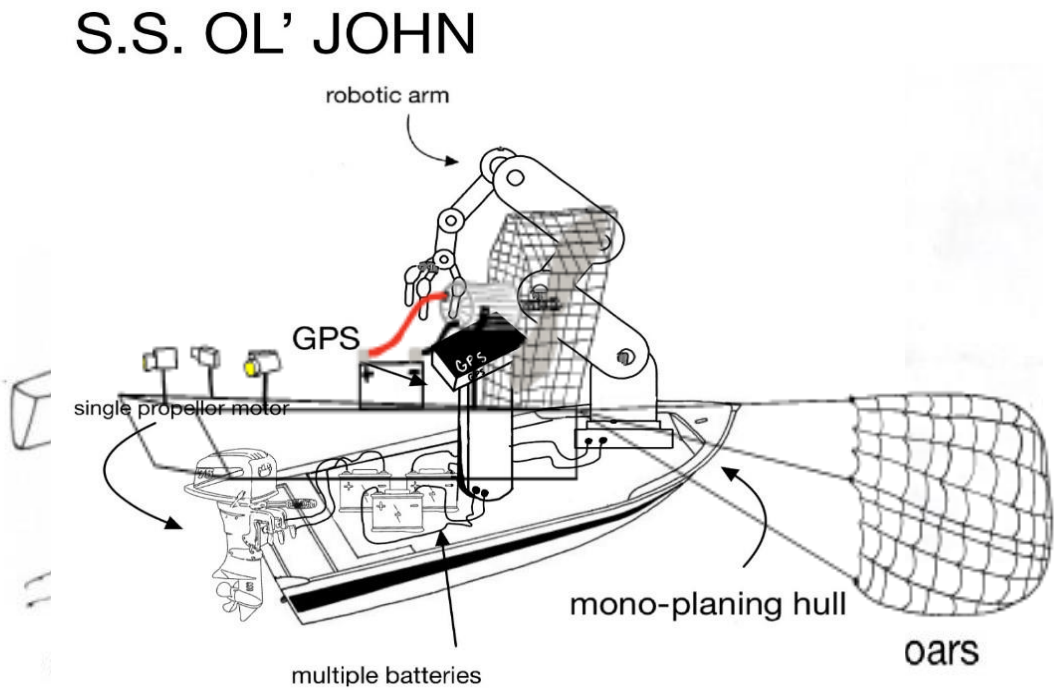


Michael
Fitzsimmons

Medium Fidelity Concepts

- S.S. Galley
- S.S. Ordonomy
- S.S. Hooker V1
- S.S. Air Goose
- S.S. Ol' John



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Sophia Barron

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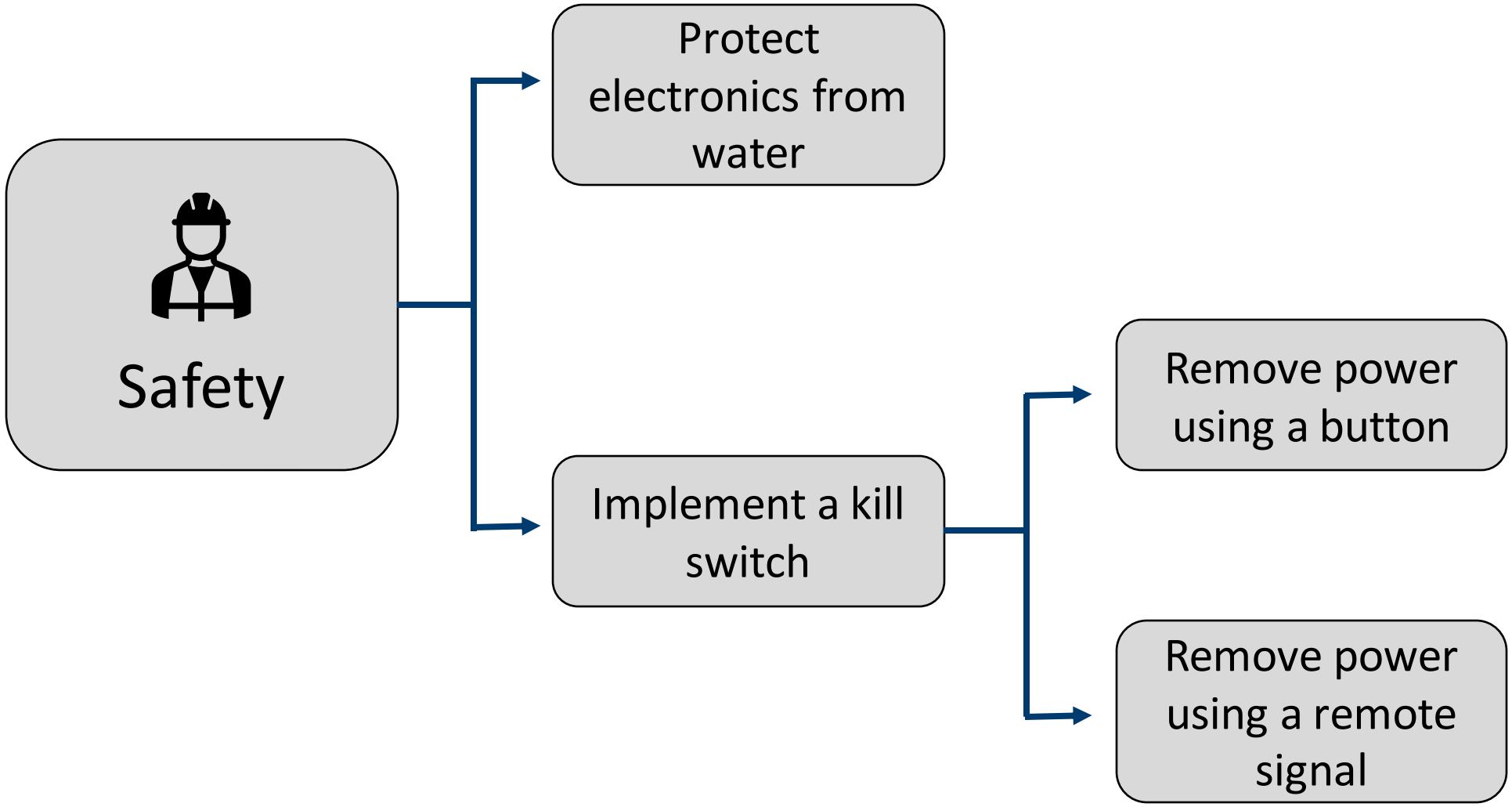

