TEC-V

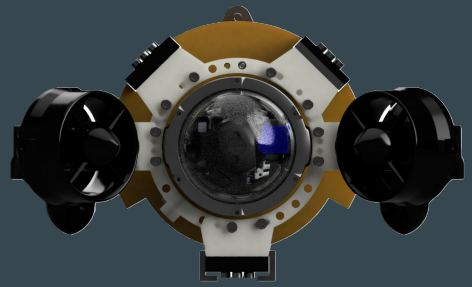
Critical Design Review

TECV.ROV

Our Website!

Our Insta!

Introduction

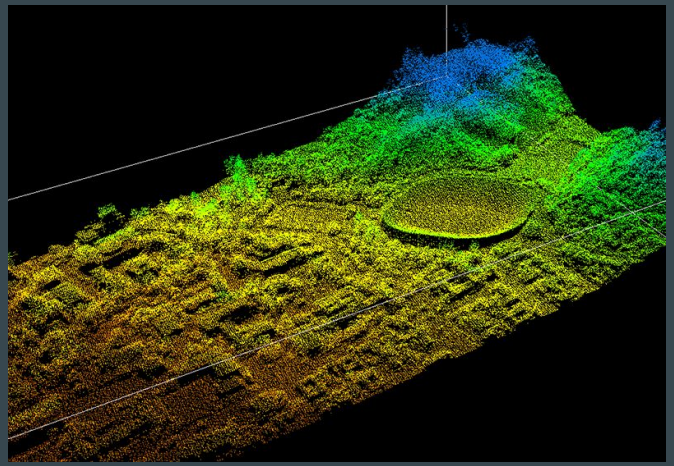


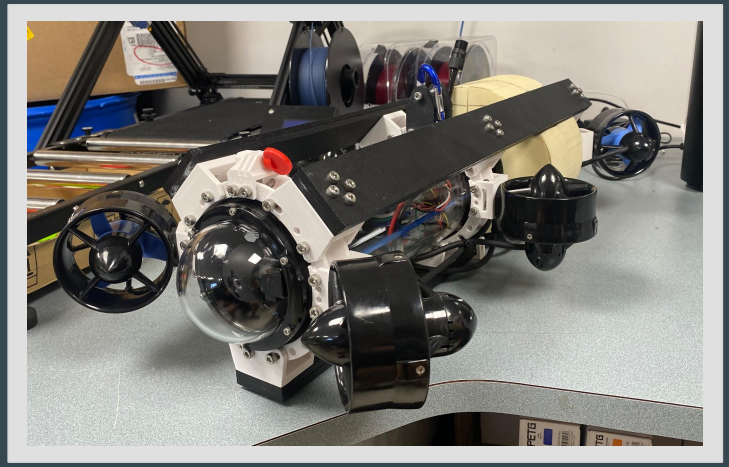
Stephen Coster (OE)	Systems Engineer
Henry Hill (OE)	ROV Technician
Mike Dowling (CSE)	Software Integration Technician
Gabor Papp (ME)	Mechanical Design Engineer
Zealand Brennan (CSE)	Simulation Analysis

Overview

Mission Statement

Develop an optimized scanning and mapping system for use in enclosed underwater environments through the integration of instrumentation onto the TEC-V platform





Applications

- Enclosed Environmental Mapping
- Cave Exploration
- Port and Harbor Monitoring
- Under-Ice Surveying
- Wreck Observation
- Entry Level AUV Platform

https://iantd.com/index.php/en-us/courses/iantd-ice-cave-mine-wreck-diving

Goals

1. Integrate Side-Scan Sonar
2. Modify Buoyancy
3. Manufacture Fairing
4. Develop Mapping Software

Sunfish AUV: https://www.youtube.com/watch?v=0MY099C1PxQ&t=61s

TEC-V

Design Specifications

Category	Threshold	Stretch	Reach
Sonar Integration	Sonar must be electrically integrated and function as designed.	Fine tune angle of sonar for maximum FOV.	Sonar mount location is hydrodynamically efficient.*
Buoyancy Modification	The system will maintain neutral buoyancy and trim.	The system will have a minimal restoring moment in roll.*	The system can maintain previous attributes in saltwater.
Fairing	The fairing is manufactured and installed.	The fairing improves outlined hydrodynamic properties.	The drag coefficients are obtained through CFD.*
Sonar Mapping	The software will be able to obtain connection to the sonar and obtain data.	The software will filter the data and eliminate most erroneous data points.*	The software will create a cloud plot of a mapping mission.

Safety and Environmental Concerns

- Appropriate PPE
- SDS
  - Resin, LiPo Batteries, Waste Disposal
- Environment
  - Entanglement, Waste Disposal, Regulations


TEC-V
Sonar

Side-Scan Sonar

- Operates in “1” Plane
- Updates as a “Waterfall”
- Detailed Return

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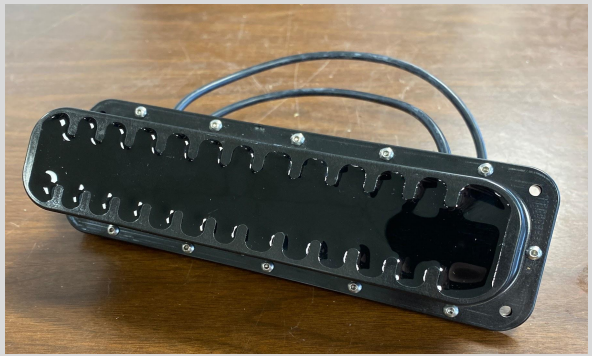
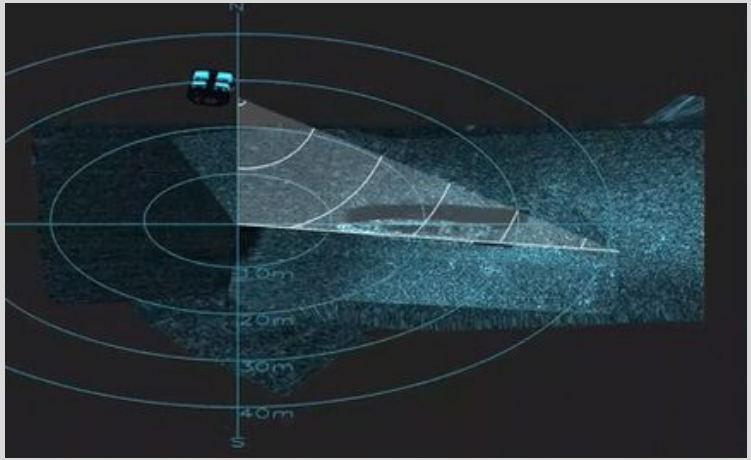
Specifications

- Cerulean FS
- Max Range: 100m
- Frequency: 450 kHz
- Direct Ethernet Connection
- Far Field: 7m
- Beam Height: 50 Degrees
- SonarView Software





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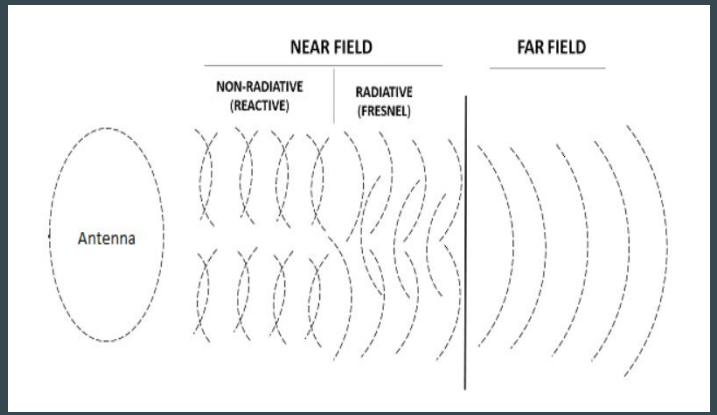
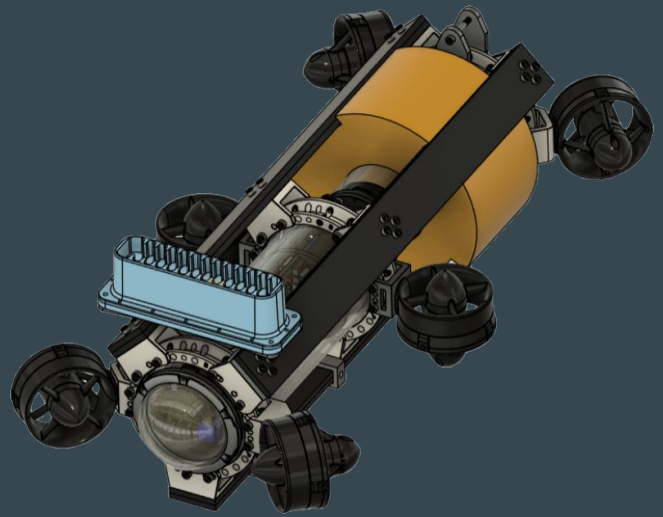
Potential Issues

