Solar Splash
Senior Project I Presentation

December 2nd, 2020

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Advisors:
Dr. Norman Asper
Dr. Karen Yan
Regina Cadillac

Lauren DeSimone
Daniel Johnson (DJ)
Eliza Sweet
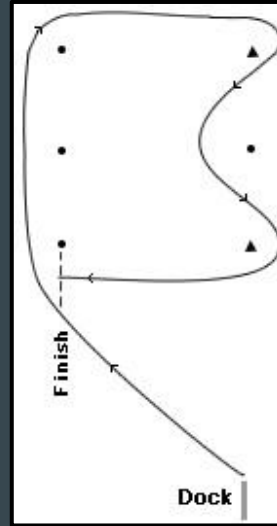Christopher Taylor

Volunteer:
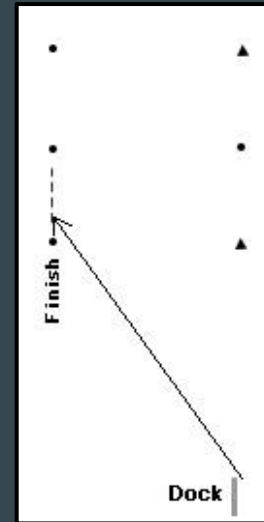Nick Moriello

Solar Splash Competition

- Springfield, Ohio
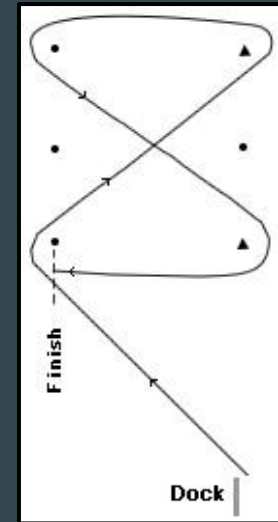- June 8th-12th, 2021

Competition Events

- Qualifying - Eligibility
- Endurance - Efficiency (2000 meters)
- Sprint - Maximum Speed (300 meters)
- Slalom - Maneuverability

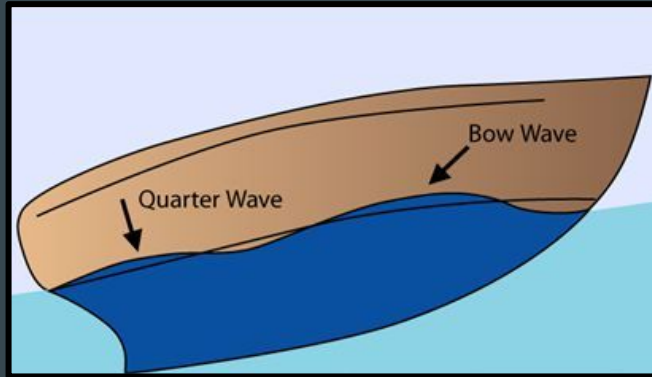Endurance Qualifier

Sprint Qualifier

Slalom

Weight Distribution & Hull
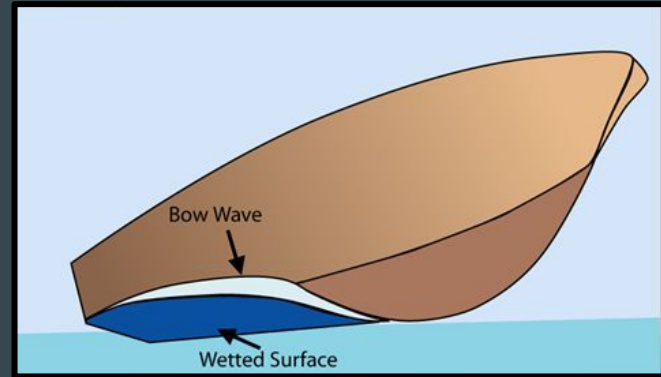
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Lauren DeSimone

Weight Distribution Objective

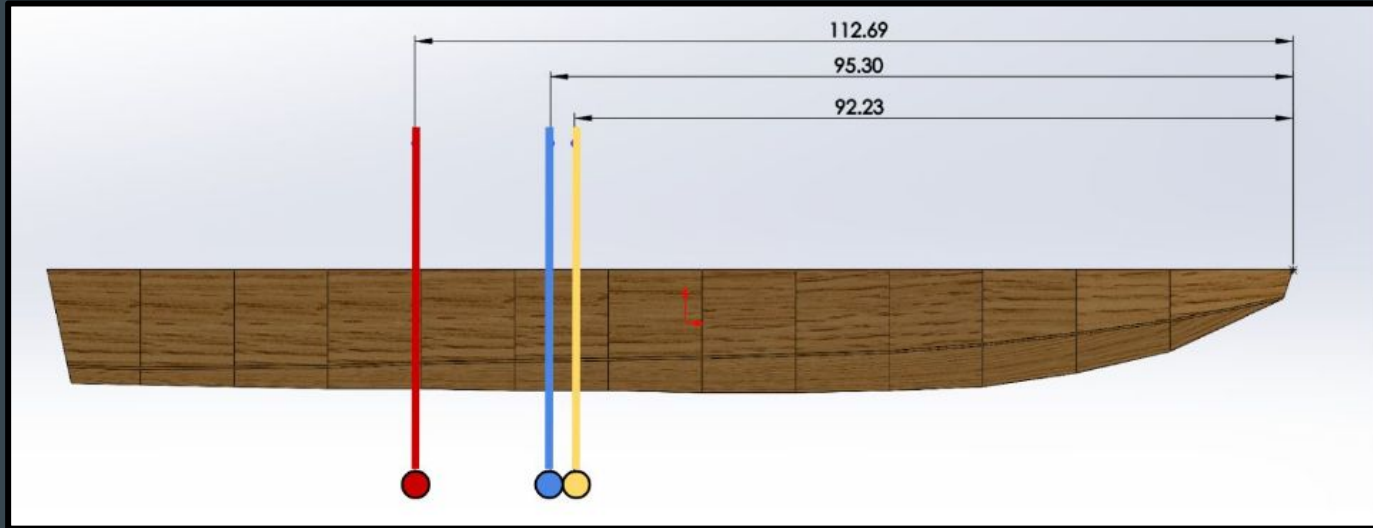### Displacement Hull

- Endurance Event
- Greater Range
- Requires less power from motor
- More comfortable

Planing Hull

- Sprint and Slalom Event
- Generates Lift
- Good maneuverability
- Higher Speed

Previous Weight Distribution

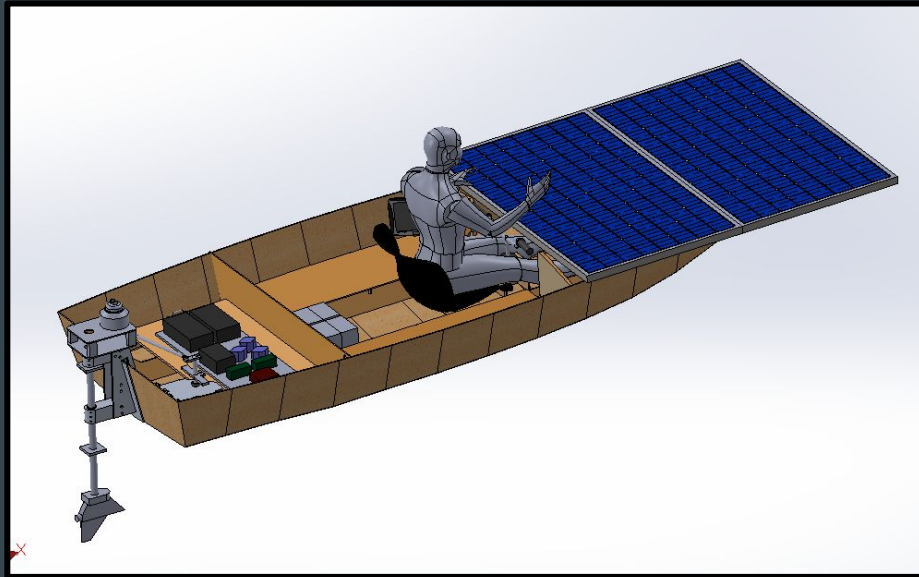Sprint COG

Endurance COG
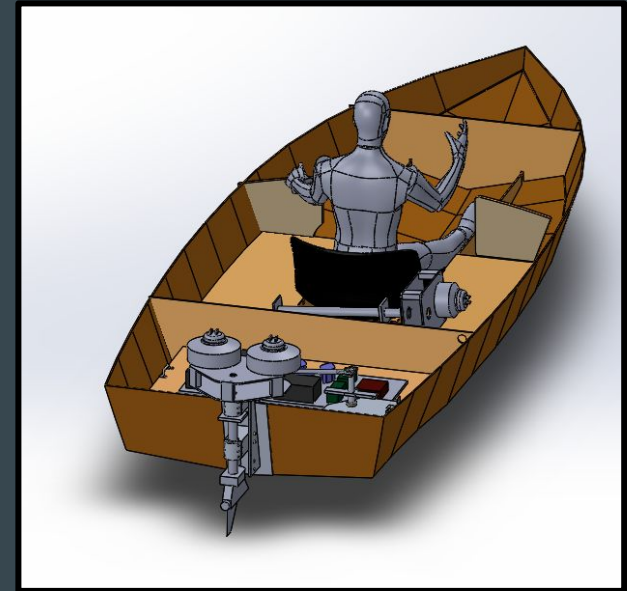
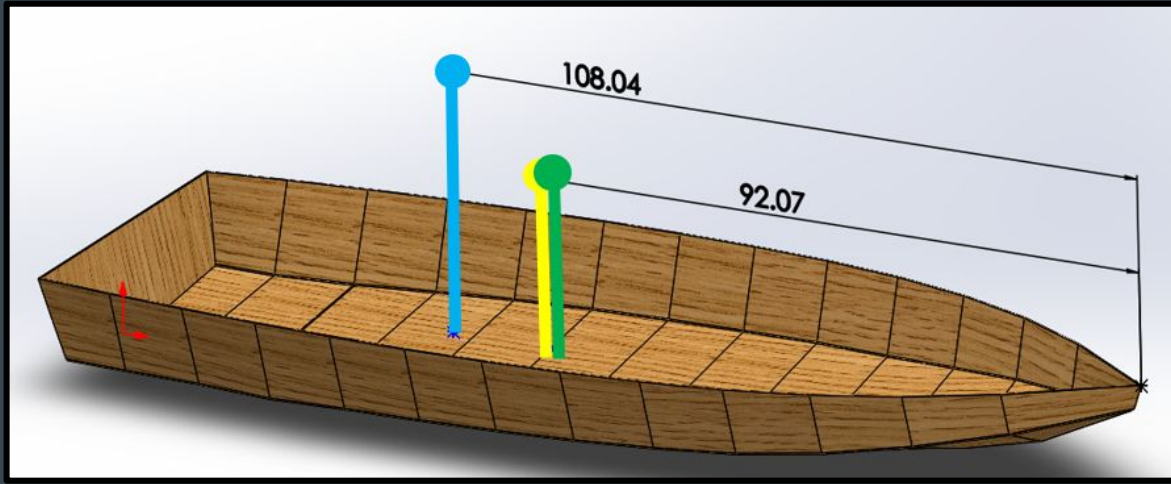Center of Flotation

