2024
PIONEER

TECHNICAL REPORT

Written by:

Allan Hancock College
DEEP SEA DOGS

2024 Travel Team

Fiona McGinnis
Alejandro Cifuentes
Colson Pusley.
Lydia Nelson
Lauren Davis
Justin Rucker

Table of Contents

Abstract

Our Company, The Deep Sea Dogs, is based out of Allan Hancock College in Santa Maria, California. We are the only college level robotics program offered in our city and have hosted a broad range of students in their majors, experience, and career goals. Our mission is to provide STEM and robotics based education through competitive robotics programs to all students regardless of their experience level.

Along with building a strong platform for college level STEM programs we strive to highlight the importance of outreach on our community and on our campus. We promote the mission of our company through our outreach to our peers, school staff, and local elementary school students.

Founded in 2023 this is our second year competition in Pioneer class of the MATE ROV Competition.

Figure 1: 2023 ROV ROVert

Figure 2: 2023 Deep Sea Dogs

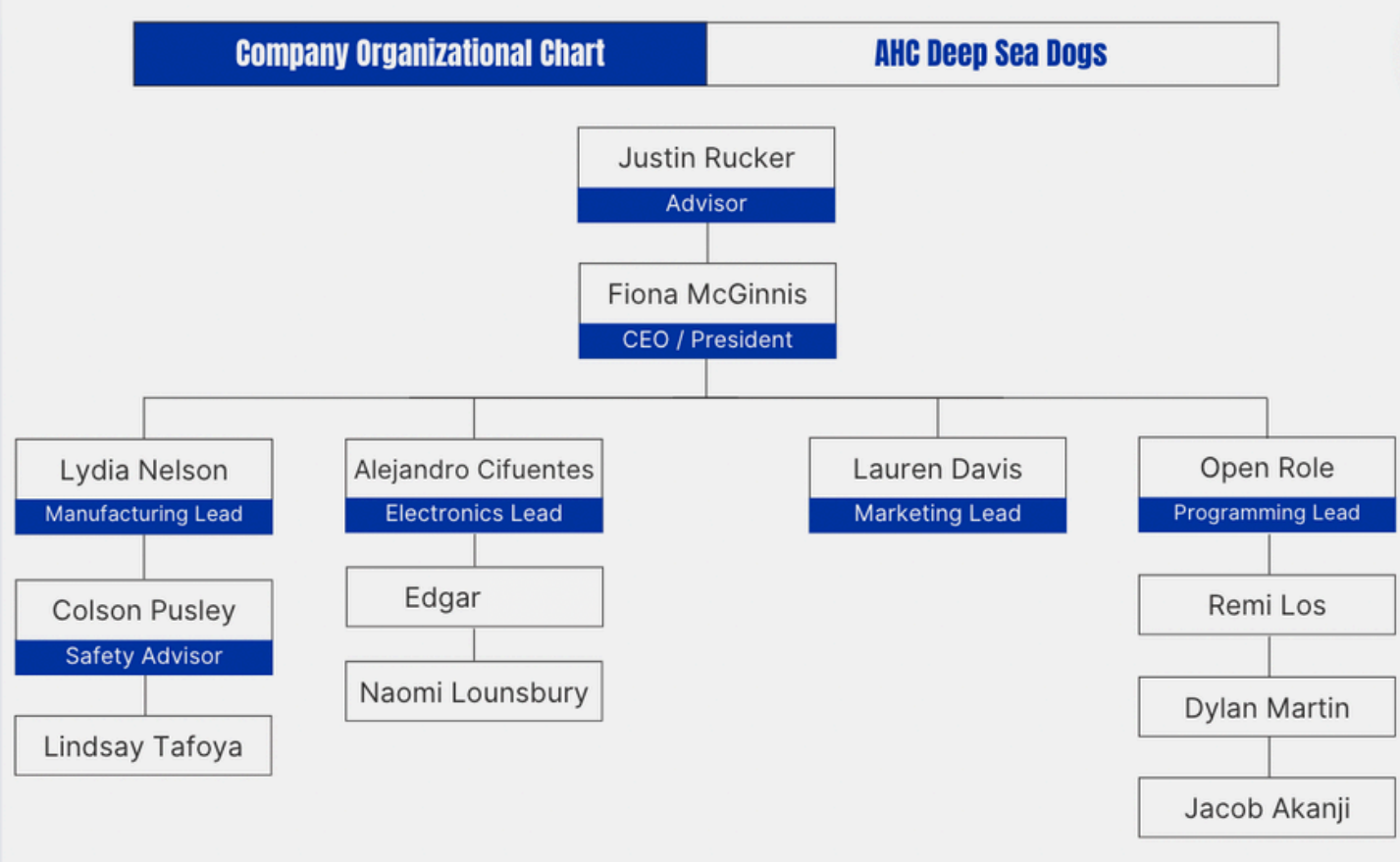
Teamwork

Our company is built in a way to have student leads take on responsibilities of the build process, ordering materials, and training our peers and fellow company members. Our team is split up into four sub-teams each in charge of one aspect of the team and all led by a student leader. The sub-teams are as follows:

- **Manufacturing**
  - Focused on the process of creating and assembling any mechanical or structure based components of the ROV.
- **Electronics**
  - Focused on waterproofing and routing all wires related to our control station and ROV.
- **Programming**
  - Focused on all code relating to controlling the ROV, camera, and drivers station.
- **Marketing**
