

Scylla MK. 1

Technical Report



Explorer Class 2026 MATE ROV

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Table of Contents

Abstract	3
Project Management	3
Design Rationale	4
Electronics Canister	5
Materials Selection	7
Buoyancy	8
Frame Design	9
Thrusters	9
Software	10
Tools	11
Camera	11
Claw	12
Technical Analysis	12
Power Consumption	12
Testing Methodology	13
Safety	15
ROV Features	15
Team Safety	16
Accounting	16
Lessons Learned	17
Acknowledgements	17
Appendix A: SID	18
Appendix B: Finances	19

Abstract

This year Allan Hancock College's Sea Dogs will be presenting the "Scylla" ROV platform. Scylla is an updated form of our 2025 ROV "All Star", specifically catered towards mission readiness and completion. Scylla is designed to handle the harsh circumstances the ocean may bring, while being able to maneuver the delicate ecosystem inside. Maintenance, safety, and ease of use were given strong focus during the design and upgrade process for Scylla. Some parts were repositioned outside of the electronics canister, like our buck converters and new fuse box, to help improve vehicle buoyancy and accessibility.

Our team is a combination of individuals with rigorous schedules who came together to create an ROV that improves upon any complications that arose from last year's model. Project management, equipment organization, and team operations were expanded on and adapted to changing conditions. We overcame challenges, such as the new competition environments and the need to design parts able to bear the brunt of the cold, salty conditions. Our

new vehicle has been designed to support more features, easier assembly, modularity, and improved safety features. Our new platform is ready and capable of handling the specifications set by MATE for the 2026 competition.



Members of our team getting ready for an escape room

Project Management

Our team worked on upgrading how its resources were managed throughout the semester. We have been fortunate to have access to a large electrical engineering laboratory for club meetings, meaning that storage space and equipment access was not a significant issue. Our team moved operations into this larger laboratory back in the summer of 2024, and continued working on organization since then. Throughout the semester, our team has worked on purchasing

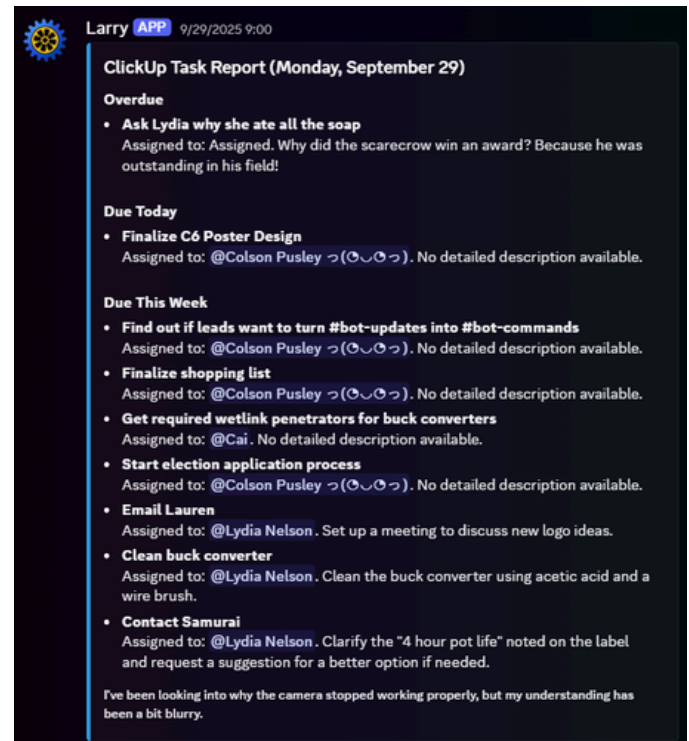
new storage bins and organizing our equipment to improve materials access.



Our conveniently spacious laboratory

Our team's project management systems were adapted based on the results of past seasons, and adjusted as team dynamics changed throughout the season. Trello was used as our project management software in the prior season, and we found that it did not allow for outlining tasks in as much detail as we would have liked. Our team researched other software solutions as a replacement, and settled on ClickUp to use for the season. ClickUp stood out for its ability to create subtasks of other tasks, organize tasks into groups, and assign tasks out to members. Additionally, ClickUp's API allowed for directly integrating a daily summary of tasks into our Discord communications, making it easy to see

at a glance what items need to be focused on or planned ahead for.



An example of our custom Discord & ClickUp integration sending an update. These updates were configured to send three times every week.

