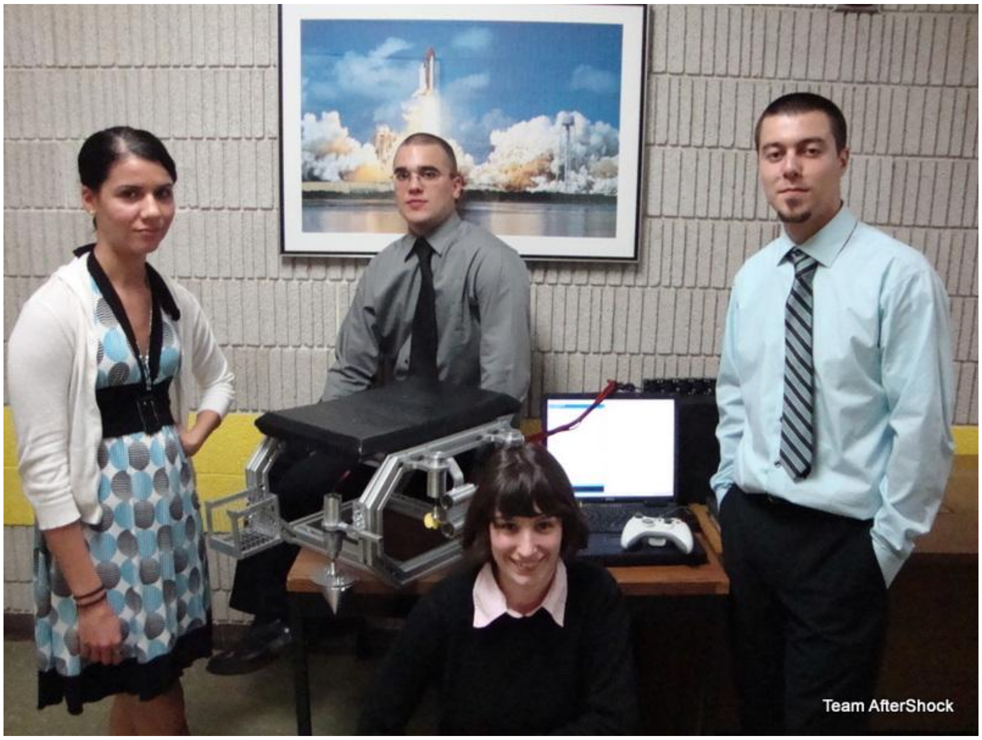
Bristol Community College

TEAM AFTERSHOCK

R.O.V. Name: Al



Team Members: (In order from left to right)

Samantha Chapman

Josh Normandin

Kate Buck

Helder Lobo

Instructors: Dr. Michael Meyers

Mentors: Al Censorio

Meghan Abella-Bowen

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ABSTRACT:

Bristol Community College's Engineering Club created Team Aftershock for the sole purpose of competing and winning the MATE 2010 ROV Competition. Team Aftershock built the remotely operated vehicle named Al, to complete the mission tasks set forth by the Marine Advanced Technology Education Center. These mission tasks were based on the 1996 exploration of the Lo'ihi seamount. This report summarizes the budget, design specifications, operation, constraints, software, research, troubleshooting and team dynamics involved in the creation of this R.O.V. This is Bristol Community College's first year competing in the Explorer class. The four team members of Team Aftershock are each involved in a field of engineering at the college. The different personality traits of each team member created many issues in the involvement and non-involvement of the R.O.V.

The creation of Al was based on a restricted budget, limited time, and a lot of hard work. Our budget was based mainly on donations and grants. All of the tools and parts were custom machined and assembled at the college with donated aluminum stock. This includes but isn't limited to the agar extractor tool, the thruster housings, the crustacean retrieval box, and the assembling of the frame. Python and Arduino coding were used to create the software needed to run Al. We also installed a water proof camera placed strategically in the rear of the R.O.V for maximum viewing angle. Al is specifically designed and equipped to fully complete the MATE 2010 Competition.

