Avi Mittal – CEO, Propulsion Engineer

Cedric Nagata – CAD Design Engineer

Hunter Banks – CFO, Pilot

David Villarreal Ortiz – Network Engineer

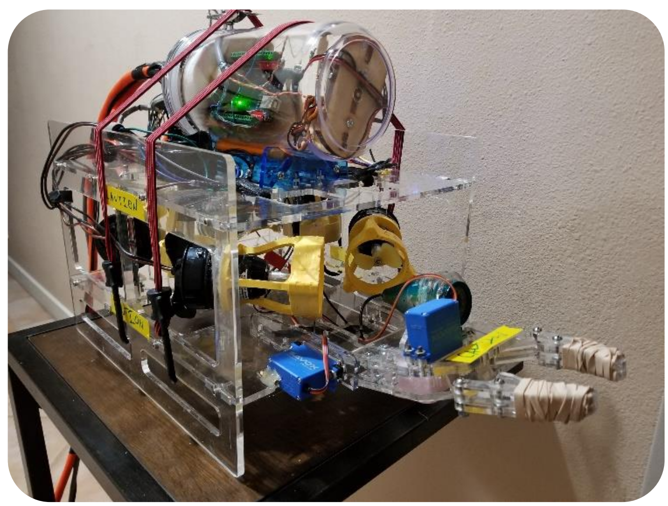
Liam Kozel – Writer, OBS Designer

Jackie Lemke – Graphic Designer

Joshua Tang – OBS Engineer

Craig Lemke – Mentor

Eric Christmyer – Mentor



Photos by Avi Mittal unless otherwise stated.

MATE 2018

SeaWolf Incorporated
Atlas 2

TECHNICAL DOCUMENTATION

Woodinville High School Woodinville, WA, USA

TABLE OF CONTENTS

ABSTRACT

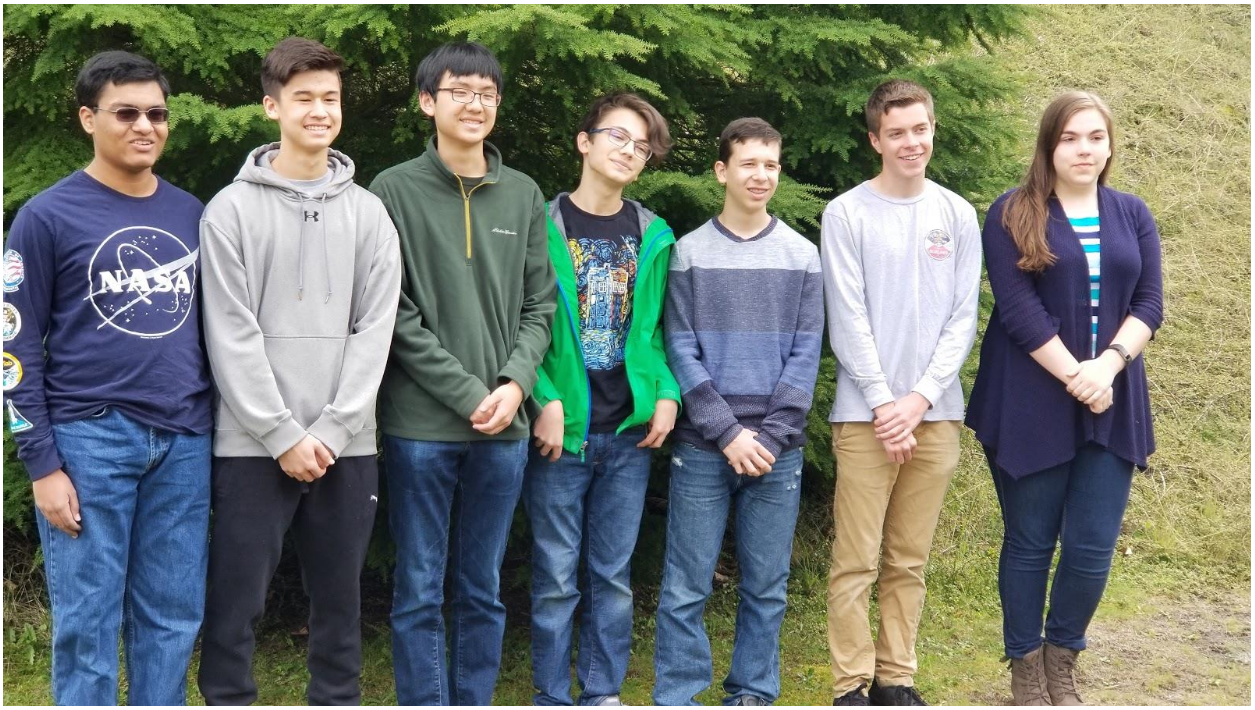
SeaWolf Inc. has polished the function and design of their ROVs for 5 years, producing ROVs easily capable of serving the Pacific Northwest marine community.

Rhino and Autodesk Inventor were used to design this year's tools. Those specialized tools include a speaker, a pressure vessel, 3 cameras, and a 2-function claw. The speaker allows us to remotely release the OBS, the pressure vessel streamlines our tether, the camera on the claw lets us find airplane parts, the center camera gives us a wide view of the scene, and the back camera lets us measure distance in the Energy Task. To manipulate objects in all missions, we've also designed a two-axis claw.

Washington has recently passed incentives towards green energy. One example are the tidal generators which are machines that take advantage of the steady moving of the tides in order to provide a consistent flow of energy. Unfortunately, this energy comes at a price, as living on the Washington coast also means being neighbors with the Cascadia Subduction Zone, a hub of earthquake and volcanic activity.

ROVs are able to assist in all of these endeavors. From doing work on underwater turbines to helping detect earthquakes, SeaWolf Inc. designs the tools to accomplish the tasks. That's why we've designed our OBS to release with sound, a 2-axis claw, and why we're using a refillable lift bag to reduce waste and lessen load on the ROV. These tools exemplify SeaWolf Inc.'s design ability in service of the PNW community.

1 / COMPANY INFORMATION



Left to right: Avi Mittal, Cedric Nagata, Joshua Tang, Liam Kozel, David Villarreal Ortiz, Hunter Banks, Jackie Lemke. Photo by Genevieve Nagata.

AVI MITTAL is the president and propulsion engineer. He is in 11th grade and plans to major in either aerospace engineering or computer science. He likes to make and play video games.