- Noise in Data
- Interfacing with Software
- Far/Near Field Interference





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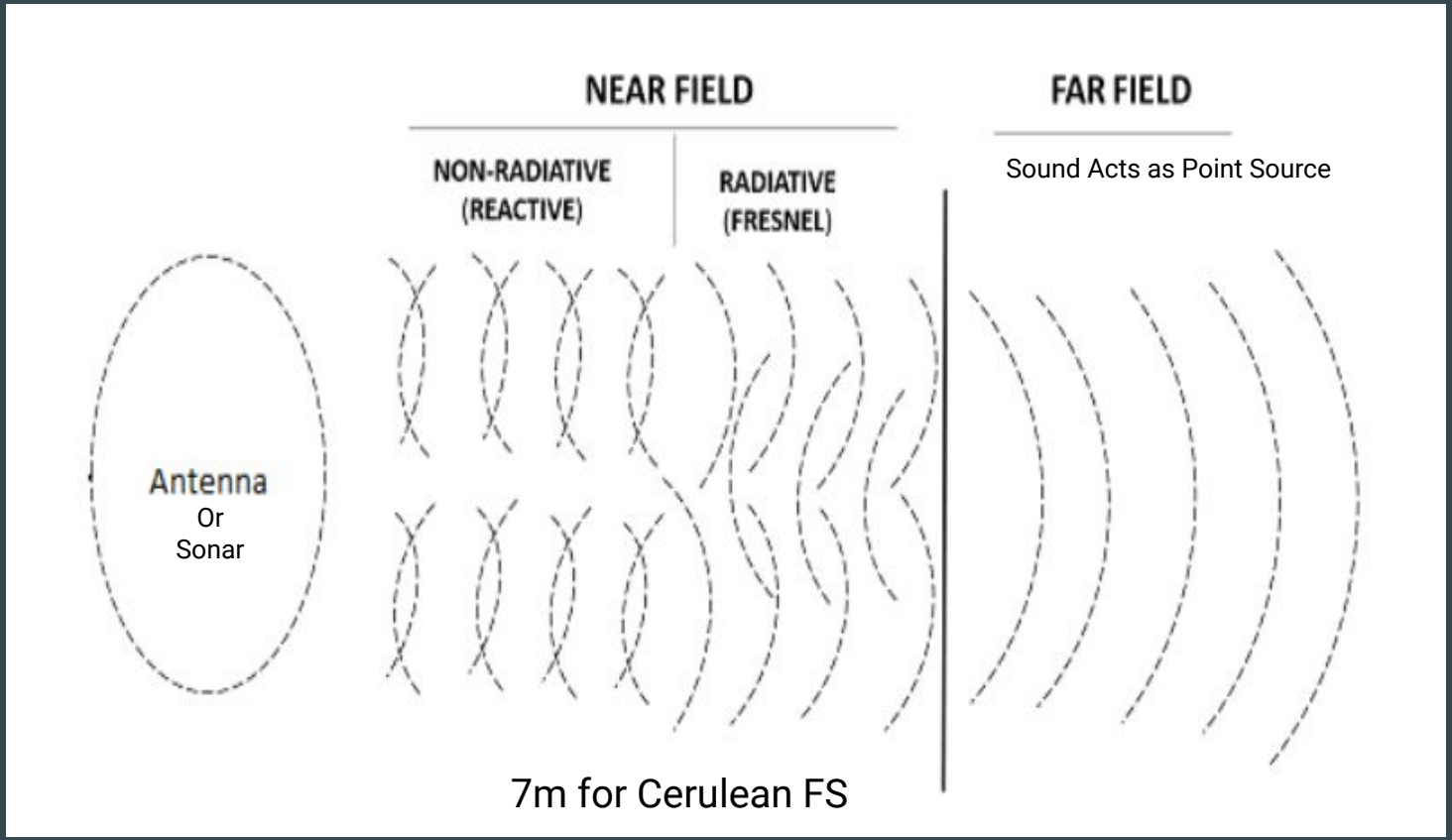
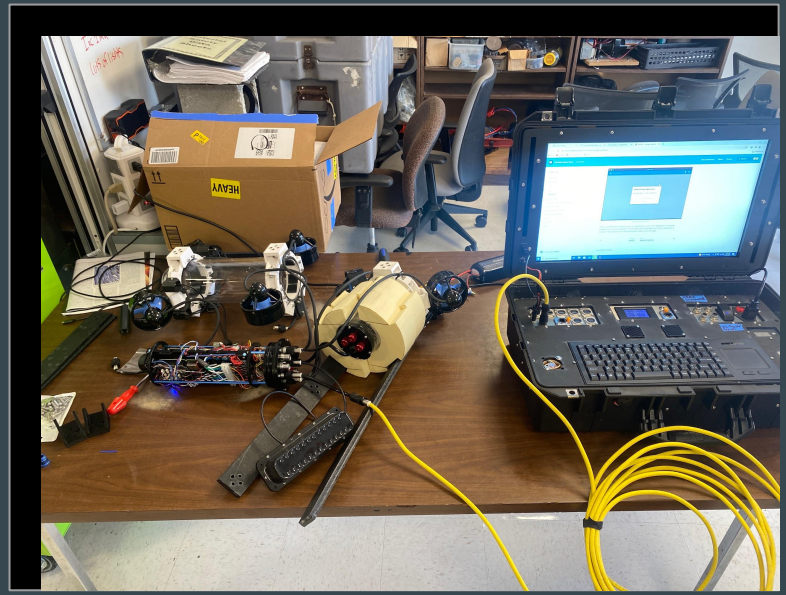


https://www.emc-directory.com/calculators/far-field-distance-calculator-for-horn-antennas

Integration

- ☐ Install Ethernet Switch
- ☐ Wire Sonar
- ☑ Connect to SonarView
- ☑ Mount to Frame
- ☐ Extract Data
- ☐ Mount to Fairing



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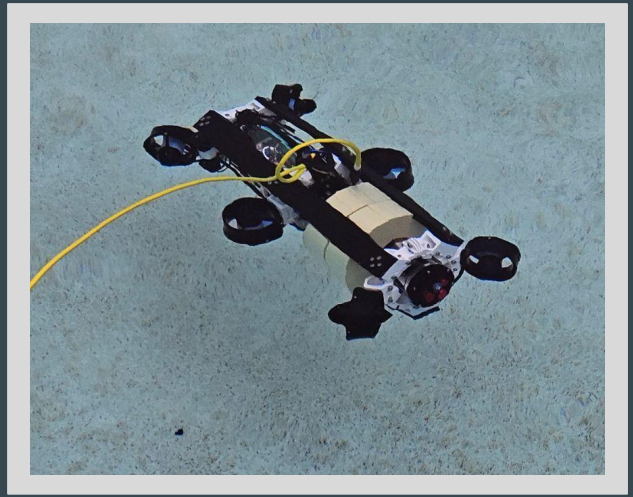
Buoyancy

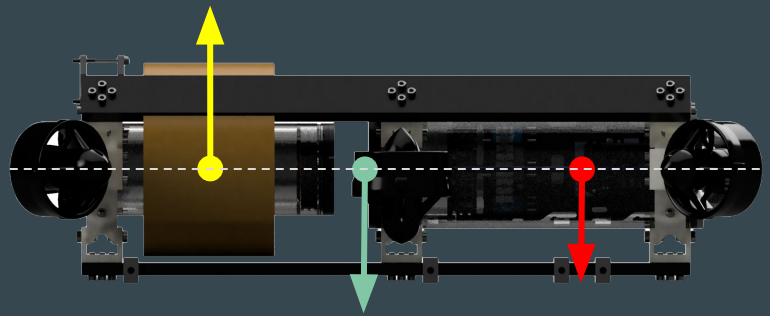
Desired Results

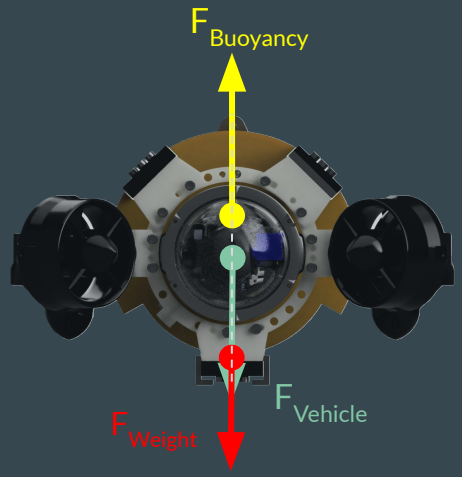
- Achieve Neutral Pitch
- Minimize Roll Restoring Moment
- Ensure Compatibility in Seawater
- Adjust Buoyancy for Additional Components (Sonar, Fairing)