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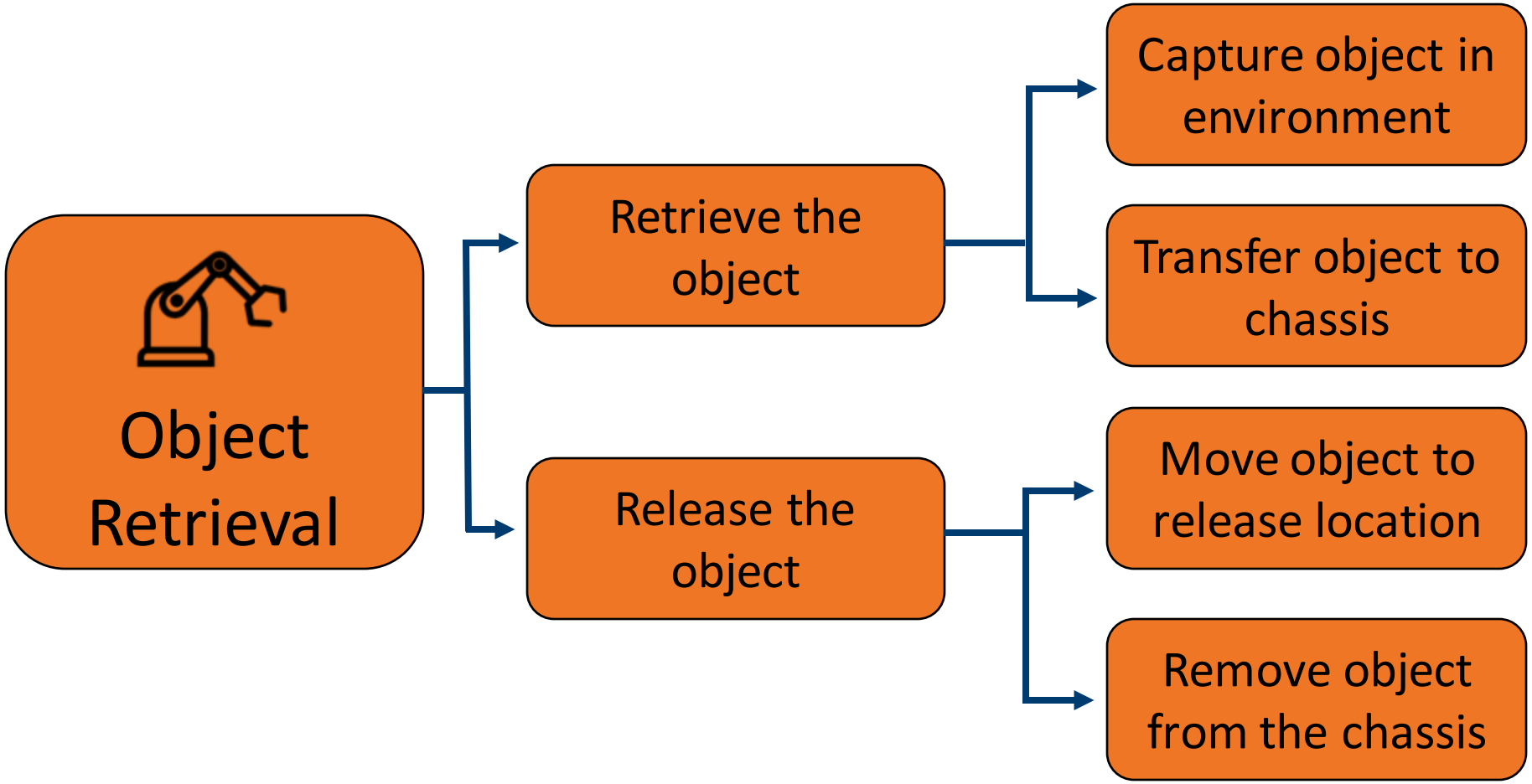

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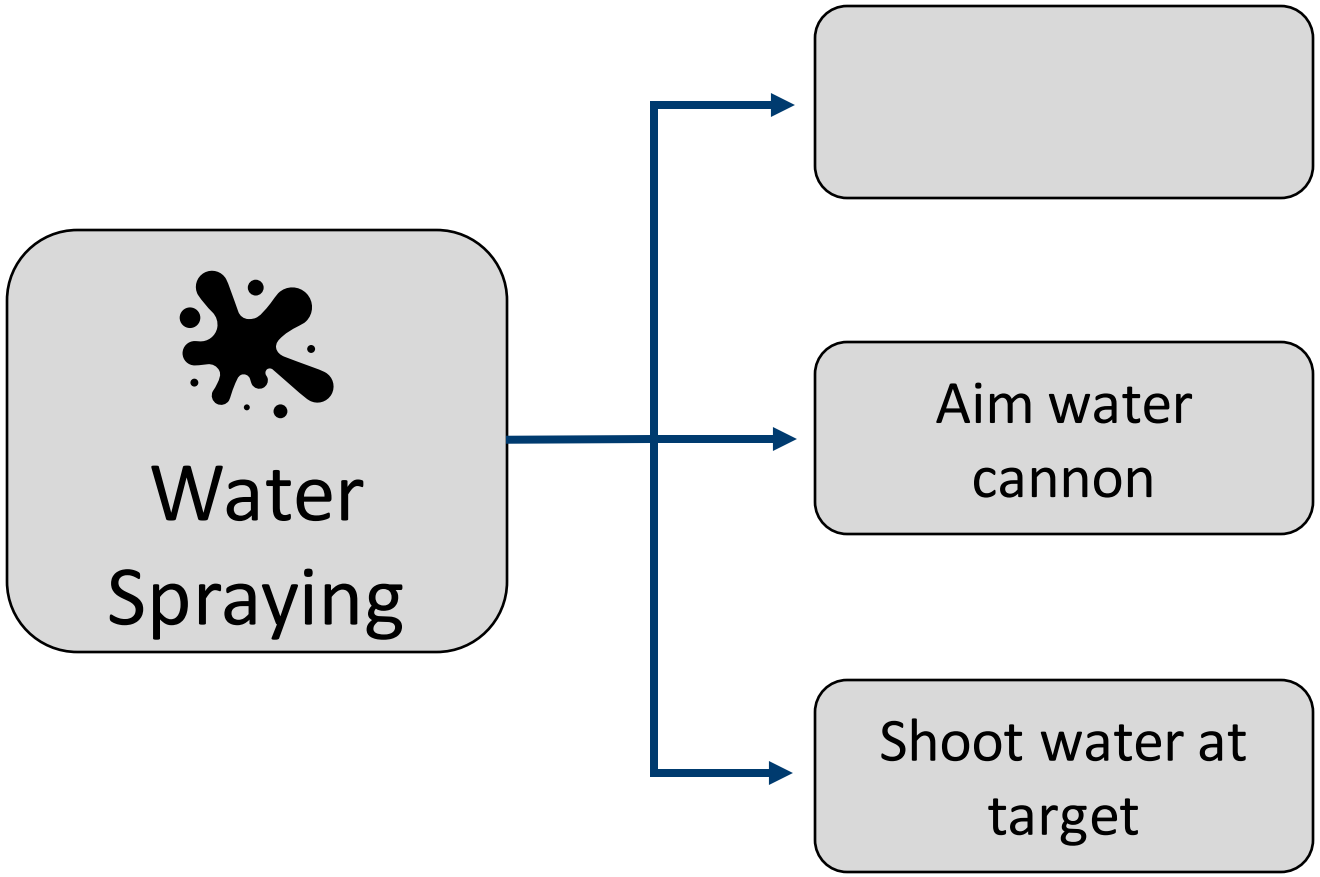