Design Rationale

Initial Testing

At the start of the season, our team's primary goal was to take our existing competition robot and resolve the maintenance issues that were encountered during the 2025 competition season. One of the

biggest goals was ensuring the canister could be removed by unbolting just a couple of screws, instead of requiring a disassembly of the frame. Easy pressure tests, achievable by relocating the pressure release valve, was an additional goal. Improving internal canister space through better component arrangement would help complete our goals of easier vehicle maintenance, while improving on the performance and functionality of our prior vehicles. To test this concept, we modified our existing "All Star" competition platform



Our tests with a modified "All Star" frame

to utilize two frame pieces. The larger piece would be used for structural integrity, while the topmost section was used to fasten the canister down onto the main platform. This was efficient at simplifying access to the internal canister, but our team found other issues with the design. The upper frame was prone to bending as the screws were tightened down, and the canister seal was dependent on evenly tightening the long screws holding the upper ring down. Pressure tests were also still complicated due to the pressure release valve being placed against a solid HDPE sheet. Our team elected to proceed forward with larger changes to the frame and electronics.

Electronics Canister

The electronics canister was the heart of our vehicle design that all of our other systems were planned to be designed around. Our previous electronics canister for All Star used an endcap for an 8" PVC pipe that mated to an aluminum baseplate, using a compression seal in tandem with an O-ring seal. While it was effective for its design specifications, it came at the cost of extremely difficult maintenance procedures.

The compression seal meant that the frame, which was delivering the compression, had to be partially disassembled in order to access the canister. The canister was also difficult to remove from the electronics plate, as we had little gripping surface to pry it apart. This became our initial focus for improvements with our upcoming ROV design.

Another significant issue that our team wanted to resolve was the tight internals of the electronics canister. It was challenging to service All Star in the 2025 season due to the electronics canister using almost all of its entire volume to house the electronics, power converters, and more. As most of the volume was taken up by the buck converters, we decided to pursue looking into avenues to relocate them outside of the electronics canister, instead placing them directly into water. This space saving measure would also allow for the buck converters to directly dissipate their heat into the water, preventing the heat from warming the air inside the rest of the electronics canister (which would in turn reduce their effectiveness).

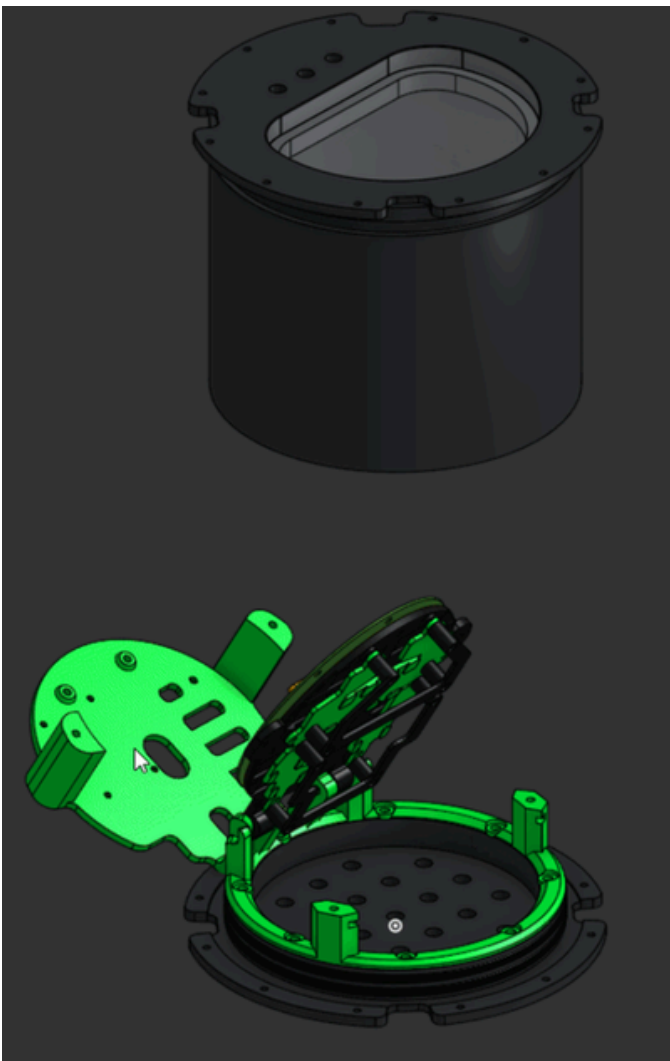
Our team built the new electronics canister around a regular 8" pipe

with a separate lid and baseplate to seal both ends. Both caps utilized two O-rings to form a seal, removing the need for the frame to compress the canister together for sealing. The canister lid and baseplate were bolted directly to separate sections of the frame, which could be separated from each other by unbolting a couple of screws. The canister lid was given mounting holes for pressure release valves and status LEDs, along with a slot for attaching a clear lid. eliminating our previous issues with All Star of no visuals on internal electronics, and a lack of easy access to the pressure release valve.