HUNTER BANKS is the pilot of the Atlas. He is in 11th grade and plans to major in business. He spends his free time on R/C planes.

CEDRIC NAGATA is the CAD engineer and the electrician. He is in 10th grade and plans to major in aerospace engineering. He has a passion for basketball and math.

DAVID ORTIZ is the network engineer. He is in 9th grade and plans to get a degree involving artificial intelligence, and enjoys playing with code.

LIAM KOZEL is a writer and OBS engineer. He is in 9th grade and plans to major in journalism.

JACKIE LEMKE is the graphic designer. She is in 12th grade and is going to Arizona State to major in marketing.

JOSHUA TANG is an OBS engineer and programmer in 12th grade and is going to Whitman college to major in computer science.

2 / SAFETY

We take safety seriously at SeaWolf Inc., and we have taken precautions to ensure our employees' safety when building the Atlas, such as:

- Always having a 25A fuse installed when systems are on. This prevents overcurrent from overheating parts, which could cause fires or smoke.

- ❖ Always wearing closed toe shoes. This prevents falling objects from causing injuries.
- ❖ Using safety glasses while soldering, or machining, or working with power tools.
- ❖ Having our tether strain relief in place when in the water, preventing the tether from breaking loose and spilling current into the water.
- ❖ Staying within reach of the power switch at all times, to ensure that we can turn off the system if anything untoward happens.
- ❖ Ensuring the system is turned off when not in use, both to reduce undue wear and to prevent mishaps from happening with no one to stop them.
- ❖ Keeping non-employees at least 5 feet away from systems when they are on, to protect them, the employees, and the system.
- ❖ Verbally warning personnel when the robot is going live and waiting for a response to ensure everyone is prepared.
- ❖ Keeping a fire extinguisher nearby when working on electronics in case of a wood or electrical fire.

Safety features on the Atlas itself will be discussed more in Section 5.8.

3 / COMPETITION THEME

EARTHQUAKE DETECTION

Living on the PNW coast gives its residents to access to the world market, easy shipping, and a myriad of cultures. However, it also exposes its citizens to the largest fault line in the US: the Cascadia Subduction Zone. The Cascadia Fault lies between the North American Plate, and the Pacific Plate, each pushing against one another as the Pacific Plate continues to grow. At some point, one plate will slip under the other, creating an earthquake, followed by a massive tsunami.

Left: The Cascadia Subduction Zone. Right: The ROV Ventana lowers a MARS sensor into the zone.

For this reason, scientists have emphasized research in this area. However, most of the instruments used cannot be placed by humans because of the danger near the fault line. To gain advanced warning of seismic activities, scientists have opted to conduct underwater experiments using

ROVs, a type of submersible robot that is able to manipulate delicate objects under incredible pressure and depth.

AIRCRAFT RECOVERY

In November of 2017, C-2A navy aircraft crashed in the Philippine Sea. Most of the crew were recovered, but two men were declared lost at sea. Soon after, the Navy announced the use of the TLP-25, a type of pinging robot in the search for the lost aircraft. It is towed along the bottom of the boat, slowly scanning the seafloor for shapes similar to the lost plane. ROVs are even being used to scout for planes in an amateur setting--the CHAA (a Canadian aviation club) uses ROVs to scout in areas suspected to house a crash site. This array of uses shows the ROVs potential in aircraft recovery.

A boat tows this probe, used to search for the wreckage.

TIDAL ENERGY

Up until now humans have focused only on harvesting the energy that the Earth provides, but when looking towards the future, we may want to look at the Moon, or more specifically the tides it causes. Tidal energy only comprises about. But scientists are moving towards the idea with the introduction of giant underwater tidal turbines. Tidal energy cannot produce any CO2 emissions, and will cause no noise complaints like wind turbines can. However, there is little data on whether they may cause harm to the natural ecosystems around them. This may be a future application of ROVs, which can be used to monitor hundreds of separate turbines to test their effects and to maintain them while underwater. It will be more efficient to use an ROV rather than a diver. In fact, Seattle has recently used an ROV in order to scout out the seafloor of the mouth of the Puget Sound for a generator.

A Verdant turbine is lowered into the East River.

HABITAT MONITORING & RESTORATION

In order to maintain a suitable environment for the generations to come, we must work towards protect our sea environment. Part of that is the necessary task of ocean monitoring through pH sampling. This type of sample is becoming more important due to the threat of extreme ocean acidification. Acidification occurs when CO2 is dissolved in seawater, which then forms carbonic acid, lowering the ocean’s pH level. This poses a threat to virtually all sea-dwelling creatures. These measurements combined with ROV samples of coral, sediment, and images help to create a clearer picture for scientists in ocean research. In the Puget Sound, ROVs are being used to monitor the endangered rockfish, whose bodies cannot be brought to the surface without damage, so the

ROV will monitor their size, range, and habitat use at their natural depth. These measurements among others help to expand the body of data necessary for ocean restoration.

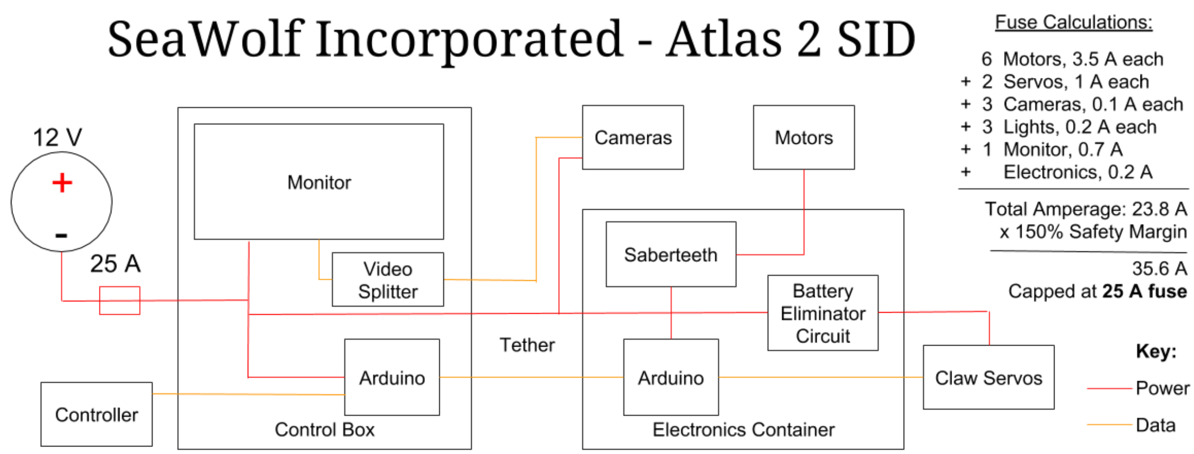
This ROV is used to survey the health of rockfish populations.