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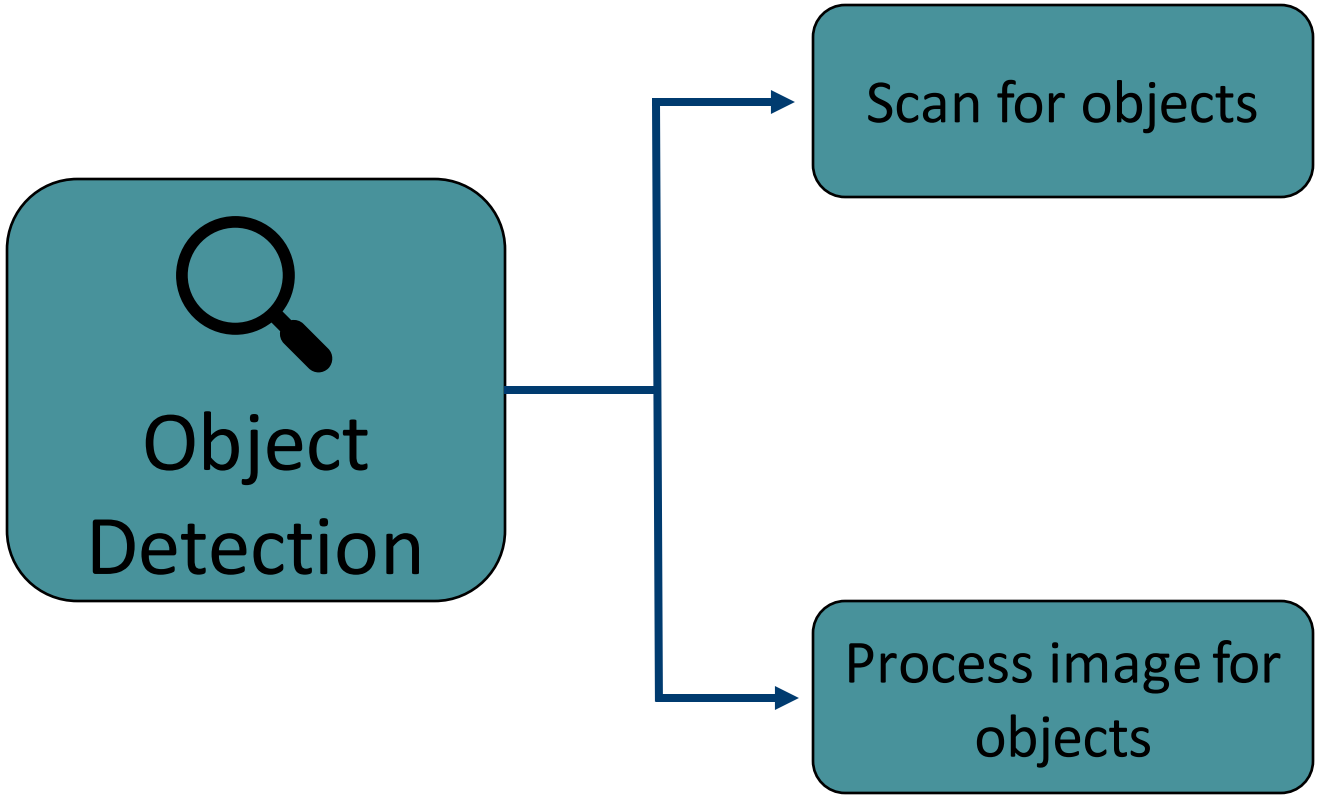

Near Future Work

- Start working on robot localization
  - Test different GPS module (found in Senior design room)
  - Draft navigation code diagram
  - Test different obstacle aversion methods on prototype
- Test given thrusters (PCB Campus)
- Start drafting and testing kill switches
  - Remote with RC transmitter
  - Physical with push button

Future Work

- Start working on materializing chosen structural design
- Start working on camera object detection
  - Geometric segmentation: Recognizing shapes
  - Semantic segmentation: Object class (Ducks, buoy, etc)
- Integrate different functional systems
  - I.e navigation w/ locomotion and object detection
- Preliminary electrical calculations/schematics
  - Power supply calculations
  - Overall block diagrams
- Finalize first draft of test code for the Autonomous navigation portion of ASV