Our PVC pipe stacked on a recently-milled HDPE baseplate.

Additionally, a stacked hinge system was developed for mounting the control system, ESCs, and other internal electronics inside the canister. These series of changes provided effective solutions to drastically simplify our vehicle maintenance procedures compared to our prior platform.



CAD model of our electronics canister stack

Materials Selection

Our general philosophy around the frame materials remained largely the same to prior seasons, such as mentioned in our previous tech report. Scylla's frame is made primarily out of CNC-machined high-density polyethylene (HDPE) sheets, as well as 3D printed polyethylene terephthalate glycol (PETG) components. PVC pipe and acrylic were used for the pipe and lid of the electronics canister. HDPE was used as the core of the frame structure due to multiple favorable characteristics, particularly its neutral buoyancy in water and ease of machining. Neutral buoyancy as a characteristic simplifies both the design process and machining process when incorporating that material, as its weight does not have to be factored into the design. HDPE was chosen for 3D printed components for its affordability, ease of use in 3D printers, UV resistance, and durable structural properties necessary for underwater environments.

One major change from last season was the conversion to a plastic baseplate for our electronics. It is common for ROVs to use a metal

baseplate for the primary canister, as it allows for efficient heat transfer into the water so that the electronics do not overheat. Due to our placement of the primary heat-generating components outside the canister, and some mission tasks being located in salt water conditions, our team determined that a metal canister was going to be a poor choice for components. The benefits of heat transfer were no longer necessary, and the need to anodize a metal baseplate was going to be a significant cost burden. Switching our canister to be entirely plastic also gave us a significant weight reduction and simplified manufacturing.

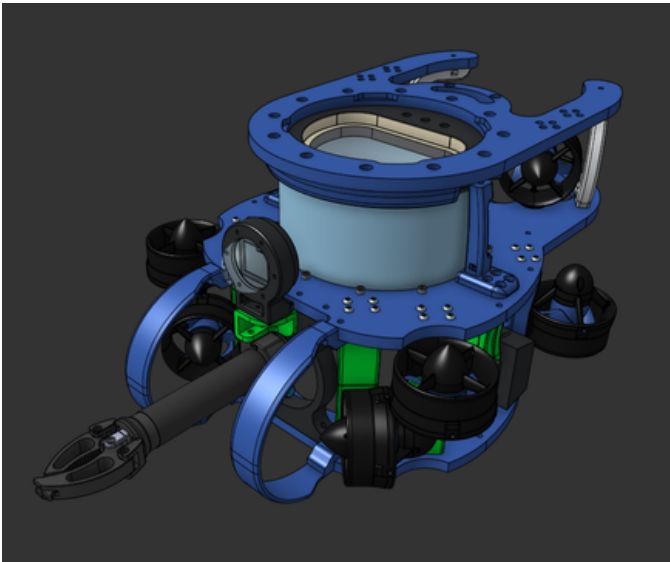
PVC piping was chosen for our canister for its broad availability and low cost, while 3D printing was used everywhere else to simplify the integration of more complex components that could not be easily machined or purchased. Acrylic was machined to make our electronics canister lid, as it provided a structurally solid and cost-effective manner of allowing for visual inspection of the internal electronics.

Buoyancy

For our design this year, we largely used the prior vehicle's real-world performance as a starting point for analyzing how our vehicle would be balanced in water this year. Last year's design required a significant amount of buoyancy to stay neutrally buoyant, meaning our goal was to shoot for a higher displacement to weight ratio before adjusting. Our HDPE frame and PETG 3D printed parts are close to neutrally buoyant, meaning they have little effect on overall buoyancy. Our improved displacement to weight ratio was ultimately achieved by relocating our 48V to 12V buck converters to be outside the main canister. Not only did this make the ROV close to neutrally buoyant, but their heavy weight means our center of mass was lowered relative to the center of buoyancy. This was validated during our initial pool tests, where we found the vehicle very close to neutrally buoyant, only requiring small adjustments to get it ideal.