New Weight Distribution Schematics

Endurance Event
Displacement Hull

Sprint/Slalom Event
Planing Hull

New Weight Distribution


108.04

92.07

Sprint COG

Center of Flotation

Endurance COG

COG Calculations

Sprint				
Part	Weight of Part (lb)	Distance from Bow (in)	Moment (lb*in)	
Electrical Panels	40	136	5440	
Batteries	80	109.5	8760	
Seat	3	81	243	
Driver	145	81	11745	
Steering	4	75	300	
Ballast	9.3	61	567.3	
Foam (Bow)	7.5	17.5	131.25	
Foam (Decking)	8.1	99	801.9	
Fire Extinguisher	3.25	73	237.25	
Toughbook	2	75	150	
Telemetry Battery	4	69	276	
Sprint Motor	60	161	9660	
Endurance Motor	41	101	4141	
Motor Mount	10	161	1610	
Block Mount	10	161	1610	
Driveshaft	4	161	644	
Propeller	9	161	1449	
Propeller Unit	4	161	644	
Stored Propeller	9	61	549	CoG (in)
	453.15		48958.7	108.041

Endurance				
Part	Weight of Part (lb)	Distance from Bow (in)	Moment (lb*in)	
Electrical Panels	40	136	5440	
Batteries	80	107	8560	
Solar Panel 1	34	32	1088	
Solar Panel 2	34	70	2380	
Seat	3	81	243	
Driver	145	81	11745	
Steering	4	75	300	
Ballast	9.3	81	753.3	
Foam (Bow)	7.5	17.5	131.25	
Foam (Decking)	8.1	99	801.9	
Fire Extinguisher	3.25	73	237.25	
Toughbook	2	75	150	
Telemetry Battery	4	69	276	
Sprint Motor	60	45	2700	
Endurance Motor	41	161	6601	
Motor Mount	10	161	1610	
Block Mount	10	161	1610	
Driveshaft	4	161	644	
Propeller	9	161	1449	
Propeller Unit	4	161	644	
Endurance Extension	1	161	161	
Stored Propeller	9	61	549	CoG (in)
	522.15		48073.7	92.069

Flotation & Buoyancy

- Competition Constraint : 120% Flotation
- 3.02 ft³ of foam needed
- Currently 7.80 ft³ of foam
- 2.6 Safety Factor
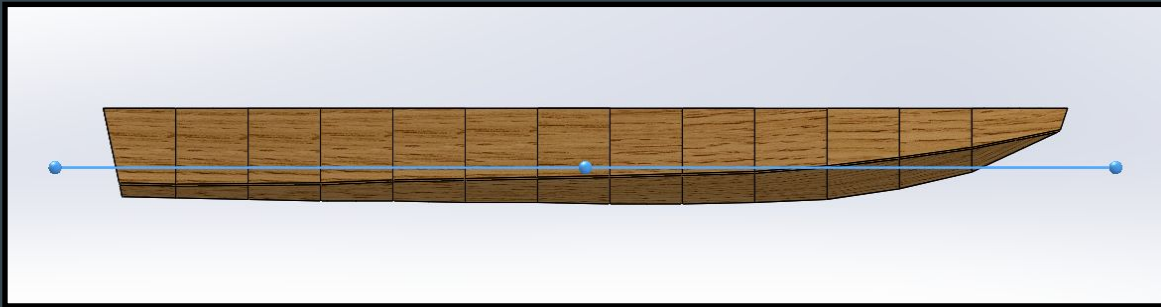
Waterline in Solidworks

Part	Weight of Part (lb)
Electrical Panels	40
Batteries	80
Solar Panel 1	34
Solar Panel 2	34
Seat	3
Driver	145
Steering	4
Ballast	9.3
Foam (Bow)	7.5
Foam (Decking)	8.1
Fire Extinguisher	3.25
Toughbook	2
Telemetry Battery	4
Sprint Motor	60
Endurance Motor	41
Motor Mount	10
Block Mount	10
Driveshaft	4
Propeller	9
Propeller Unit	4
Endurance Extension	1
Stored Propeller	9
Hull	225
Misc.	20
Total	782.75

Future Steps

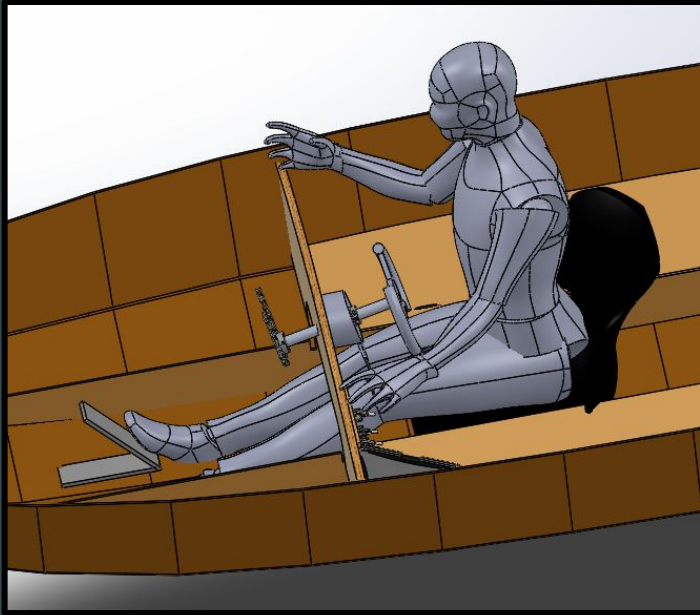- Remove dashboard and pedal
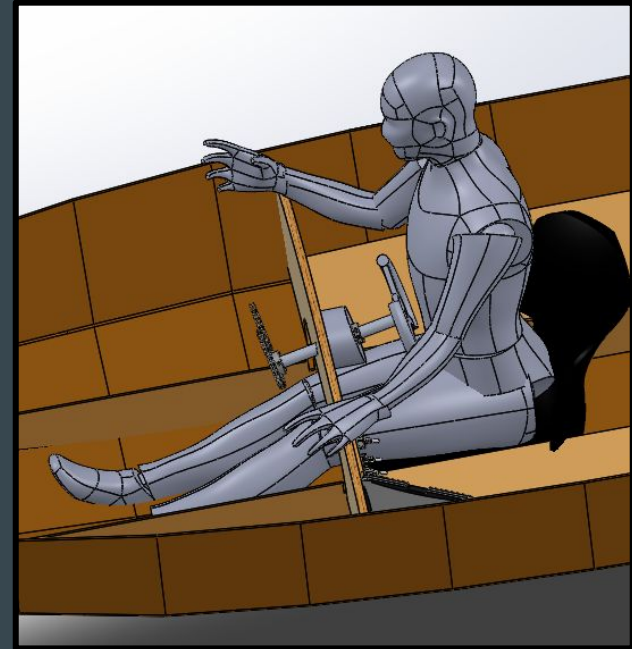- Construct foam mounts for motors

Steering

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Lauren DeSimone

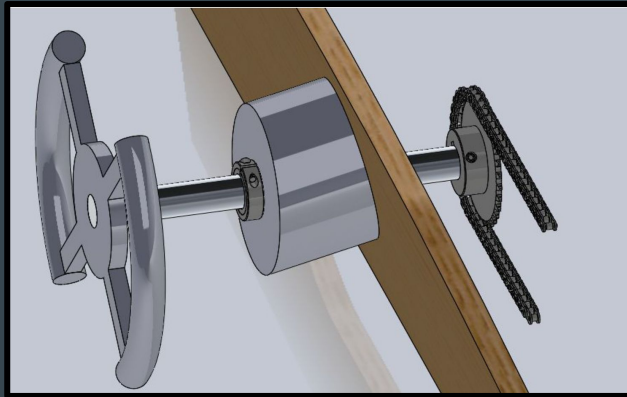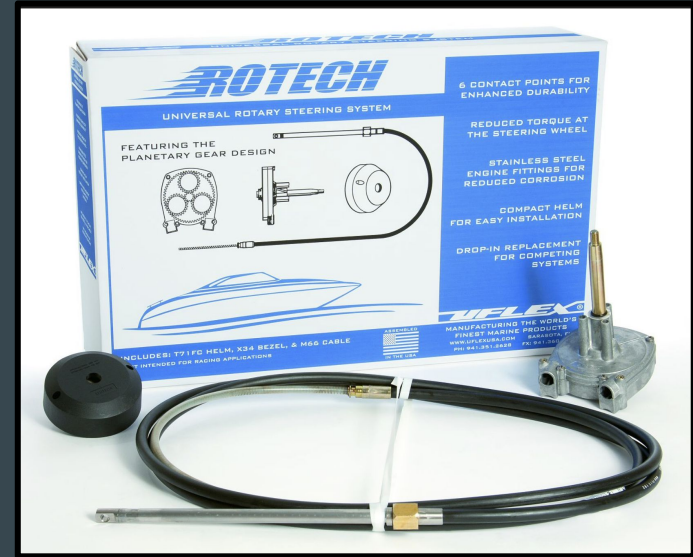# Steering Objective