REQUEST FOR PROPOSALS:

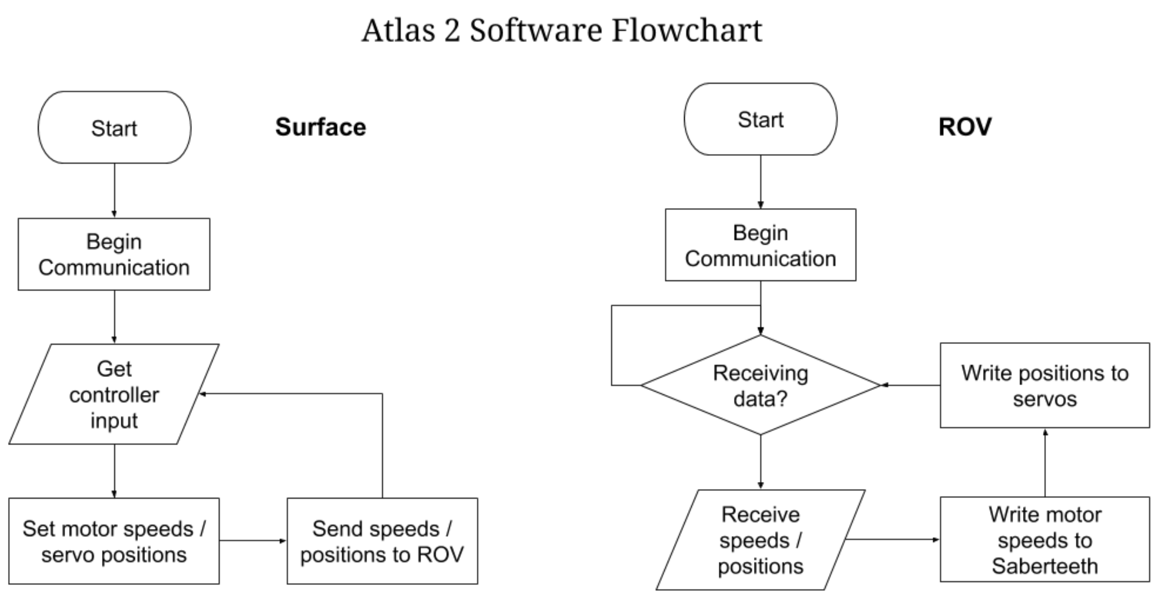
The Applied Physics Laboratory at the University of Washington (UW) has issued a request for proposals for a remotely operated vehicle and crew that can operate in salt and freshwater in the Pacific Northwest. The ROV must be able to locate the wreckage of a vintage aircraft and return its engine to the surface, install or recover a seismometer, and install a tidal turbine along with instruments to monitor the environment.

4 / SYSTEM DIAGRAMS

4.1 / SYSTEM INTEGRATION DIAGRAM



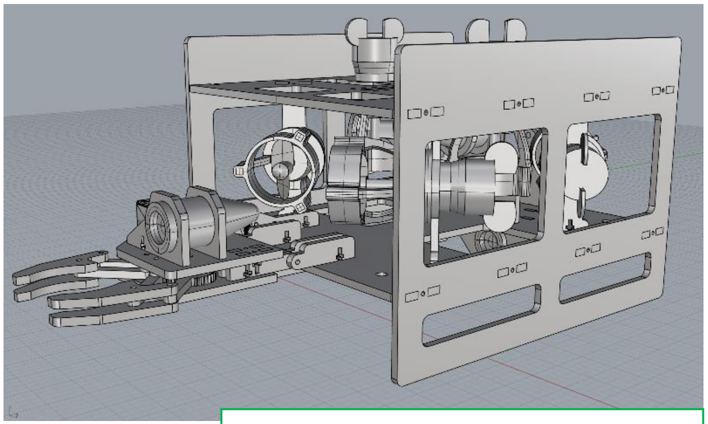
4.2 / SOFTWARE FLOWCHART



5 / DESIGN RATIONALE

The SeaWolf Atlas needed many special design considerations for it to be inexpensive and simple, yet effective. 3D modeling in the program Rhinoceros 5 and rapid prototyping out of wood were used extensively for designing the ROV.

5.1 / FRAME



A model of the Atlas 2 frame in Rhino 3D, without its electronics housing. 3D models by Cedric Nagata.

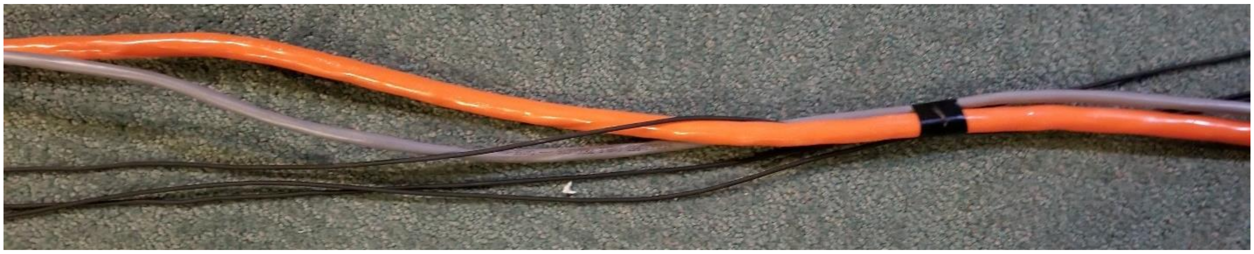
The Atlas has a cuboid frame, measuring 36 cm long by 31 cm wide by 31 cm tall (14 x 12 x 12 in). Its length increases to 46 cm with the claw attached and its height to 49 cm with the electronics housing. The frame is composed of cast acrylic and weighs about 1.8 kg. Cast acrylic was chosen for three main reasons: it is readily available, it can endure extended contact with water, and it produces a clean finish when laser-cut – no burnt or jagged edges, improving safety and keeping the water clean. Every corner on the frame is rounded to prevent injuries.