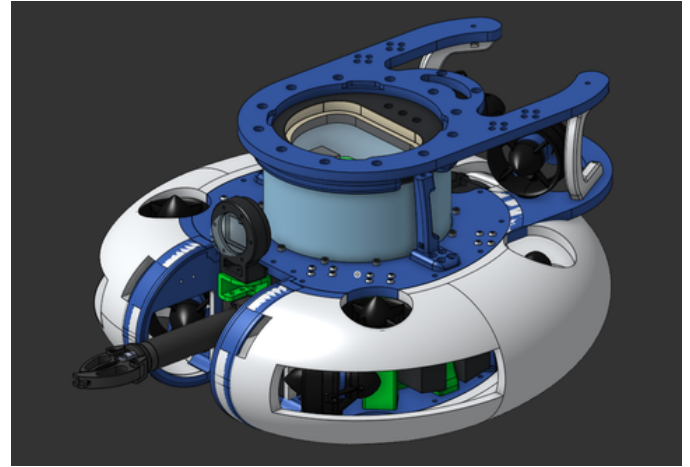
Frame Design

The design of the frame is our largest deviation from our prior competition vehicles. Last year's frame was used as a starting point, but as the initial concept work for the design started, we found that more extensive modifications would be needed to facilitate our goal of easier maintenance. Key features and overall vehicle shaping were incorporated around serviceability, such as with the large open region underneath the primary canister. Vehicle aesthetics were also given a stronger focus during the design process; our vehicle was complimented last season for a strong visual design, yet we felt that there was still room for improvement.



Our frame design with minimal shrouding, suitable for turbulent environments

Submarines from science fiction were looked to for inspiration with the design shaping, and the *Seamoth* from the Subnautica series of games was the primary inspiration for the vehicle design.



Our frame design with maximal shrouding, suitable for dangerous environments



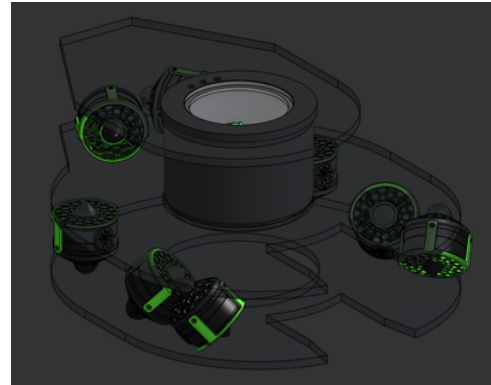
The reference Seamoth

Thrusters

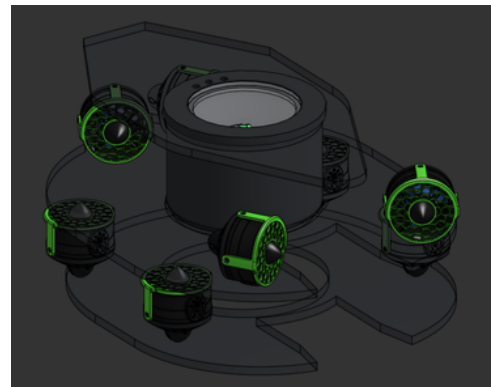
Because some of the competition tasks will be placed inside a flume tank, maximizing vehicle maneuverability was prioritized to prevent loss of control during a

competition run. As a result, our team chose to implement a standard 8-thruster configuration: 4 vertical thrusters paired with four horizontal thrusters arranged in a diamond shape. This configuration provides a full 6 degrees of freedom, while also matching our BlueOS software stack with minimal integration difficulty. Fitting all 8 onto our frame design required extra attention, as we wanted to avoid blocking the line of sight of any cameras, and avoid damaging the Seamoth-esque aesthetic style. The obvious answer was to mount the frontal horizontal thrusters lower, but they started encroaching on the two vertical thrusters. An experimental design was proposed that would mount the four frontal thrusters at an angle, so that they would not interfere with each other and inhibit performance. Our team ultimately chose to stick to a standard configuration and work with the slight performance reduction, as we knew our vehicles were already overperforming relative to the fine precision that was more often needed when completing mission tasks. This makes the ROV close to neutrally buoyant, and their heavy weight means our center of mass was lowered

relative to the center of buoyancy.



