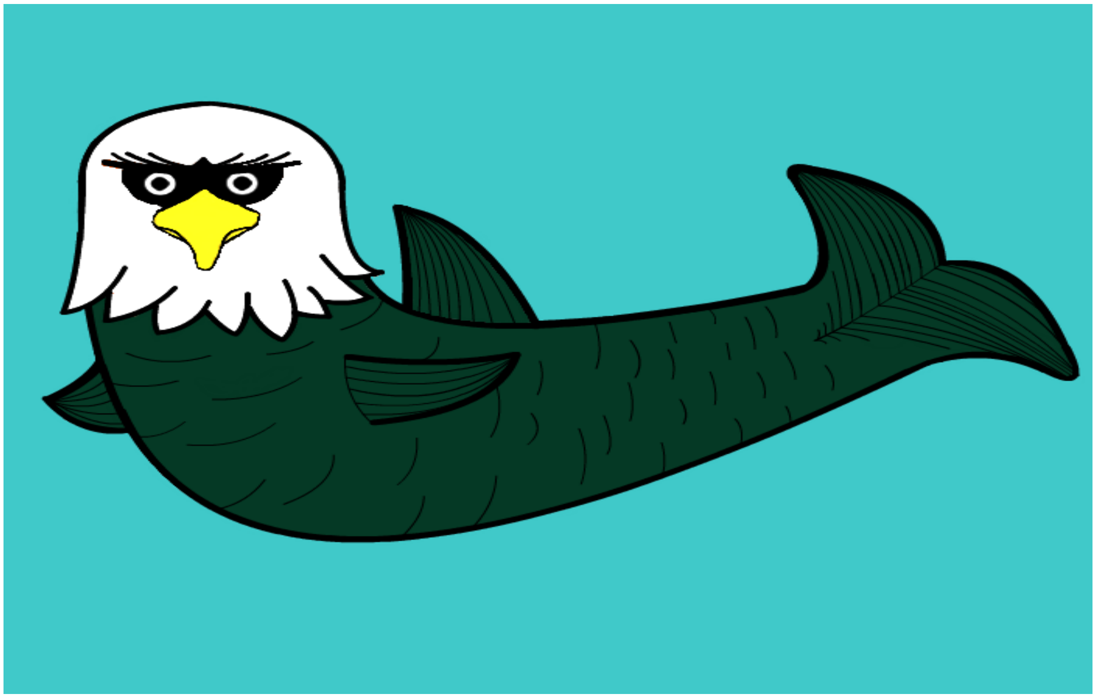

SEAGLES

John Hancock College Preparatory High School,

Chicago, Illinois

Technical Report

Company Information

Carlos Barrios, CEO -leadership and management skills, plans to be an aerospace engineer.

Jesse Delgado, CSO, Engineer -leadership and technical skills, plans to be a software engineer.

Brian Hernandez, Supervisor -problem solver, plans to be a computer software engineer.

Joseph Nunez, CMO -great public speaking skills, plans to be a mechanical engineer.

Giselle Villalobos, CRO -editing, takes precautions, plans to study linguistics.

Victor Salgado, CVO -organized, creative, plans to be a rehabilitation counselor.

Javier Lopez, **Co-pilot** -expert RC driver, plans to be a medical doctor.

Ivan Lopez, Pilot -veteran ROV pilot, plans to be a computer engineer.

Angel Rebollo, CFO & Reserve Pilot -mathematician, plans to be a computer engineer.

Olga Martinez, Designer -trilingual, teamwork skills, plans to be a biomedical engineer.

Tatyana Hornof, **Technician** -money management skills, plans to be a neonatologist.

Mentors

Jennifer Stites, Aidan Phillips, Joseph Page

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Abstract

The SEAGLES are located on Chicago's Southwest side at John Hancock College Preparatory High School. SEAGLES is a new company that consists of high school students from 10th to 12th grade. The Hancock Eagle Remotely Operated Vehicle (HERO-V) was designed to be both simple and cost-efficient. The HERO-V was designed to assist in surveying Arctic seas, inspecting subsea pipelines, and monitoring offshore oilfield production & maintenance. Our final product is equipped with a camera, allowing effective maneuvering and a clear view of the subsurface of the sea. In addition, it has four motors that have the ability to be controlled individually to maximize mobility, providing propulsion in all directions. Furthermore, the HERO-V is outfitted with two hooks to enable the manipulation of objects. Finally, our ROV has flotation devices attached on its frame and tether for buoyancy.