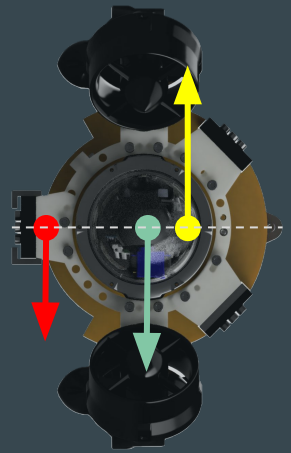


Force Analysis

- Moment Calculated from Force and Distance
- Relative to Vehicle Central Axes
- Roll Calculated at 90° Angle







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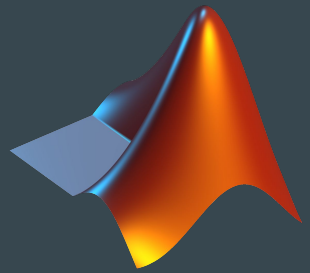
Matlab Code

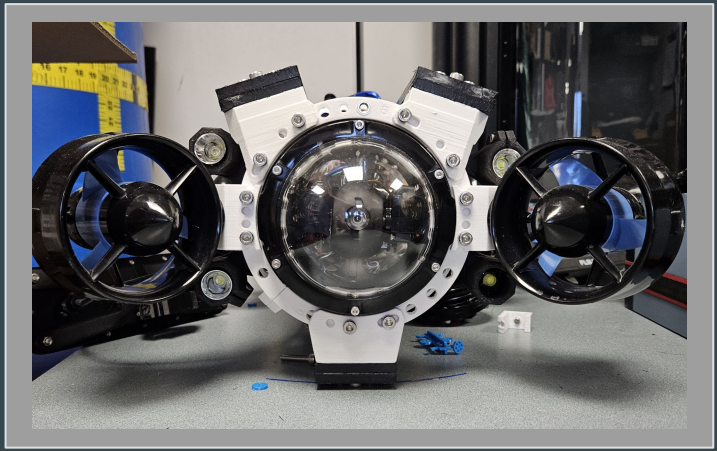
- Calculates Total Moment for Pitch and Roll
- Able to Account for Different Water Densities
- Determines Amount of Foam/Weight can be Changed

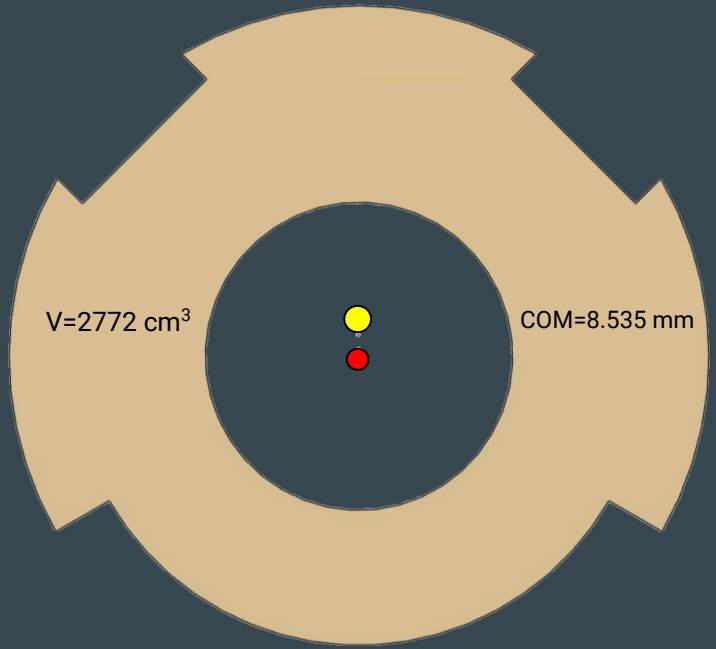


```
mass_vehicle = 10.5-mass_foam; %kg
mass_battery=1.204; %kg
volume_vehicle = 0.004948+0.00535; %Volume of TECV with no weights or buoyancy (m^3)
denisty_vehicle = mass_vehicle/volume_vehicle; %kg/m^3

F_net_vehicle=(density_water*g*volume_vehicle)-(mass_vehicle*g); %Net force on vehicle (N)
F_net_foam= (density_water*g*volume_foam)-(mass_foam*g); %Net force on foam (N)
F_net_lead= (density_water*g*volume_lead)-(mass_lead*g);  %Net force on weights (N)

F_single_weight = F_net_lead/4;
F_foam_test=(density_water*g*.0002164)-((density_foam*.0002164)*g);
F_foam_total=F_net_foam-F_foam_test;
F3=F_net_foam+F_single_weight;
```

Progress

- Modified Foam to Fit with New Brackets
  - Reduced Moment Arm
  - Equivalent to 1 Ballast Weight





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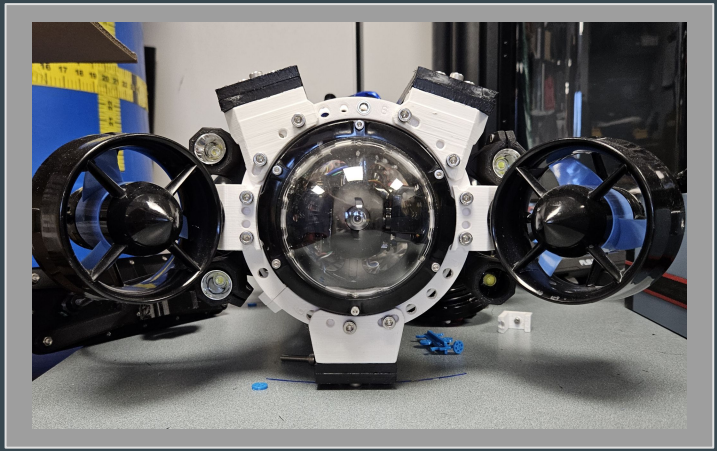
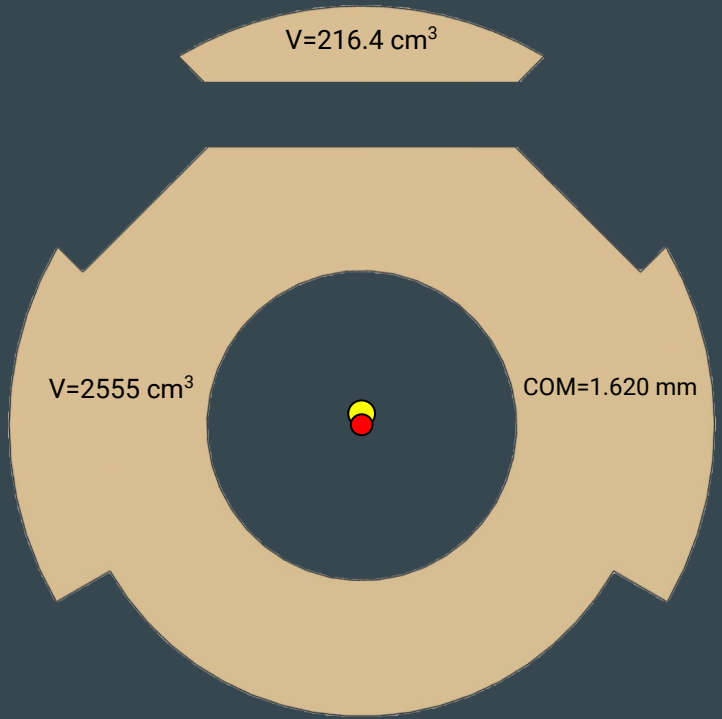