  - In charge of branding and design elements related to presenting our team to the public

Each sub-team has their own agenda items and priorities within the team to ensure our company's success during the competition season. Each team focuses on a specific area of work to take on aspects of either the technical or marketing / outreach documentation and paperwork.

Our Marketing lead role has been updated to also serve as our team's treasurer allowing us to track our finances easier and plan our budget to go alongside our college's fiscal year. We have records kept of our companies meeting minutes, transactions, and previous years documentation to help aid us in our seasonal processes.



Our company has a fixed meeting time of 3pm-6pm on Wednesdays to organize for the work required that week and to plan for future events / fundraisers. This time gives our company and its members the opportunity to discuss design ideas, hold leadership meetings, and plan for missions. This meeting time is the only block of time our full team is able to meet up and organize our thoughts for the remaining season work. Our meetings throughout the rest of the week are split up in blocks of time based on availability, priorities, and people required to accomplish the work. This schedule is great for our company as it provides the needed flexibility of hours for our students' busy schedules and still allows for the needed hours to accomplish the work required to develop and test our product.

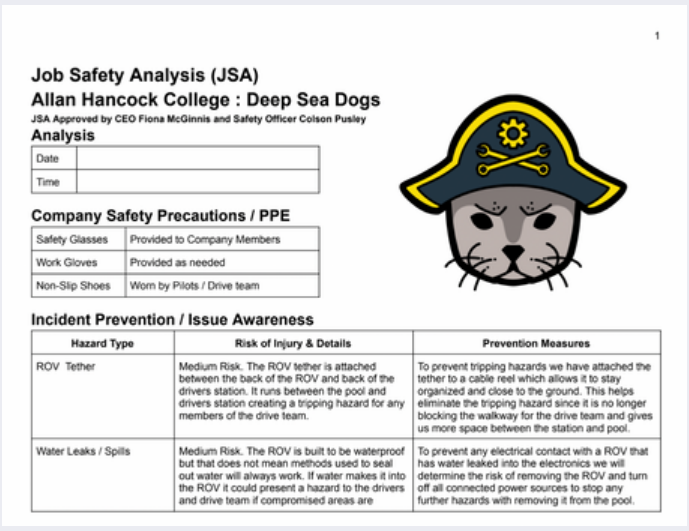
We utilize Discord as an online workspace to keep constant communication between our team members and discuss strategies for challenges and design options for the ROV. When extra time is needed for discussion we are able to hold team / leadership meetings within our various channels.