Design proposal based on experimental 8-thruster layout



Design proposal based on standard 8-thruster layout

Software

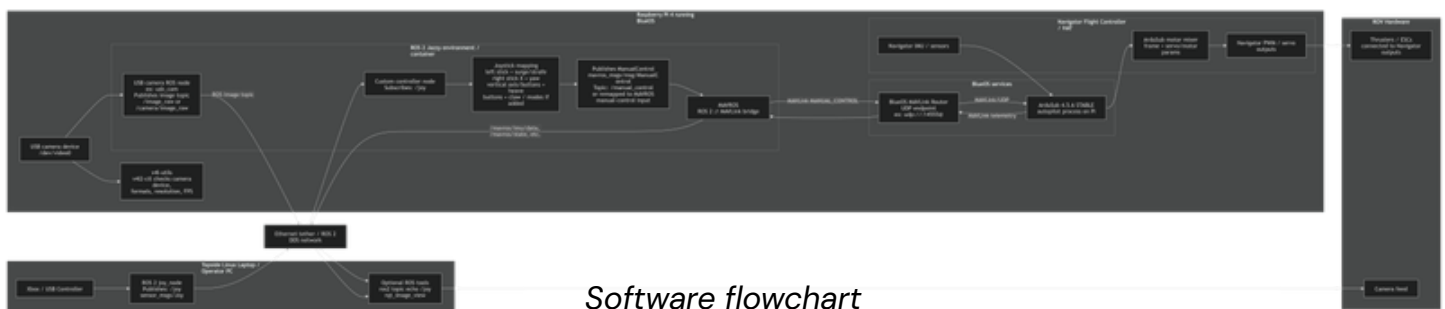
Scylla's architecture is based on an ROS 2 + BlueOS software stack integrated into a Raspberry Pi 4 and Navigator flight control board. Through separate ROS 2 nodes, commands enter the setup and flow toward a central Raspberry Pi. This small computer handles incoming data with a unique Python-based ROS 2 module

made just for it. Once processed, those directions move onward through MAVROS to reach the Blue Robotics Navigator unit. Signals shift from there – transformed into MAVLink format by ArduSub running on the device. With that conversion done, the Navigator sorts how power should split across controls. Each of the eight equipped T200 thrusters receives tailored PWM output based on combined motion needs. This permits stabilized movement freedom in all six axes and simplistic control of our claw. Our software setup utilizes a BlueOS terminal to help catch problems early. Instead of waiting until everything was linked together, separate tests were run first. A lone thruster hooked straight to the Navigator using GPIO pins made real-time feedback possible. Through that link, they watched how well it responded when signals came through. Control precision and power delivery were confirmed using BlueOS tools built for motor checks.

Tools

Camera

Our camera design is largely similar to the ones employed on All Star last season, which was elaborated on in our previous technical report. The camera mount was designed with simplified assembly in mind and protecting the internal electronics. The design was inspired by the camera holder of our previous ROV, which utilized a plastic dome on the front that locked into a plastic cover. We utilized a plastic base and small plastic dome that covered the camera, providing maximum visibility in a small package. Once a gasket maker sealant was applied around the base, screws were utilized to connect the camera to the mounting bracket and apply pressure to the sealant. Power and data are routed through a direct USB connection linking the onboard Raspberry Pi to the mounted camera, allowing simultaneous power delivery



and real-time video transmission. This design allows for efficient replacement of parts and adjustable frame positioning, permitting us to change placement on the fly according to mission needs.

Claw

As the mission tasks will rely on a claw that can rotate as well as open/close, our team chose to base Scylla's claw on the Newton Subsea Gripper from Blue Robotics. It forms the primary gripping functionality for our claw to grab onto objects of various sizes that can be encountered during competition runs. Additionally, we are utilizing a waterproof servo housing from Blue Trail Engineering as the rotation element for our claw. Our team found that the purchased claw exceeded expectations due to its incorporated features, such as its motor control detector which would only apply as much pressure to an object as needed. In addition, the claw was rated for depths much exceeding what was necessary for our vehicle, and the competition, eliminating concerns about having to reinforce the claw with extra components.

Technical Analysis

Build vs. Buy

This year presented unusual circumstances for our team, as we had easy access to funding for parts yet limited manpower and resources available to work on the various aspects of the vehicle design. Our team continued its tradition of building the frame and electronics stack from the ground up, as ready-made solutions were generally not suitable for our requirements, and



Scylla's claw and primary camera

were comparatively simple for our design team to improve on over last year. On the other hand, when this decision came to more complex components, we chose to purchase and integrate existing solutions, mainly to avoid “reinventing the wheel” for components that did not require it. The claw was a noteworthy example of this; our team has built its own claw designs in prior seasons to save on costs, but ran into several issues with water ingress that were not fully resolved before. We instead elected to purchase the Newton subsea gripper from Blue Robotics, and pre-made servo housings for rotating the claw. Using these options saved our team valuable engineering man-hours that were directed towards improving the frame and electronics instead. These components also offered easier integration into our BlueOS software stack, helping to simplify development for our software team.