Current Design

New Design, Skipper 7" up

Steering Improvements

- Chain & Sprocket -----> Push Pull Cable
  - Increased Safety
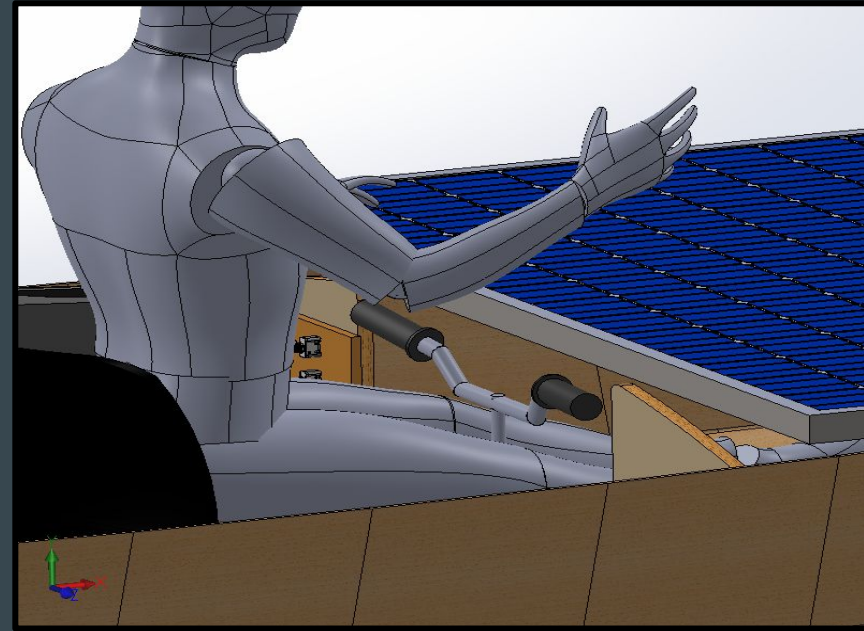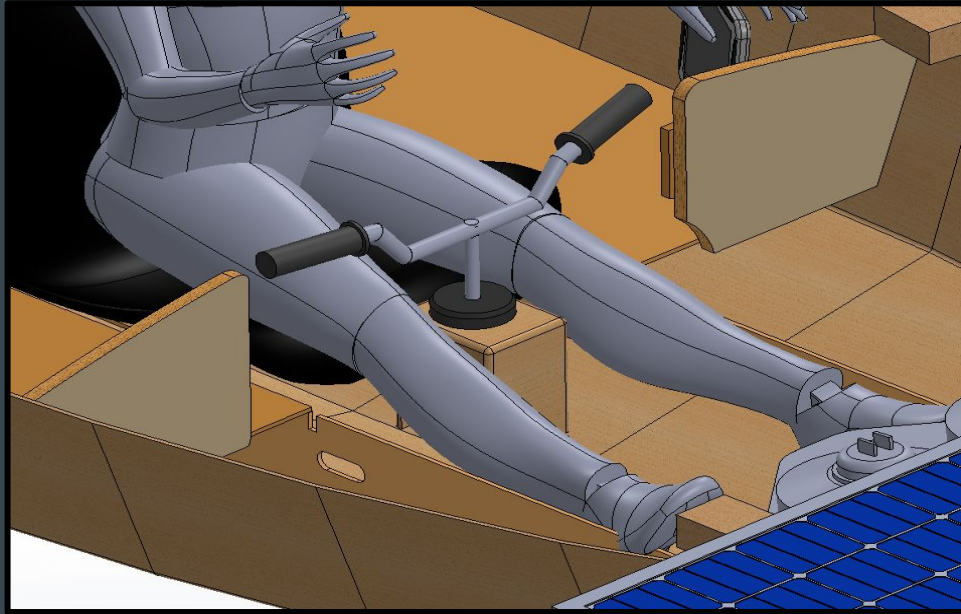 - Better Mechanical Advantage

Previous Chain & Sprocket Design
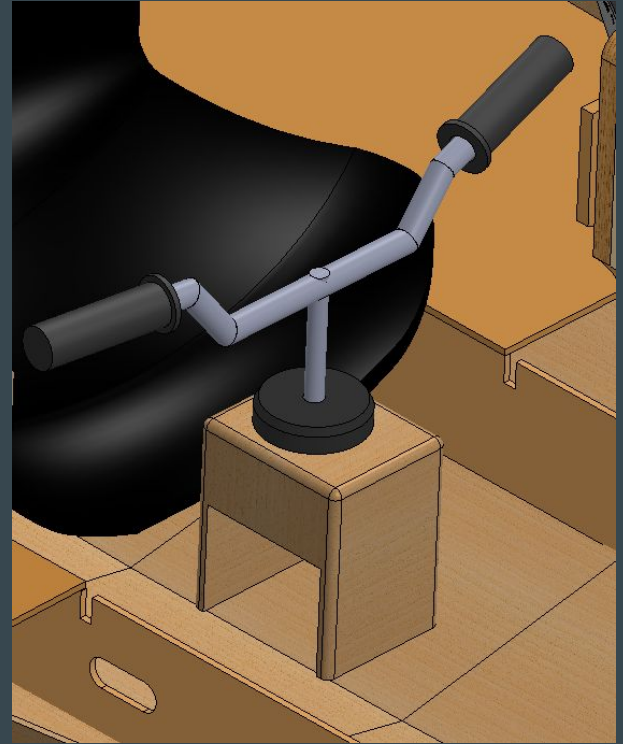

Push Pull Cable

Steering Design

Future Steps

- Construct steering post
- Reshape handlebar
- Install Steering Cables
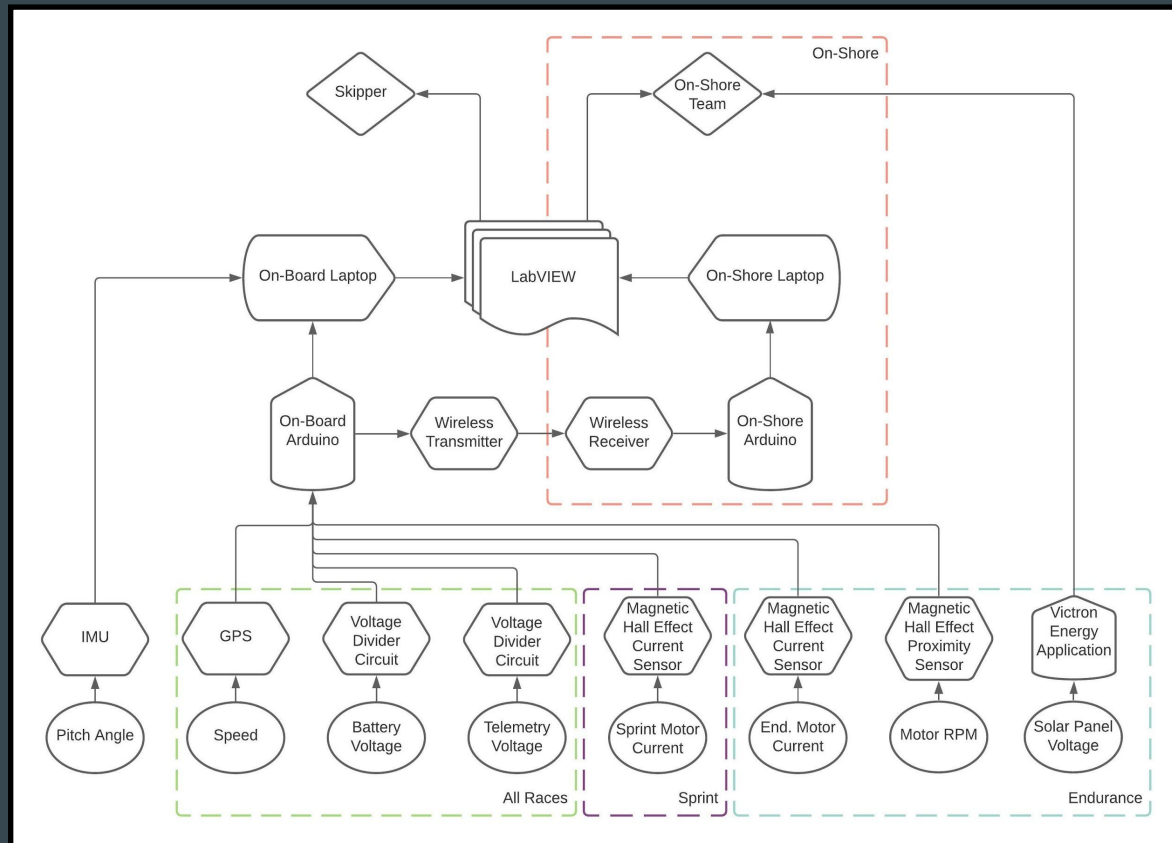

Handlebar from Inventory

Wooden Steering Post

Telemetry System

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Eliza Sweet

Goals & System Flowchart

1. Optimized Data Acquisition
2. Optimized Synchronous Feedback
   ○ LabVIEW
3. Implemented Asynchronous Feedback
   ○ MATLAB

Telemetry Data Collection Flowchart

Preliminary Testing & Optimization

- Hardware/Software Compatibility & Optimization
  - GPS
  - IMU
- Hardware Constraints
  - Voltage Dividers