Safety

Providing a safe working environment is a priority for our company so ensuring that students are able to work on our product and accessories without harm is crucial. We want to guarantee our students are safe in our workplace and that our product cannot cause harm. Listed below are the methods and safety features implemented into our 2024 ROV and drivers station.

We outline our safety procedures and processes within our Company Safety Analysis and our Job Safety Analysis (JSA). Our company members are encouraged to wear PPE while working with the ROV and float components and test ROV functions in secure areas.
Since we are a small team we are able to look out for all of our teammates and provide them assistance with all tasks so no one has to take on any potentially dangerous tasks solo.

Figure 3: Team photo from 2023 ROV



1

Job Safety Analysis (JSA)
Allan Hancock College : Deep Sea Dogs
JSA Approved by CEO Fiona McGinnis and Safety Officer Colson Pusley
Analysis

Date	
Time	

Company Safety Precautions / PPE

Safety Glasses	Provided to Company Members
Work Gloves	Provided as needed
Non-Slip Shoes	Worn by Pilots / Drive team

Incident Prevention / Issue Awareness

Hazard Type	Risk of Injury & Details	Prevention Measures
ROV Tether	Medium Risk. The ROV tether is attached between the back of the ROV and back of the drivers station. It runs between the pool and drivers station creating a tripping hazard for any members of the drive team.	To prevent tripping hazards we have attached the tether to a cable reel which allows it to stay organized and close to the ground. This helps eliminate the tripping hazard since it is no longer blocking the walkway for the drive team and gives us more space between the station and pool.
Water Leaks / Spills	Medium Risk. The ROV is built to be waterproof but that does not mean methods used to seal out water will always work. If water makes it into the ROV it could present a hazard to the drivers and drive team if compromised areas are	To prevent any electrical contact with a ROV that has water leaked into the electronics we will determine the risk of removing the ROV and turn off all connected power sources to stop any further hazards with removing it from the pool.

Figure 4: Company JSA

Product Design Rationale

The overall design of the ROV is based on the specifications provided by MATE for the Eagle Ray kit. This choice was made for our frame design due to the limited material we had and the constrained time limit we had to assemble and machine parts of our ROV. Since this was our first year working with the eagle ray kit we did not want to make too many additions or major changes that could result in potential failure of seals or damage to the electronic canister. This consensus allowed us to design components on a similar level to the ones we required while still maintaining that factor of safety and robustness needed to withstand the water.

Design starts off with a team discussion. Members of our team presented on various different frame types, styles of ROV, float systems, and tether management in order for us to determine the most efficient style and what we could emulate and succeed the best with. By determining the style of ROV and float we wanted to design it was easy to discuss the potential challenges we would be able to accomplish and rank them in terms of wants, needs, and goals.

The goal of our ROV is to be a lightweight device that is able to efficiently accomplish seasonal challenges and give our students experience on the creative, design, and engineering processes.

Product Systems

Frame:

Our frame is made from High Density Polyethylene (HDPE) and allows for our ROV to achieve natural buoyancy easily without having to add any extra materials or weights. We were donated this material through the Eagle Ray Kit from MATE and unanimously decided that this would be the best material for the frame not only because it was provided to us but it would create the best structure for our ROV. We previously used PVC pipe to create our 2023 ROV "ROVert" and it served its purpose for the course of the season however did not provide the level of stability that we needed for this season.

The material serves as a light-weight alternative and allows for easy maintenance on the ROV. The modular structure of the frame lets us assemble and disassemble the frame with ease

Electronic Housing:

Our electronics are housed within our ROV's canister located in the center of our frame. It is secured in place with the ROV's handles and three support beams located on the sides and top of the canister.
The tube contains several circuit boards designed and provided by MATE along with our thruster controllers and an Arduino. The housing is sealed with 3D printed end caps and wetlink penetrators to allow the wires to enter safely.

