ALTUM
OPERATIONS

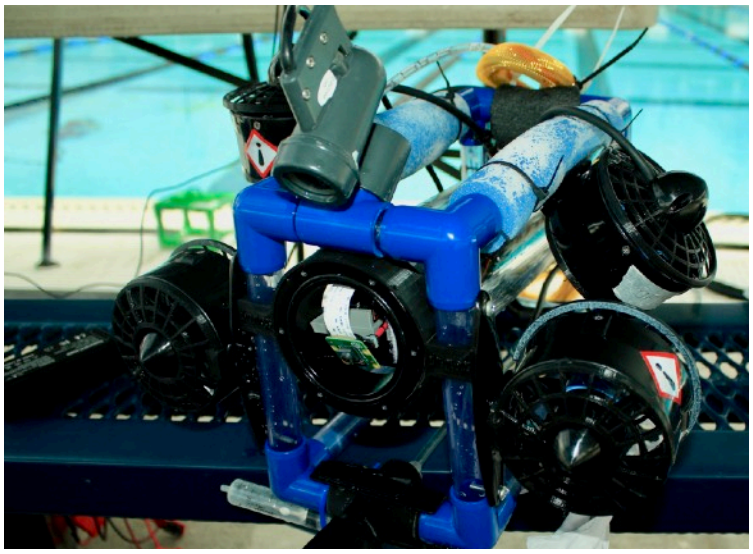
Glacier High School ROV
41267 Highway 41
Oakhurst, CA 93644

Team Members:

Jackson Roeder, 2022: CEO, Government and Regulatory Affairs
Tobin Cox, 2021: CFO, Media Outreach
Daniel Silguero, 2021: Pilot, Mechanical Engineer
Lucas Fulce, 2022: Tether Manager**,** Chief Safety Officer
Gavin Jasper, 2022: Co-pilot**,** Chief Electrical Engineer

Faculty Mentor: John Rumohr

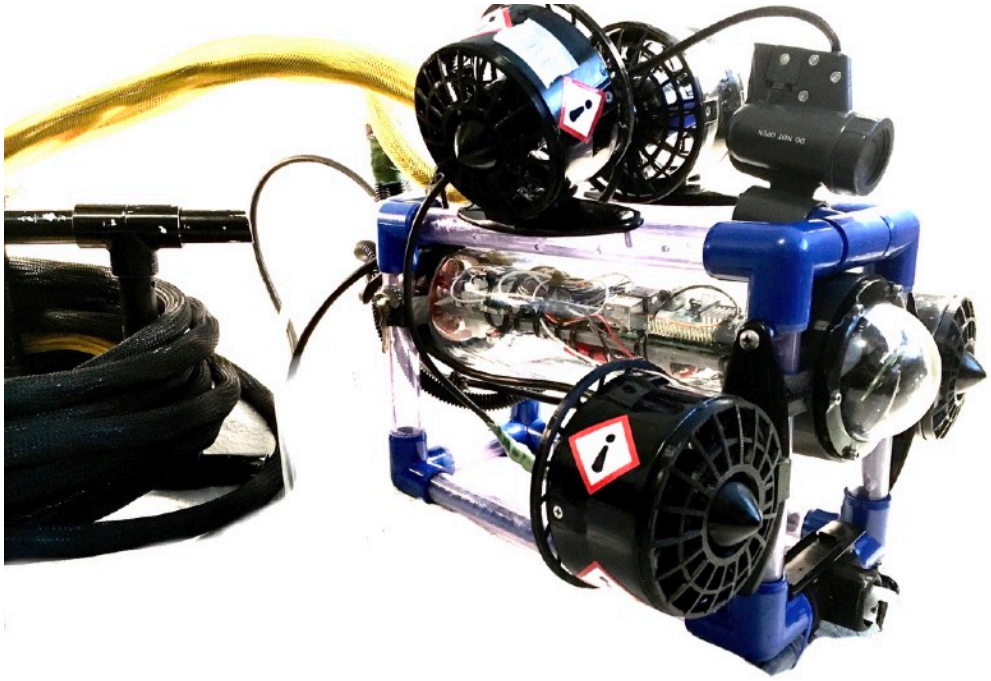
TEAM ALTUM OPERATIONS
IMAGE CREDIT: GAVIN JASPER



THE ROV, PRUDENTIA
IMAGE CREDIT: GAVIN JASPER

Abstract

To assist the Eastman Chemical Company with its quest to help Kingsport, TN, Altum Operations has built an all-new ROV, Prudentia, which means wisdom in Latin. This completely redesigned ROV is capable of assisting Eastman with three tasks. Prudentia is built to ensure public safety, monitor waterways and preserve heritage and history. To accomplish this, Prudentia is able to inspect and make repairs to a hydroelectric dam, monitor water quality, determine habitat diversity, and restore fish habitats; as well as recover a Civil War-era cannon and mark the location of unexploded cannon shells. Prudentia is quick, compact and powerful, which allows for tasks to be done in the most efficient manner possible. Using custom-built motor shrouds, tube mounts, and an electronics tray, Altum Operations has customized Prudentia to be environmentally friendly while still having the perfect components for the jobs. The four Blue Robotics T100 motors allow Prudentia to maneuver quickly and allow the vehicle to lift heavy objects such as Civil War cannons. Prudentia is also very adept at retrieving water samples and bringing them up to the surface for testing. Using each teammate's separate strengths, Altum Operations has been able to efficiently build this ROV.