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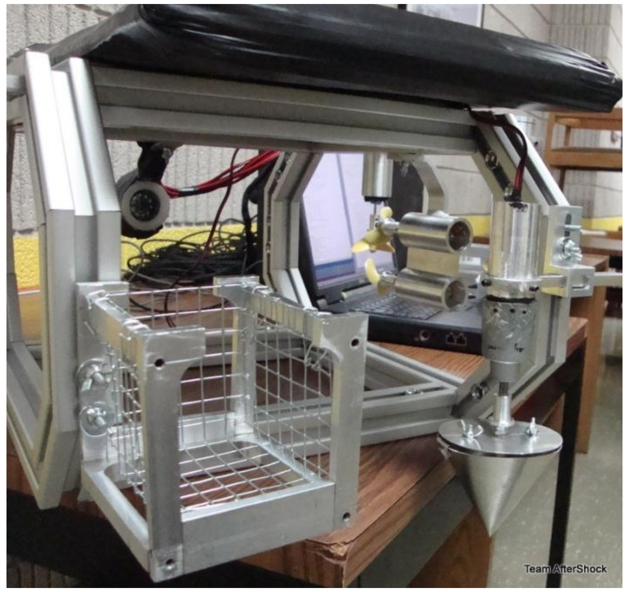
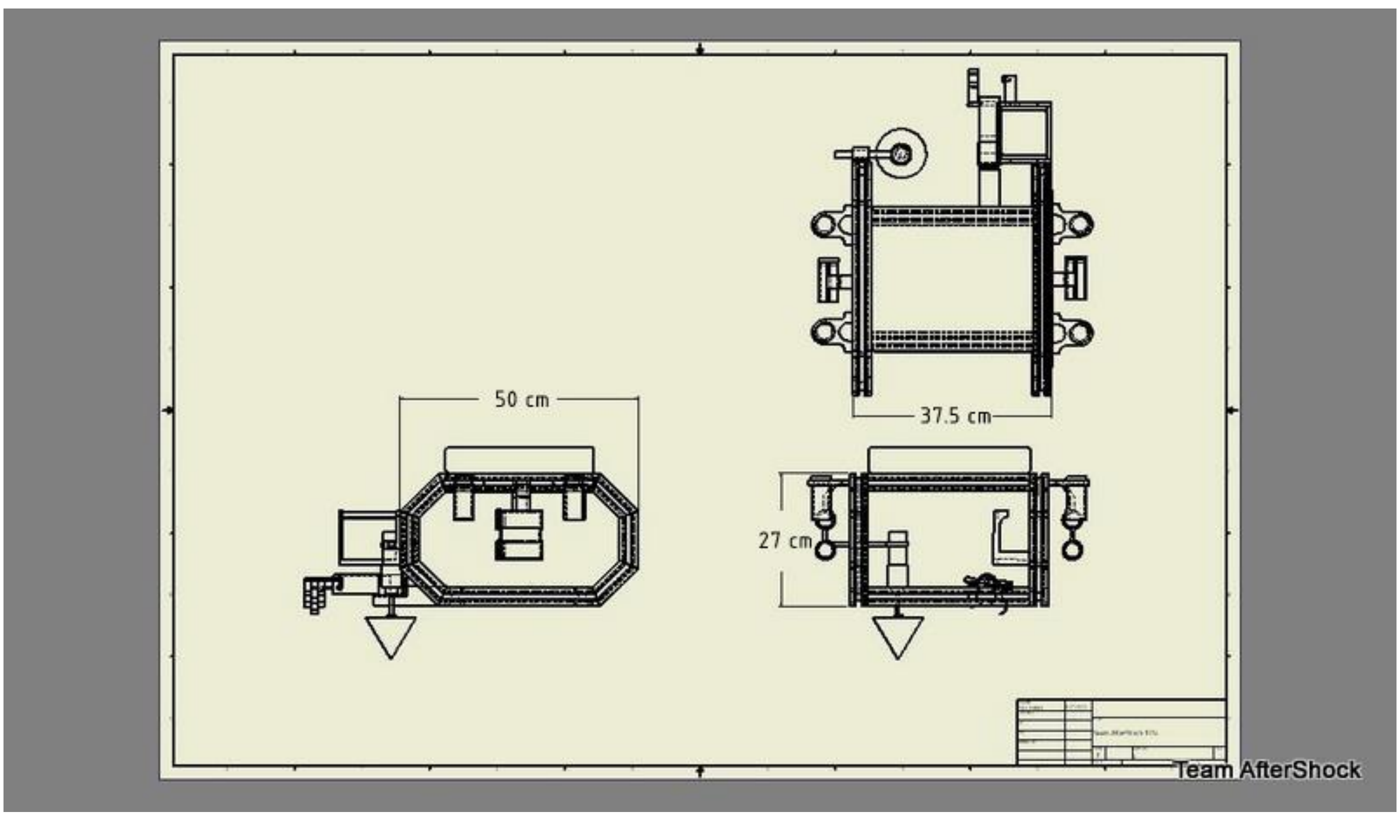
Photographs of Completed ROV:

(Figure—ROV Right Isometric View)



(Figure—ROV Left Isometric View)



(Figure—Inventor Dimension Drawing)

Team AfterShock's Budget

Donations:		Amount
	Donation for Supplies from the SMART Grant	$600.00
	Donation: Meghan Abella-Bowen	$100.00
	Donation: Sarah Garret	$50.00
	Donation: Michael Vieira	$50.00
	Donation: Cathy Claredon	$50.00
	Donation: Susan Hoy	$50.00
	Doantion: James Pelletier	$20.00
	Donation: Eileen Young	$100.00
	Donation: BCC Engineering Club	$60.00
	Donation: Rotary Club	$220.00
	Donation for Travel from the SMART Grant	$3,799.36
	Donation for Housing from the SMART Grant	$500.00
	TOTAL AMOUNT DONATED:	$5,599.36