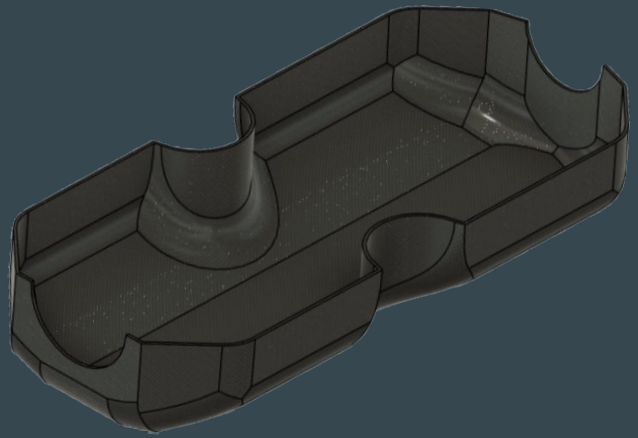

TEC-V
Fairing

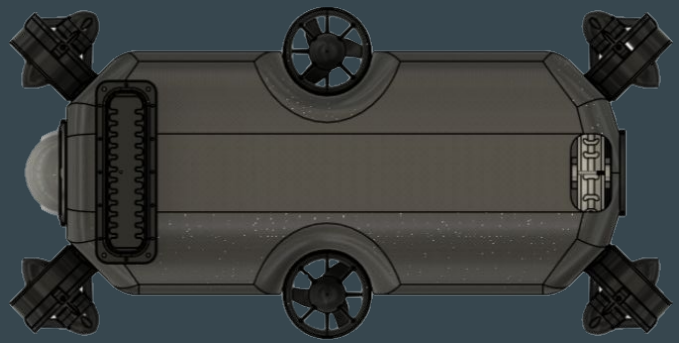
Motivation

- Protection
- Hydrodynamics
  - Flat Sides → Increasing Yaw Drag
  - Cylindrical → Decreasing Roll Drag
  - Symmetrical → No Lift
- Aesthetics
  - CF Looks Great
  - High-Visibility Paint Scheme

Design

- Two Symmetric Shells
- Mounted to New Frame Brackets
- Neutral Buoyancy

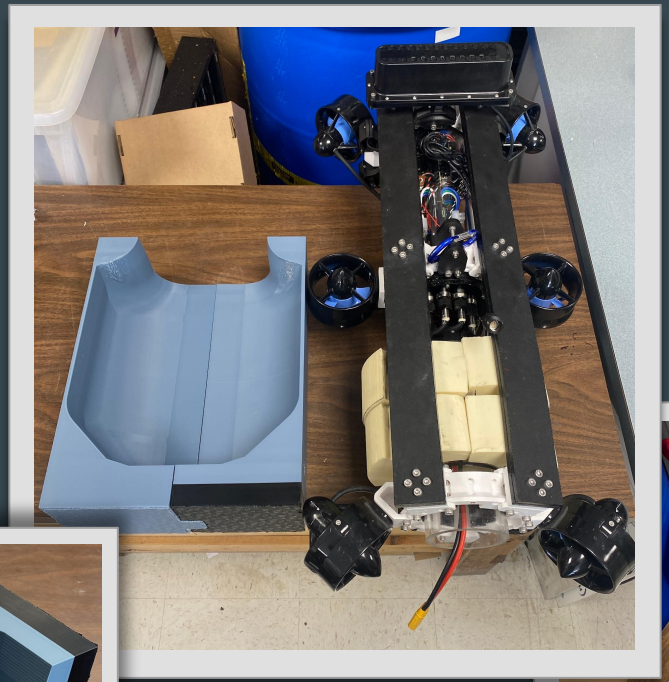


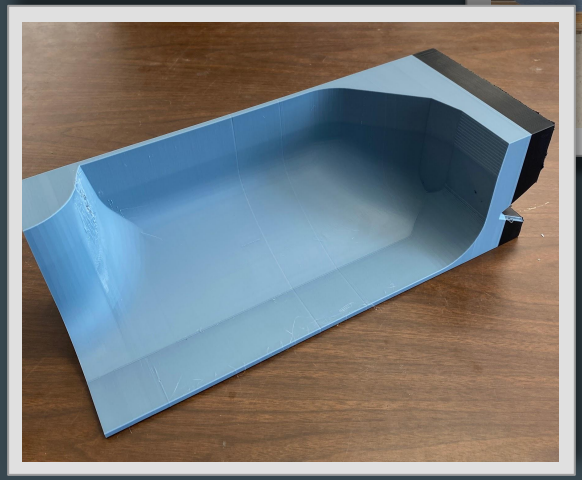


Note: Sonar will be mounted at rear

Mold

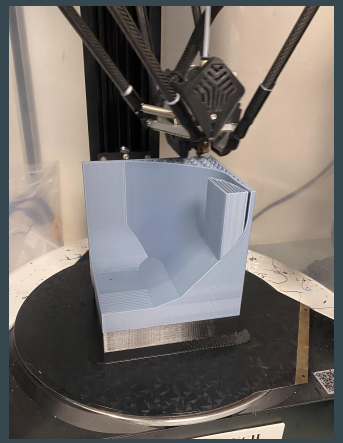
- 3D Printed PETG
- 4 Parts
- Draft Angle





Manufacture Process

Step 1	Step 2	Step 3	Step 4	Step 5
Prepare Mold	Cover in Vacuum Bag	Lay Fabric	Cover in Vacuum Bag	Post Processing

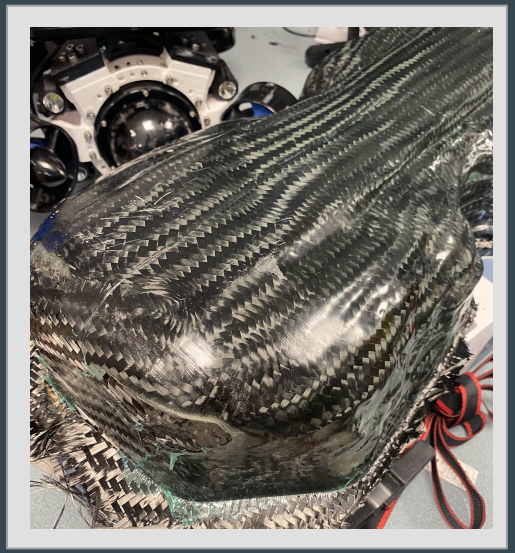




First Attempt at S.C.

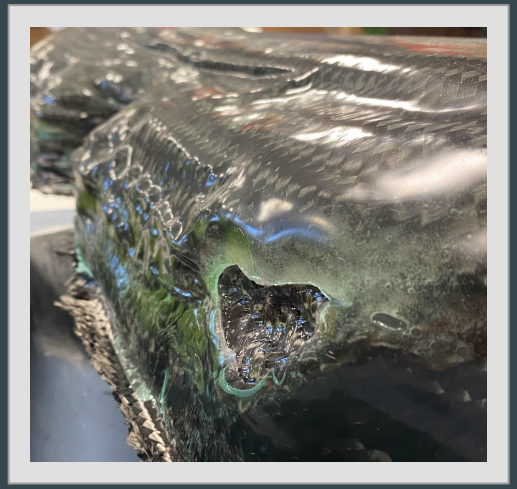
Successes

- Mold Survived
- Elastic Vacuum Bag Worked
- Fabric and Matrix Performed Well



Failures

- Unsalvageable Part
- Poor Vacuum
  - Air Cavities, Resin Pools
- Vacuum Bag Stuck to Resin

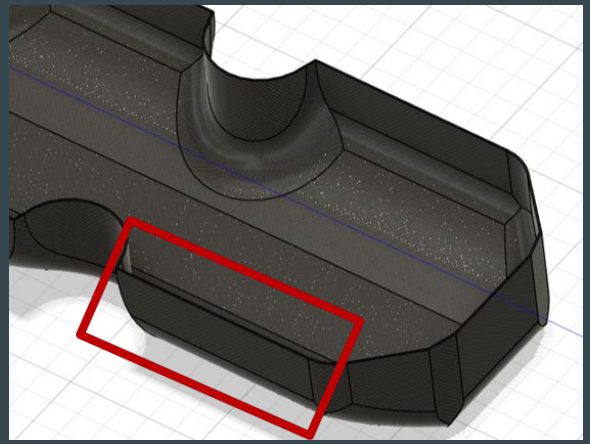


Future Improvements

- Cut Templates for Fabric
- Use More Breather Cloth for Even Vacuum
- Apply Less Resin
- Try, Try Again

Laminate Properties

- BIMAX-H-48 → C-120 Fabric
- Vf Estimate: 0.55
- Max Speed: 4 kts
- Pressure: 0.3223 psi