Optimal Voltage Divider Hardware to Eliminate Microcontroller Damage

Hardware	V_{in} (V)	V_{out} (V)	R_1 (Ω)	R_2 (Ω)
Batteries	36	3.87	83k	10k
Telemetry Battery	12	4.00	10k	5k
Sprint Current	16	3.81	64k	20k
Endurance Current	16	3.95	61k	20k
Endurance Motor RPM	30	4.00	26k	4k

GPS LabVIEW Output

IMU LabVIEW Output

Synchronous Feedback Optimization
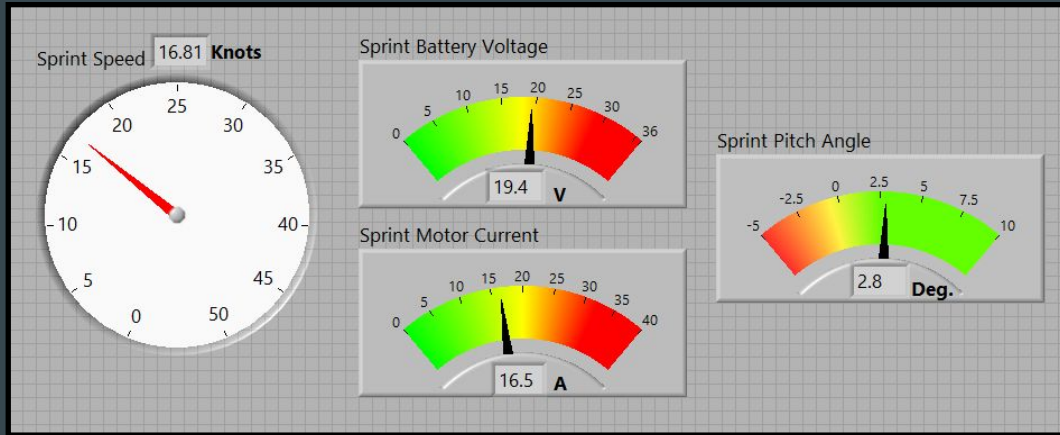
Sprint/Slalom UI
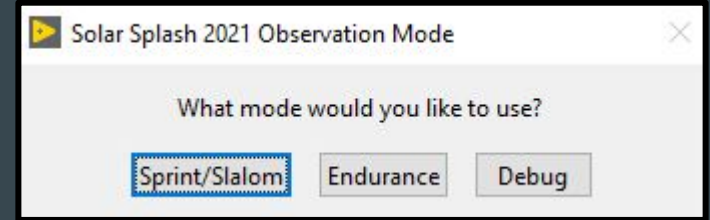
Mode Selection UI

Endurance UI

Upcoming Manufacturing & Implementation

1. Rewire & relabel entire system
2. Implement all current and motor RPM sensors
3. Assemble IMU housing
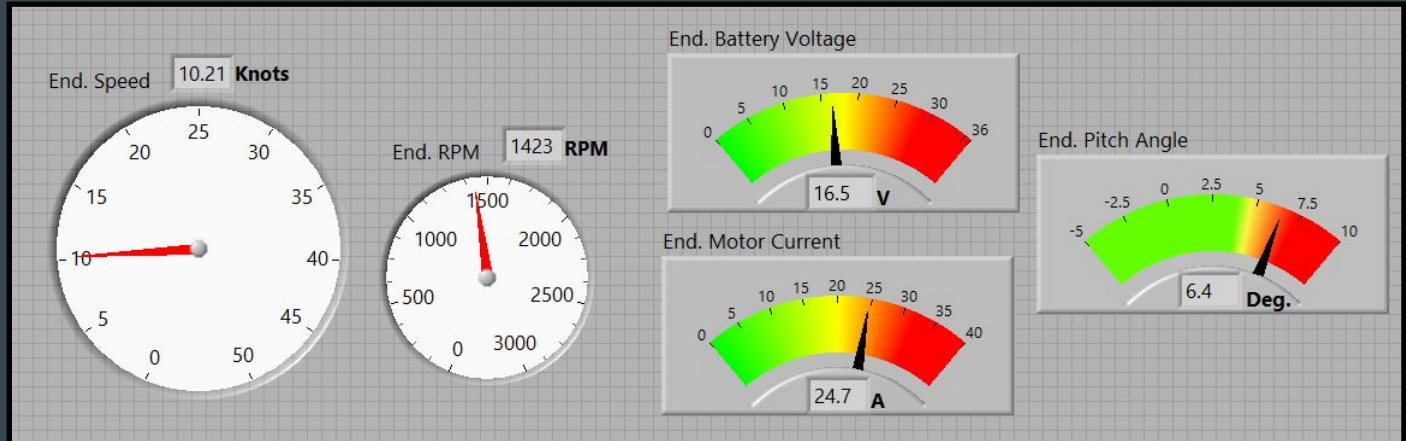
4. Wire pump
5. Program LabVIEW and MATLAB

	TASK TITLE	Member	% OF TASK COMPLETE	WINTER 2020-2021 DECEMBER				JANUARY				SPRING 2021 FEBRUARY				MARCH				APRIL				MAY				SUMMER 2021 JUNE			
				1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
4	Manufacturing																														
4.7	Telemetry Installation	E	1%																										
4.7.1	Rewire and Relabel	E & D	0%																										
4.7.2	Hall Effect Sensors	E	0%																										
4.7.3	Assemble IMU Housing	E	0%																										
4.7.4	Wire Pump	E	0%																										
4.7.5	Program LabVIEW	E	5%																										
4.7.6	Program MATLAB	E	0%																										
5	Integration and Testing																										
5.1	Telemetric Integration	E	0%																										
5.2	Skipper Practice	T	0%																										
5.3	Endurance Practice	T	0%																										
5.4	Sprint Practice	T	0%																										

Telemetry Manufacturing and Integration & Testing Gantt Chart for Spring 2021
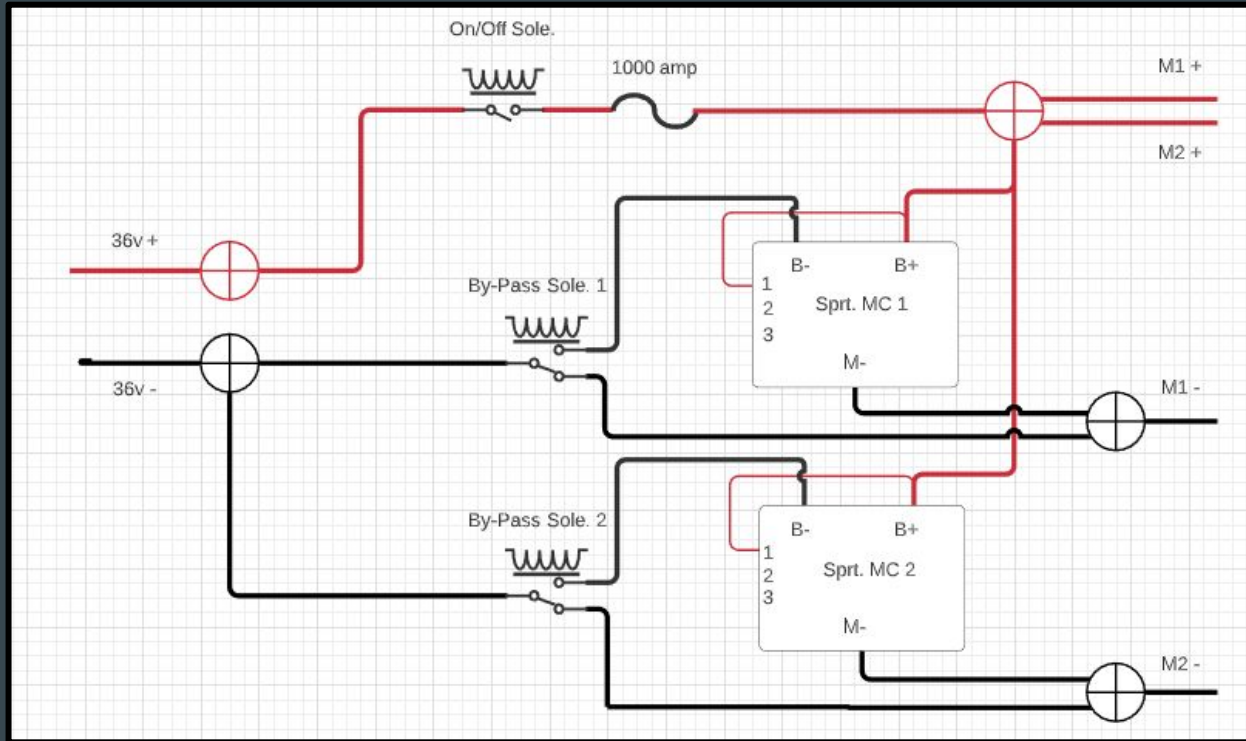
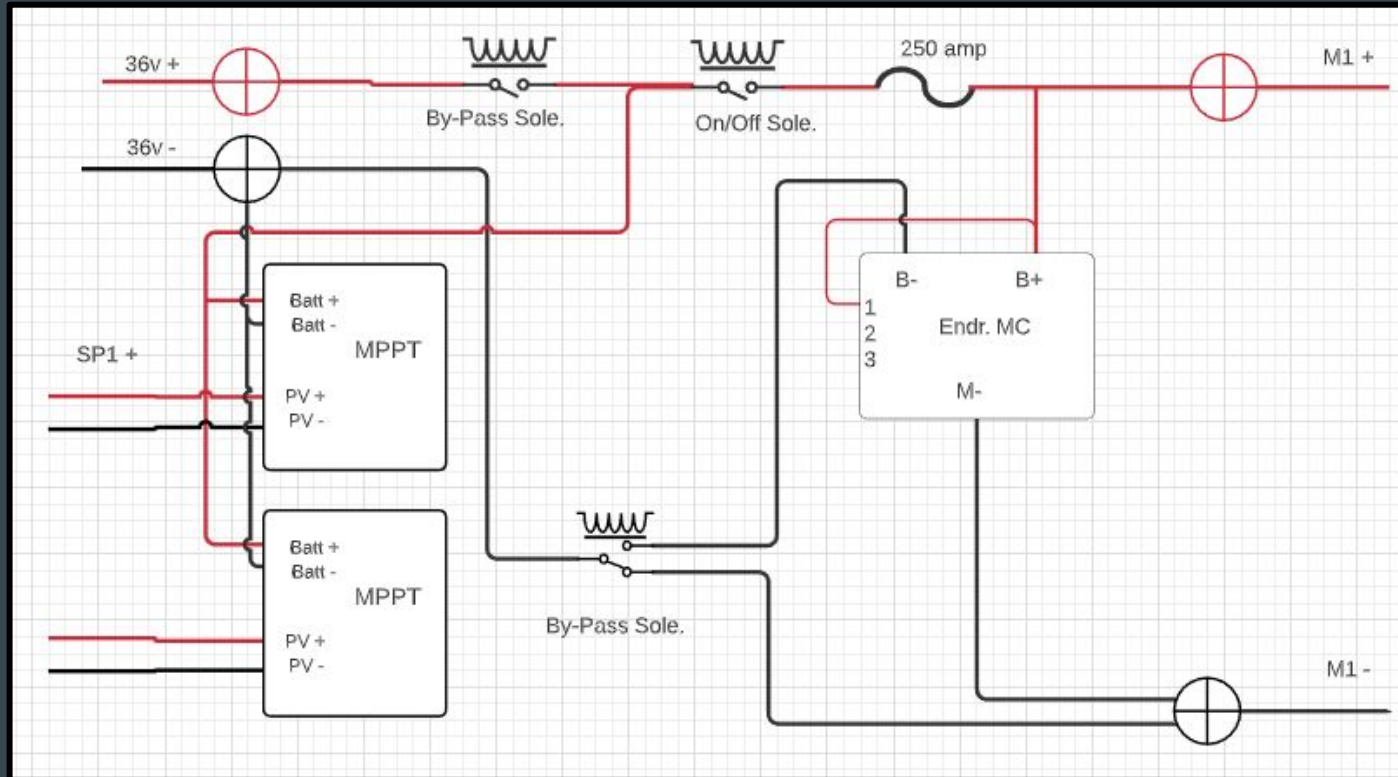# Electrical System