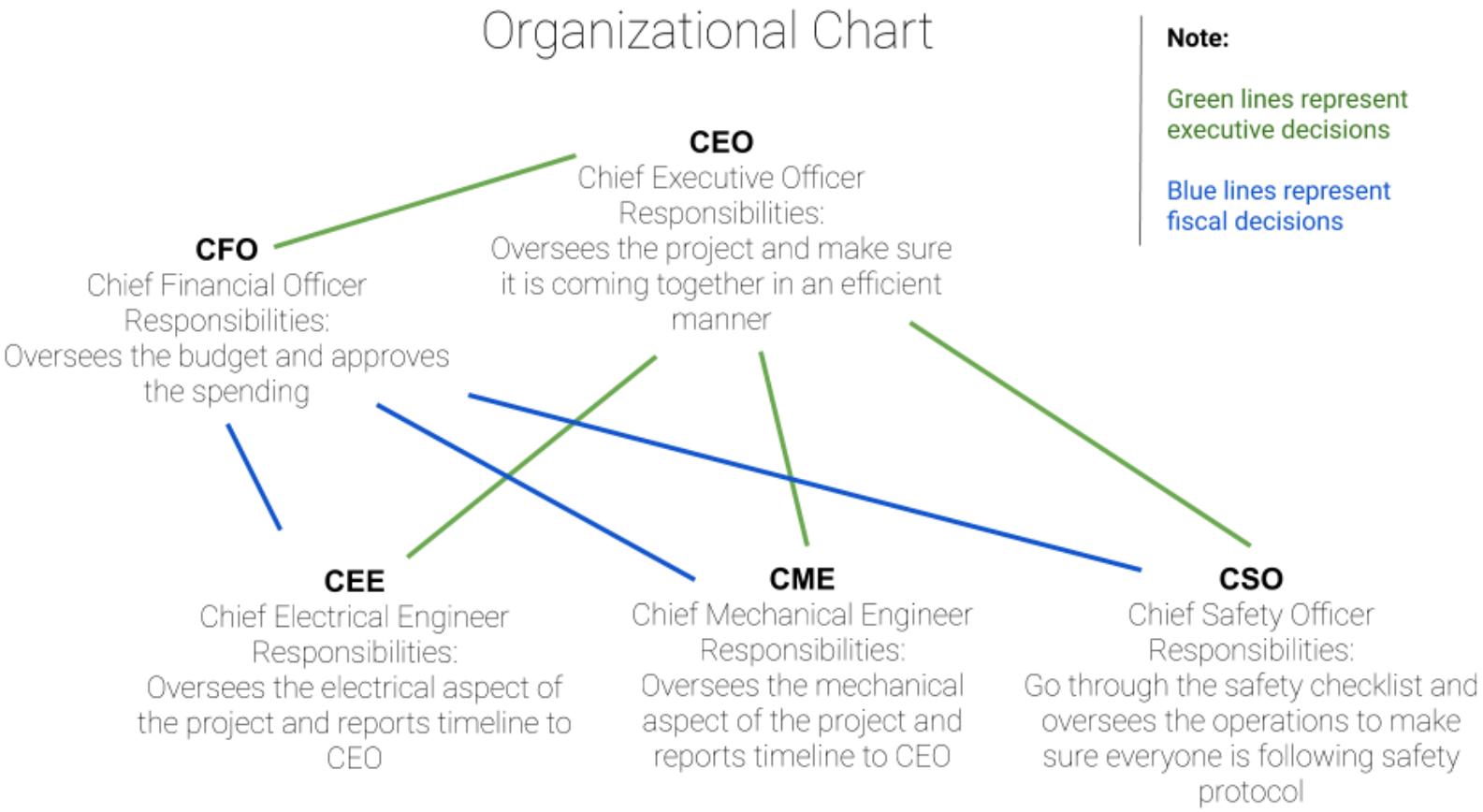
COMPLETED ROV
IMAGE CREDIT: TOBIN COX

Table Of Contents

Project Management and Scheduling

Project Management

At the beginning of the school year (September 2018), Altum Operations created multiple departments inside itself. These departments are: Mechanical, Electrical, Safety, and Executive. Both the Mechanical and Electrical departments consist of two team members. One of whom is appointed as chief of that department. The chief's role is to report to the CEO all non-fiscal decisions. The CEO manages the company's operations. The CFO reports to the CEO and is responsible for budget control. Fiscal decisions are made by the CFO. Marketing and outreach is also controlled by the CEO (see chart below).



Scheduling

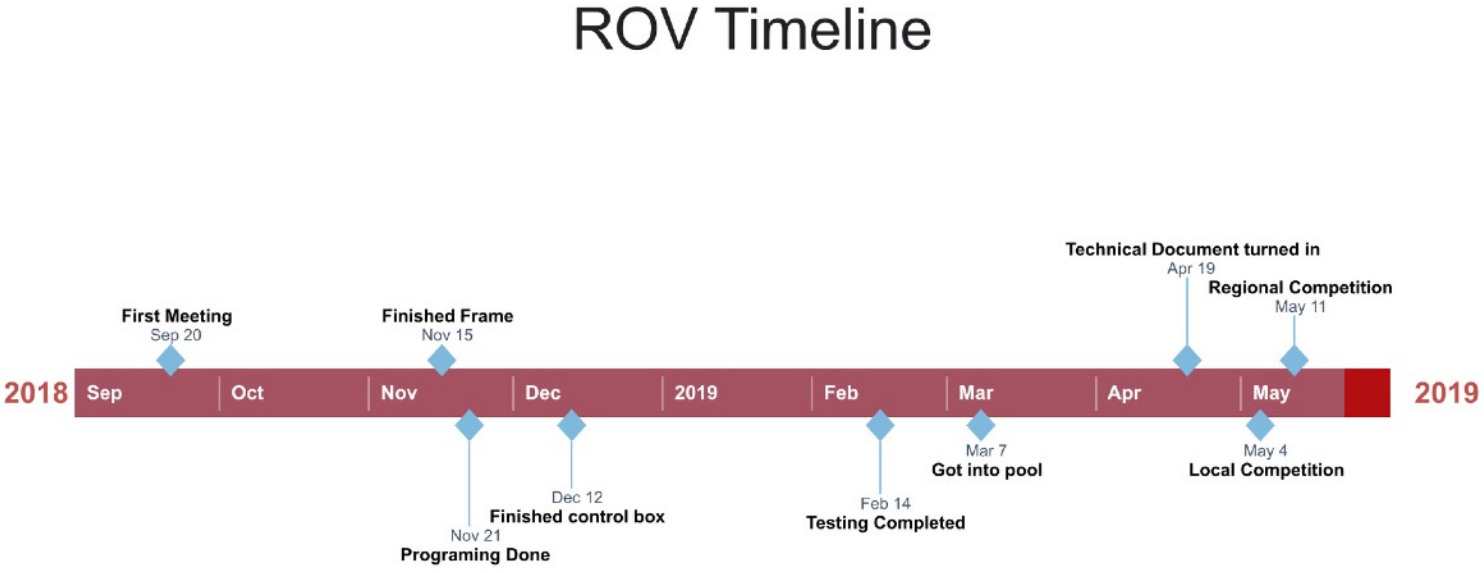
At the beginning of the year (September, 2018), Altum Operations laid out its annual plan. This plan consisted of goals and a timeline for building Prudentia. The primary deadlines were:

- Frame (Nov. 15),
- Programing (Nov. 21)
- Control system (Nov. 21)
- Dry systems test (Dec. 19)
- ROV in pool (Mar. 7).