Figure 5: ROV frame pieces

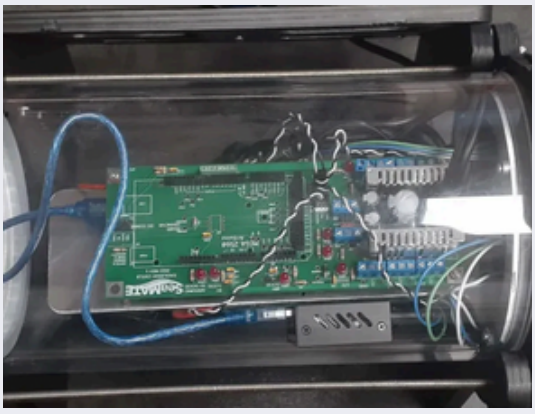


Figure 6: Electronic Housing

Programming

The software design process has proven to be an incredible learning process with various ups and downs for the software engineers involved. For 2024, the Deep Sea Dogs decided to use the MATE-provided Python code and Arduino sketches as a basis for the thruster control. This choice was made primarily due to the lack of experience working with the hardware that the team had possessed. Ultimately, the team decided to use Python due to prior experience, along with the comfort of the availability of a wide variety of tooling that could be utilized. Using Python allowed the team to easily test the software on multiple platforms.

Heavy debugging and modifying the provided code allowed the engineers to grasp the general code flow and communication between the software and the hardware. Once the engineers could successfully test the ROV with the provided code in the early stages of the project, they decided to move in a direction that would allow a better overall software architecture along with a more enjoyable piloting experience. This included a massive overhaul of the code provided for the thrusters as well as a custom-built graphical user interface (GUI). This was the first step that was taken to comfortably pilot the ROV. Down the line, the team has plans to implement object detection and measuring, data collection, autonomous docking, and more.

An overview of the libraries used to build the software at the time of preparing this document is as follows:

matplotlib (https://matplotlib.org/): Used to generate real-time graphs for monitoring voltages, temperatures, and joystick inputs.
NumPy (https://numpy.org): Used for array/matrix operations necessary for the functionality of the camera and other algorithms implemented.
opencv-python (https://pypi.org/project/opencv-python): Used for capturing video and photographs with the installed camera, as well as object detection.
pygame (https://www.pygame.org/news): Used for joystick input and related functionality.
PyQt5 (https://www.riverbankcomputing.com/software/pyqt/): Used for building the GUI.
pyserial (https://github.com/pyserial/pyserial): Used for serial port access; allows for seamless communication between the hardware and software.

Buoyancy and Ballast

Our company's goal was to create a naturally Buoyant ROV that does not require additional weights to drive outside of testing and troubleshooting. Using HDPE for the frame this season has allowed us to accomplish this goal and monitoring the pressure inside of the electronics canister allows us to monitor our ROV more closely to make sure it is pool ready and buoyant. Thruster location allows the ROV to freely move in the pool while maintaining its natural Buoyancy.

Figure 7: Picture of 2024 ROV

Thruster Placement

ROV Thrusters are mounted on the left and ride side plates on the ROV. Two are facing upward in the upper center sections of the panels and two more are placed on the back end of the panel. Figure # shows the mounted Thrusters on our ROV.
Extra holes are prepared on the frame for alternate Thruster mounting spaces.