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Daniel Johnson (DJ)

Sprint Configuration

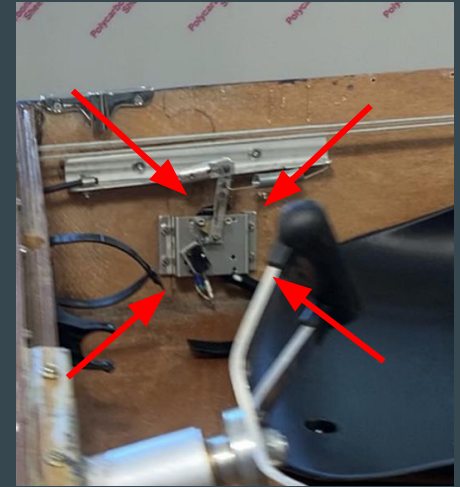*2020-2021 Sprint Configuration*

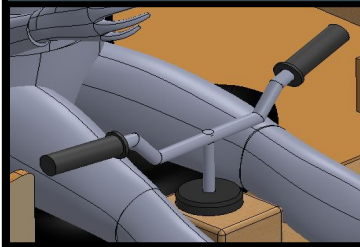# Endurance Configuration

Speed Control and Bypass

2019-2020 Pedal

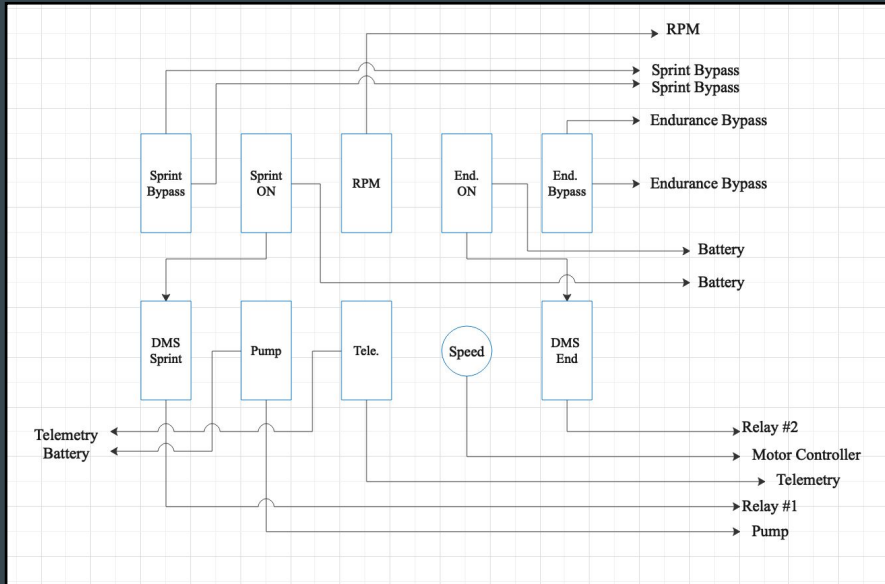*2020-2021 Steering wheel and Throttle*

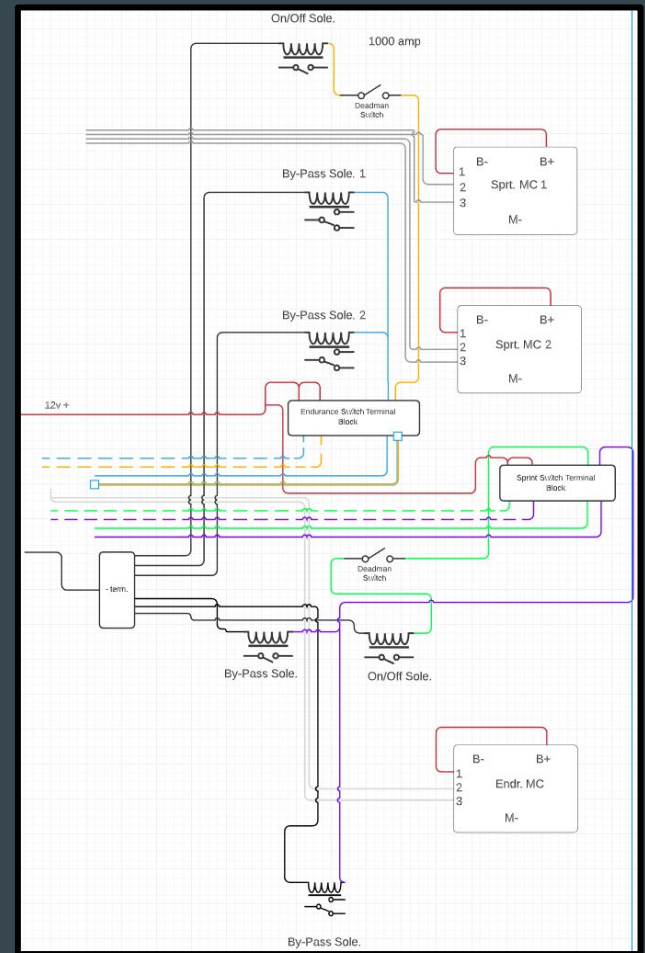*2019-2020 Potentiometer and Micro switch*