Altum Operations meets two times each week: Thursday (normal class time) and Wednesday (the team's separate meeting). This allows the company to fix any issues and adjust anything on Prudentia before the Thursday meeting. The purpose of the Wednesday meeting is three fold:

- strategize for the coming week (entire team)
- work on main ROV (mechanical team)
- work on electronics/programming (electrical team)

The purpose of the Thursday meetings is to: practice with Prudentia in the pool, identify any issues or leaks, address any issues with Prudentia.



This year, Altum Operations has had to master time management. Initially, the company was not very efficient with time. After a slow start, Altum Operations started scheduling and setting deadlines, which has allowed for more efficient progress.

Design Rationale

Theme Significance

This year, Eastman Chemical Company has partnered with MATE to accomplish what they term "Good for Good" in Kingsport, Tennessee. The goals are: to ensure public safety, to maintain healthy waterways, and to preserve history. To assist Eastman with these goals, Altum Operations has created the ROV, Prudentia, to specifically fulfill their request.

BOONE DAM
IMAGE CREDIT: WWW.TUNNELINGONLINE.COM

Ensure Public Safety

The Eastman Company RFP requires a dam inspection, along with replacing crucial parts of the dam. Prudentia is designed to be small and compact to inspect even the tightest crevices of the dam. After inspecting the dam, the crew on deck counts the number of cracks and measures the longest one. Prudentia has a camera perfectly placed to identify and measure the cracks. Additionally, due to erosion at the base of the dam, Eastman's RFP requires grout to be added when necessary. Altum Operations has meticulously crafted a cup which transports and applies the grout where needed.

Healthy Waterways

The Eastman Chemical Company is investing in the restoration of fish species and habitat in Boone Lake. This requires the water temperature of the lake to

be measured. Prudentia is equipped with a custom and highly accurate temperature probe and display screen. In order to take water samples, Prudentia is fitted with a hydraulic operated, gimbal mounted claw to carefully retrieve the sample without breaking the container. To test certain parts of the water, Altum Operations has been trained to efficiently and effectively test the water. Prudentia is environmentally friendly and in doing its work will not disturb the surrounding habitats.

Preserving History

Eastman Company is seeking to recover a Civil War era cannon from the Holston River. To measure the Civil War era cannons, Prudentia's camera is perfectly angled to be able to see the cannon while looking at the measuring tool. To calculate the volume, Altum Operations has trained its members in the necessary mathematical calculations. In addition, they have thoroughly tested the pounds per thrust on Prudentia and can figure out whether it can sufficiently lift the cannon without help. Additionally, unexploded cannon shells have been discovered in the river. Eastman's RFP calls for the ROV to identify and mark unexploded shells so that an EOD team may remove them.

Frame

Last year, Altum Operation's ROV, Potentia, did not actually have a frame. The whole ROV was built around the electronics housing. There were pros and cons to this design. One of the pros was that the ROV was sleek and fast but it lacked durability and stability. This year, the Eastman Chemical Company RFP required a durable ROV. Altum Operations has responded by creating a robust yet efficient frame. Prudentia's frame consists of furniture grade PolyVinyl Chloride (PVC) which is strong and easy to use. Prudentia's frame is a rectangular prism with dimensions of Length 29 cm X Width 14 cm X Height 20 cm not including the motors. The frame is compact and maneuverable and maximizes Prudentia's power and control. Prudentia is designed for the many diverse and difficult environments it may encounter. It is made for adaptability with maneuverability in mind. Because of the material and type of frame used, Altum Operations can easily connect any tool or even extra motors to the ROV if needed.

Motors

The ROV Prudentia is powered by four Blue Robotics, T-100 motors. T-100s are incredibly powerful and durable yet also sleek and light. T-100s are brushless, water cooled powerhouses and can run at high speeds for large amounts of time. Specifically, each motor has 5 pounds of thrust (Source 3). A brushless motor is a motor that uses magnets to push and pull the propeller so it can spin faster than a normal motor. Each motor has its own Electronic Speed Controller (ESC) which controls the motor's speed. These ESCs are what receive the signals from the Arduino. Part of any motor's effectiveness is its positioning relative to the object it is trying to move. Altum Operations has performed many tests to find that perfect positioning. In those tests, the most effective positioning was two motors on top of but in the middle and two on the very front edges of Prudentia. To protect wildlife and humans from the spinning propellers, Altum Operations has designed and 3D printed custom motor shrouds that attach to the front and back of the T-100 motors. These motors are so powerful that Prudentia can pull up the degraded tire from the bottom of the pool without using a lift bag.

Watertight Enclosure

Electronics are the fundamental part of any ROV, and Altum Operations goes to great lengths to protect them while underwater. To this end, the company uses the Blue Robotics 3" Watertight Enclosure. It is made of durable acrylic and framed with aluminum. This tube contains all the major electronics, including the Raspberry Pi and Arduino Uno. The anterior of the enclosure is capped by a clear dome, providing a great wide-angle capability for the HD camera. The posterior of the tube is sealed by an aluminum end cap with waterproof penetrators for data and power wires. Since the enclosure is mostly full of air, even when carrying all electronics,

3" ELECTRONICS ENCLOSURE.
IMAGE CREDIT: WWW.BLUEROBOTICS.COM

Prudentia has no need for extra flotation. This gives the ROV a simple and durable exterior, as well as excellent hydrodynamics.

Onboard Electronics

All of Prudentia's electronic components are kept dry by the electronics tube and are held in place by the custom 3D printed tray. These electronic components include: Raspberry Pi, a Pi camera, a step-down unit, and four ESCs. The Raspberry Pi controls the Pi camera which is for the image recognition software. The step-down unit converts the voltage of the twelve-volt power input into five volts, so that the Raspberry Pi can be safely powered. The ESCs are connected to the motors and take the signal from the tether and control the brushless motors. The Electronics are well organized and can be accessed easily. The ROV would not be able to perform without the electronics that are inside of the tube.

Cameras

Prudentia uses four different cameras while completing missions underwater. These cameras are a main front view camera, a Raspberry Pi camera, a backup camera, and the miniature ROV camera. The front camera is a waterproof fishing camera. The mechanical team from Altum Operations has connected this camera to a tilt system using hydraulics. This allows for the pilot to view a front view of the ROV or to look down on the claw. The Raspberry Pi camera is connected to the onboard Raspberry Pi and is used for the Image Recognition Software. On the back of Prudentia, there is a backup camera that is especially helpful when carrying items from the bottom of the river to the surface. As a later edition to Prudentia, this camera has improved it's performance immensely. The final camera is located inside the acrylic tube in the miniature ROV. The main camera, backup camera, and miniature ROV camera are all viewed through two monitors

THE FRONT VIEW CAMERA
IMAGE CREDIT: GAVIN JASPER

located in the control box. One can switch between the backup camera and the miniature ROV camera on one of those screens.