Primary Markets

NAVSEA
NAVAL SEA SYSTEMS COMMAND

Ivanna
Caballero

Secondary Markets

INSANE BOATS

BOSTON WHALER®

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Stakeholders

NAVSEA
NAVAL SEA SYSTEMS COMMAND

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Markets

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Michael
Fitzsimmons

Medium Fidelity Concepts

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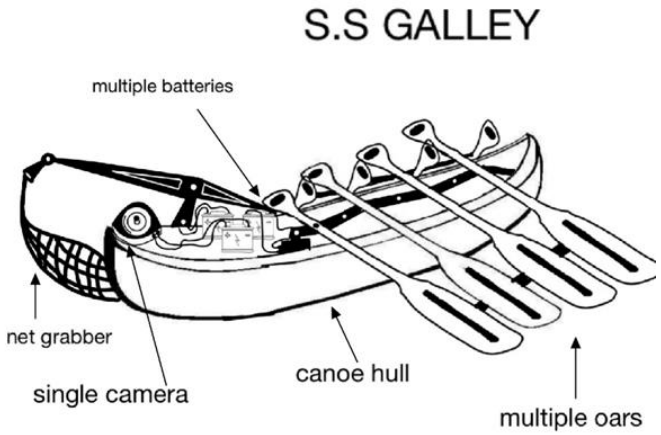
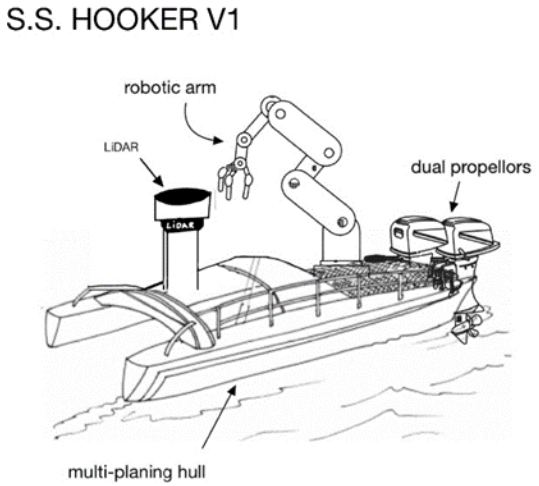
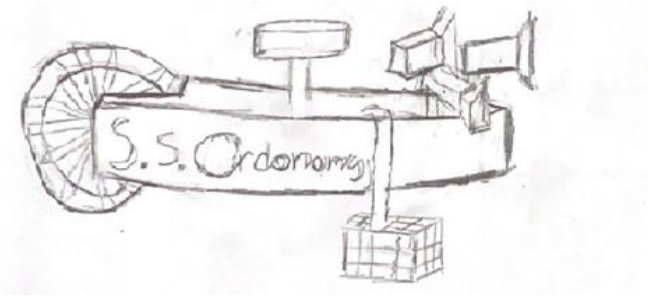
S.S Galley



S.S Hooker V1



S.S Ordonomy



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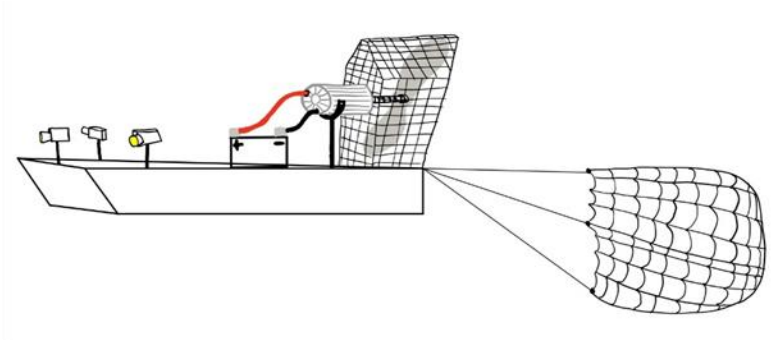
S.S Air Goose



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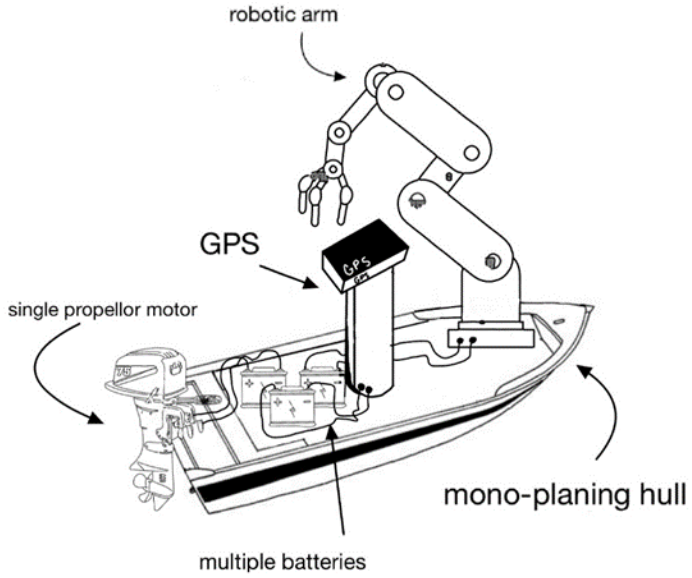

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5 Medium Fidelity Concepts

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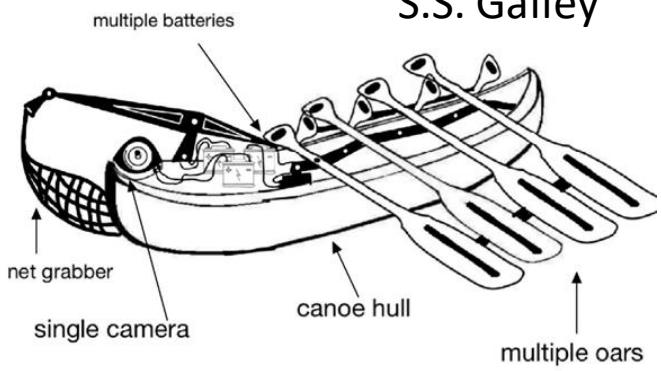

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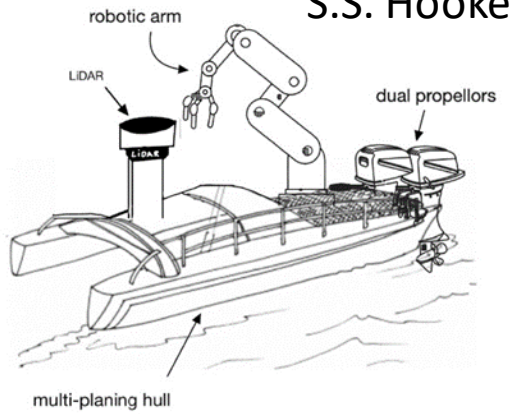