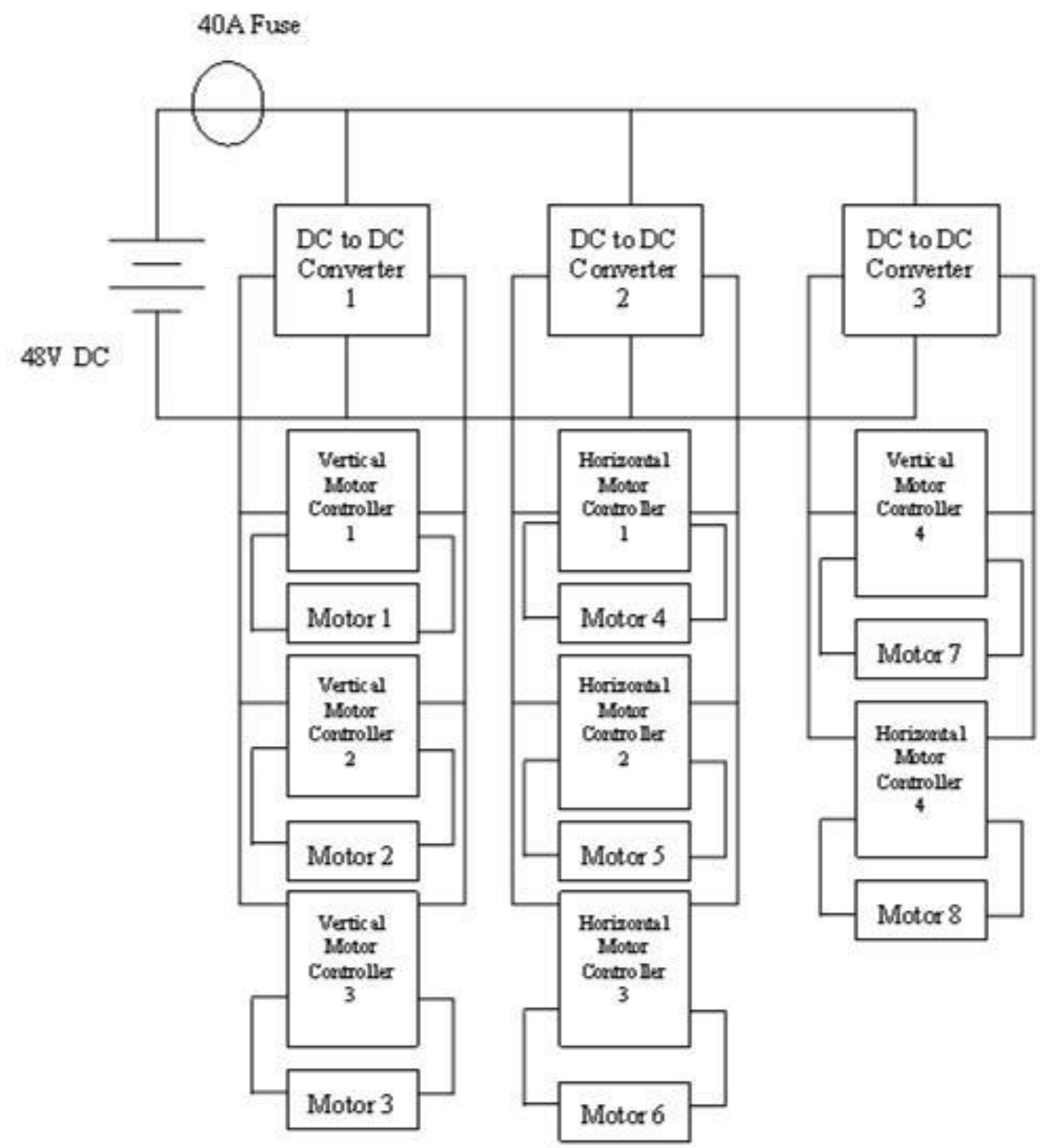
ROV Cost:		Amount
	Frame (Extruded Aluminum, Spring Fasteners, and Handles)	$259.26
	Motors (9 12V DC Motors)	$50.00
	Tether (100 feet double stranded wire)	$307.00
	Controls (XBOX Controller, Micro Controller, Motor Controllers, and Computer)	$172.46
	Cameras	$32.00
	Miscellaneous Hardware (Set Screws, Bolts, Washers, Nuts, and Wing Nuts)	$30.00
	DC to DC converter	$312.20
	TOTAL:	$1,162.92

ROV Donation Cost:		Amount	
	Motor Housings (Stock Aluminum)	$486.00	* Material Donated by BCC
	Gripper (PVC Pipe, Hardware, 4 Nylon Gears, and 1 Nylon Gear Track)	$46.27	* Material Donated by Meghan Abella Bowen
	Crustacean Box (Stock Aluminum, Hardware, and Chicken Wire)	$20.00	*Material Donated by BCC
	AGAR Tool (Aluminum Sheet Stock, Aluminum Stock, Hardware, Drill Transmission)	$45.00	*Material Donated by Del Thurston
	J-Bolt Extractor (Stock Aluminum and Aluminum Rod)	**$10.00**	* Material Donated by BCC
	Camera	$249.99	* Donated by Don Chapman
	Camera Housing (PVC and Lexan)	$40.00	*Donated by Joshua Normandin
	Hydrophone	$43.00	**Donated by Dr. Michael Meyers
	Temperature Sensor (DS1620)	$10.00	* Donated by Dr. Michael Meyers
	Lights (Flashlights)	$10.00	*Donated by BCC
	Bouyance Cap (Boat, Deck and Hull Coring)	$50.00	* Donated by Don Chapman
	TOTAL:	$1,010.26	

Miscellaneous Costs:		Amount	
	Transportation	$3,799.36	Donation by the SMART Grant
	Housing	$500.00	Donation by the SMART Grant
	TOTAL:	$4,299.36	

Total income: $5,599.36
Total Cost of ROV: $1,162.92
Total Cost of ROV without Donations: $2,173.18
Total Spent: $1,162.92

ELECTRICAL SCHEMATIC



DESIGN RATIONALE of VEHICLE SYSTEMS and PAYLOAD DESCRIPTIONS

Materials:

We decided to construct our R.O.V. primarily out of Aluminum; this includes but is not limited to the frame, motor housings, motor housing brackets, crustacean tool, agar extraction tool, prop adaptors, and other custom brackets. Aluminum was chosen because of its light weight and ability to resist corrosion.

Frame:

All of the frame parts were purchased from DARLEX (Vickers-Warnick Manufacturing). The frame is built out of Four-Slot 35mm x 35mm Aluminum Extrusion. The material was mainly chosen because of its modularity. The slot in the Extrusion would allow us to easily mount our motors and any additional tools. The frame dimensions were driven mainly by the cave entrance, L bend and the shipping box to Hawaii. We decided that in order to be able to safely navigate the cave it would be best to have 20 cm of clearance on all sides of the frame. The next issue to address was shipping. We did not have enough capital in our budget to send the R.O.V. to Hawaii via freight which would have cost an estimated $775.00 USD. Instead we turned to the USPS. We could ship anything we want, 34 kg and under that could fit in a 31 cm x 31 cm x 15 cm box for $14.99. This meant that our frame design had to be easily disassembled and reassembled in a timely manner. We first drew the frame by hand, then in Inventor and finally built it. With these given constraints, the final dimensions of the frame were 50.0cm x 37.5cm x 27.5cm. All of the frame pieces and angle cuts were done using a knee mill. The frame is joined together with assorted Stainless Steel Variable Angle Connectors.

Buoyancy:

The Buoyancy cap was made out of AIREX® C70 - Universal Structural Foam. The buoyancy of the ROV is slightly positive to allow for recovery to the surface if catastrophic failure such as severance of the ROV from the tether occurs. The Cap volume has been determined to allow for positive buoyancy with minimum additional ballast added to the ROV. We weighed the ROV in the water and then calculated the required volume of the buoyancy cap. Water testing confirmed the volume adjustments required. We experimented spacing the foam out in the inside of the cap. Our goal was to make it very easy for the pilot to roll or pitch the R.O.V. in every direction. These results were most easily obtained by concentrating the foam in the center of the cap and leaving air pockets in the middle. Once all water testing was complete the buoyancy cap received final shaping and was covered in fiberglass to improve structural integrity and durability.