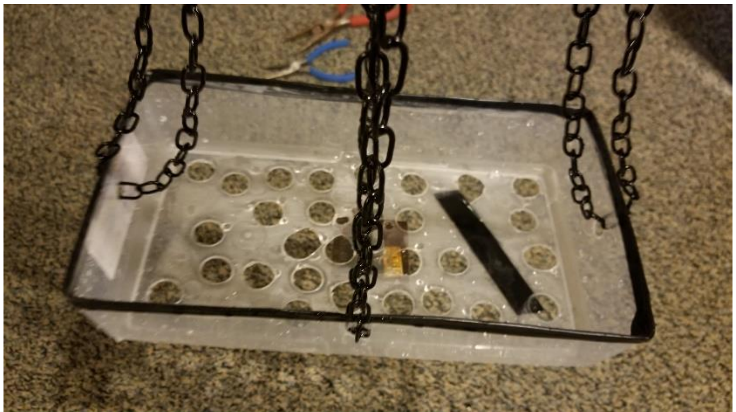
The frame was designed in the CAD software Rhinoceros 3D. The slot-and-tab joins ensure the robot is sturdy without needing very many screws; only 16 are used for the frame. The holes cut in the frame reduce weight and hydrodynamic drag, as well as letting the propeller thrust flow freely. The mounting plates were tested to the breaking point to ensure they would hold up to the repeated stresses of motor thrust.

5.1.1 TETHER

The 14 m (46 ft) tether has 5 cables: an extension cord for power, a Cat-5e cable for communications, and 3 camera cables. The extension cord is bright orange for high visibility in the water, making it less likely that the ROV or a diver gets tangled in it. The camera cable has 5 conductors for power, lights, and video. The Cat-5e cable is shielded to ensure the Atlas 2 gets its commands without errors. Each camera cable includes power, video, and lights. High-density foam floats make the tether nearly neutrally buoyant. The tether weighs 4.6 kg, requiring three 5 x 5 x 2.5 cm (2 x 2 x 1 in) slices of foam every 2 meters. Strain relief at both ends protects the tether from any pulling or twisting.

A section of tether. The orange cable is for power, the gray cable is for communications, and the black cables are for the cameras.





The crane basket has chains on all sides for stability, so nothing is dropped when it is raised/lowered.

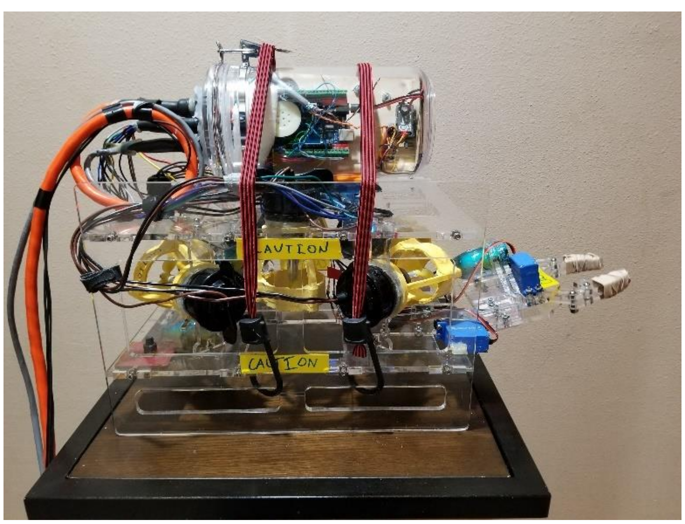
5.1.2 CRANE

The included hand-operated crane is used to speed missions by limiting trips to the surface. A round trip to the surface and back to drop off a sample could last 30-40 seconds per task, but with a crane, the ROV can simply drop it and any other cargo in the basket and have everything raised at once. The basket is simply a cut-down plastic box with holes to reduce drag, with cut edges sanded down to prevent injury. It is attached to an 8 m (26 ft) nylon cable with #100 chain to form the crane, attached on all 4 sides of the basket for stability.

5.2 / PROPULSION

The Atlas 2 uses 6 Johnson 500 GPH bilge pump motors for propulsion – 4 500 GPH for horizontal and 2 750 GPH for vertical. The 750 GPH motors are used for vertical movement because their added pumping power is useful when carrying heavy loads to the surface. The 500 GPH motors consume about 36 W of power (3A @ 12V) and the 750 GPH motors draw about 42 W (3.5A @ 12V).

The motors are arranged in a vectored layout, with a horizontal motor at each corner pointing 45° inward and a vertical motor on both sides. This allows for 4 axes of motion: longitudinal (forward/backward), lateral (left/right or "strafing"), rotary (turning left/right), and vertical (up/down). The angle of the horizontal motors represents a tradeoff between speed and maneuverability. Angling them less means speed is higher going forwards and lower when strafing or rotating. The 45° angle is optimal for maneuverability, since thrust is the same for all axes of motion. Bilge pump motors were chosen because we could reuse them from last year's Atlas 1, and they have proven themselves reliable.



Here the 3 starboard motors, with their propellers and shouds, are visible.

5.3 / CONTROL STATION

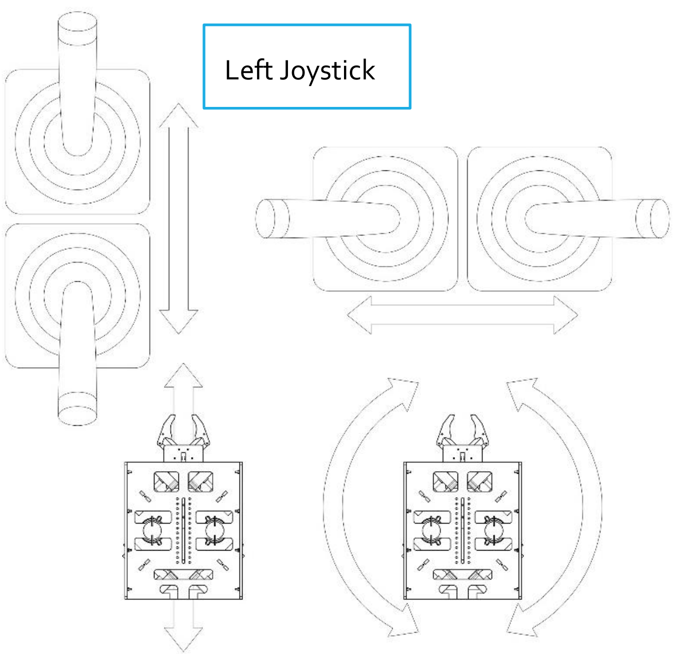
The control station, affectionately called "The Box" at SeaWolf, Inc., is a Pelican 1600 case. This Pelican case was chosen because it is highly durable and waterproof, and because it was easy to source. Inside the case is a laser-cut wood frame that holds all the electronics.