Tether

The tether is compact and flexible for maximum movement of Prudentia. With a sixteen-gauge power wire, the ROV loses no power to resistance. Inside the tether are three Ethernet cables, two hydraulic tubes, a camera wire, and one power wire. The sheath covering the tether is flexible and resilient, protecting the wires inside from any scratching. Secured with a strain relief on both sides and buoyancy attached on the bottom, the tether has many attributes that increase the abilities of Prudentia.

THE TETHER
IMAGE CREDIT: EMILIE COX

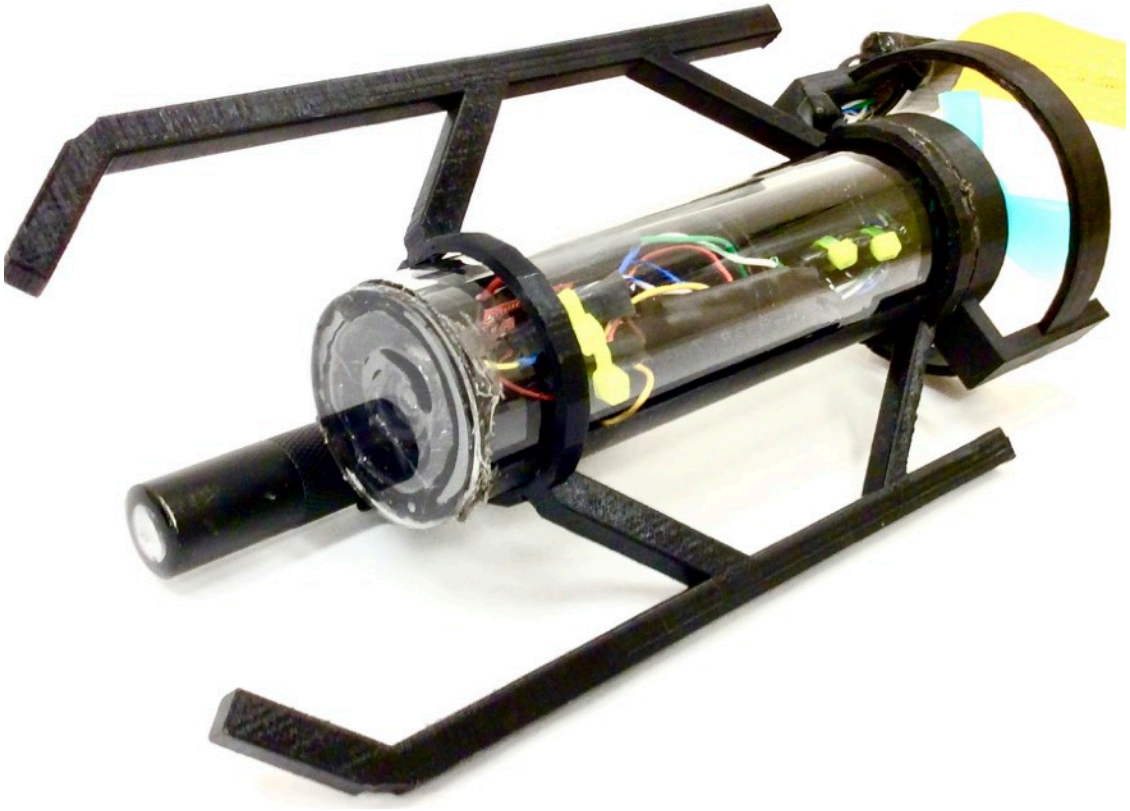
Buoyancy and Ballast

Altum Operation's ROV buoyancy and ballast system consist of several items that allow for neutral buoyancy. The plexiglass tube traps air and serves as a major flotation. To serve as ballast, two pieces of rebar have been cut to fit in the tubing on the bottom of Prudentia to neutralize the buoyancy. The team has meticulously shaved off bits of rebar until they achieved neutral buoyancy. Altum Operations has placed pipe insulation on the top of the frame to counter the weight distribution.

The Miniature ROV

The Eastman Chemical Company RFP specifies needing a miniature ROV that can be launched from the main ROV. This was a design challenge that Altum Operations overcame with much thought. Two members of the company were delegated to come up with a design for the “mini ROV”. The resulting product is truly innovative and effective. The mini ROV, now named Importunus, is small, light, and

capable. The mini ROV is built around a 1" acrylic tube with a frame constructed from 3D printed PLA plastic and is powered by a small brushless motor. The tube houses a camera and the brushless motor's ESC. These components connect to a very thin tether made up of half of an ethernet cable. This cable connects to a pre-programmed Arduino micro controller on the main ROV. The exterior of the acrylic tube is equipped with small skids constructed of PLA. This system allows for the mini ROV to drive easily through the small pipe to check for sludge with only one motor.



MINI ROV, IMPORTUNUS
IMAGE CREDIT: DANIEL SILGUERO

Tools

The Claw

Altum Operations has created a state-of-the-art tool that maximizes Prudentia's efficiency when completing missions. The ROV utilizes a 3D printed hydraulic claw. To control the claw, two hydraulic tubing lines filled with water are used. The two lines allow the gripper to open, grab, and rotate. The tasks given to the team are simple with the claw. Using pressure the co-pilot can control the claw to either rotate or open and close. At the top of the mission area, the syringe is pulled and the pressure is decreased inside of the tube, so the opposite side's syringe plunger is pulled in. The same happens vice versa. Pushing the syringe at the top increases the pressure pressing against the opposite plunger. The hydraulic tubes are double sealed and free of any leaks or air. Prudentia's modern tool is very effective at completing its job.

MECHANICAL DRAWING OF THE CLAW
CAD DRAWING BY: DANIEL SILGUERO

The Temperature Probe

A temperature probe was donated to Altum Operations. This probe connects directly to a topside monitor thus making it so that no programming is needed. Temperature readings are visible in the small monitor mounted in the control box. This probe is used for taking water temperature samples from the bottom of rivers.