Propulsion System:

Our goal this year was to stay away from conventional bilge pumps or pricey off-self thruster setups. Instead we designed and built our own custom thrusters. The motors behind our thrusters are Jameco’s Reliapro 29SYT003. These motors are capable of achieving 18000 rpm and deliver 509 g-cm of torque at max efficiency. Now because these were ordinary DC motors we needed to devise a way to waterproof them. Our answer to the task was an aluminum watertight motor housing that was equipped with shaft seals. The construction of these housing was pretty simple but it was indeed time consuming. Now because of our budget constraints it was not as simple as going out and purchasing round aluminum stock that was 2 cm larger than the outside diameter of the motor; we couldn't afford it. Instead we had to use the materials we had at the school. This meant starting off with a 7.5cm x 3.5cm x 200cm rectangular stock and turning it into our circular motor housings. This meant cutting 4cm lengths of the rectangular stock and turning them in the lathe until they were perfectly circular. We then bored out a center hole to match the outer diameter of the motor so we could gently press them in. We then needed to make our watertight caps. We constructed these the same way as the motor holders. Both caps had a center hole; one for the wires, the other for the propeller shaft. The cap with the propeller shaft hole then needed to be outfitted with shaft seal to protect the motor.

When equipped with 1250 propellers and submerged in about two (2) feet of water our thrusters are capable of developing 12 N and drawing 5.7 Amps a piece. We have a total of eight (8) thrusters on board; Four (4) vertical and Four (4) horizontal. The placement of the thrusters will allow the R.O.V. to pivot in all directions. Because of current draw limitations the motors will be throttled to run at a max of 75% of their full capacity during the mission.

TOOLS

Robotic arm:

In two out of the four mission/tasks a gripping ability is needed to acquire and/or move multiple objects. Due to the objectives described below we created a gripper with a 180° turning ability. In mission/task one, two j-pins need to be pulled in order to remove the HRH from the elevator. Once the j-pins are removed the HRH needs to be picked up off the elevator and placed at the site that is rumbling. HUGO's cap also needs to be removed and the connector, that is back on the platform, (which holds the elevator and is the prior site of the HRH) needs to be inserted into HUGO at a 45° angle. In mission/task three there is a single objective that requires a gripping motion. Below the hypothermal vents are a number of "spires" (a.k.a vertical positioned pvc pipes) of different diameters. One of these spires need to be taken hold of and returned to the surface for maximum points. As a result of these objectives the team created a gripper with rotational maneuvering capabilities. The gripper has to be able to grab spires of different diameters (mission/task #2), be able to put the connector in at a 45° angle (mission/task #1), and grab piping that is positioned both vertically and horizontally. The gripper must also have the capability to pick up the maximum weight of the HRH.

The design of the gripper was created through a series of gears and tracks. In the top cylinder, two jaws are attached along an aluminum rod. Each aluminum rod contains an implanted gear track that runs along their underside. These tracks move in and out of the gripper cylinder by a gear (#1) powered by a 12V DC motor. (See electrical schematic for details) At the end of the top cylinder a large spur gear is attached flush against the back wall. This spur gear, which I will name spur gear #2, is epoxyed to only allow 180° of rotation. Directly below spur gear #2 a smaller spur gear is vertically aligned. This spur gear, which I will name spur gear #3, turns spur gear #2. This sequentially rotates the upper cylinder the full 180° allowed by spur gear #1. (See sketch for visual assistance)

Agar Extractor:

After breaking down the technical specifications provided by MATE of Task #4 Collecting Bacterial Sample, we came to the conclusion that we needed a tool that can quickly and easily extract the agar and yet still be hand crafted to fall within our budget. We thought of several designs, one which was a simple sharp edged PVC cylinder that when pressed would "core out" and section of agar. Through testing we found out that the force needed to penetrate the surface tension of the agar was far greater than anticipated, especially the force that is need to "break the vacuum seal" of the agar to allow our tool to core out a piece of agar. We thought of using a Archimedes screw to break up the agar and this would allow the tool to hold onto the sample within itself. Unfortunately this design also had design flaws. No matter how sharp we made the cylinder the surface tension still posed a problem by needing to much force and thus it was taking too much time to penetrate the sample. We are truly proud of our final design. It's a hand crafted cone shaped slicing tool that is spun using a small DC motor and a transmission out of a small cordless drill. This extractor solves the inherent design flaws of all our other designs. In order to quickly penetrate the surface tension of the agar sample we need a small surface area to easily break the surface tension. Once the surface tension is broken, the "cone" spins and cuts into the sample with ease. Another benefit to this design is that the "cone" can be engineered to hold a specific amount of agar. According to the mission specifications we are allowed to pick up between 100 to 175ml of agar. We specifically designed our tool to extract 130ml of agar.

Designing this tool was very challenging. We started out by creating a "cone" out of 0.635 mm aluminum sheet. We manually formed the aluminum into the "cone" shape, what was designed to hold approximately 130ml. At first we attached the "cone" directly onto a small DC motor. Although, after testing we found that when the DC motor operated on the nominal voltage of 12 volts, the "cone" had enough torque to cut into the agar but it spun at an unstable and extremely dangerous high speed. If we lowered the voltage we had the safe low speed that was needed but we lost the all the torque that was essential in cutting through the agar. We needed the "cone" to spin at a manageable low speed yet the high torque in order to slice through the sample. After brainstorming our options, we decided to pull apart a cordless drill and use the transmission and motor from that drill to cut through the agar. This method worked flawlessly but it had one major flaw. The steel material in the transmission and motor was far too dense and thus we would have stability issues once we attached it to our ROV. Soon after, we talked to a fellow student and dear friend at our college, Del Thurston, who donated a small broken cordless hand drill that we took apart and used to make this tool. This new transmission was light yet strong enough to fulfill all our parameters. We then attached the original small DC motor to a custom aluminum motor housing, meticulously attached the transmission to this custom housing, and finally attached that to the "cone". We feel that this final design provides us with a tool that spins at a slow manageable safe speed yet provided us with high torque that can easily cut and slice through the sample quickly providing us with 130ml of agar. Once at the surface, the "cone" easily separates from the transmission assembly in order to quickly measure the amount of agar collected. It's located at the front of our ROV, where it can easily "core" the agar sample. This tool incorporates all our knowledge of electrical, mechanical, and design engineering. Simply stated, we are extremely proud of the engineering design process we had to go through in order to make this tool function perfectly.