At the front of the case is an Arduino microcontroller that translates controller inputs. At the rear is the camera splitter that incorporates all 3 cameras. The top half of the case houses the 19-inch 12V monitor.

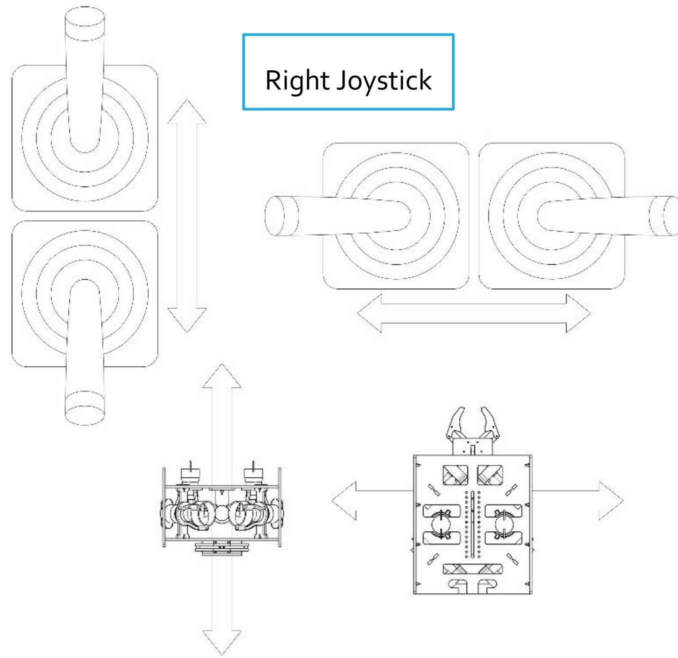
The Atlas connects to the control station through a power plug, a data plug, and 9 camera plugs. The PS4 controller connects via USB. There are 3 light switches and a master power switch so power can be shut off in an emergency.

5.3.2 HANDHELD CONTROLLER

The controller is a DualShock 4 from a PS4 game console. A PS4 controller is used because it has very high quality analog sticks, a large number of buttons, and a light that the Atlas 2 uses to show propulsion status. The PS4 controller setup is very intuitive to learn and use, and in fact uses the same control scheme as "Mode 2" in R/C drone circles. To enhance control, the Atlas 2 makes use of power curves to improve precision at low speeds without sacrificing the Atlas 2's top speed.



When the left joystick is pushed up or down, the ROV goes forwards or backwards.	When the left joystick is pushed left or right, the ROV turns left or right.

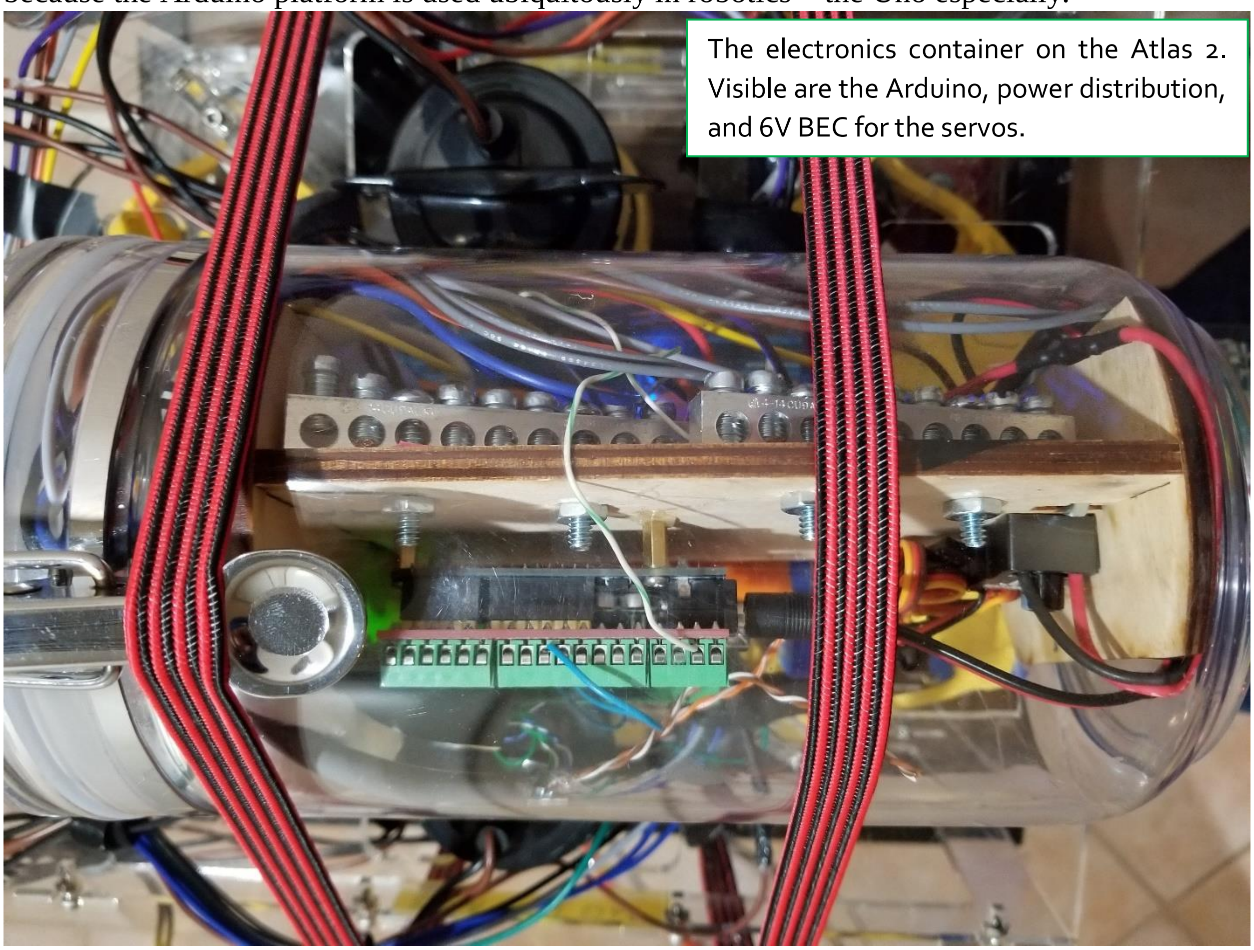


When the right joystick is pushed up or down, the ROV goes up or down.	When the right joystick is pushed left or right, the ROV slides left or right.