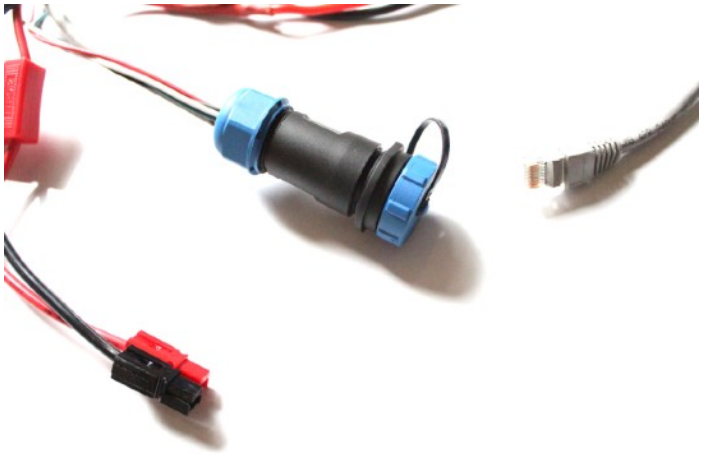
The Marker

Functioning as a landmark, this rope enables the pilot to have a marker to locate the position of the ROV while underwater and help identify the orientation of the ROV. Hung from a boat or land, the ROV can locate where the piloting team is

stationed. This unique marker allows the team to improve the performance of the ROV.

Control System

The topside control system is built around one major component, the Arduino Uno. The adaptable versatility of this Arduino sets Prudentia apart. Altum Operation's engineers program all of Prudentia's systems, sensors, and tools using only this single Arduino. A breadboard is also connected to the Arduino making even more space for add-ons. Altum Operations has considered safety throughout this intricate system. The whole system is protected by a 15 Amp fuse which is installed at the very front of the power wires. This prevents Prudentia from receiving too much power and frying. As a back up, a volt/amp meter is installed to ensure that the pilot and copilot may constantly monitor what is going on with the power. Prudentia is powered by a 12V car battery connected by Anderson Power Poles. Additionally, Altum Operations has attached a unique waterproof connector that allows the product user to use any form of power connector they desire.



ANDERSON POWER POLE CONNECTOR, TETHER CONNECTOR, AND ETHERNET CONNECTOR
IMAGE CREDIT: TOBIN COX

Here is a brief timeline describing how the control system works:

System Startup:

Power runs through power wire to main kill switch > Once the switch is activated, it sends power through the Volt/Amp meter to power the whole system.

While Running the ROV:

Potentiometers (joysticks) receive signals from the pilot and send to Arduino > Arduino translates those signals into PWM signals and send them down through tether to ESCs > ESCs receive signals and control motors accordingly,

housing the topside electronics in our control box.

The decision was made to use a hard-sided, waterproof gun case to house the control system because it is durable, light, and spacious. This box holds the Arduino, the fishing camera monitor, main power switches, and more. Through the years this gun case has proved very faithful and unbreakable. The electronics are mounted in the bottom of the box on a piece of plywood. Covering the bottom section of the control box is a sheet of plexiglass. This innovative feature allows for the pilot/copilot to constantly have a visual of the electronics. Mounted on this plexiglass is the main kill switch, as well as a servo tester. This servo tester allows any user to attach up to four servos and control them easily without any programming. In all, this system is extremely capable while still being simple and very versatile.

Code

In order for Alum Operations to use the best propulsion systems available, they needed to attach a micro-controller to the ROV. Called an Arduino, this micro-controller takes the electrical input from the joysticks and translates it into a signal which the Electronic Speed Controllers (ESC) can read and send to the motors. In order for the Arduino to achieve success, the device needed to be programmed. The code, programmed for maximum efficiency, is well organized and does its job effectively. The Arduino is programmed with a library of C/C++ functions. While the Arduino is a micro-controller and is inside our control box, we also have an onboard computer inside the tube, a Raspberry Pi. The Raspberry Pi manages the Pi camera, which is also inside of the tube. The Pi is programmed with its own terminal language.

Optical Systems

Altum Operations has designed several ways of seeing from Prudentia's perspective. There is a high-definition Raspberry Pi camera that shows a live-action feed on a PC's Browser. The Pi camera uses the onboard Raspberry Pi camera that is connected to the PC via an Ethernet Cable that is inside of Prudentia's tether. The Pi camera is small, lightweight and fits easily inside the waterproof tube. The Pi camera's main purpose is to recognize benthic species with image recognition software. The image recognition software takes an image directly from the feed and analyzes it for

different species. It then counts the different species that it recognizes and gives the information back to the co-pilot. Although not the main means of sight beneath the water, the Pi camera is still one of the most vital parts of the ROV's systems. The main camera is the top optical system, as it is the one that the pilot uses for driving Prudentia. It is mounted strategically on the top of the ROV and angled so that we can see the tool. The camera is connected to the control board's monitor which displays the view from the ROV directly above the control box. Altum Operations's many optical systems are designed for maximum convenience.