Crustacean Retriever:

During our crustacean tool brainstorming sessions, we discussed many designs. From basic nets to a suction device that would capture the crustaceans in a holding box. As we learner from past competitions, sometimes the simpler the design the better it functions. The suction device that we originally prototyped didn't meet our expectations. It simply didn't create enough suction to capture and hold a crustacean. We found that a simple net would suffice but the netting could entangle on the pegs of the cave wall depending on the spacing of the pegs on the cave wall. We learned from past experiences that we should design a tool to function under any environment regardless of what the constraints might be. Thus, after considering what the spacing of the pegs could be we came up with our final design and its dimensions. Our Crustacean Retriever is a 10x12x10cm aluminum box placed at the front of our ROV, which can be placed flush with the cave wall. It encases a crustacean, lifts it out of its position and into the crustacean retriever box. The aluminum frame was made using our knee mill, and the wire sides were made by hand. This tool can easily capture five crustaceans in a timely manner.

Electrical System:

When designing the R.O.V.'s electrical control system we felt it be best to follow a few simple guidelines; easy to use, keep anything that wasn't waterproof at the surface and everything needs to be capable of running on a 12 volt system. With these given guidelines we did realize we had some drawbacks. Now because we decided to use a twelve (12) volt system we had to decide on a way to step down the MATE power supply which is rated at forty-eight (48) volts. Our solution: to use three (3) DC to DC converters that are similar to those inside of an electric golf cart. All of the converters are connected in Parallel with the voltage source at. Each converter is rated for 40~60V Input and 12V output at 20 Amps. Each of the converters will have different loads. The first will be running three (3) of the vertical thrusters. The second will be running three (3) of the horizontal thrusters. The third will be running the remaining two (2) thrusters, all specialty tools, and cameras. Our total current draw will never exceed 37.6 Amps.

Our control system uses different pieces of hardware that are able to communicate to one another because of our custom programs. The pilot will be able to select any usb controller of their choice and it could be easily interfaced with our programs. In our case we decided to use an XBOX 360 controller because we were all fairly familiar with it. The job of the first program is to read the controller values and translate it to a serial signal that the micro controller can understand. This program was written in Python and was adapted from http://principialabs.com/ and very heavily modified.

Our second program lives and runs in the Arduino and the Arduino runtime environment. The runtime environment breaks the serial signal down and sends the motor assignments to the Arduino. The Arduino then takes the motor assignments and disperses them to the appropriate HB25 motor controllers. The motor controllers connect to Al's tether at the surface. The benefit of having multiple motor controllers is that we can vary the signal of intensity to individual motors at the same time. An example of this would be we can angle the ROV at a 45 degree angle without having to adjust buoyancy. This will aid us in picking up the crustaceans in the cave.

The tether will be made out of nine conductors; six for the motors, one for power for all specialty tools, one for the camera, one cat-5 for the signal for the gripper as well as the hydrophone. To achieve neutral buoyancy we used pipe insulation foam. During our testing we tried using three meters of unmolested tether to help with our cave entrance. We decided against this because the tether acted like an anchor and did more harm than good.

For our temperature sensor we used the DS1620 which is accurate to a thousand of a degree which is well within MATE specifications. The temperature sensor is connected to the Aduino which sends the temperature value to the laptop screen. As a team the hydrophone is one of our difficult technical challenges. In our first two designs we could hear the "rumbling sounds" but couldn't pinpoint the direction. Our current design is still in the process of final modification. The readout of the frequency will be determined by a usb oscilloscope connected to our laptop.

By using one strategically placed camera we found that we could be able to guide our ROV throughout all the various mission tasks. Our camera is a water proof black and white camera with 420 lines of resolution providing an analog signal, connected through a RCA connector and with a current requirement of approximately 100 mili amps. The camera is bolted onto the slotted aluminum extrusion.