5.4 / ELECTRONICS HOUSING & SOFTWARE

This is the first time SeaWolf has attempted an underwater electronics housing, but it was a necessity for this year's challenge. The housing is a modified kitchen jar. To ensure it would be completely waterproof, we tested it at depths of 12 m in Lake Washington for 30 minutes and at depths of 5 m for 2 hours. After modifications, it would never contain more than a few drops of water. To prevent this small amount of water from shorting our electronics, we added diaper foam to absorb all of it. We have not had a single short-circuit due to water so far.

Two Arduino microcontrollers are used to translate the controller inputs and control the motors and servos: one at the surface and one on the ROV. This microcontroller was chosen because the Arduino platform is used ubiquitously in robotics—the Uno especially.



The electronics container on the Atlas 2. Visible are the Arduino, power distribution, and 6V BEC for the servos.

The surface microcontroller takes joystick/button inputs and uses previous data to determine what speed to set the motors to and what position to set the servos to. It then sends this data to the ROV over an RS232 serial connection. The ROV microcontroller receives this data from the surface controller and writes the motor speeds to the Saberteeth and the claw positions to the servos.

The Sabertooth ESCs take the serial inputs and use it to change voltage to the motors, controlling their speeds. Saberteeth were chosen for a few reasons: they could be reused from last year, they have proven reliable and durable, and they have safety features like overcurrent protection to keep both the system and personnel from harm. Power to all the components in the control station and the electronics container is provided through power distributors, which use screw terminals for easy assembly and disassembly.

5.5 / FLOTATION & WATERPROOFING

The electronics container itself provides nearly all the buoyancy for the Atlas 2. It was fortuitous to find a container that so closely matches the 2.4 L of air required for the Atlas to float. Weights on the corners provide ballast.

Waterproof connections are of the utmost importance in an ROV. Any exposed conductors could shock anything that comes near. To ensure that underwater connections are sealed, SeaWolf follows a 3-step process: coat the exposed area in hot glue, cover it with heat-shrink tubing and shrink it around the area, and finally seal the ends of the heat-shrink tubing with more hot glue. This method of double-waterproofing has proven highly effective for 4 years now.

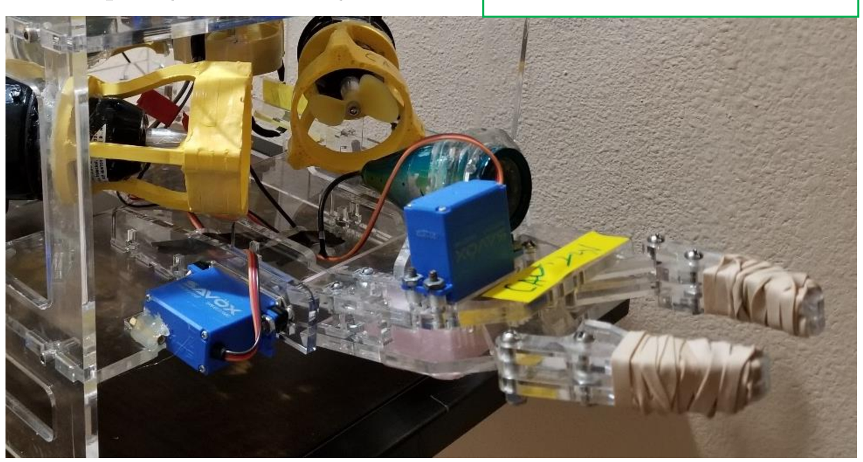
The motor wires on the Atlas. The clear hot glue and black heat-shrink tubing are visible around the joints.

5.6 / MANIPULATOR

The Atlas 2 carries a gripper, or "claw", on its front. One was deemed necessary for the mission tasks outlined in the RFP, many of which involve moving hardware underwater. The claw has both grip and pitch functionality, which is plenty of dexterity for the required tasks.

The claw is powered by two Savox servos that have been opened up and waterproofed with marine grease. Servos are ideal for the claw because they can be rotated to a precise angle and will self-correct to stay there—essential when picking up objects of all shapes and sizes.

The claw, with its grip servo pictured on the right and its pitch servo on the left.



The manipulator is made of acrylic because the material was on hand, and its claws have rubber grips to increase friction and thus grip. The bolts are held on with Nylock nuts so that the rotation of the arms does not loosen them. The claws apply about 7 N (1.6 lbs) of grip force and are split into 2 plates with a gap in the middle to increase gripping area.

An example of camera interference that used to be a major issue in the Atlas. Having an onboard electronics housing prevents this.

5.7 / CAMERAS

The Atlas 2 has three cameras: one mounted on the claw, one facing the rear, and one slung under the bottom. They are commercial fish-finder cameras rated to over 50 m depth. After so many camera difficulties, SeaWolf has invested in commercial cameras to ensure waterproofness at depth. The camera also has built-in LEDs for increased visibility. The camera uses RCA connectors, making internal wiring more convenient since there are less wires per signal.

Left: Claw camera. Right: Rear camera. Just visible at the bottom is the bottom camera.

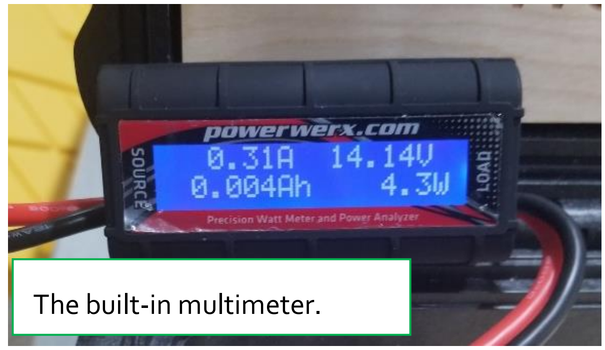
Historically, SeaWolf has had issues with interference on the camera signal from the motors, but this problem was solved by moving the electronics onboard. The changing voltage of the motor cables in the tether were inducing interference in the camera wires, so by replacing them with a steady power cable, the interference was greatly reduced.