Power Consumption

The primary downside of our 8-thruster configuration is that it introduces the possibility of exceeding our 30A competition fuse limit. At full power, our thrusters can utilize over 1,600W of power by themselves, which

exceeds the 1,440W limit imposed by our 30A fuse. Even before factoring in the other electrical systems of the ROV, it's evident that the vehicle could draw enough power to break a fuse. Our team chose to utilize software-based power restrictions to ensure our thrusters do not blow the mainline fuse during normal operations. Our other options were to use fewer thrusters or entrust our pilots with being careful during vehicle operation. Both of these came with larger downsides; only equipping six or seven thrusters would compromise our maneuverability, and our team of pilots were most likely to be new members still learning the ropes of vehicle control. The reduced ROV speeds imposed by software throttle limits were less of a problem, especially as we know our vehicles can operate at speeds faster than the currents we could face at the competition.

Testing Methodology

Prototyping

Our initial prototypes for our ROV components were built from entirely 3D printed parts. This allowed us to verify the accuracy of our parts and

catch for possible mistakes prior to finalizing the parts for machining. Live testing of electrical and software components was used as the vehicle grew nearer to completion. Our team tested our thrusters by placing them in a sealed Red Vines licorice container to ensure it responded to commands) this was done at the same time we tested the software. This ensured we could test the software would work once the vehicle was fully assembled, yet ensuring water spillage in our laboratory was minimal.

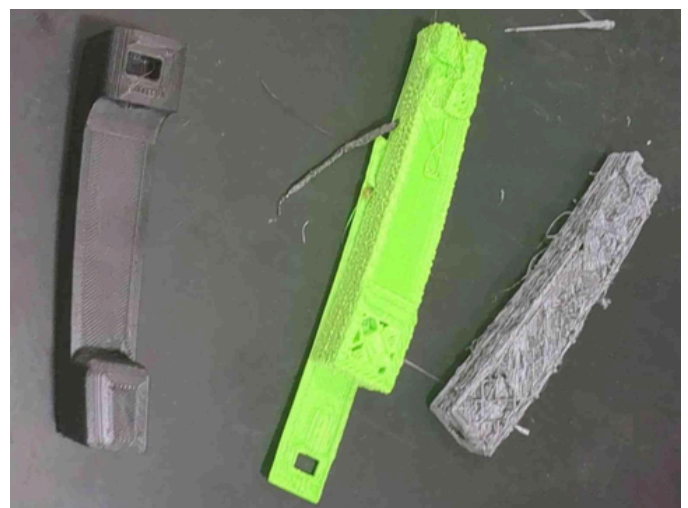


A small-scale test print of the canister

Our custom designed waterproof buck converters went through significant testing to ensure they were sealed

before assembly. Early on we tested the manufacturers sealant on the buck converter housings to see if it was sufficiently waterproof, looking for corrosion/rusting and any other issues that might come up. Once we saw that the initial sealant was not meant for water submersion, we applied a highly specialized Samurai marine sealant and then re-ran the tests. Once we found the tests had passed cleanly, we moved forward with assembly.

In one phase of building the robot, we used 3D print parts that worked out well, but we found the process of printing them came with its own set of obstacles. Our 3D printers struggled to print parts at 100% infill, due to moisture ingress with our filament and small imperfections leading to larger problems as the prints progressed.



Failed prints due to moisture

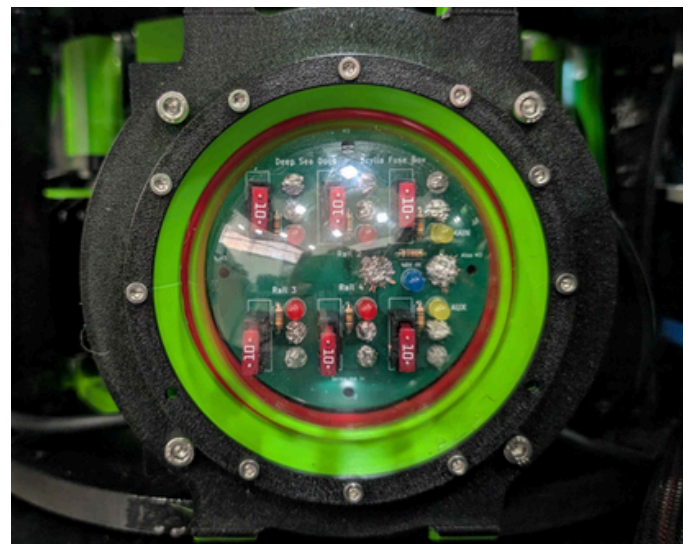
This required a keen eye for quality inspection and re-working measurements as needed, but ultimately meant that we spent significant amounts of time printing and re-printing parts. We learned valuable lessons on the difference between designing parts that go together in theory versus how much room we needed to leave to construct the parts together.