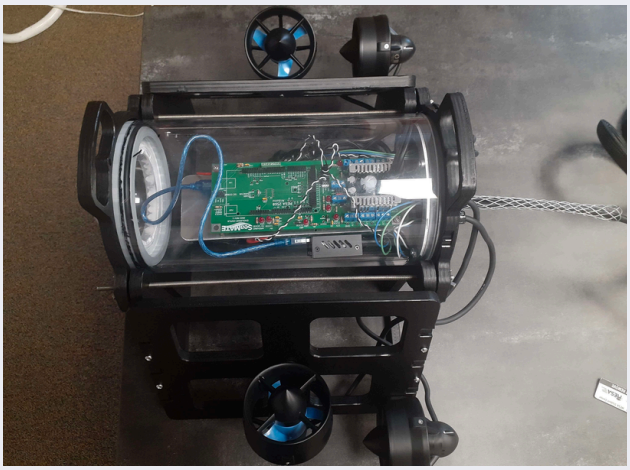


Figure 8: Thruster Placement on ROV

Payload and Tools

We are in the process of designing and attaching additional tools to our ROV to assist in the presented challenges at the upcoming competitions. We will be attaching a mechanical claw to the ROV that will be capable of picking up, placing, and lifting objects while submerged. We are planning on making the claw custom to our company by 3D printing the components and creating the CAD models ourselves.