5.8 / SAFETY FEATURES

Safety is paramount in the operation of ROVs. Here is a list of some of the features the Atlas 2 has to protect both hardware and personnel from harm:

- There are no soldered connections in the entire control box – any damaged parts can be replaced immediately.
- The master power switch can shut off power to the entire Atlas 2 system instantly.
- The electronics container is padded with absorbent diaper foam in case of leaks.

- Anderson connectors are used for many of the ports, and RCA and USB plugs for the rest. Systems can be quickly unplugged if they malfunction.
- The crimps in the Anderson connectors are sealed with hot glue so they don't pull out; this also makes them water-resistant.
- Every propeller is shrouded 3 mm in front and behind to protect divers' fingers.
- A multimeter is built into the system to easily check for overcurrent or overvoltage.
- The motor software has an option to limit motor speed if overcurrent becomes an issue. This is disabled by default, as the Atlas 2 draws only 20A at 12V.



The built-in multimeter.

6 / FINANCES

6.1 / BUDGET

NOTE: This is the total cost of the Atlas 2 development project, **including** the cost of tools and other things not associated with the sale of an Atlas 2 unit and **excluding** reused and donated parts. Since many things were reused from last year, this costing is significantly lower than in 6.1 / Project Costing. Total expenses were $560, which was significantly over budget. This was mainly due to the overheating and malfunction of two servos during an endurance test.

Key: Below estimate Within 10% of estimate Above estimate

Category	Description	Projected Cost	Amount Spent
Electronics (Components)	Microcontrollers, joysticks, servos, etc.	**$200**	**$269.50**
Electronics (Hardware)	Monitors, cameras, motors, etc.	**$25**	**$30.97**
Structure	PVC piping, structural components, case	**$100**	**$92.95**
Connections	Wiring, connectors, jumpers	**$25**	**$39.08**
Tools	Multimeters, soldering irons, etc.	**$150**	**$125.95**
	TOTAL	**$500**	**$558.45**

6.2 / PROJECT COSTING

NOTE: This is a valuation of the Atlas 2 system. It **excludes** the costs of tools and other hardware we have paid for that are not included in the Atlas 2 system itself. For the costing of these items, see 6.2 / Budget. The value of an Atlas 2 unit is $1620.

Quantity	Part	Source	Cost per Unit	Total Cost
1	Fuse Holder	Reused	$4.97	$4.97
1	Pelican Case	Reused	$159.99	$159.99
1	19-Inch 12 Volt Monitor	Reused	$144.00	$144.00
1	18-2 Wire 100'	Donated	$11.98	$11.98
1	Extension Cord	Bought	$24.59	$24.59
4	Sabertooth Speed Control	Reused	$59.99	$239.96
2	Savox Servo	Bought	$37.60	$75.20
2	Arduino Uno	Reused	$10.50	$21.00
4	500 GPH Bilge Pump Motor	Reused	$17.27	$69.08
2	750 GPH Bilge Pump Motor	Reused	$22.84	$45.68
3	Propeller Set	Reused	$22.99	$68.97
3	Fish Finder Camera	Reused	$134.00	$402.00
1	Tool Box	Reused	$39.99	$39.99
2	Watertight Container	Reused	$15.49	$30.98
1	PS4 Controller	Reused	$59.00	$59.00
1.15	Acrylic Sheet (m^2)	Bought	$135.00	$155.25
1	Battery Eliminator Circuit	Reused	$19.99	$19.99
1	BNC Splitter	Bought	$45.00	$45.00
	Key: Over $100		**Total Value:**	$1,617.63

7 / CHALLENGES

There were many challenges that we as a company had to overcome during the process of developing the Atlas 2. These problems had to be faced, thought logically through, and solved before they caused too much of a strain on our deadlines. We at SeaWolf Inc. believe that these challenges made us a better team, honing our troubleshooting and problem-solving skills.

7.1 / TEAM CHALLENGES

In order to move the ROV club to Woodinville High, it was necessary to establish a new club and get funding to start the year. However, we ran into some issues receiving money from the school from that year, so we had to invest most of our ROV season into finding funding. This struggle sucked a lot of our time that could be used to create a new robot, leading us to believe we may not even compete. Luckily, we were able to edge out the deadlines and get an ROV in the water.

Another challenge we faced was that we undervalued business practices like outreach in favor of building an impressive system, but, nearing the end of the development program, we have realized that business and marketing are just as important as the ROV itself. In the MATE competition, we are not only to be engineers: we must “think of [our]selves as entrepreneurs”.

7.2 / TECHNICAL CHALLENGES

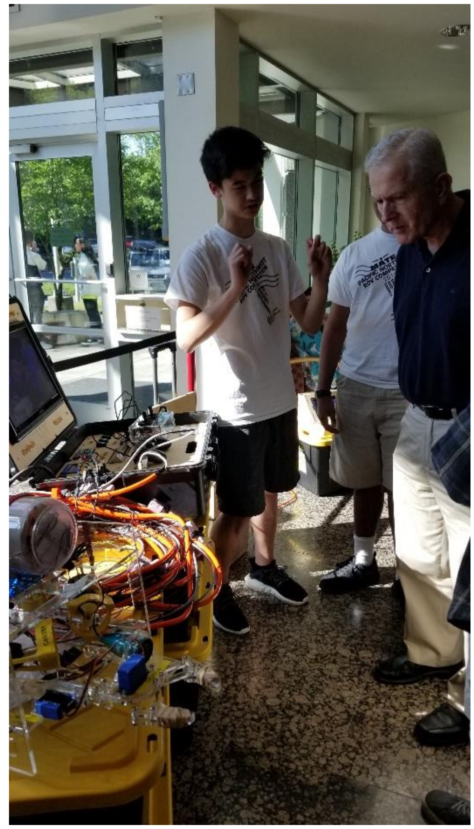
As always, SeaWolf had to overcome several technical issues in creating the Atlas, but this has improved our engineering skills. The largest problem was dealing with camera signal interference, which has been destroying our view for two years now. We tried many strategies to clean up the signal, including isolating the camera’s power and ground and adding an electrical choke to block motor interference. None of it worked. To troubleshoot, we took apart the tether and separated the camera and motor wires. The camera signal immediately cleared. Thus, we had narrowed down the source of the interference to inductance from the motor wires in the tether. To solve this, we tried wrapping the wires in a grounded shield. That didn’t work either. Finally, we eliminated the entire issue by placing our motor controllers in a pressure vessel so the camera wires would run next to a steady voltage rather than an oscillating one. The interference was not gone, but it was substantially reduced. This was an important lesson in the art of troubleshooting.