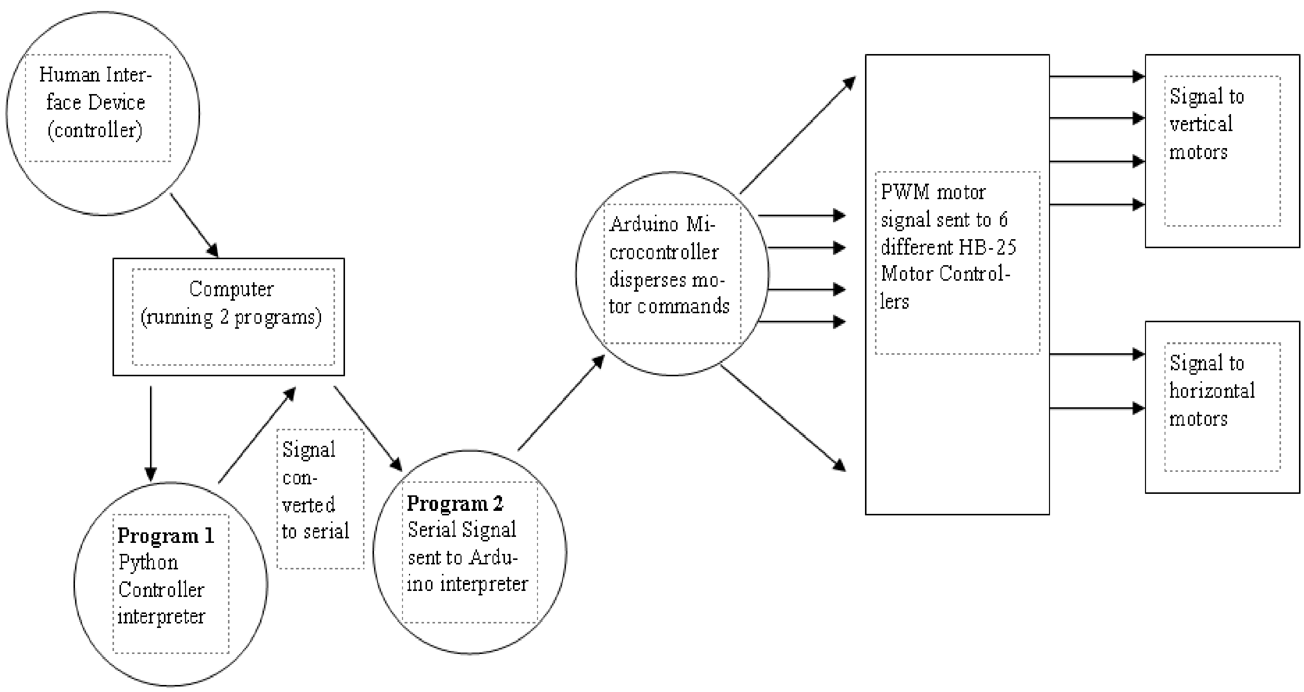
```
void loop() {
  // Wait for serial input (min 3 bytes in buffer)
  if (Serial.available() > 2) {
    // Read the first byte
    startbyte = Serial.read();
    // If it's really the startbyte (255) ...
    if (startbyte == 255) {
      // ... then get the next two bytes
      for (i=0;i<2;i++) {
        userInput[i] = Serial.read();
      }
      // First byte = servo to move?
      servo = userInput[0];
      // Second byte = which position?
      pos = userInput[1];
      // Packet error checking and recovery
      if (pos == 255) { servo = 255; }
```

(Figure – Arduino Sketch Excerpt)

```python
if (axis != "unknown"):
    str = "Axis: %s; Value: %f" % (axis, e.dict['value'])
    # uncomment to debug
    output(str, e.dict['joy'])

    # Arduino joystick-servo
    if (axis == "X"):
        pos = e.dict['value']
        # convert joystick position to servo increment, 0-180
        move = round(pos * 90, 0)
        if (move < 0):
            servo = int(90 - abs(move))
        else:
            servo = int(move + 90)
        # convert position to ASCII character
        servoPosition = chr(servo)
        # and send to Arduino over serial connection
        ser.write(servoPosition)
        # uncomment to debug
        #print servo, servoPosition
```

(Figure—Python Script Excerpt)



(Figure—Program Flowchart)

CHALLENGES

Two of our four members have competed in last year's MATE Competition. This year we truly wanted to make a custom ROV. Considering last year's ROV was custom, we truly had to out do ourselves. We decided to make as many parts of our ROV using only a knee mill and a lathe. We didn't use any CNC machining even though we have two or any 3D printers which we also have access too. To us this project isn't about who has more money or who has the technology to make the "best" ROV. It's about learning life-long lessons of honest hard work and learning the ability to take the lead when the job calls for it.Having such great instructional support truly make a difference and instills confidence in students like us. We knew this semester was going to be challenging but not as practically impossible as it would end of being. All of us are full time students. Some of us are taking more credits than "full time". Some of us are also working or living on their own. After all we are at a Community college, and we aren't your typical college students. All four members of Team AfterShock re-instituted the BCC Engineering Club so that we can spread the word that our little known community college doesn't just teach basic courses, it truly can change lives.

As we labored on our ROV we quickly realized one of our challenges. Half way through our build, it was announced to us, due to sudden policy changed in our lab, we were no longer able to use the knee mill or lathe without one of our instructors present at all times. This wasn't because we broke any rules, or got injured using one of the tools, even though at that point we were devastated and insulted. One person's decision had just made a challenging project practically impossible. We knew no matter what, the show must go on. We owe it to ourselves and possibly future students to finish what we started, no matter what.

Lastly, we also didn't have much capital, never mind building a great ROV or traveling halfway around the world to compete. Luckily we had a plan, in which we made professional donation letters and sent them out to as many organizations and companies as possible. We made an account at our foundation so businesses could send tax exempt donations and money. As time went on we had received some donations but not nearly enough. Our savior in disguise was in the form of the SMART Program. Meghan Abella-Bowen donated thousands of dollars, and because of her and her NSF Grant, they are the reason we are competing at the International Competition. We hope that more and more students have this opportunity to compete at such a great competition, like we have had these last two years.

TROUBLESHOOTING TECHNIQUE:

If at any point in time a motor would stop working that motors fuse would blow. We used smart Glow fused which light up once the fuses blow. This allows easy detection, of motor failure, which would allow us to quickly repair a motor if one were to fail unexpectedly. During our testing we ran into buoyancy issues where our cap held onto air. We drilled small pinholes into the cap to locate the air pockets that were preventing us from submersing.

FUTURE IMPROVEMENTS:

Project funding is and will continue to be a challenge. During this past year we were fortunate enough to receive funding support for supplies from our college through a grant. In addition to the grant funds the team also developed and implemented a fund raising campaign to support the team's efforts. Funds from the grant and our fund raising are overseen by the college. However, accessing the funds has been a challenge. Due to the changing nature of building the ROV we are constantly researching companies to find the best price for supplies. If we want to receive supplies in a timely manner (3 or 4 day turn around time) we need to purchase the product out of pocket and then submit a requisition for reimbursement to the college. This process can be time consuming and also requires the student to have access to a credit/debit card to cover the money up front. In the future we would like to work with the college to explore the option of using a debit card with a preset limit. With a debit card it would also provide us with a bank statement which would show us what we purchased, when, and from what vendor. This coupled with the receipts would provide a record keeping system showing us what was actually purchased and detailed prices. We feel this process would also take the pressure off students to purchases miscellaneous parts with their own money.