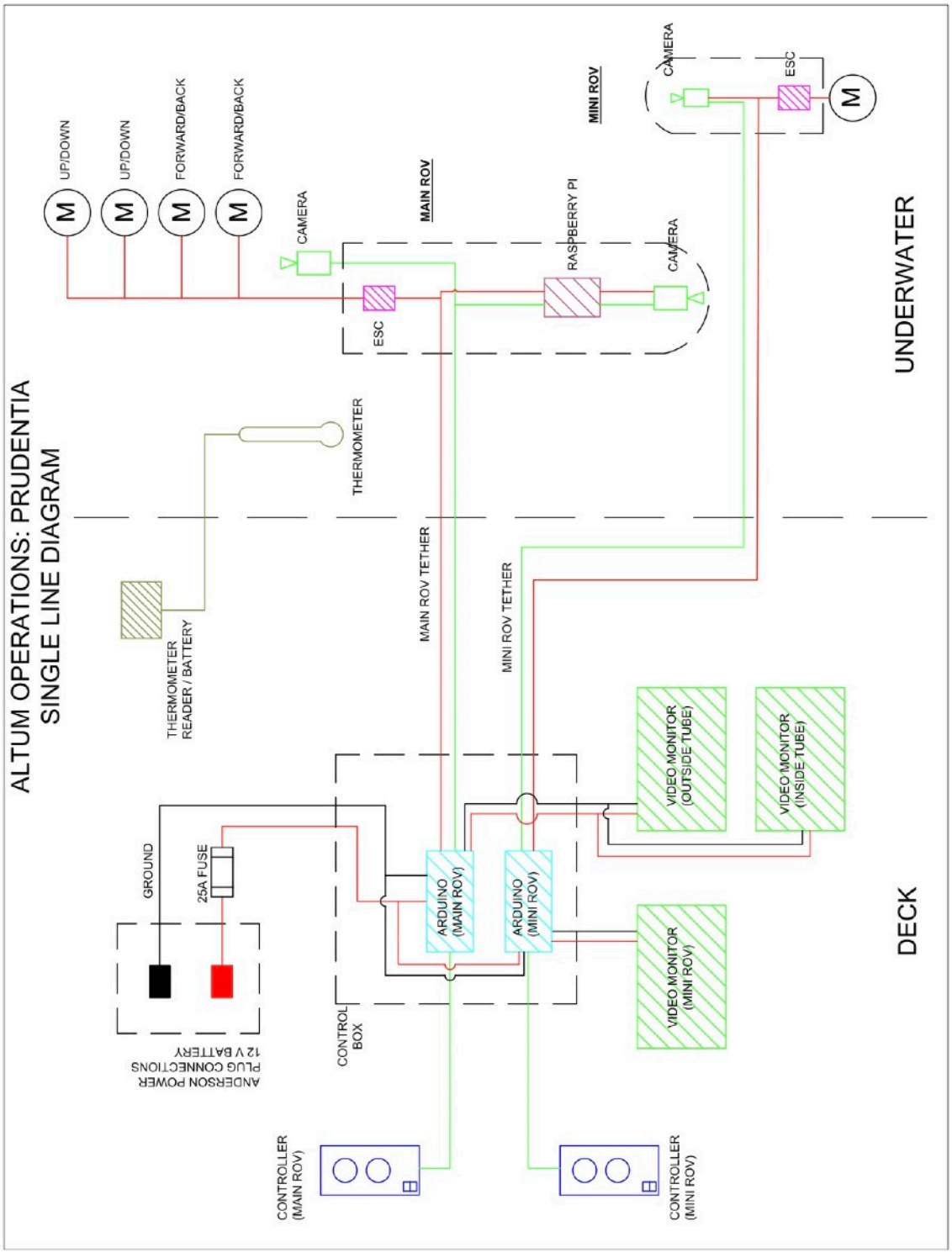
New vs. Reused

At the beginning of the ROV's design/planning stage, one of the choices that had to be made was either to buy new components for the ROV or to reuse parts from previous years. The company decided to take the recycling option for most of the parts, but to buy some of the more sensitive parts to ensure that there would be no system failure. Reliability is key to any component on the ROV. This was why the company chose to reuse only some parts. For example, last year, Altum Operations used three Blue Robotics T-100 motors for its ROV. This year, instead of buying new motors, the company simply reused all three because we knew that these components themselves are incredibly reliable. However, a new T-100 motor was purchased for additional power. The only other purchased item (using fundraised money) was the PVC for the frame of the ROV. This was done to ensure that the frame of the ROV is stable. Altum Operations takes pride as a company in its cost-effective products.

Build vs. Buy

Another decision that was made at the beginning of the year was whether to build or buy the components for the ROV. Altum Operations chose to build most of the parts for Prudentia because it was more cost effective than buying all new parts. For instance, a pre-made tether could have been used but instead the mechanical team custom made a tether that is just as effective yet much less expensive.

SID



Fuse Calculations

Motors 12.5*4=50 amps

Cameras .25*3=.75 amp

Arduino .05 amps

Raspberry pi 2.5 amps

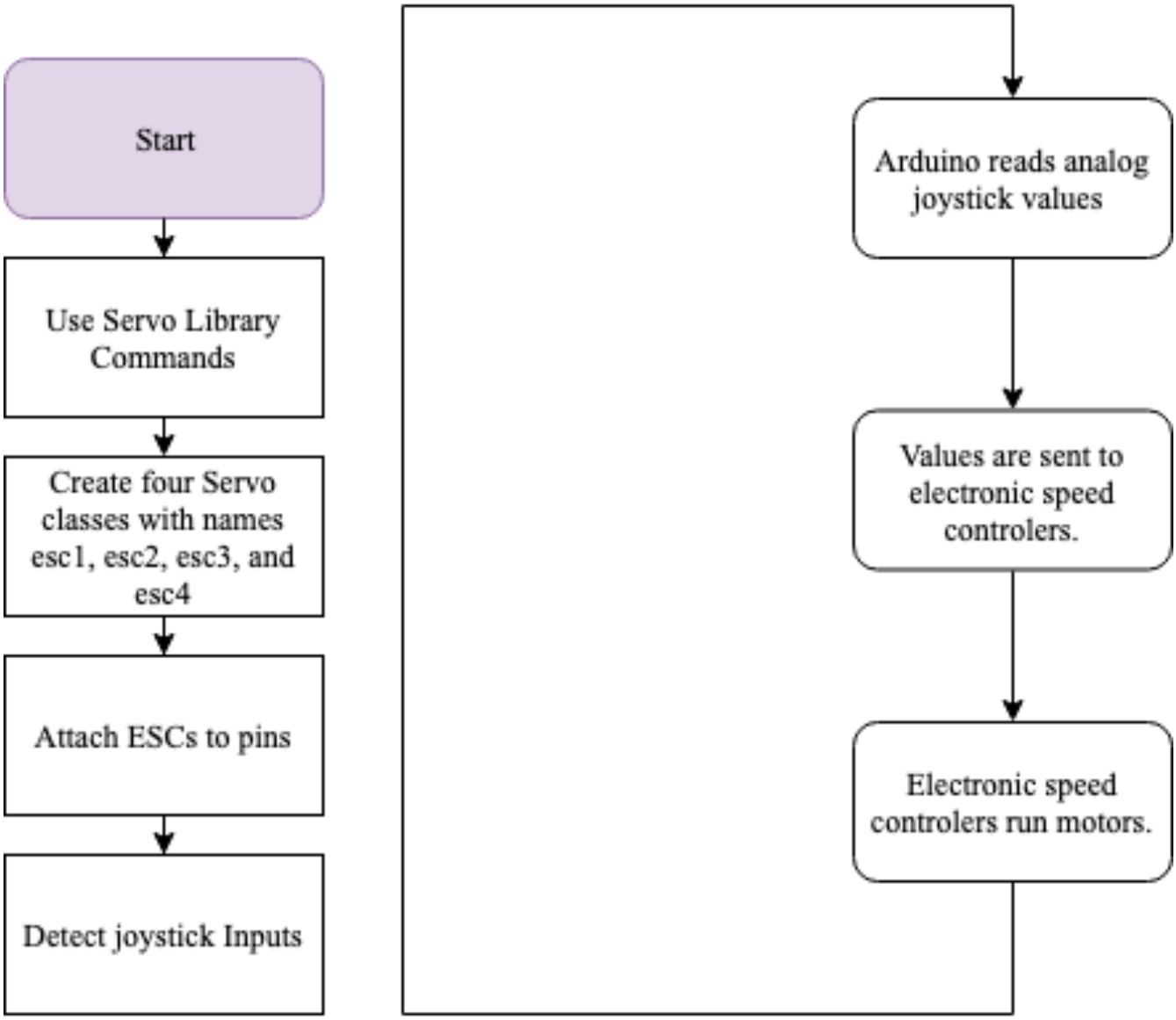
Total 53.30 amps

53.30 * 150%= 79.95 amps

Note:

Altum Operation's T-100 motors do not run at full power. Therefore, this allows us to use a much smaller fuse. Altum Operations uses a **25 Amp Fuse.**

Software Flowchart



DESIGNED BY: GAVIN JASPER AND CHRIS JASPER

Safety

Philosophy

Because safety should always be the utmost priority of any company, Altum Operations prides itself in making safety the most important aspect of its company. Possible issues are identified in advance, and rules are put into place to help prevent potential safety hazards. When working with dangerous substances, the team makes sure to follow all precautions listed on the packaging of the items purchased. When cutting or soldering, it is a requirement for employees and supervisors to wear safety goggles. Before using tools, members must know how to properly and safely operate the devices. The company ensures that workspaces are clean and free of hazards. Altum Operation's safety philosophy is reflected in the design of its ROV.

Features

Altum Operation's ROV includes many safety features. The T-100 thrusters were designed and created by Blue Robotics, and they are ensured to be waterproof. The mechanical department has added plastic around the thrusters to prevent anything from getting caught or cut by the propellers. The watertight enclosure has been tested and sealed to stop leakage. Electronics are safely stored inside the enclosure. Prudentia's tether has a protective sheath so that it cannot be damaged. The power wire has a 15 amp fuse to keep the ROV from shorting out in emergencies. The company has built a kill switch into the control box that can turn off the entire ROV system. All of these features ensure that Altum Operation's underwater ROV is as safe as possible.

Safety Checklists

Workshop Checklist

1. Employees must wear safety goggles while soldering, cutting PVC and using the saw or the drill.
2. Employees must wear pants while using the soldering iron.

3. Employees must check their surroundings to see if there are any dangers while using tools.
4. Running or "messing around" in the workplace is prohibited.
5. Employees must wear closed-toe shoes.
6. The workspace must be clean and clutter free.

Pre-Mission Checklist

1. All components of the ROV are properly attached.
2. Propellers are not exposed from the shroud.
3. Electronics have no exposed or visible copper.
4. Wires are secured in assigned places.
5. Strain relief is tightened and tether is secured on the ROV and control system.
6. Tether is kept neatly in the tether management system.
7. Deck crew is following the dress code (closed-toe shoes and hair tied back).

8. No power is running to the controls until everything is prepared and secured.
9. When all crew members signal that they are prepared, the power is then turned on.

The Altum Operations Safety Manager is responsible to review this safety checklist with the rest of the team before workshop or pool competition activities. This checklist is an effective reminder to the entire team. By reviewing this safety checklist before each activity, the importance of safety at all times is established and reenforced.

Critical Analysis

Testing and Troubleshooting

When building Prudentia, Altum Operations had several methods of troubleshooting. For the electronics, a voltmeter was used to determine if there were

malfunctions in any components. Once the problem was located, the team would figure out the most efficient repair without sacrificing any performance.

The tools were constantly field tested underwater so that the team could determine what needed to be adjusted. In the beginning, the mechanical team prototyped a claw using LEGOs and found that the design had weak gripping strength and didn't rotate. After making adjustments to the design, a new claw was 3D printed. This claw rotated but was still lacking some grip strength. In the end, the team settled with a metal claw with rubber grips which provided the rotation and proper grip strength.

The Blue Robotics tube that was used had some issues with waterproofing around the entrance point of the silicone wires. Epoxy was used to seal the penetrators, but it wouldn't adhere to the silicone. This caused water to leak between the sheath of the wire and the penetrator. To fix this, the team first tried to add heavy duty hot glue around the seals, but this did not work. After no method to seal the wires individually was found, the decision was made to cast the back cap in resin, sealing all the penetrators in place. This also covered up any small gaps between the wire and the sheath and between the sheath and the penetrator, thus solving the waterproofing dilemma.

When building Prudentia, Altum Operations had to make sure they were assembling the best ROV possible. Several methods were used to perfect the ROV. When testing buoyancy, the team had a trial and error system using rebar as weight. When adjusting motor placement, calculations were made to determine where the motors would go for maximum efficiency. When 3D printing pieces, the company always printed out a prototype to make sure it was perfect before it invested in the material.

Challenges

To create the image recognition software, the electrical team experienced several challenges. At the outset, they did not know where to start, so they had to ask for help from a professional computer software developer. Once he gave insight, the electrical team got to work. After they programmed the code, they tried to run it and initially, it did not work. After consulting the computer software developer again, they

finally got it to work. In addition to the the software developer, the company also had to reach out for help on the SID drawing. One team member was learning CAD, so they consulted with Fulce Engineering for assistance.

Altum Operations also struggled with certain missions. There were challenges lifting the degraded tire and the cannon to the surface. After some improvements, Altum Operations is now able to complete these missions with ease. It was determined that the cannon was too heavy for Prudentia to lift on its own, so the issue was resolved by attaching a lift bag to the cannon and filling the lift bag with air. There were challenges with the degraded tire because it was too large for Prudentia's claw to effectively grip. With troubleshooting and field testing, an effective claw with a wider grip was designed. Now that the methods to complete these missions have been reworked, they are some of he most easily accomplished tasks.

Lessons Learned

Throughout this experience, several valuable lessons were learned. One critical lesson was the importance of organization. At the beginning of the year, the company had challenges with organization and time management, which impeded progress. This was addressed through schedules and weekly emails, and progress was made more efficiently.

Another lesson was how to work through differences. As decisions became more consequential, teamwork became rocky. Positive team dynamics and communication was encouraged by enlisting a leadership specialist to give personalized insight through an escape room experience. This experience promoted compromise and effective communication and the teamwork throughout the whole company improved.