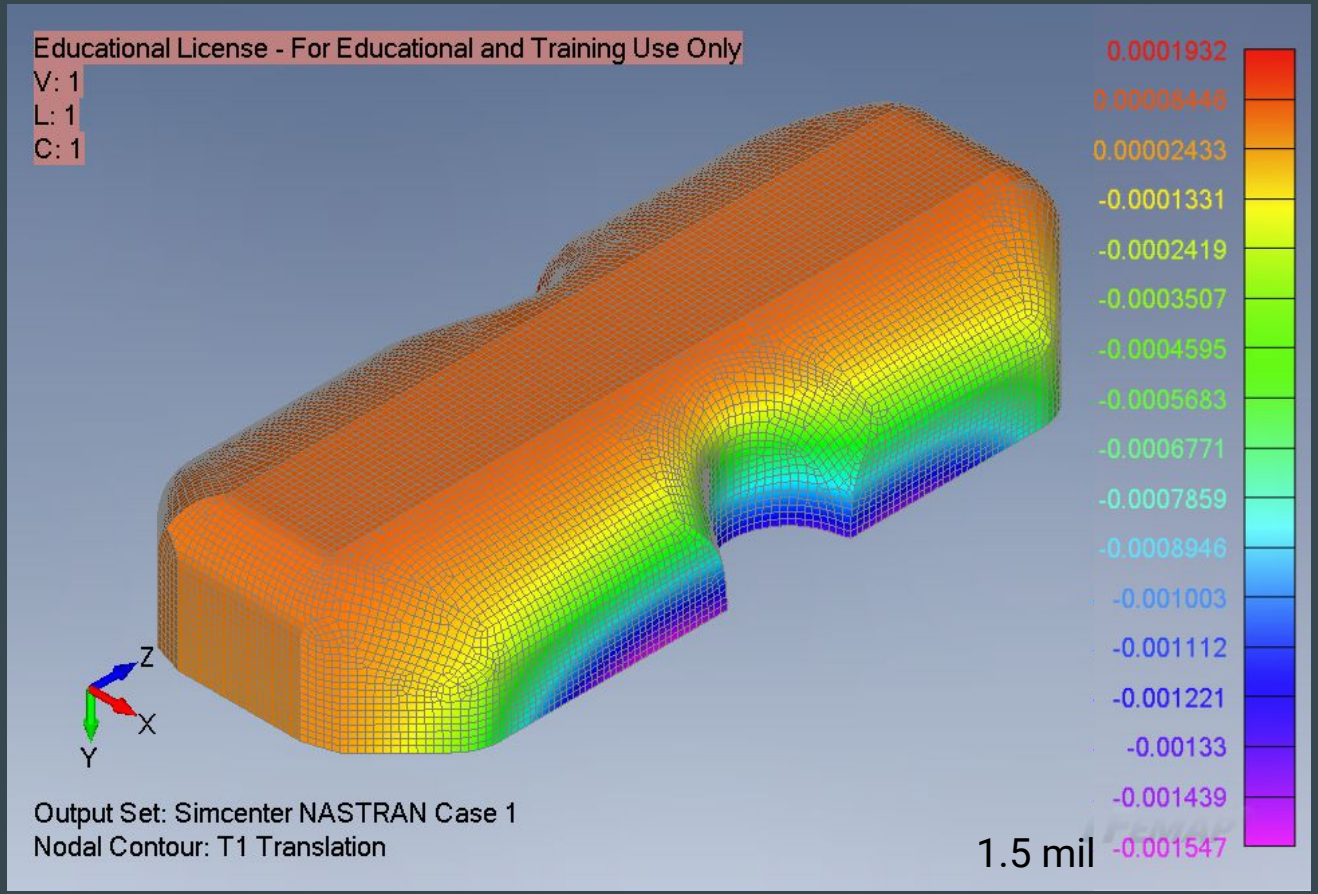


$$F = \frac{1}{2} C_d \rho A V^2$$

Thickness (2 layers) (mils)	21.73
Deflection (mils)	24.92
L/Δ	76.2
Stress (ksi)	76.5

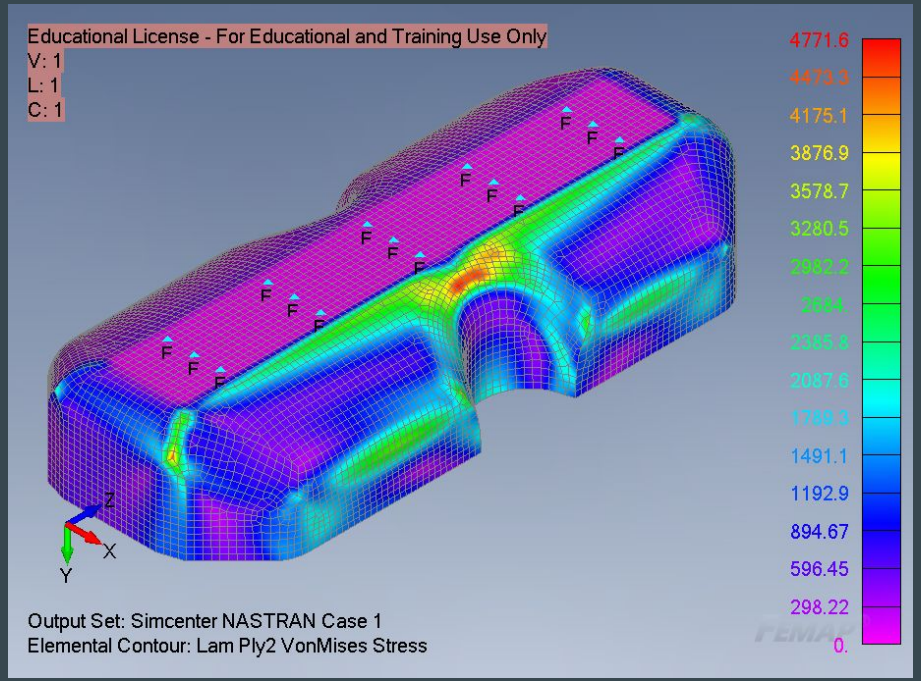
Note: L/Δ should be > 50

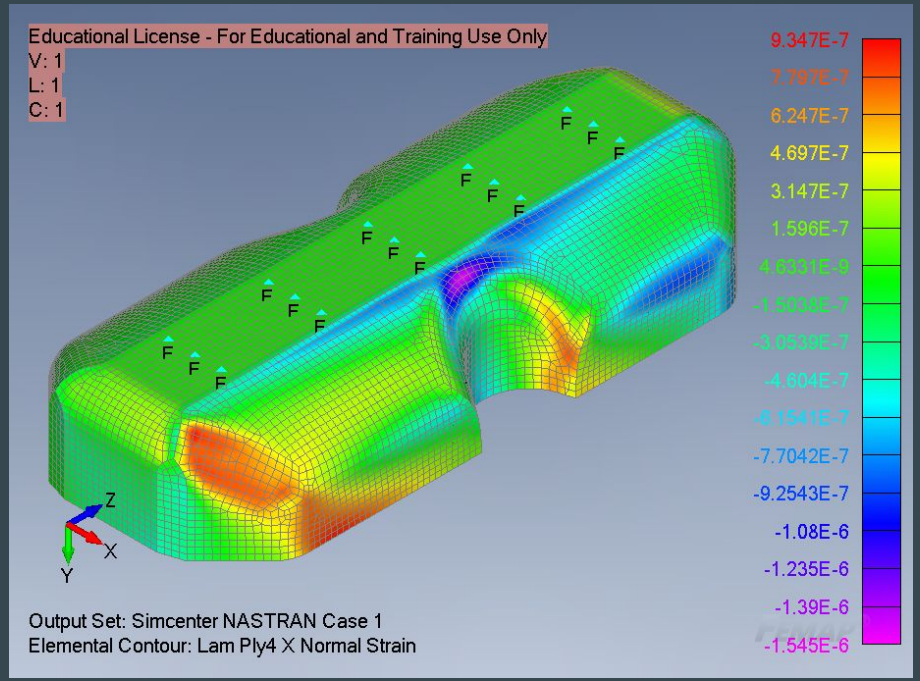
FEA



Credit: Jolie Elliott

FEA



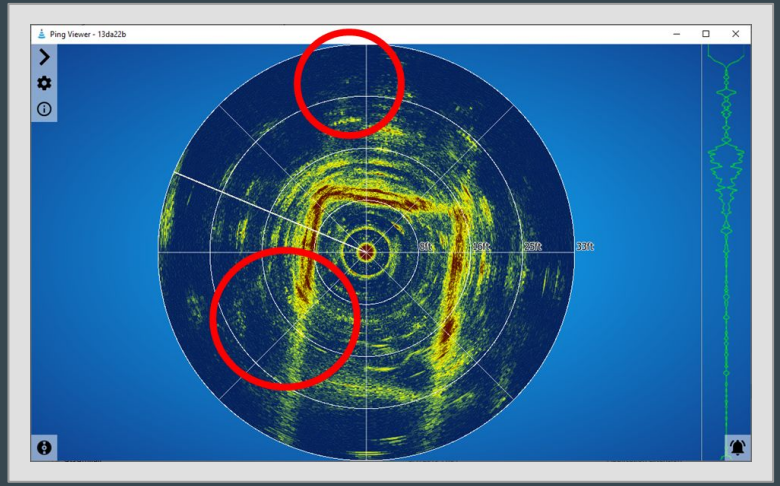


Credit: Jolie Elliott


TEC-V
Mapping

Method

- Interface with Sonar
- Mitigate Sonar Noise
- Testing
- Optimize Website User Interface