As BCC continues to participate in this competition (and possible others) we are realizing that there are some areas for improvement that would be beneficial to the team and all engineering students. Specifically, as we become more advanced in our building process, the need for more access to computer labs, tools, and machining equipment is key to producing a quality project. Currently, access to labs and equipment is restricted to set hours, approximately 6 per week. The time restraint created scheduling challenges as team members tried to adjust their schedules to be work during available lab hours. This made it difficult for all team members to log time on specialized tools and machining equipment. In order to support future engineering teams and students we would like to work with the Engineering Department and College Administration to develop new policies and procedures that would allow students more access to the engineering labs on campus. Possible new procedures might include creating a student equipment training workshop and safety training workshops.

LESSONS LEARNED/ REFLECTIONS:

Samantha:

During the preparation of our R.O.V there were many new things that I learned and new skills I attained. One new skill that I learned was how to use a lathe. My vocational school instructors bore into my mind the dangers of a machine and ever since then I have been frightened of them. Most of the parts on the R.O.V had to be machined using the lathe and when it came my turn to use it I was hesitant. This competition forced me to work outside my comfort zone and take in new challenges such as this one. I also learned how NOT to work in a team environment. Many of the challenges that we came across were mostly due to team miscommunications and personality conflicts. The next time I work in a team environment I will know how to better improve clarity and have a more open mind towards other team members.

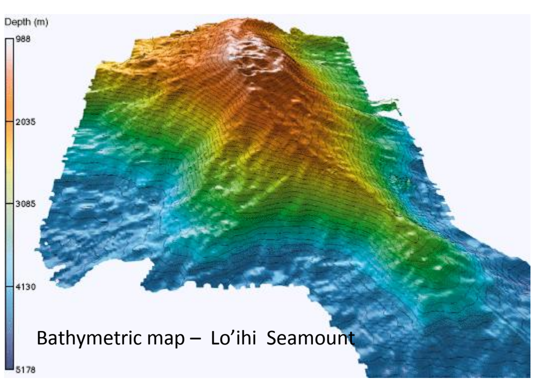
Helder:

Before this experience I would consider myself a "go-getter". Even though I'm still considered myself that, I've learned how to better "read between the lines". In the past I would have been more stern. I would have gotten my point across but I might have come across being too harsh. I learned sometimes it’s better to understand and give people more benefit of the doubt. Although on the flip side, this method also leaves room for procrastination. During this semester there has been several times where we adjusted our time-line in order to accommodate other team members, in the hope that we wouldn't be alienating them. I have also learned to keep learning and stay honest because everyone is different and reacts differently, but if 'm always honest not brutally honest, then "no harm, no foul". Last year, I was the "communications" guy. I did the majority of the paper work, and made sure all our deadlines were met. I didn't do much of the actually hands on building because I was unsure of what to do. I observed my team members and learned as much as possible. This year, I knew that Josh and I had the most experience so obviously we had to take the lead on most of the hands on building. I can say without a shadow of a doubt that I went from not knowing what an knee mill was to spending countless hours using ours to make our custom parts. I now know every aspect of that machine. I know how to use the knee mill because I have a great a great tool instructor Al Censorio and from past team members on how to properly attack design and engineering problems.

<u>LO’IHI SEAMOUNT RESEARCH</u>

The Lo’ihi seamount, also known as the “youngest volcano in Hawaii”, has been the topic of many studies since the early 1940s. The seamount is currently positioned on the southeast Island of Hawaii. It is just one volcano among a chain of other Hawaiian volcanoes known as the “Hawaiian-Emperor Seamount Chain”.

The Lo’ihi volcano runs just south of the volcano of Kilauea, roughly 30 miles from Hawaii’s shore. It currently sits on Mauna Loa, the largest active shield volcano on Earth, and is located on top of the Hawai’i “Hot Spot”. “The Hawai’i “ **hotspot** “or “**hot spot”** is a portion of the Earth's surface that may be far from tectonic plate boundaries and that experiences volcanism due to a rising mantle plume.” – (Wikepedia) Lo’ihi stands more than 3000 meters high and 969 meters below sea level. Currently the volcano is in-between the pre-shield an shield phase. Shield volcanoes are built almost entirely of lava flow. – (Kious and Tilling) These types of volcanoes are characteristically shallow sloping and non-explosive. “They are built up slowly by the accretion of thousands of flows of highly fluid basaltic (from basalt, a hard, dense dark volcanic rock) lava that spread widely over great distances, and then cool as thin, gently dipping sheets.” – (Kious and Tilling) Lo’ihi currently accumulates rock at an average rate of 3.5 mm (0.14 in) per year near the base, and 7.8 mm (0.31 in) near the summit.



Bathymetric map – Lo’ihi Seamount

Due to volcanic activity, depressions, known as pit craters, were formed in the summit by the sinking of top soil into recessed chambers. These pit craters are named West pit, East pit, and Pele’s pit. The youngest of this group is Pele’s pit(formerly known as Pele’s vents), which was formed in summer of 1996 during a multitude of earthquakes. Among the pit craters, Lo'ihi consists of a number of fissures created by lava flow along an 11 km rift zone.

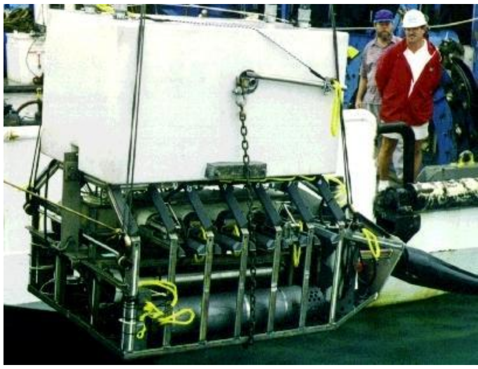
Lo'ihi began forming as early as 400,000 years ago. This is an estimate based on the amount of time it would take for a volcano of Lo'ihi's mass to grow through volcanic soil accumulation. – (Creative Commons Attribution) The Hawaii Center for Volcanology tested 17 dredge samples during a 1978 expedition. Through radiometric dating (a.k.a radioactive dating) scientists were able to determine a few samples were 300,000 years old and some younger samples were 4,000 to 21,000 years old. Radioactive dating is the "comparison between the observed abundance of a naturally occurring radioactive isotope and its decay products, using known decay rates."- (Wikepedia)

The Lo'ihi seamount was first depicted on a map in 1940. In 1952 a swarm of earthquakes emitted from the volcano brought further attention and study. In the mid-1970s to the mid 1990's a series of lesser volcanic earthquakes were recorded. After a series of earthquakes in 1986, five OBO (Ocean Bottom Observers) were sent for a month on Lo'ihi. In 1987 a submersible DSV named Alvin was deployed to survey Lo'ihi. Alvin was also famous for the discovery of the Titanic in 1968.