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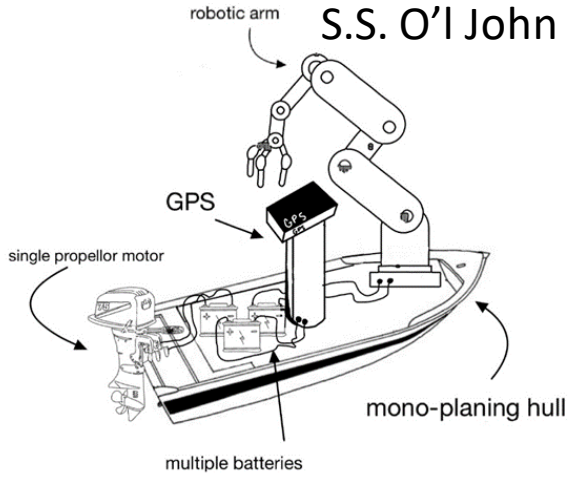

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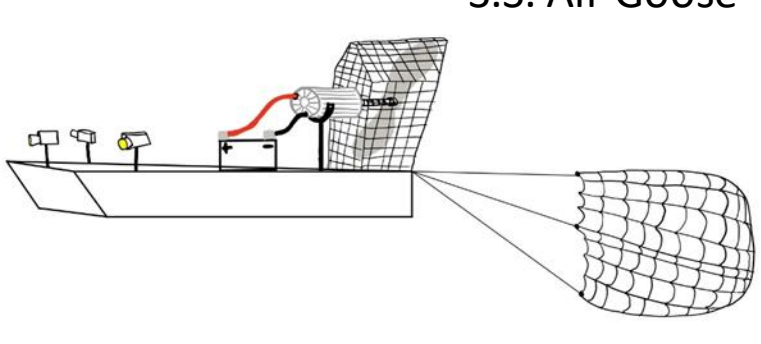

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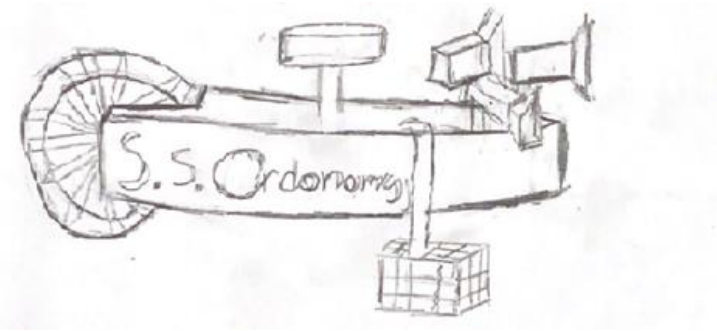

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Fitzsimmons

High Fidelity Concepts

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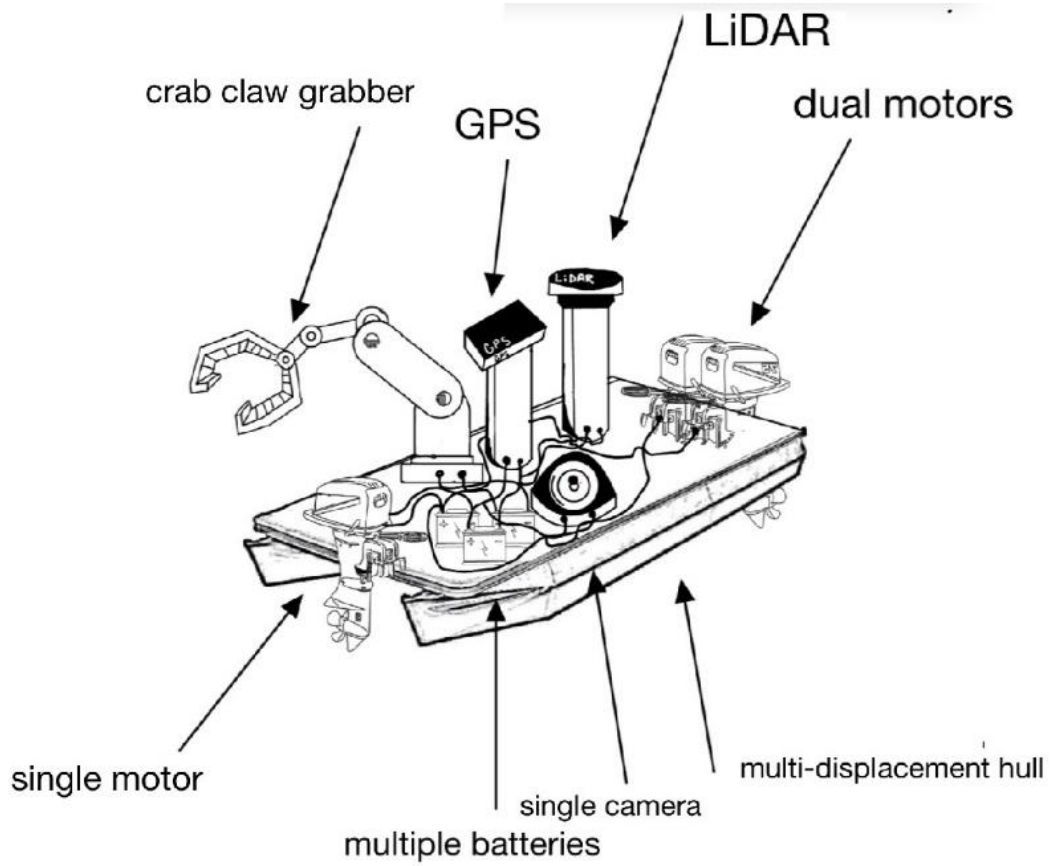
Michael Fitzsimmons

S.S. Shayne 1.0

- Multi-displacement hull
- Dual rear propellers
- Single front propeller
- GPS, camera, and Lidar
- Crab claw grabber
- Multiple batteries