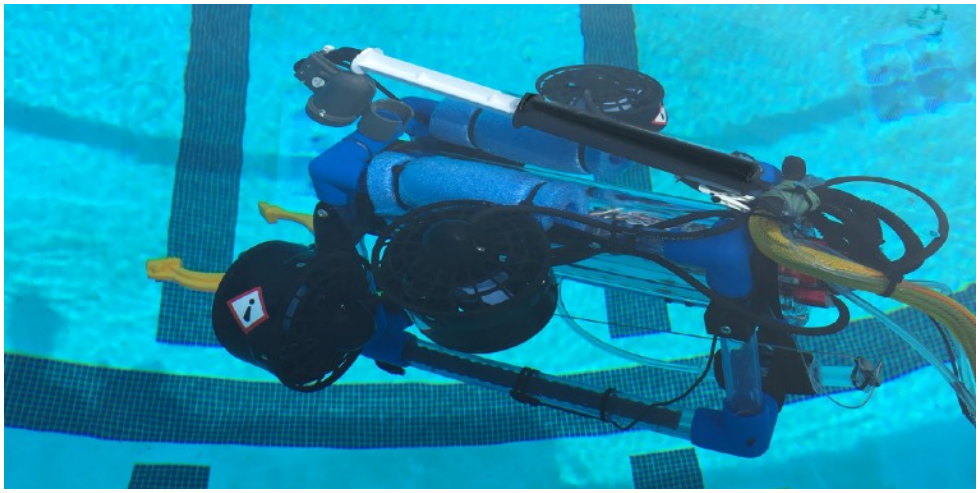


IMAGE CREDIT: TOBIN COX

Acknowledgments

This year, Altum Operations has received many contributions of funds, equipment and other support. They would like to thank Mountain Home School and Glacier High School for providing tools and a lab in which to work. They would also like to thank Yosemite High School for allowing them to practice in their pool. Altum Operations appreciates Mr. John Rumohr, who has been an inspirational teacher and mentor and has given up many hours of his own time to assist the team. Altum Operations is also sincerely grateful for the Oakhurst Kiwanis and Oakhurst Noon Rotary who generously donated their funds toward this amazing program. The company thanks Blue Robotics who was instrumental in giving technical support for the items purchased from them. Altum Operations appreciates Brian Fulce for helping us with AutoCAD. Thank you to the team parents for driving and supporting us; likewise, thanks to all the siblings for being there to cheer the team on. Last, but definitely not least, Altum Operations would like to thank MATE for hosting these competitions and providing valuable tutorials.

References

1 https://epd.georgia.gov/safe-dams-program-faq-owner-inspections

2 www.timesnews.net/News/2015/08/03/Eastman-Environmental-stewardship-is-important-to-

3 www.bluerobotics.com

4 www.marinetech.org

5 http://www.civilwarartillery.com/manufacturers.htm

6 www.exchangeplace.info

Accounting

Donations

Every year Altum Operations goes into the community and presents to various companies and organizations about its project. Not only is this a great way to get the word out about underwater robotics, but some organizations and companies donate to the project. This also simulates what engineering companies have to do in the real world. Altum Operations received a generous donation of $500 from the Oakhurst Kiwanis Club. This club appreciated Altum Operation's vision and provided the materials needed to make this ROV possible. Additionally, the Noon Rotary Club of Oakhurst donated $500.

Cost Accounting

Altum Operations had $400.00 left over from last year's budget. After receiving money from the Oakhurst Kiwanis Club, Altum Operations had a total of $900.00 in the budget. The initial cost projection for the ROV was $415.00. This would include $150 for electronics, $75 for frame components, $40 for media outreach, $100 for company costs, and $50 for the emergency budget. The ROV itself cost $210.00 which was within the budget. After the construction of Pudentia, the Noon Rotary of Oakhurst donated $500 to Altum Operations.

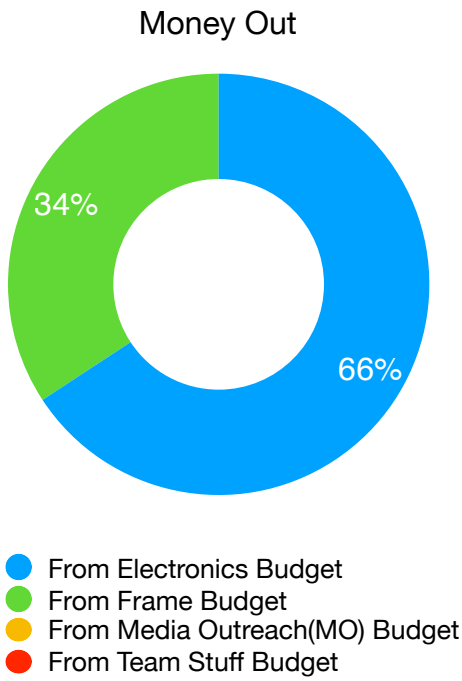
Miscellaneous Costs

There was an entrance fee of $200 dollars for Altum Operations to enter the Monterey Regional Competition. This cost was covered by Glacier High School. The school also paid the entrance fee for the MATE World Championship. To get to the World Championship, Altum Operations projects spending $10,000 for transportation lodging, and food. Glacier High School will cover the cost of the team's airline flights, and Altum Operations hopes to fundraise the additional money needed.

Finance Breakdown

MONEY IN	
Leftover from 2017/2018	$412
Kiwanis Donation	$500
Noon Rotary	$500
TOTAL INCOME	**$1,412**

MONEY OUT	
From Electronics Budget	$182
From Frame Budget	$75
From Media Outreach(MO) Budget	$14
From Team Stuff Budget	$125
From Emergency Budget	$0
TOTAL EXPENSES	**$396**



Items Bought

PLACE OF PURCHASE	Item	Purpose	Quantity	Price	Procurement Type
FORMFIT	PVC	Frame	17	$75.00	Purchased
BLUE ROBOTICS	T-100 Motor	Propulsion	1	$119.00	Purchased
BLUE ROBOTICS	Basic ESC	Electronics	1	$25.00	Purchased
N/A	3D Printed Tube Mounts	Frame	2	N/A	Donated
BLUE ROBOTICS	Electronics Tube	Electronics	1	N/A	Re-used
BLUE ROBOTICS	Cable Penetrators	Electronics	8	N/A	Re-used
AMAZON.COM	Raspberry Pi Step down unit	Electronics	1	$8.30	Purchased
AMAZON.COM	Raspberry Pi Camera	Electronics	1	$25.00	Purchased
AMAZON.COM	Raspberry Pi	Electronics	1	$37.45	Purchased
VISTAPRINT.COM	T-shirts	Team Stuff	5	$125	Purchased