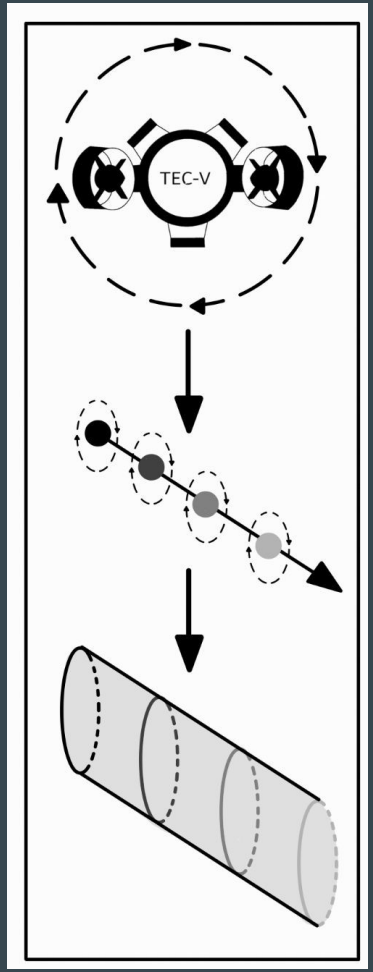

```python
for currentAngle in range(400):
    # Read a single iteration of intensity data
    ping_data = ping360.transmitAngle(currentAngle)

    # Extracting intensity as integer values
    intensity_data = [(struct.unpack('!H', int(data).to_bytes(2, byteorder='big'))[0], i)
                      for i, data in enumerate(ping_data.msg_data)]

    # Store the raw data for the current angle
    raw_data[currentAngle] = intensity_data
```