Safety

ROV Safety Features

Safety was incorporated as a strong focus in this year's vehicle design, with safety-focused features across the board. Similar to last year, the ROV frame was designed around minimizing sharp edges or loose wires in as many ways as possible. Rounded curves were made a central part of the vehicle design and aesthetics, while screw ends were terminated inside 3D printed parts where possible. External wiring is largely condensed inside the lower central area of the frame, preventing loose wires from being exposed and able to catch on mission tasks.

A dedicated fuse box was added as a new safety feature for this year's vehicle. Positioned in the back of the robot, it ensures that all components of the vehicle are fused, with the four primary 12V buck converters fused separately from the main 48V line into the canister. This fuse box also incorporates LED visual indicators for if the buck converters and internal modules are receiving power, helping to quickly diagnose power delivery issues.



Fuse box with status LEDs

Additional fuses are installed inside the primary electronics canister, protecting the Raspberry Pi and claw servo. Our electronics stack is further protected by a leak sensor, alerting the pilot if water leakage is detected at the bottom of the canister.

A modular component shielding makes up a core part of Scylla's safety features for operating around mission tasks. Modeled after the Seamoth submarine, Scylla's lower frame shrouding can be switched out with different versions that have increased or lower densities of shrouding mesh. Higher density shrouding can be installed when movement speed is less essential or the environmental risk is higher. Lower density shrouding can be installed for situations where reduced maneuverability is a safety risk, such as when operating in a turbulent environment like the flume tank.

Team Safety

Safety is a top priority for our team, setting the pace long before tools touch circuit boards. Fume hoods have been a longstanding safety measure provided to team members during electrical work, to ensure proper air quality and reduce exposure to harmful airborne chemicals. Goggles were also made available and required for dangerous machining operations, especially around sparks or flying bits generated by cutting machinery. Team members

were educated on correct ways to touch wires to keep shock rate low. Additionally, our workspace at all times was kept organized to prevent accidents. Most days, safety just showed up in small moments such as someone pausing to ask a question or someone stepping in to clarify a step. Because members joined at different times, with varying backgrounds, talking things through became normal instead of rare. Before starting anything new, team members ensured to clarify steps out loud before procedures started.

Accounting

Our team was largely funded through the MESA/STEM and CTE departments at Allan Hancock College, along with other campus departments that helped cover travel expenses. Our team engaged in fundraising through 3D printed widget sales at campus events, serving mainly as a fundraising opportunity and to help us grow our club accounts in preparation for possible large expenditures in the future.