Switch Control

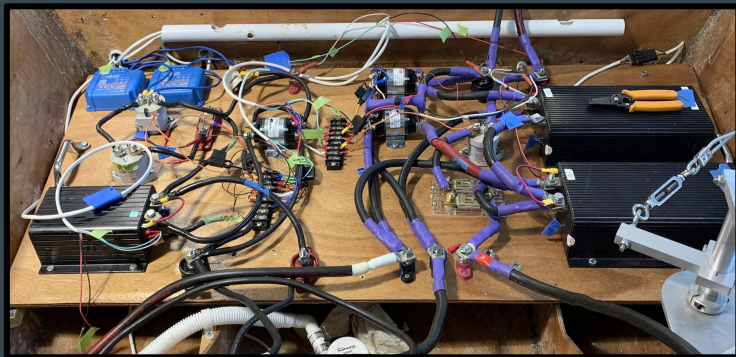*2019-2020 On-Board Switch Panel*

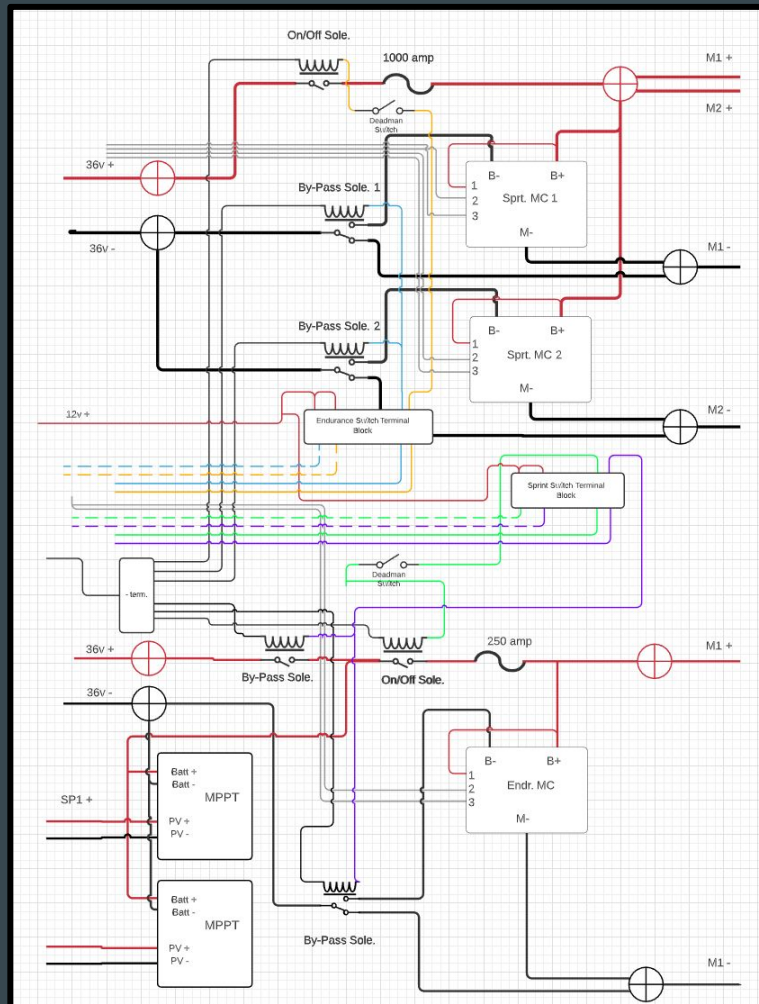*2020-2021 Switch Panel Schematic*

2020-2021 Switch Board wiring

Overall Layout

- Improve wire organization
  - Wire hooks and clamps
  - Label
- Polycarbonate cover
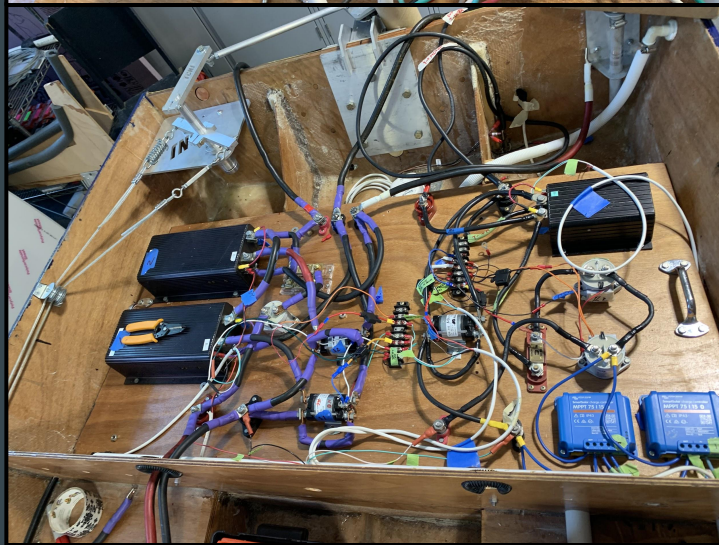- Motor controller board supports

2019-2020 Electrical Board

2020-2021 Electrical Board Layout

Future steps

- Re-Build Electrical Board

- Single Pull Throttle Implementation

- On-Board Control Completion

- Wire Organization

- Polycarbonate Cover

- Wooden Board Supports

Motor Mounts

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Christopher Taylor

Motor Mounting

1. Updated Blocks

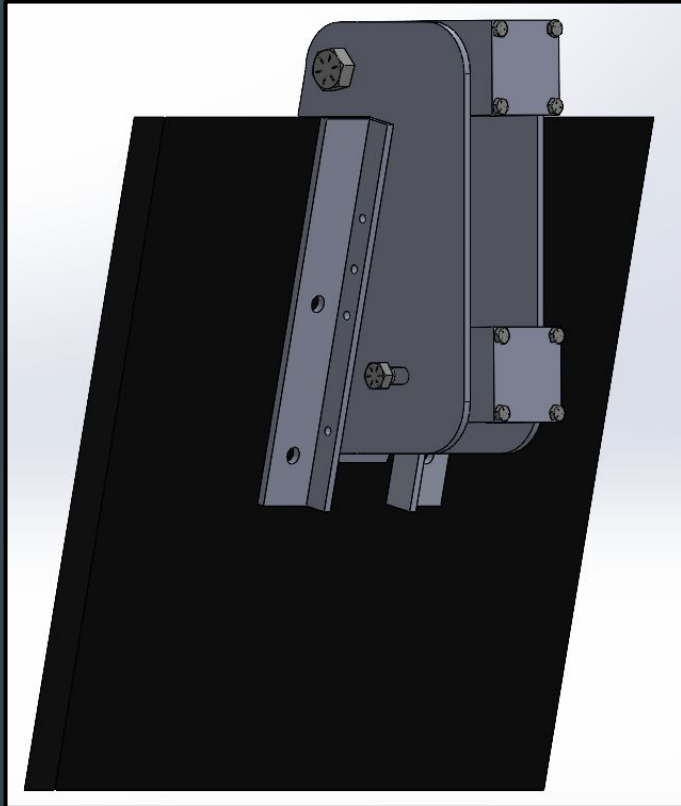2. Improved Mounting Plates

3. Wedge Tilt System

2019-2020 Mounting
Configuration Side View (Right)

2019-2020 Mounting
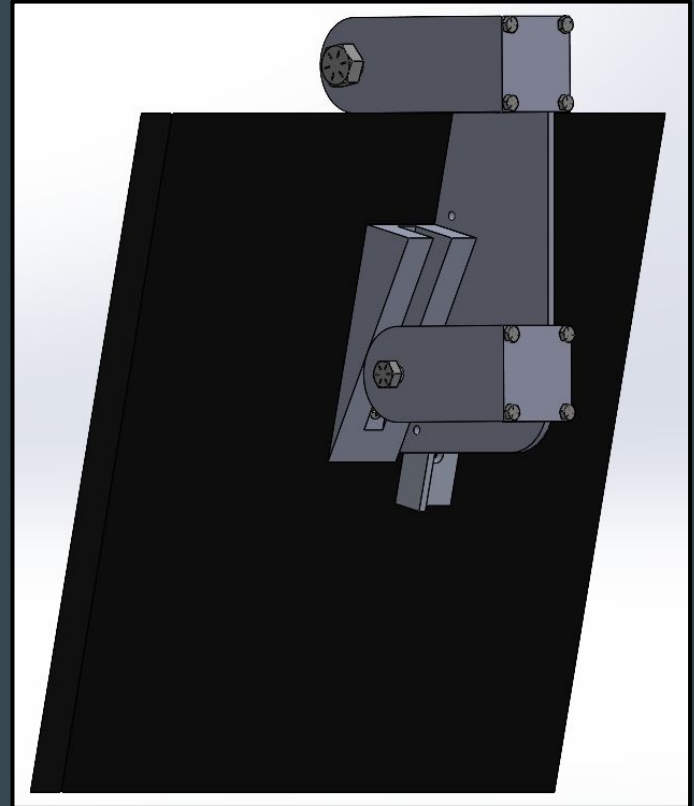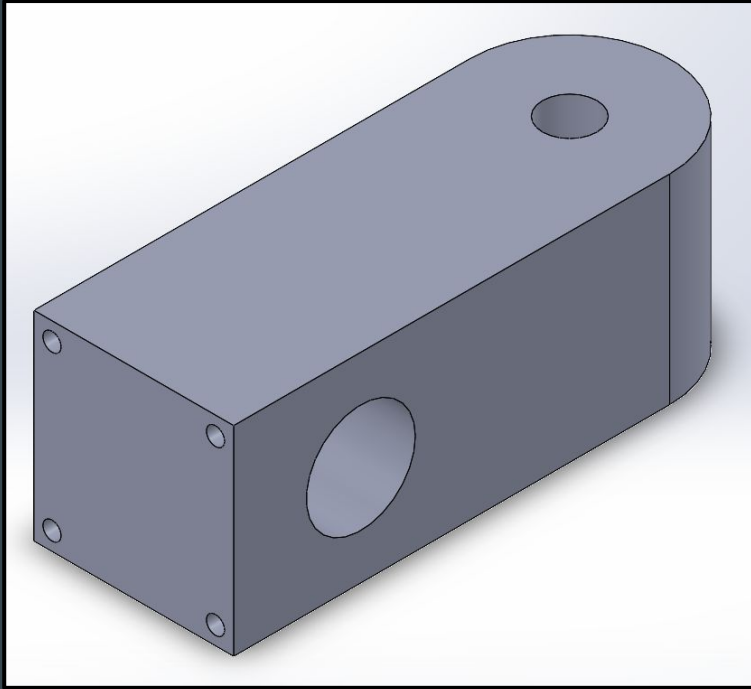Configuration Top View (Left)

Motor Mounting

2020-2021 Mounting
Configuration (Left)

2020-2021 Wedge
Configuration (Right)

Motor Mounting

2020-2021 Mounting Blocks
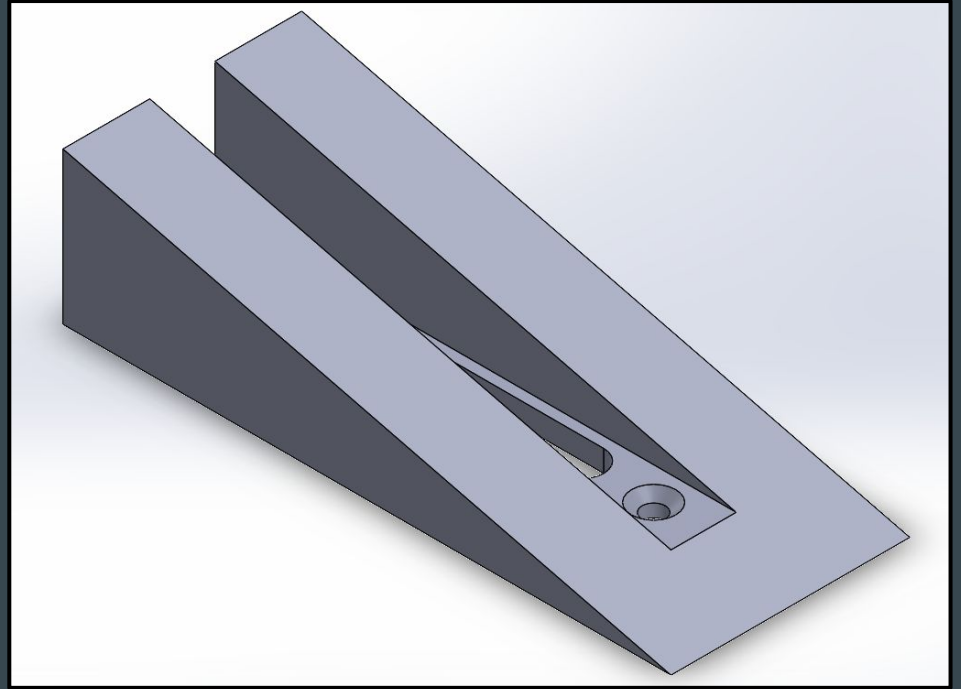
2020-2021 Tilting Wedge