TEC-V

Cylindrical Mapping

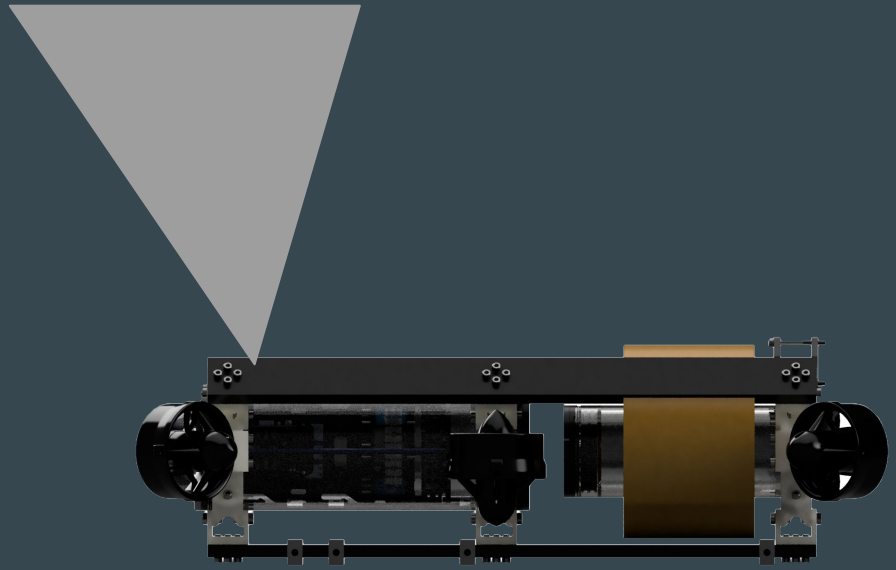


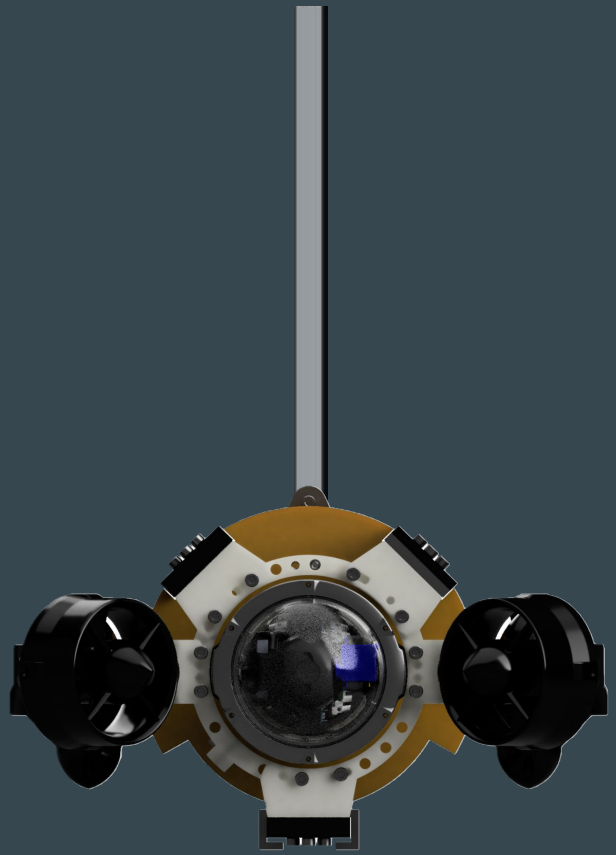
Roll Maneuver

Manipulate Data into a Cylinder

Connect Cylinders

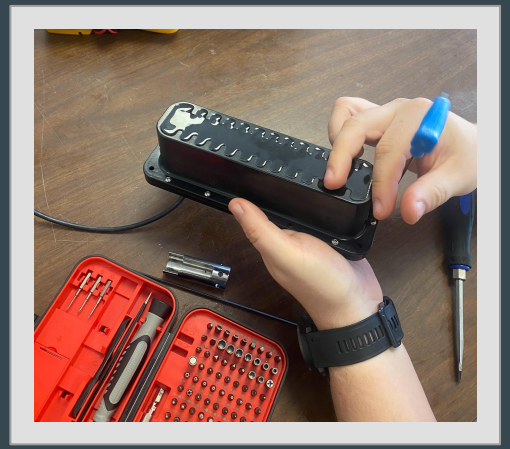
Scan Maneuver

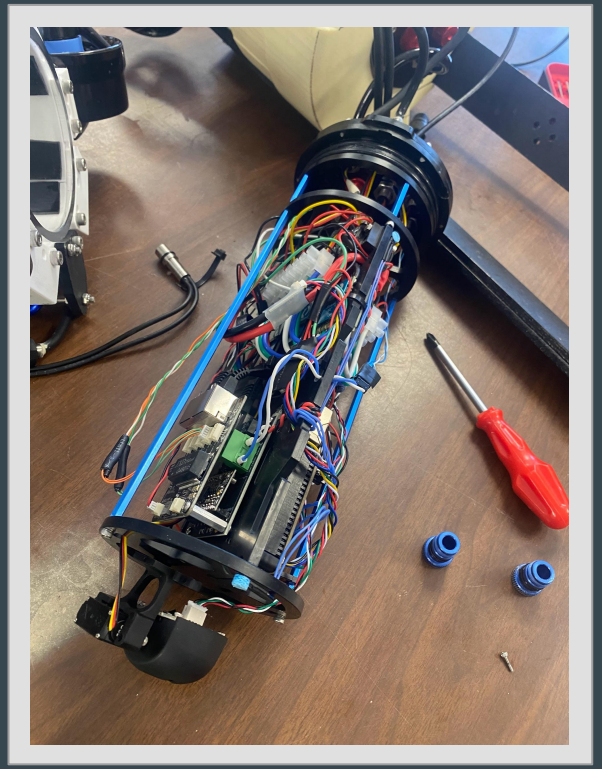




Progress

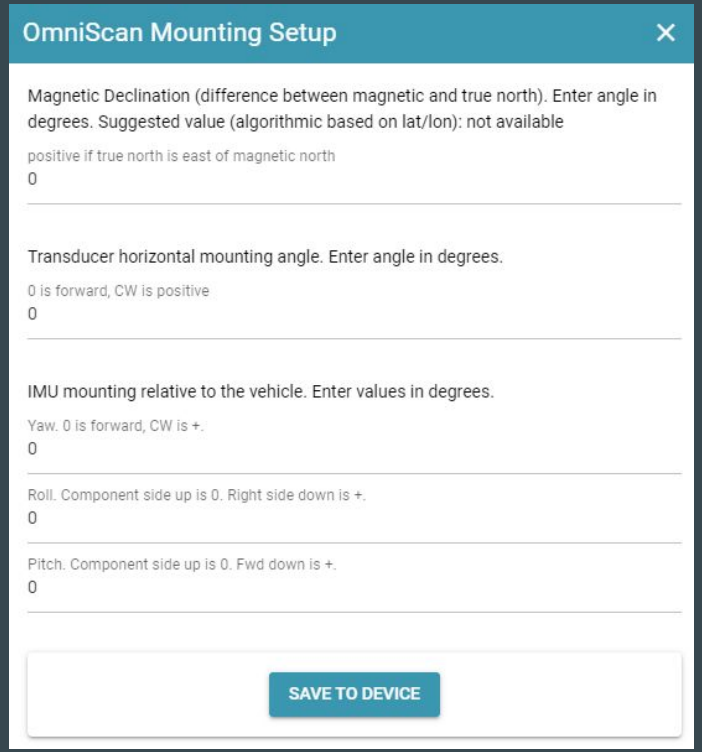
- Ethernet Switch Installed
- Sonar Integrated
- Sonar Works on SonarView





Issues

- Sonar Only Scans in XY Plane
  - Onboard IMU Only Allows Horizontal Scans
- Encrypted Software
  - Limited Alterations for Data Acquisition
- CSE Senior Design Halted Cerulean Sonar Progress



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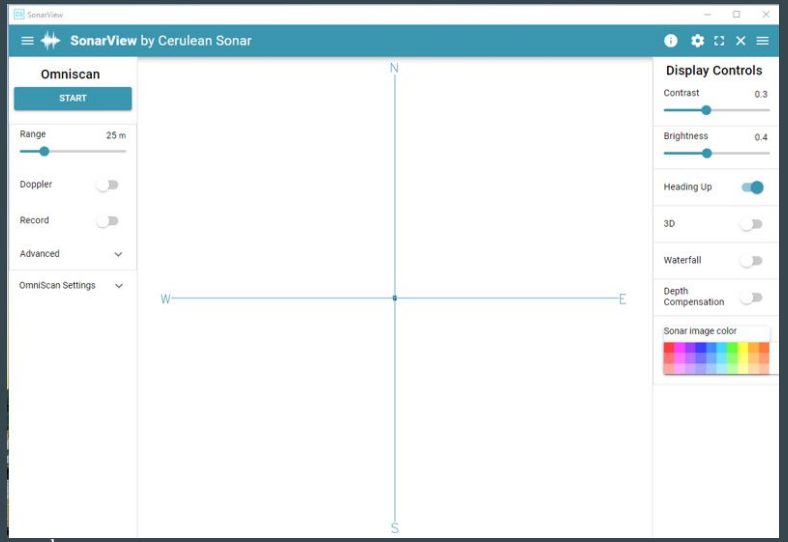
Solutions

- Utilize Waterfall Mode
  - Data Stitched After Mission
- Use Log Files
  - Could Have Raw Data
- Use Serial Info
  - More Data Processing



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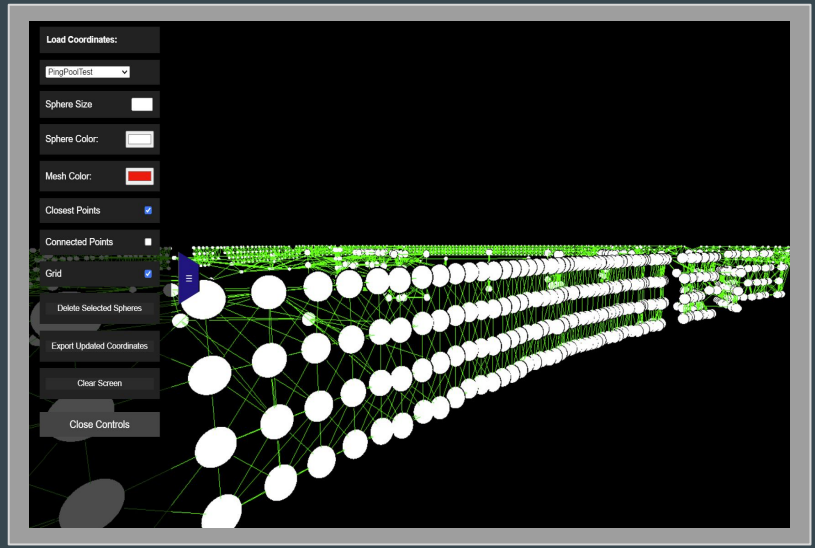
Summer Plans

- Acquire Sonar Data
- Filter Data
- Integrate Data to Website
- Perform Mapping Missions

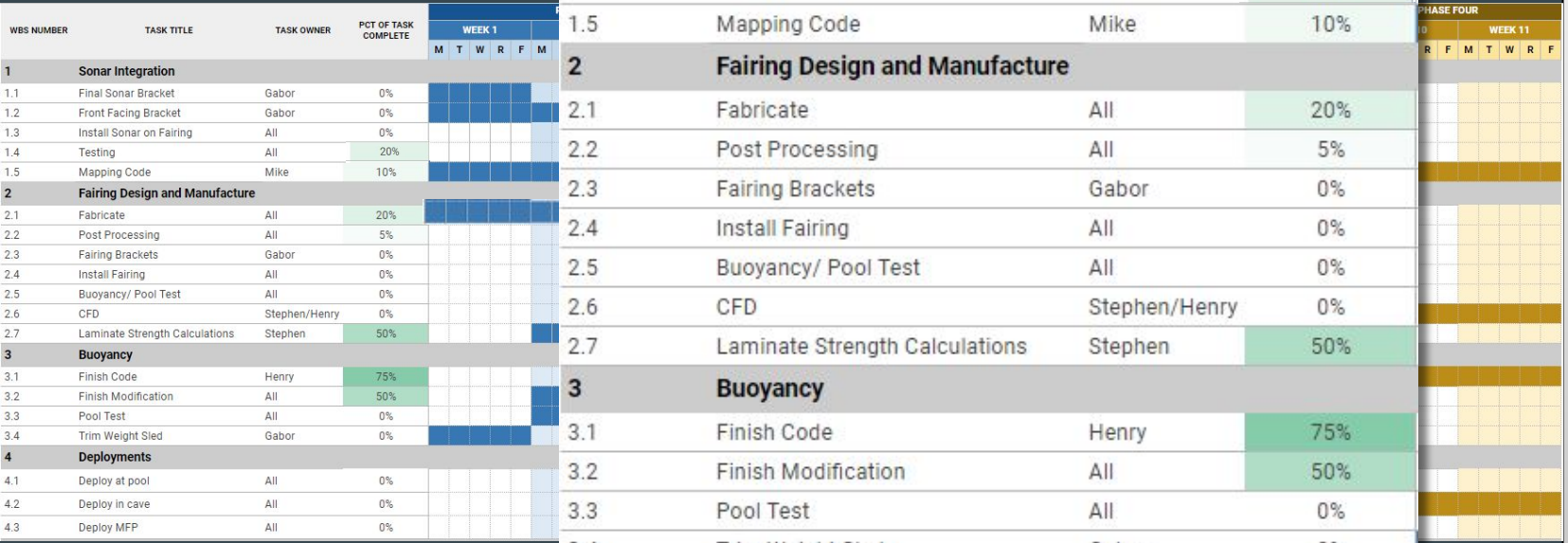



TEC-V
Timeline

Spring Gantt

1	**Sonar Integration**		
1.1	Research Sonar Solution	Stephen	100%
1.1.1	Purchase Sonar	Stephen	100%
1.2	Design Sonar Bracket	Gabor	90%
1.3	Integrate Sonar Electronics	Henry/Stephen	100%
1.4	Pot Sonar Termination	Henry	100%
1.5	Test Sonar using PingViewer	Mike	100%
1.6	Design and Test Mapping Code	Mike	50%
2	**Fairing Design and Manufacture**		
2.1	Integrate Sonar into Rendering	Gabor	100%
2.2	Finalize Design	All	100%
2.3	Perform CFD	Henry/Stephen	0%
2.4	Print Mold	Stephen	100%
2.5	Fabricate at Structural Composties	Henry/Stephen	30%
2.6	Post Processing	Henry/Stephen	10%
2.7	Installation	All	0%
3	**Buoyancy**		
3.1	Redo Math	Henry/Stephen	100%
3.2	Brainstorm Solution for Neutral B	All	100%
3.3	Fabricate Solution	Gabor	60%
3.4	Design/ install new weight sled	Gabor	0%
3.5	Install	Henry	90%
3.6	Pool Test	All	0%
3.7	Saltwater Test	All	0%