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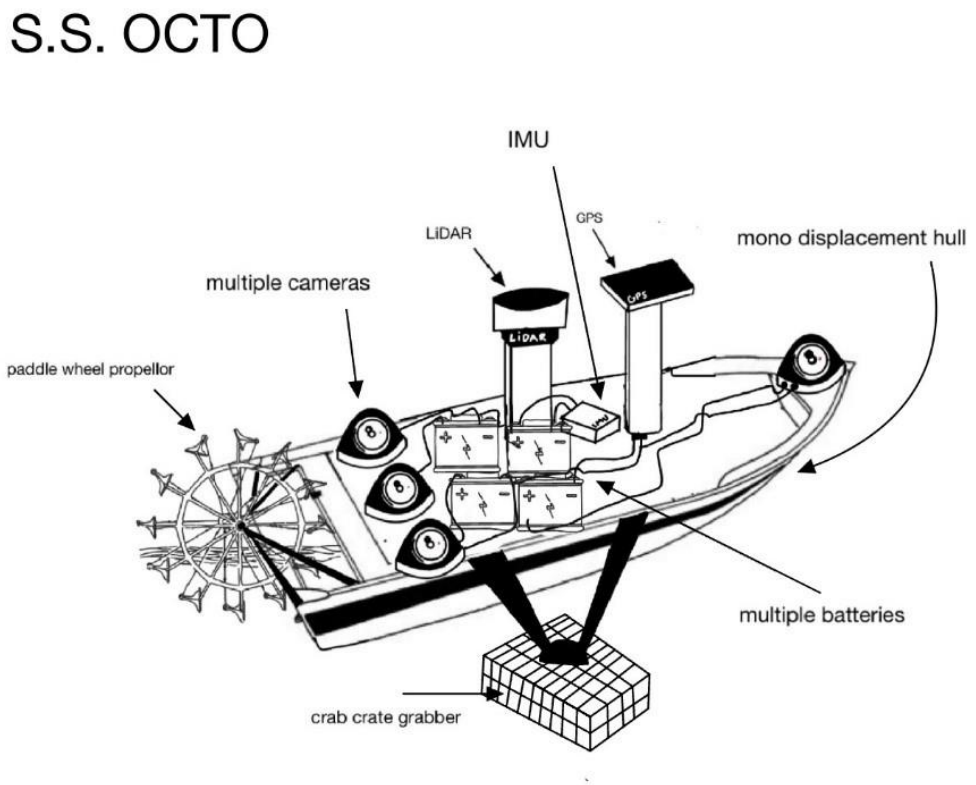
S.S. Octo

- Mono-displacement Hull
- Paddle wheel propeller
- Multiple cameras
- GPS, Lidar, IMU
- Crab crate
- Multiple batteries



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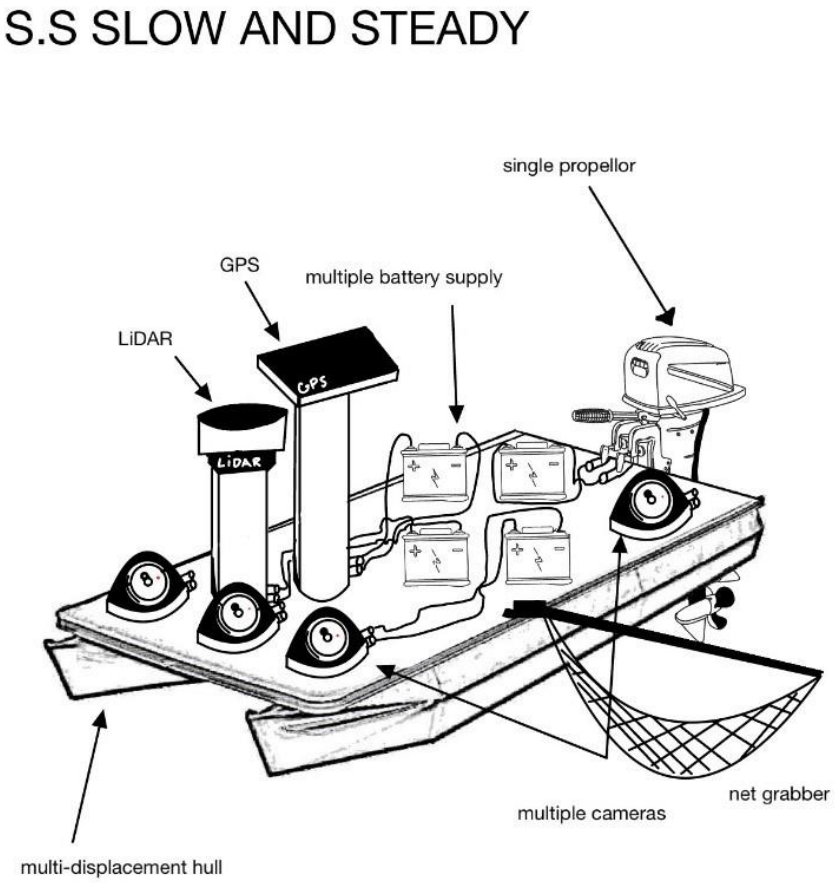
S.S. Slow N' Steady

- Multi-displacement hull
- Single propeller
- GPS & Lidar
- Multiple batteries
- Multiple Cameras
- Net Grabber



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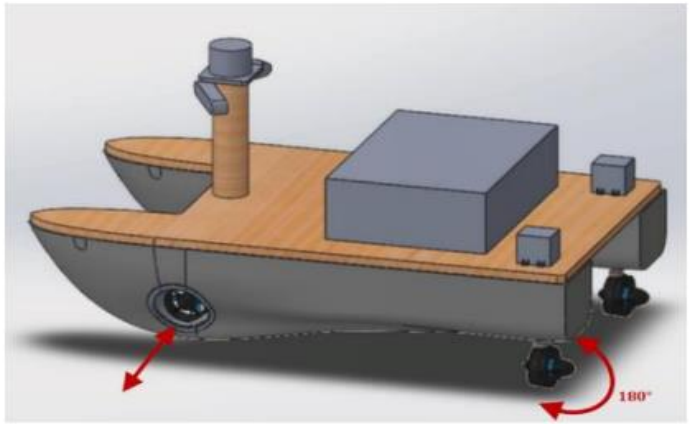
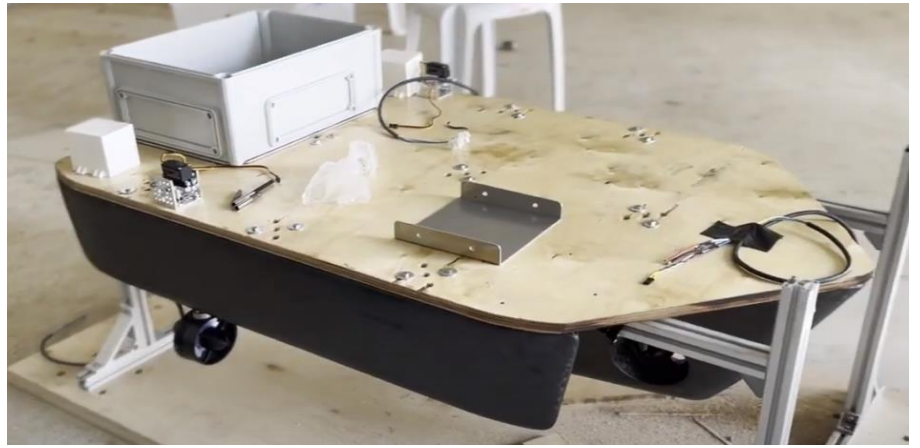
Nicholas
Norwood