Power Transfer Unit

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Christopher Taylor

Power Transfer Unit
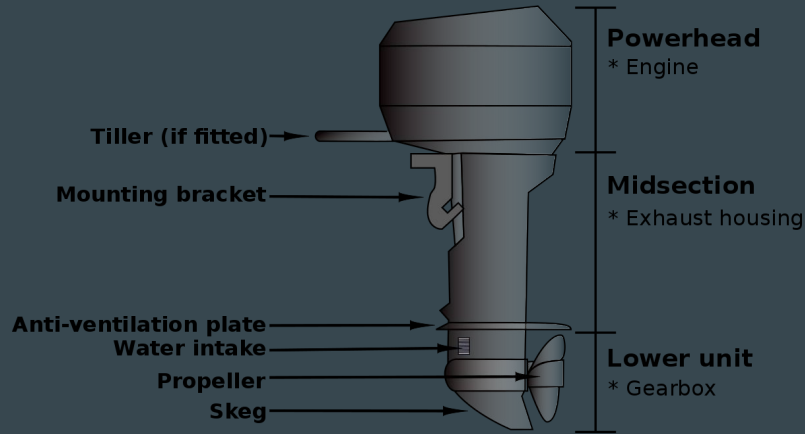
Outboard Motor Components

Powerhead
* Engine

Tiller (if fitted) →

Mounting bracket →

Midsection
* Exhaust housing

Anti-ventilation plate →
Water intake →
Propeller →
Skeg →

Lower unit
* Gearbox

2019-2020 Endurance Extension

2019-2020 Sprint Configuration

Power Transfer Unit
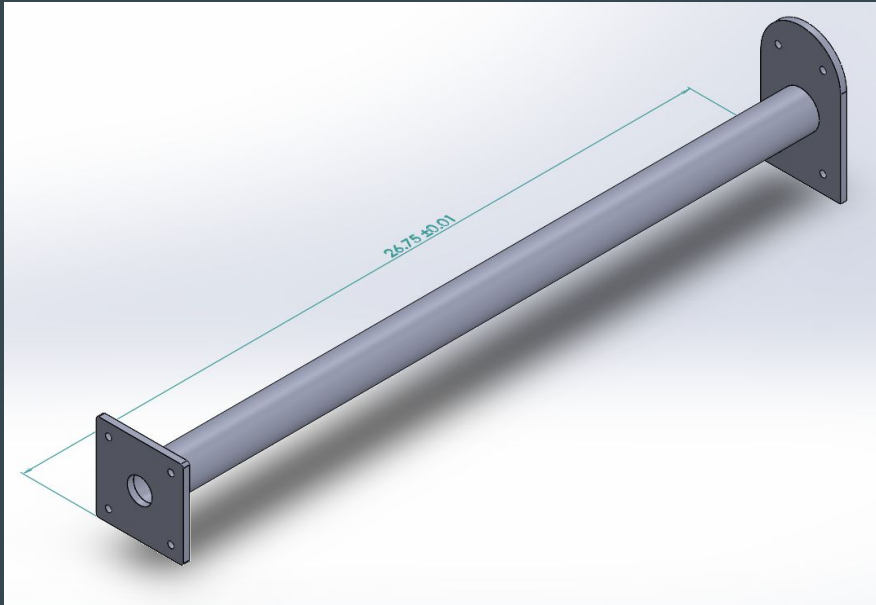
2020-2021 Endurance Housing
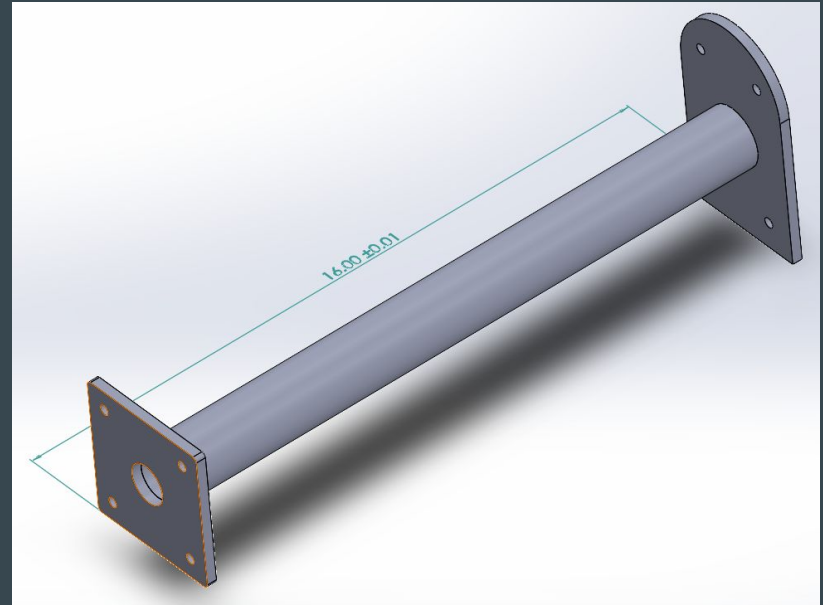
2020-2021 Sprint Housing

ANSYS Analysis

60 lbs

51 lbs
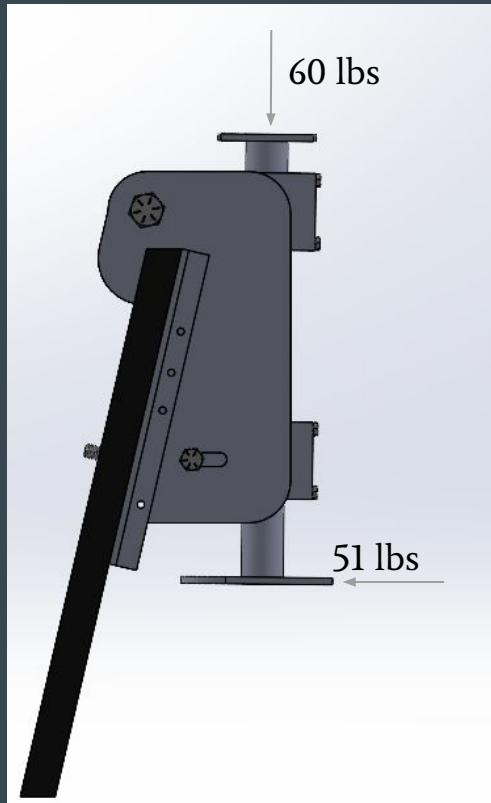
Spring Analysis (Left)
Element Size: 0.965 square inches
Element Type: Quad/Tri

Spring Analysis (Right)
Element Size: 1.0089 square inches
Element Type: Quad/Tri

41 lbs

35 lbs
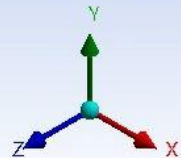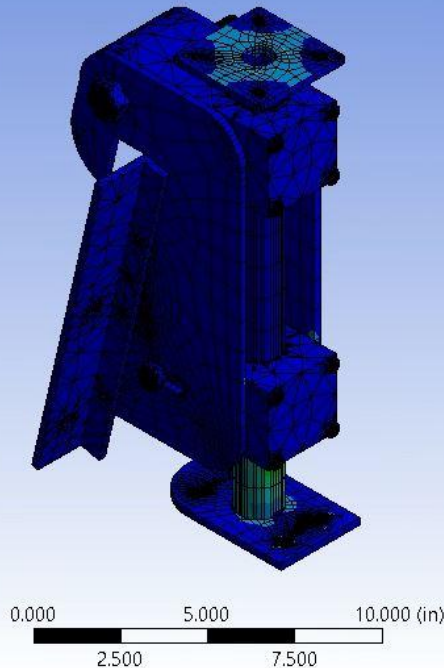
Sprint Configuration Power Transfer Unit

Endurance Configuration Power Transfer Unit
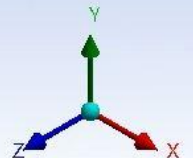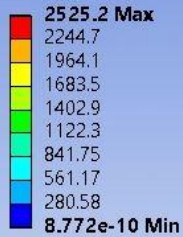
Future Plans