Lessons Learned

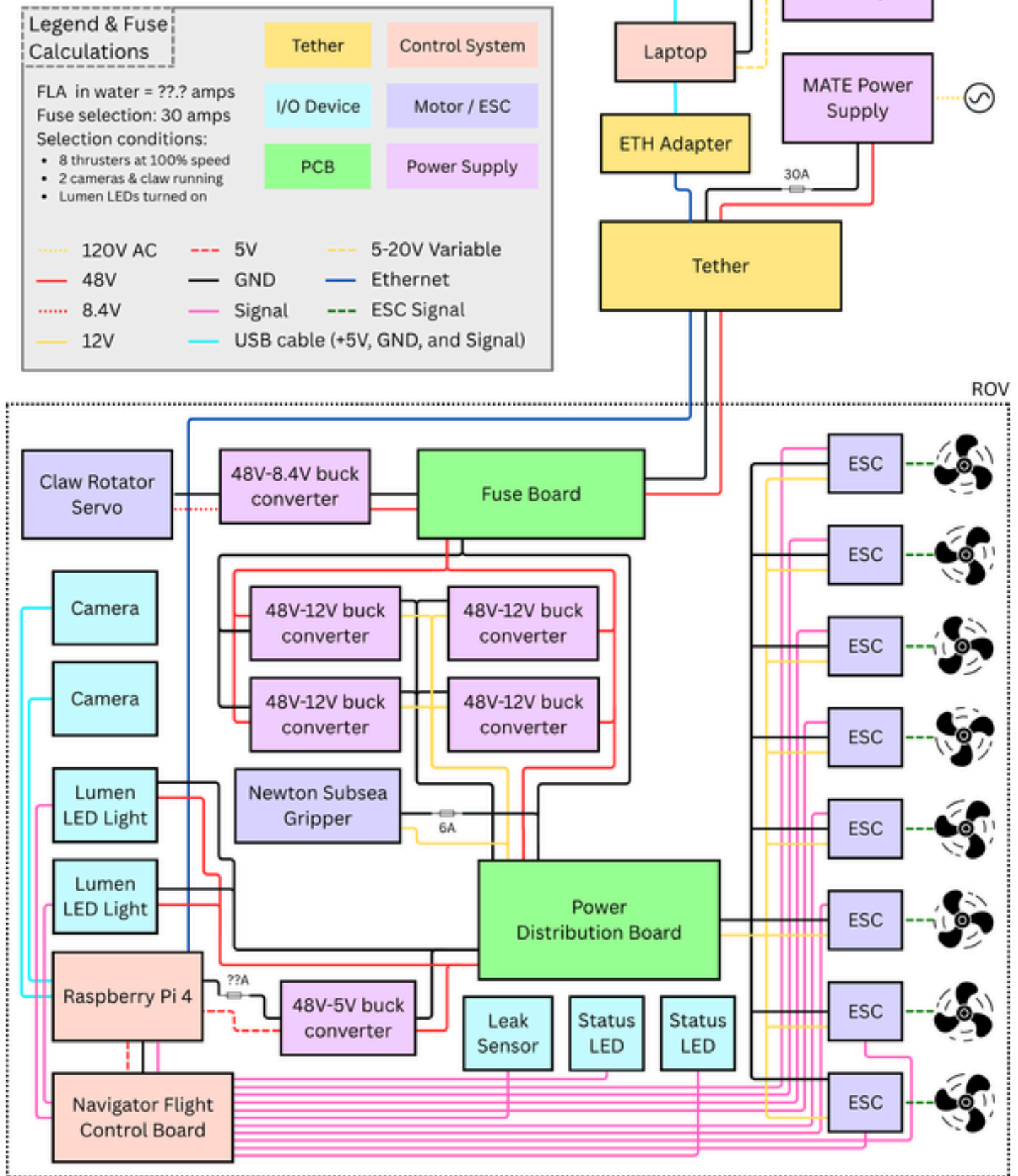
The biggest lesson that our team learned from this season was about the importance of adaptability. We approached the 2025–2026 season with a strong gameplan that was built on how our prior seasons had operated, and did not anticipate needing to change it significantly over time. Our original plans centered around a “build instead of buy” philosophy being our only option, when in reality our scarcest resource was time and manpower. As time progressed, we ultimately found that our team approached the season with gameplans that depended on a larger leadership team than what we had available. In addition, all of our initial leadership team members encountered challenges in their personal lives that severely restricted their availability to help the rest of the team. While the team was able to adapt to the changing dynamics, a less rigid decision making structure would have been beneficial to have implemented earlier on.

Acknowledgements

Our team is immensely grateful to both the MATE ROV Competition and Allan Hancock College for allowing our team to be able to build robots and compete with them against members of the globe. The Allan Hancock College CTE department and MESA/STEM Center have been instrumental for helping fund our equipment and travel costs, allowing our team to focus entirely on the vehicle assembly, and we owe them our thanks. Our advisors Justin and Greg deserve our utmost thanks for their technical expertise and coordination that they provided for our team. The AHC Machine Shop, along with their instructor Hector, provided plenty of expertise in manufacturing components for our vehicle and deserve our thanks. Last but not least, we would like to thank everyone else who assisted our team along the way, including Dawn Fuller, Dominic Bello, Mark Kozel, David Beal and Francisco Cool from Allan Hancock College.

Appendix A: SID

System Integration Diagram: Scylla



Appendix B: Finances

Description	Company Expenditures	Donations	Reused Items
Starting funds	\$1450.00		
Income			
Fundraising	\$60.00		
College Funding Bonus	\$100.00		
Total	\$160.00		
ROV Expenses:			
3D Printer Filament		\$100.00	
Other Raw Materials		\$150.00	
Electronics Canister		\$40.00	
Thrusters		\$500.00	\$1,600.00
Strain relief			\$25.00
Tether			\$121.00
Raspberry Pi		\$100.00	\$100.00
O-rings		\$30.00	\$30.00
Sealants & Lubricants		\$62.00	
Cameras		\$100.00	\$50.00
Servos		\$80.00	
Buck converters		\$110.00	
Penetrators		\$139.00	
Other		\$262.00	
Total		\$1,673.00	\$1,926.00
Non-ROV expenditures			
PVC props		\$150.00	
Travel apparel		\$300.00	
Tools	\$100.00	\$100.00	
Lodging		\$17,901.00	
Travel meals		\$6,708.00	
Airfare		\$15,135.00	
Other		\$1250.00	
Total	\$100	\$45,619.37	