8 / LESSONS

The challenges we’ve faced have made us a better company and a better team. This year we’ve worked hard to secure a place within our high school’s community when establishing the club, and learned the importance of proper administration. We have improved our troubleshooting methods and our knowledge of electrical, mechanical, and software engineering. All of these challenges have forced us to become much more open to new possibilities, such as underwater electronics and larger team sizes. This flexibility is what has allowed us to create a successful robot as a successful team.

Over the course of developing the Atlas, we have learned quite a bit about how to run a team and how to act more independently of advisors. We have exposed ourselves more to administration and public relations and have gained new understanding of how to run a business. An example that comes to mind is our public demonstration at Kirkland Marina Park – we set that up ourselves. One of the most important lessons we have learned is that time management is paramount. Building a successful ROV takes a huge amount of time and effort, and we have learned we must be willing to sacrifice our free time for the Atlas. We have also found that proper delegation is key to getting all the required work done; over the course of developing the Atlas we took on responsibilities according more to our roles, instead everyone doing everything. This allowed us to accomplish much more in a given amount of time than last year.

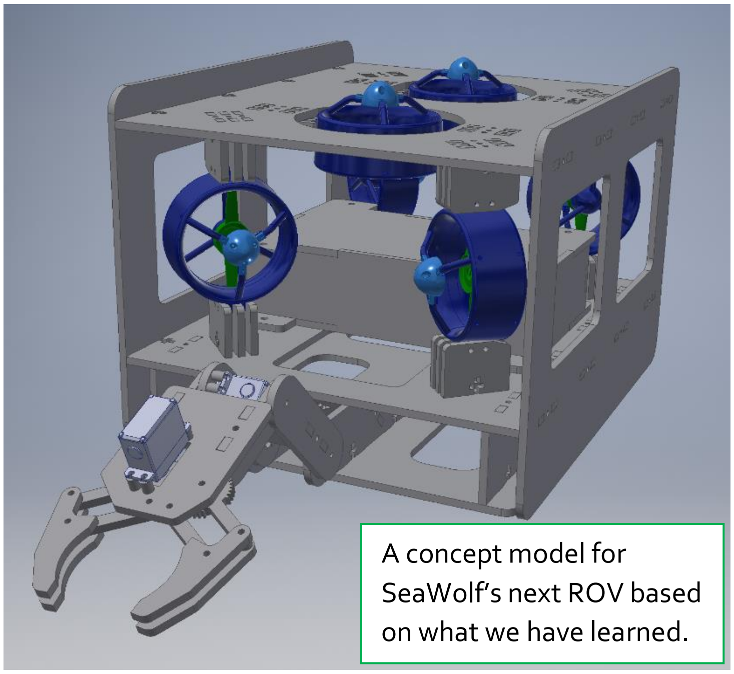
In terms of technical learning, we have all broadened our scope of knowledge, each team member learning some of the skills that others use for their roles. This will allow us to be more technically well-rounded in the workforce later. We have learned how to construct waterproof containers and connections for underwater electronics housings. We also have a better knowledge of programming due to the addition of a communications system, and more experience with 3D modeling due to the more complex frame. Finally, and most importantly, we have a better understanding of the troubleshooting process and solving problems like the camera interference that has plagued us for two years.



The SeaWolf team at a presentation in front of school district officials.

9 / FUTURE IMPROVEMENTS

As effective as the Atlas 2 might be, improvements can always be made. The frame was a heavy and quite brittle, and the clear acrylic was difficult to see underwater. The solution would be to use Starboard, which is stronger and less dense than acrylic. The servos were fragile due to their plastic case, so metal ones will be necessary. The tether flotation should be attached more securely, and it and the wiring should be more elegant in general. The wiring inside the electronics housing was especially difficult, and much of it could be rewired using pass-throughs and grommets. The cameras still need work. They are likely as good as they will be, but as analog cameras the signal is prone to degradation. Digital cameras are the next logical step.



A concept model for SeaWolf's next ROV based on what we have learned.

All the above are changes that SeaWolf Inc. is planning to add before the international competition, but there are many other things that could be better. The motors could be brushless, allowing the Atlas to be quicker, more maneuverable, and more efficient. A Raspberry Pi computer could be added to the control box to allow interfacing with the Atlas system over a web server, allowing video to be broadcast. A second monitor could be added to complement the new cameras.

10 / REFLECTIONS

THE EXPERIENCE

As participants in the MATE Challenge, we must take on two roles. We should be competitors as students and as entrepreneurs, educationally and commercially. We must work as a team of friends and as one of colleagues. We have to be teenagers and we have to be SeaWolf Incorporated. That is the point of the MATE competition: to introduce students to both technology and business and to have fun in the process, so that years from now we can be readier than ever to enter the field.

AVI MITTAL

This project has been an incredible experience. The Atlas represents the culmination of so much time and effort, but to see it move so fluidly is worth it. By far the most rewarding and prideful experience was demonstrating the Atlas in Lake Washington before a crowd. I want to pursue a career in the aerospace or computer science field; I have not quite decided. However, what I do know is that the skills I have built will come in handy in each field. The lessons I have learned about teamwork and entrepreneurship will serve well when I become part of the workforce. MATE has provided an irreplaceable opportunity to create something great.

CEDRIC NAGATA

I have realized many things during my experience this year, including the idea that there is more reward from planning every step of a process in detail, rather than making the easiest and quickest solution. To me, it is not just about getting the task done as quick as possible, but more about learning different ways to approach the problem. This is more valuable because it provides a better experience, and more knowledge for the next time a similar task occurs. The way I like to work is best represented by the proverb, “Give someone a fish, they have food for a day; teach someone to fish, they have food for a lifetime.” If I just speed through a task and I don’t learn anything from it, I don’t benefit from the experience. If I take the time to understand what I am doing, I will not only be able to come up with a better solution to the task, but I will also learn valuable skills that could help me later on. This mentality will continue to aid me in my future career, and my life.

HUNTER BANKS

I feel that this project has been incredible, and I’m very fortunate for this opportunity. I am proud of what our team has accomplished with all the hours we spent coding, wiring, and troubleshooting. As the CEO, I have learned leadership skills, as well as how to build a successful team and company. With the creation of the Atlas, I tried to push myself to learn new things so I would come out of it as a better person.

11 / ACKNOWLEDGEMENTS

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