ALVIN

CRUSTACEAN

In 1996, over 4,000 earthquakes were recorded in the Lo'ihi seamount. Research showed that the site called "Pele's Vents" had collapsed; now forming what is called "Pele's Pit". New hypothermal vents also began to transpire. These vents emitted fluids ranging in temperatures from 30◦ C to 200◦C. Bacteria was also acknowledged to be forming along the crater floor. Most of the hypothermal vents deposited minerals and other materials that formed "chimney-like structure" – (MATE 2010). To better monitor the seamount scientists installed the "Hawaii Undersea Geological Observatory (HUGO)" – (MATE 2010) on the summit of Lo'ihi. HUGO is connected to a junction box that lies along the north rift zone of the volcano. After two failures of the cable HUGO became non-operable.



HUGO JUNCTION BOX

All the missions in the MATE 2010 ROV competition are based off of the 1996 research operations and scientific observations. In mission one it is specified that we must pick up the hydrophone and move it to the site that is rumbling. This is the event in which scientists wished to record the seismic activity of the volcano. Next the cap on "HUGO" needs to be opened and the connector inserted. I believe this is based off of the repairs done on the cable. The second mission describes going in and out of a cave and collecting "crustaceans". During the excavation of Lo'ihi a new species of crustacean were discovered. This mission re-enacts just that. The third mission details measuring the temperature and collecting a vent spire. As described above vents were discovered emitting a range of temperatures from 30°C to 200°C. The materials emitted from the vents created "black chimneys" or in our case "vent spires". Lastly the fourth mission entitles the team to pick up a sample of bacterial mat "agar" from the "sea" floor. This is the bacteria deposit that emanated after the eruptions of 1996.

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-ADVICE:
Dr. Michael Meyers

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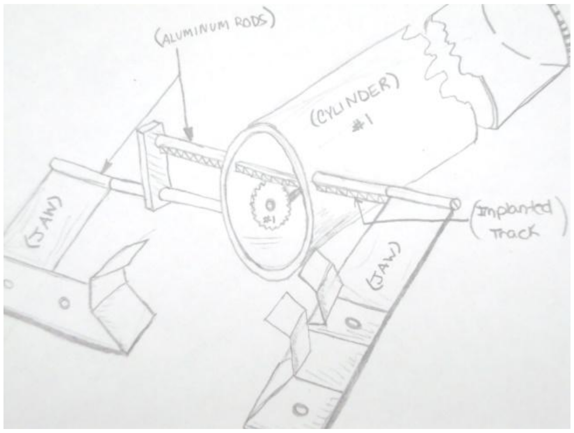
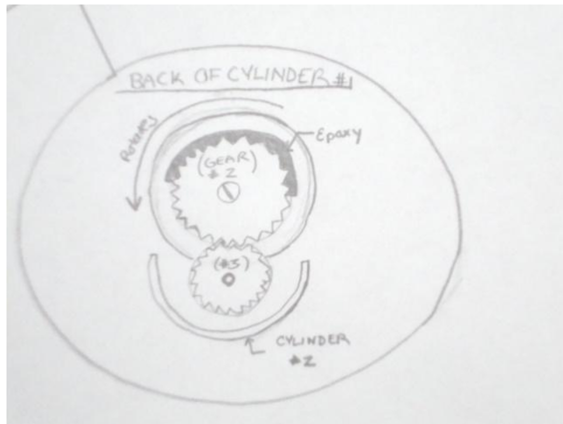
APPENDIX:

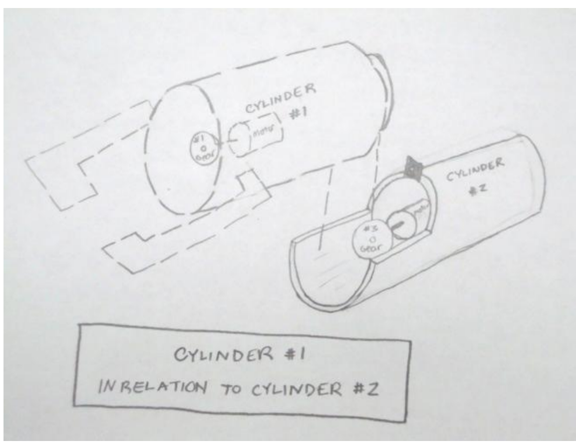
Sketches of Gripper:



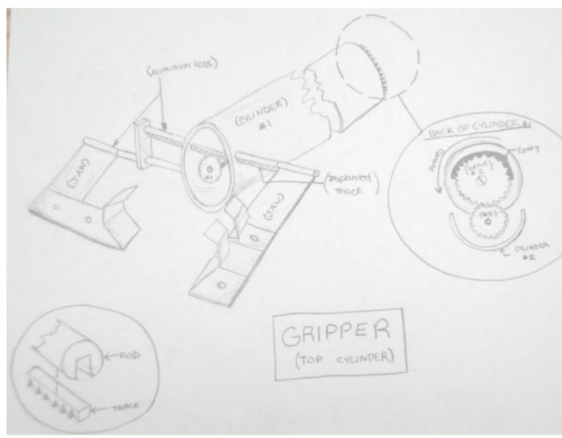
Gripper Cylinder



Back of Cylinder



Cylinder #1 and #2



Gear Relationships

Team AfterShock Timeline