Pugh Charts – Tel Aviv





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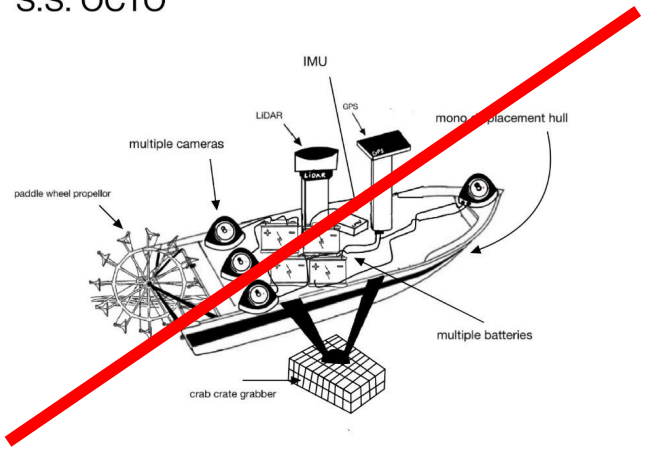
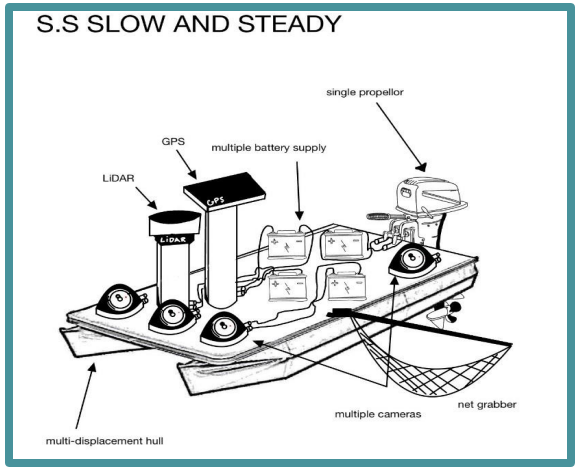
Nicholas Norwood

Pugh Charts – 1st Iteration

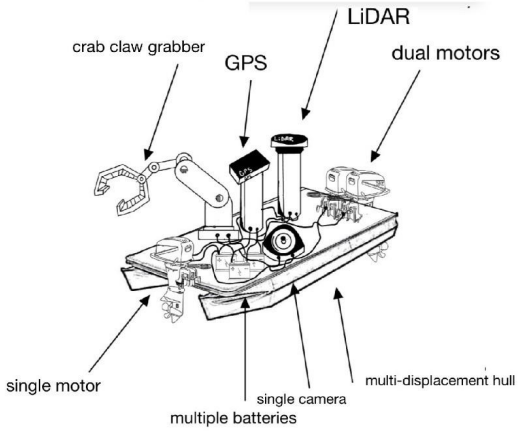
S.S. OCTO



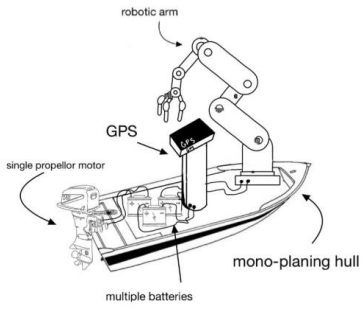
S.S SLOW AND STEADY



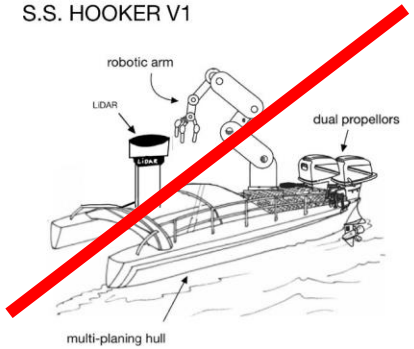
S.S. SHAYNE 1.0



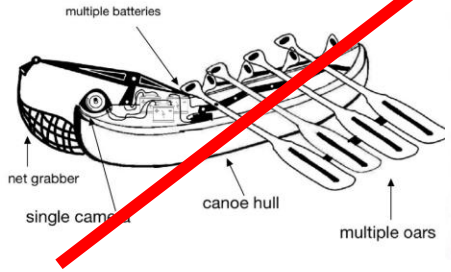
S.S. OL' JOHN



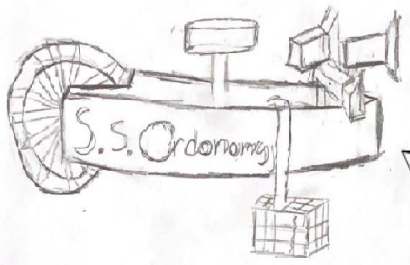
S.S. HOOKER V1



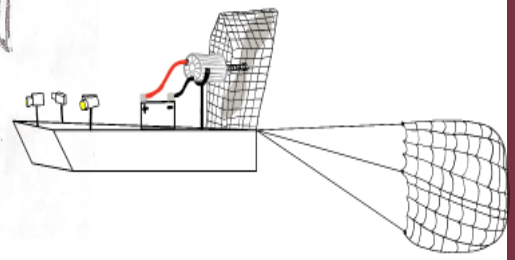
S.S GALLEY



S.S. Ordonomy



S.S. Air Goose



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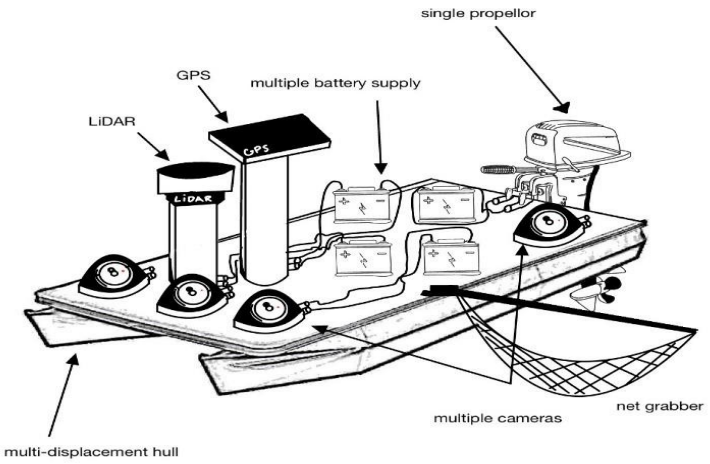
Nicholas Norwood