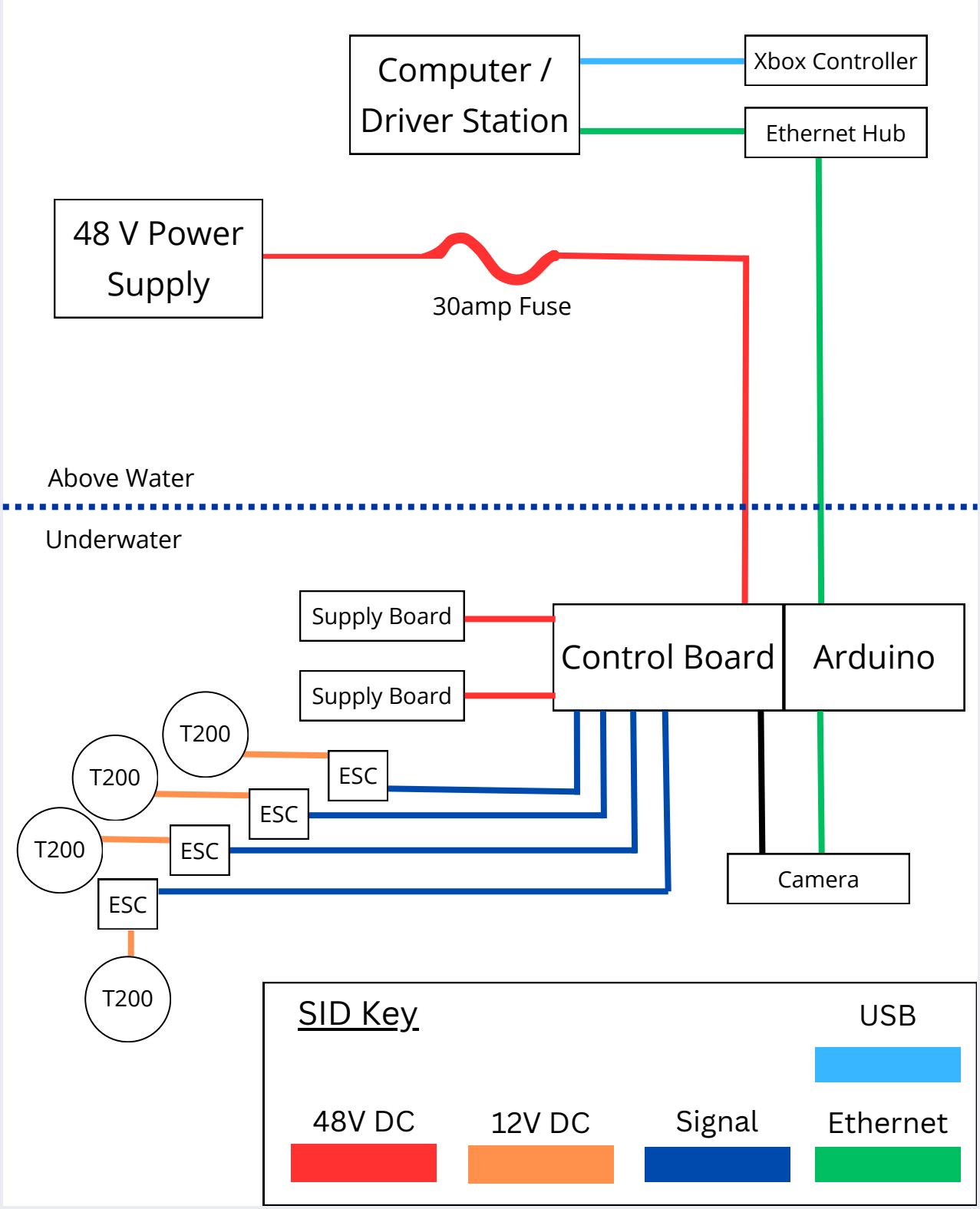
Build vs. Buy vs. Used

We prefer to make everything in-house and designed by our students. This comes with some complications in material since some components are specified for the competition that do not have alternatives; however, anywhere we are able to innovate we have put forward our original designs. With our previous ROV we didn't have much direction and it left us open to a lot of experimentation and freedoms with the design process. This is something we wanted to take and refine for this season as we were able to take guidance from the steps in our project manual and innovate creative solutions to make our ROV more suited for our company's needs.

Spacers, shrouds, and even the end caps for our electronic housing are all 3D printed from donated materials by students and our community. 3D printing major ROV components comes with concerns for long term stability however it allows us to make modifications specified to our team and allows us to save money on our already limited budget to use towards more crucial components we are unable to fabricate or design ourselves.

We received donated materials for an Eagle Ray ROV Kit and a VRC VEX robot kit. Although the materials do not overlap consistently to build a single product we were able to use a lot of the hardware from the VEX kit to mount several of our ROV's electronics and thrusters.

SID


Computer / Driver Station
Xbox Controller
Ethernet Hub
48 V Power Supply
30amp Fuse
Above Water
Underwater
Supply Board
Supply Board
Control Board
Arduino
T200
T200
T200
T200
ESC
ESC
ESC
ESC
Camera
SID Key
USB
48V DC
12V DC
Signal
Ethernet

Troubleshooting

Troubleshooting was a major issue in our previous season so many steps were taken this season to improve our companies ability to perform maintenance on the ROV and diagnose potential issues.
Our electronics, camera, and tether connections are all properly waterproofed to prevent leaks and help us isolate potential failure points if we were to run into issues. Our 2023 ROV had a leak that caused for our camera to malfunction which is something we have made great efforts to prevent on our current ROV.

We keep a log of all errors we run into both with assembly and programming to refer back to them on future issues and keep a consistant documentation of potential errors within our product. We are able to track these errors digitally through our companies Discord and documentation.

We look at troubleshooting as a area our team can use to grow and learn how to develop solutions to issues while teaching students the processes of engineering. Our troubleshooting efforts earned us the "Guts and Glory" award at the 2023 MATE ROV Championship.

Figure 9: Team testing thruster code

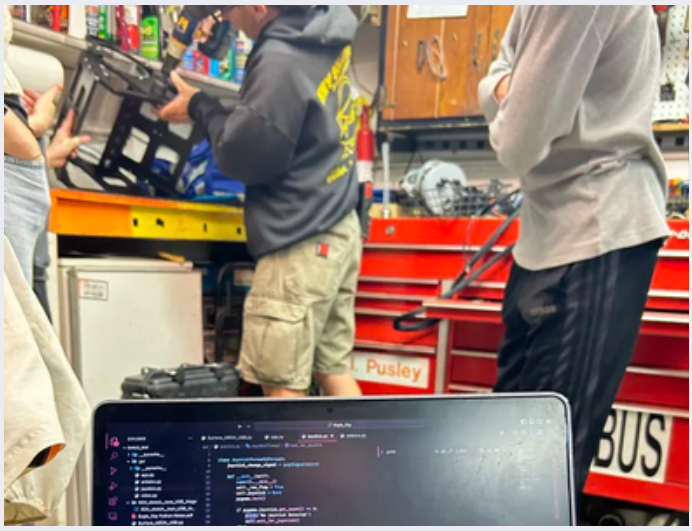


Figure 10: Testing ROV Functions

Accounting

Income:

Income for our company is sustained through grants offered through MTS / MATE, Allan Hancock College, and community organizations. We have unique opportunities for fundraising through our college allowing us to fundraise at local businesses in their fundraiser night programs and through programs like SnapRaise which allows for us to invite potential donors to view our program.

Expenses:

Expenses vary per season and vary depending on the amount of grant funding we receive. Team members are eligible to get reimbursements for all expenses on their end for team materials from any of the listed categories. We are very fortunate to have received extra grant funding this season which helps cover all of the increased expenses from having a more expensive product and travel plan.

Income				
Source	**Type**	**Description**		**Amount**
MTS: MATE ROV	Grant	Travel Expenses / Eagle Ray Kit		$15,000
SnapRaise	Fundraiser	Donations from Community		$2,500
Allan Hancock College MESA	Grant	Travel Expenses / General Team Costs		$10,000
Allan Hancock College	Materials	Donation of VRC / Misc Robot Kits		~$800
Expenses				
Category	Expense Type	Description	Projected Costs	Actual
ROV / Float Costs	Build Costs	Parts required for ROV and Float assembly	$5,000	~$4,300
Team Travel	Competition	Hotels, Flights, Car Rentals, etc.. (Travel Costs)	$20,000	Pending
Apparel	Marketing	Uniforms for Company Members	$1,200	Pending
Field Elements	Build Costs	Field Elements for driving practice	$400	Pending
Marketing	Marketing	Presentation Materials for Competition	$100	$80
Advertising	Marketing	Flyers and handouts for events	$100	$30

Figure #: 2024 Projected Income and Expenses

Company Outreach

Outreach Events

Our company uses every available event on our campus to advertise our product and mission. We participate in Allan Hancock Colleges Bulldog Bow-wow, Club Day, Earth Day, Diversity Day, and more to teach students about STEM / Robotics careers and opportunities our company has for them.
We participate in Allan Hancock Colleges Bulldog Bound events teaching local elementary school students about careers in STEM and agriculture. Through our outreach at AHC we have grown our reach to around 2000 local students.

Media

This season we have created an Instagram account to assist with our marketing efforts and get students more connected with our program. We post about upcoming events for the team and recaps of outreach events we have participated in.

Figure #: Presenting ROV at Cal Poly

Figure #: AHC Bulldog Bound 2023

Acknowledgements

We would like to Ackowledge the contributions of our company members, sponsors, and advisors to assisting in our ongoing goals to provide STEM education to college students.

We would like to thank Allan Hancock College, Allan Hancock College's MESA/STEM Program, MATE, and the Marine Technical Society for being sponsors of our company and providing staff support and funding.

We would like to thank our advisor Justin Rucker for everything he contributes to our company and the endless support he provides to our students. Our company would not exist without his support and we are very thankful for that.

References

- Allan Hancock College
  - Graphics and Programs
    - https://www.hancockcollege.edu/news/gis.php?locale=en
    - https://www.hancockcollege.edu/mesa/index.php?locale=en
  - MESA / STEM Academic Success Center
    - https://www.hancockcollege.edu/mesa/index.php
- MATE
  - Eagle Ray Kit Assembly Guides
    - https://docs.google.com/document/d/e/2PACX-1vS-ZB-vO-YfQuQ-f9nKG_2RiUr9i-rpxabmCoFyxCNp9dGV4_UXAmpnVdpmDkNVusVFTY4PcBeyOmvr/pub?urp=gmail_link
  - 2023 Pioneer Archive
    - https://materovcompetition.org/2023-competition-archive