- Manufacturing
  - Motor Mounting Components
  - Sprint and Endurance Misdescriptions
- Testing
  - Integrated Designs
  - System Efficiency and Reliability
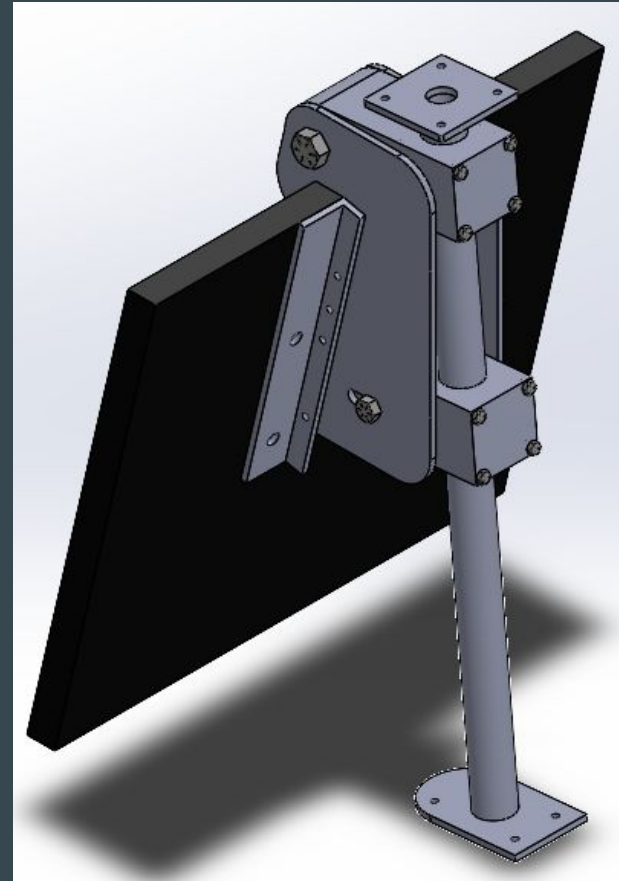
Project Management

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2021 Expected Budget

2020-2021 Expected Budget, Excluding Travel Expenses

Misc. 2.3% **$20.89**

Drivetrain 15.3% **$136.94**

Hull and Weight **$141.79** 15.8%

Steering **$66.00** 7.4%

Outboard Motor Mounts 24.6% **$220.13**

Telemetry **$229.30** 25.7%

Electrical 8.9% **$79.64**
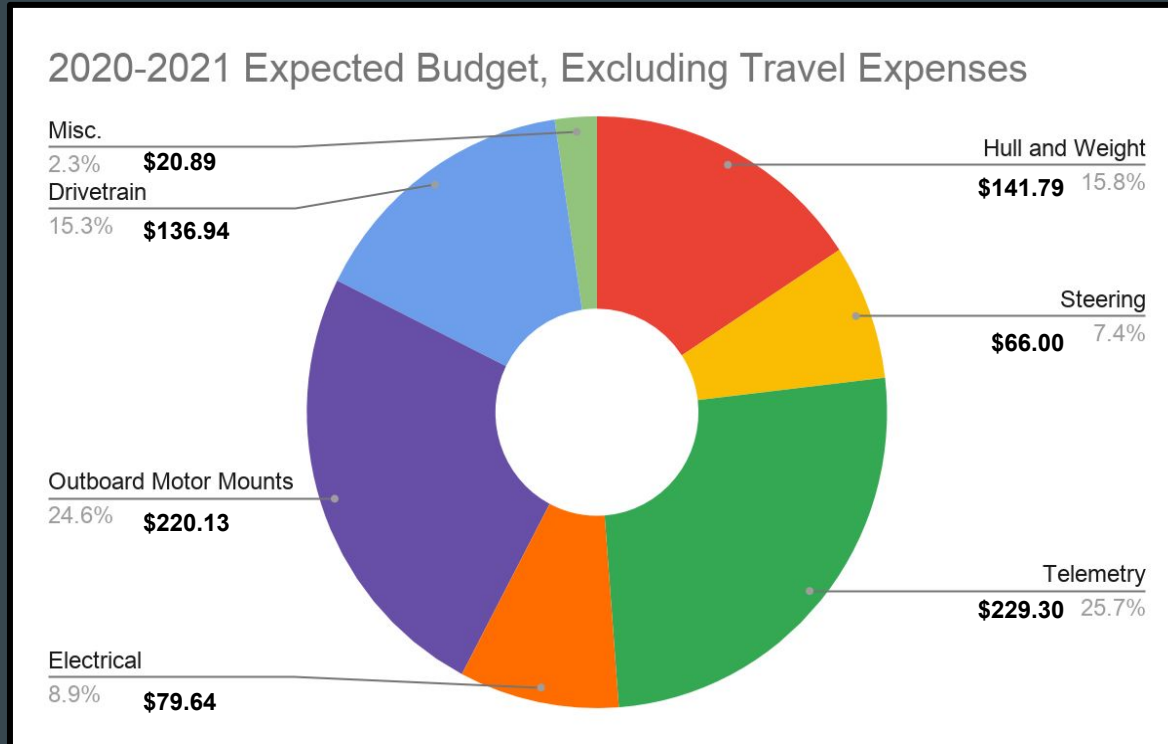
Budget Details

- Original Estimated Budget: $5,450
  - Travel & Registration Fee: $4,750
  - Project: $700

- Current Estimated Budget: $6,938.72
  - Travel & Registration Fee: $6,045.03
  - Project: $893.69

2020-2021 Expected Budget, Including Travel Expenses

Outboard Motor Mounts
3.2%

Telemetry
3.3%

Hull and Weight
2.0%

Travel
87.1%

Media

GANTT Chart

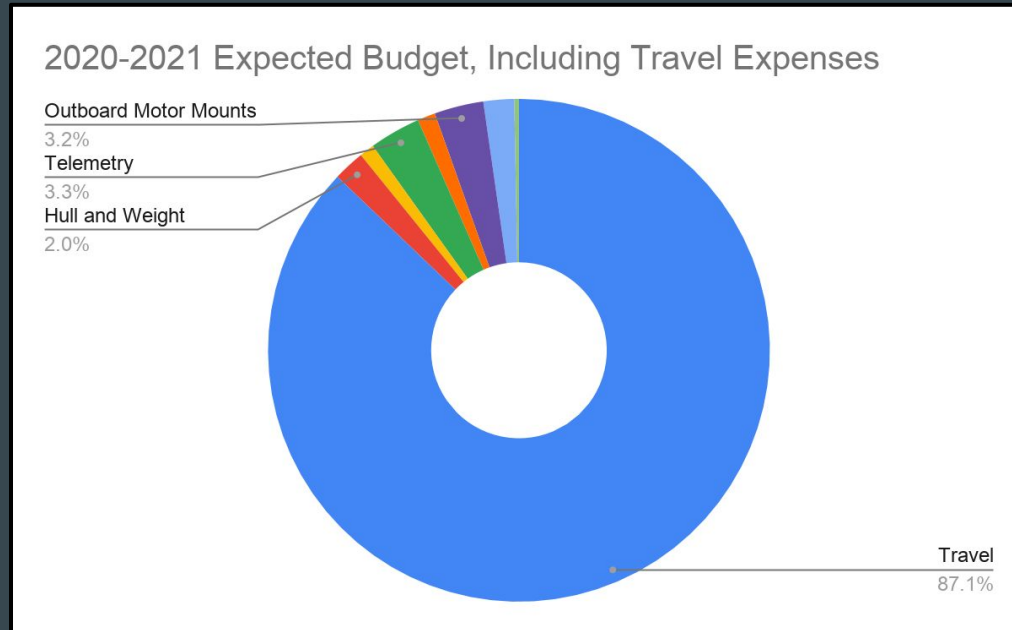| #	TASK TITLE	Member	% OF TASK COMPLETE
1	**Team Responsibilties**		
1.1	Preliminary Research	T	100%
1.2	Project Proposal	T	100%
1.3	Register for Competition	T	90%
1.4	Budget	E	90%
1.5	Schedule	T	70%
1.6	Critical Path Network	T	100%
1.7	Preliminary Design Review	T	100%
1.8	Truck Rental	L	20%
1.9	SP1 Presentation	T	80%
1.1	SP2 Presentation	T	0%
2	**Preliminary Testing**		
2.1	Measure waterline and COG/COF	L	100%
2.2	Weigh and measure all boat components	L	100%
2.3	Testing Telemetry Equipment	E	50%
2.4	Lake Testing	T	100%
3	**Design**		
3.1	Weight Distribution	L	100%
3.3	Steering	L	60%
3.4	Electrical	D	98%
3.5	Telemetry	E	94%
3.5.1	Schematic	E	100%
3.5.2	GPS	E	100%
3.5.3	IMU	E	90%
3.5.4	Current	E	100%
3.5.5	Voltage	E	100%
3.5.6	RPM	E	100%
3.5.7	LabView	E	100%
3.5.8	Communication Channel	E	100%
3.5.9	Performance Review Program	E	60%
3.6	Motor Mount	C	40%
3.7	Drivetrain	C	35%
4	**Manufacturing**		
4.1	Relocation of Skipper and Dash Modifications	L	0%
4.2	Foam cut outs for motors	L	0%
4.3	Endurance sleeve	C	0%
4.4	Motor Mount	C	0%
4.5	Electrical	D	25%
4.6	Steering	L	0%
4.7	Telemetry Installation	E	1%
4.7.1	Rewire and Relabel	E & D	0%
4.7.2	Hall Effect Sensors	E	0%
4.7.3	Assemble IMU Housing	E	0%
4.7.4	Wire Pump	E	0%
4.7.5	Program LabVIEW	E	5%
4.7.6	Program MATLAB	E	0%
5	**Integration and Testing**		
5.1	Telemetric Integration	E	0%
5.2	Skipper Practice	T	0%
5.3	Endurance Practice	T	0%
5.4	Sprint Practice	T	0%
6	**Competition**		
6.1	Packing	T	0%
6.2	Travel	T	0%
6.3	Competition	T	0%

Timeline columns: SUMMER 2020 (JUNE, JULY, AUGUST), FALL 2020 (SEPTEMBER, OCTOBER, NOVEMBER), WINTER 2020-2021 (DECEMBER, JANUARY), SPRING 2021 (FEBRUARY, MARCH, APRIL, MAY), SUMMER 2021 (JUNE)

We are here ▶

Solar Splash 2020-2021

Questions?

Lauren DeSimone
Weight Distribution and Steering

Daniel Johnson
Electrical System

Eliza Sweet
Telemetry System

Christopher Taylor
Power Transmission System