Summer Gantt



WBS NUMBER	TASK TITLE	TASK OWNER	PCT OF TASK COMPLETE
1	**Sonar Integration**		
1.1	Final Sonar Bracket	Gabor	0%
1.2	Front Facing Bracket	Gabor	0%
1.3	Install Sonar on Fairing	All	0%
1.4	Testing	All	20%
1.5	Mapping Code	Mike	10%
2	**Fairing Design and Manufacture**		
2.1	Fabricate	All	20%
2.2	Post Processing	All	5%
2.3	Fairing Brackets	Gabor	0%
2.4	Install Fairing	All	0%
2.5	Buoyancy/ Pool Test	All	0%
2.6	CFD	Stephen/Henry	0%
2.7	Laminate Strength Calculations	Stephen	50%
3	**Buoyancy**		
3.1	Finish Code	Henry	75%
3.2	Finish Modification	All	50%
3.3	Pool Test	All	0%
3.4	Trim Weight Sled	Gabor	0%
4	**Deployments**		
4.1	Deploy at pool	All	0%
4.2	Deploy in cave	All	0%
4.3	Deploy MFP	All	0%

1	**Sonar Integration**		
1.1	Final Sonar Bracket	Gabor	0%
1.2	Front Facing Bracket	Gabor	0%
1.3	Install Sonar on Fairing	All	0%
1.4	Testing	All	20%
1.5	Mapping Code	Mike	10%
2	**Fairing Design and Manufacture**		
2.1	Fabricate	All	20%
2.2	Post Processing	All	5%
2.3	Fairing Brackets	Gabor	0%
2.4	Install Fairing	All	0%
2.5	Buoyancy/ Pool Test	All	0%
2.6	CFD	Stephen/Henry	0%
2.7	Laminate Strength Calculations	Stephen	50%
3	**Buoyancy**		
3.1	Finish Code	Henry	75%
3.2	Finish Modification	All	50%
3.3	Pool Test	All	0%
3.4	Trim Weight Sled	Gabor	0%
4	**Deployments**		
4.1	Deploy at pool	All	0%
4.2	Deploy in cave	All	0%
4.3	Deploy MFP	All	0%


TEC-V
Budget

BOM

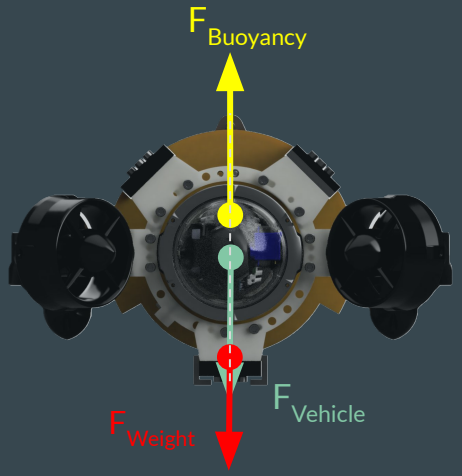
TEC-V
Bill of Materials

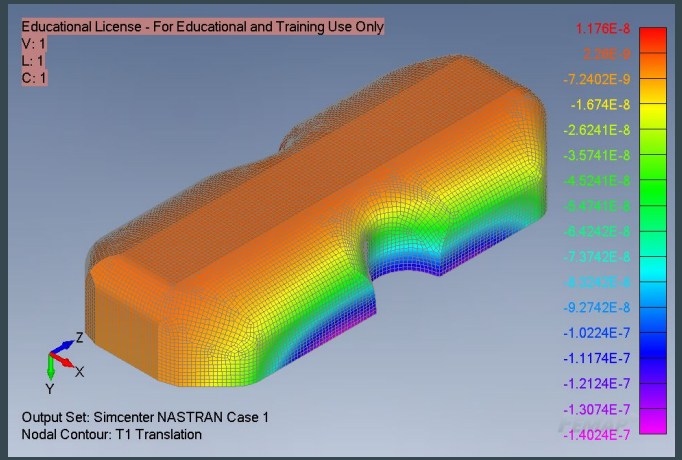
Item	Description	Source	Pt #	Qty	Unit of Meas	Unit Price ($)	Total Price	Link	Notes
Spring 24									
	Crulean Omniscan 450 FS Sonar	Crulean Sonar	9015.8	1	Unit	$2,110.50	$2,110.50	https://cerulea	Includes Shipping and Discount
	Composite materials	Structural Comp		0	n/a	$0.00	$0.00	https://structu	Supplied by Structural Composites
	Blue Robotics Ethernet switch	BlueRobotics	BR-100457	1	Unit	$175.00	$175.00	https://bluerol	
	Strechlon 200 Bag	FibreGlast	1678	1	Unit	$25.95	$25.95	https://www.fi	5 yard roll
	WestSystems Epoxy/Clear Hardener	Amazon	207SA-BUNDLE	1	Unit	$126.12	$126.12	https://www.a	
	PETG filament	Amazon	B08ZB6X2M6	4	Unit	$25.00	$100.00	https://www.a	
	JB Weld Marine Potting compound	Amazon	B00R2CDVIW	1	Unit	$7.12	$7.12	https://www.a	
	BlueTrial 3-pin termination	BlueTrail Eng	COB-3130-SS	1	Unit	$25.00	$25.00	https://www.b	
	BlueTrial 3-pin bulkhead	BlueTrail Eng	COB-1130-SS	1	Unit	$42.00	$42.00	https://www.b	
						Subtotals:	$2,611.69		

Epoxy: +$125

$2610

Questions?


F Buoyancy
F Vehicle
F Weight


Educational License - For Educational and Training Use Only
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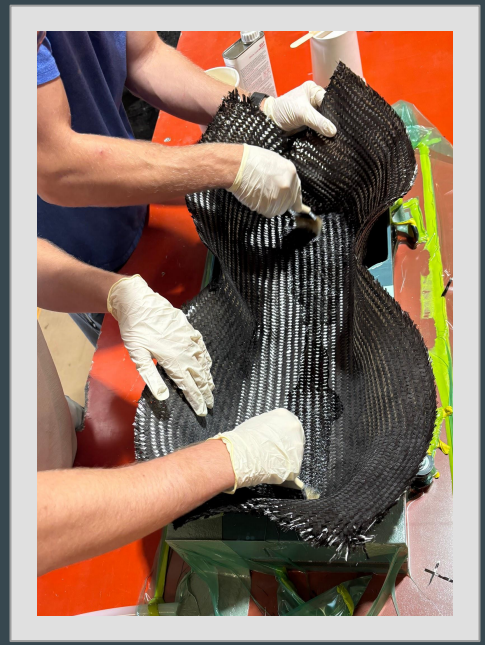
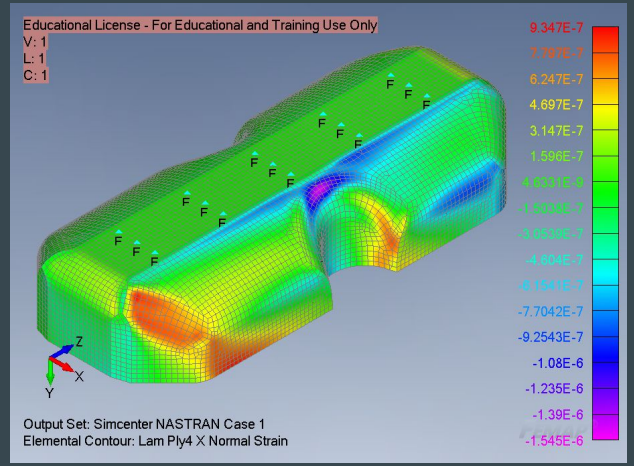
Z
X
Y
Output Set: Simcenter NASTRAN Case 1
Nodal Contour: T1 Translation



Appendix

- **Goals:** Fairing, Sonar, Buoyancy, Mapping
- **Deployments:** Pool, MFP, Caves
- **Progress:** Laminate Study, Hand Lamination, Sonar Integration, Buoyancy Modification



TECV.ROV

Our Website!

Our Insta!

Mapping Website!

TEC-V