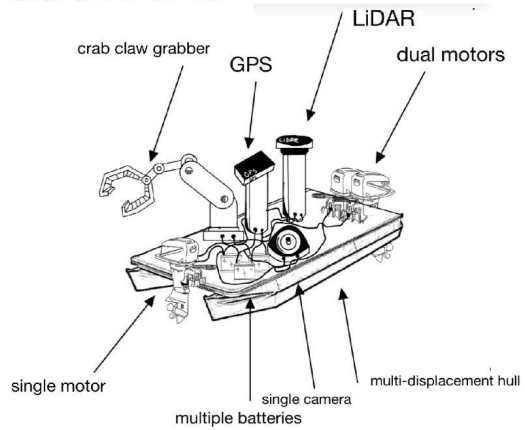
Pugh Charts – 2nd Iteration

New Datum

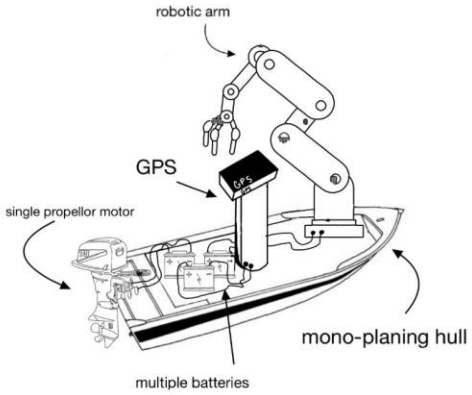
S.S SLOW AND STEADY



S.S. SHAYNE 1.0



S.S. OL' JOHN



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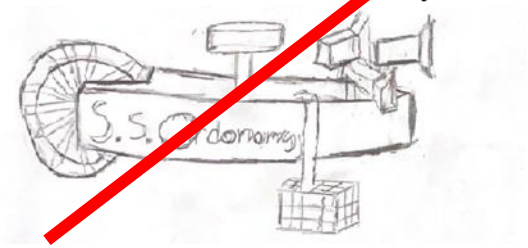
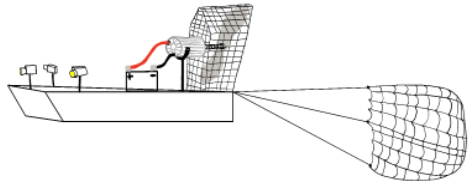


S.S. Air Goose



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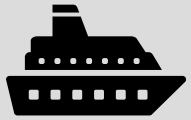
Functional Decomposition

Locomotion

Navigation



Structure

Power Systems

Safety

Object Retrieval

Water Spraying

Object Detection

Functional Decomposition


Locomotion


Navigation


Structure


Power Systems


Safety


Object Retrieval


Water Spraying


Object Detection

Functional Decomposition

Locomotion

Navigation

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Power Systems

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Water Spraying

Object Detection

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Locomotion

Navigation

Structure

Power Systems

Safety

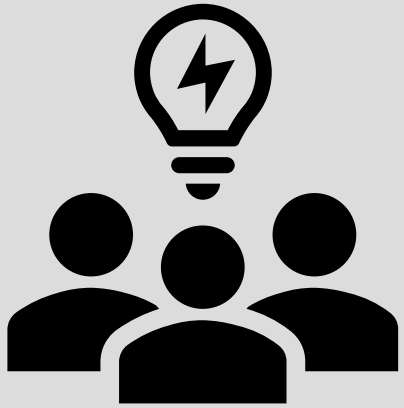
Object Retrieval

Water Spraying

Object Detection

Michael
Fitzsimmons

Concept Generation



100 Concepts

5 Medium Fidelity

3 High Fidelity

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Critical Targets and Metrics

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Norwood

Concept Selection

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Concept Selection

Customer Needs	Weight
Stability	9
Cost Stays Within Budget	8
Modular Components	6
Weight	6
Size Within Competition Rules	5
Navigation	5
Run Time	3
Object Detection	2
Autonomy	1
Object Retrieval	0

Target	Priority
Battery Power	1
Buoyancy	2
Sensor Resolution	3
Size	4
Weight	5
Navigation	6
Deflection Angle	7

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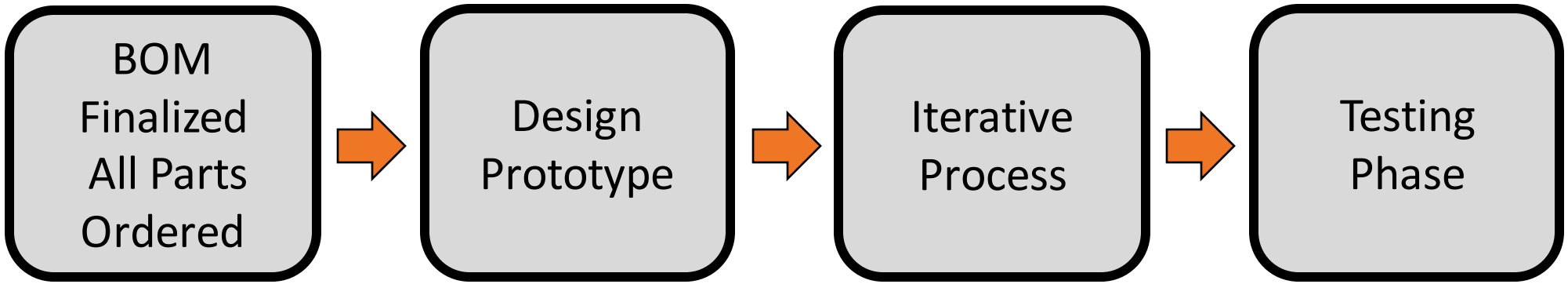
Engineering

Future Work and Timeline



- This is 10-point
- This is 15–point Times
- This is 20–point
- This is 25–point
- This is 30–point
- This is 35–point
- This is 40–point
- This is 50–point
- This is 60–point

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