Company Mission

The Seagles is a company dedicated to providing the best cost efficient and yet effective marine ROV system. Our skilled team of design engineers constructed a unique ROV according to MATE standards. Seagle's latest creation, HERO-V, has been manufactured with impeccable precision and careful attention to detail. We recognize the importance of any task given to us, and firmly believe that HERO-V is best suited for the missions we are given.

- Frame

The Seagles decided to create a simple cost efficient frame that allowed large amounts of water flow through it. The ROVs frame was built in the shape of a box to build on its "simple yet effective" design. It is 45 cm x 36 cm. The frame also helps reduce the cost of the HERO-V. One reason the HERO-V was given this frame was because it would make sure that a water current would not impact the ROVs performance while attempting to complete the mission. This water current factor was also tackled by drilling several holes into the frame to allow water to pass through efficiently.

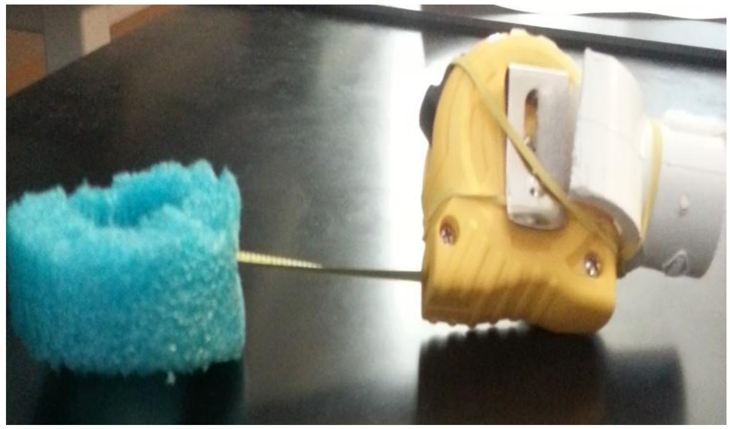
The first thing we did when deciding how to make the frame was how it would hold the various parts and attachments while still maintaining neutral buoyancy. To effectively perform the missions, four thrusters were attached to smoothly roam underwater. Two of the thrusters are placed in a horizontal position and the other two are put into a vertical position to maintain an even control system. Two hooks, a camera, a modified tape measurer, and a net are also attached to complete the several tasks detailed in the missions.

- Attachments

A net was placed onto the front/top PVC pipe of the frame to catch simulated algae. The net was made using a small fish tank net but was unwinded to make it larger and able to wrap around the PVC.

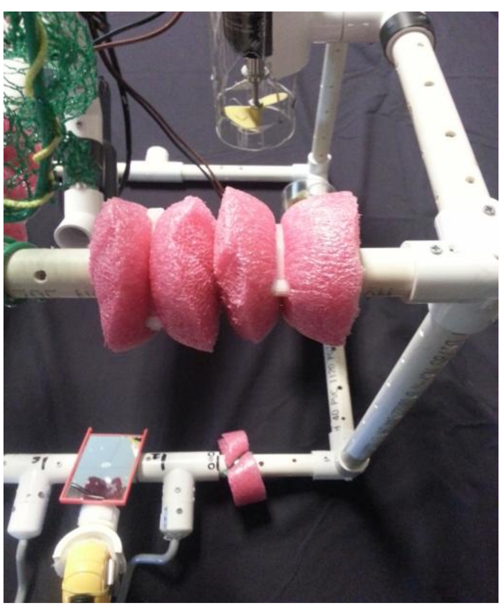
A fruit net was used to keep a long distance from the back of the net to the frame so the algae would float up but be kept in the net. Since the net is at the top of the ROV, it is not visible in the camera. To fix this problem a mirror was placed on the front/bottom PVC pipe at an angle to allow the camera to view the net and its placement compared to the placement of the simulated algae in the mission "Science Under the Ice".

Two hooks were placed to perform several different tasks within the two missions. One of the hooks was modified by simply bending the front to catch and move different items for the missions. The other hook was kept straight and can be used to catch the simulated sea urchin and place the sensor into the PVC square in "Science Under the Ice."



One of our proudest attachments that was placed onto the HERO-V was our measuring device. Our measuring device is a modified tape measurer. What we did was attach a (height) tall hollowed out flotation device at one end. It is attached onto the bottom/ front PVC pipe. To describe its purpose there is one task in "Science Under the Ice" where we are to be able to measure a simulated iceberg. How the iceberg is setup, there is one long, thin, and vertical PVC pipe that is placed in the center of a cross pcv. Each point of the cross is a different length away from the center. One of the tasks that include the iceberg is to measure all 4 points from the center. To achieve this, the rover will position the hollowed out flotation device to fit around the long vertical center piece.once the flotation device is attached the rover will back away, pulling the measuring tape out to measure the length of the PVC.

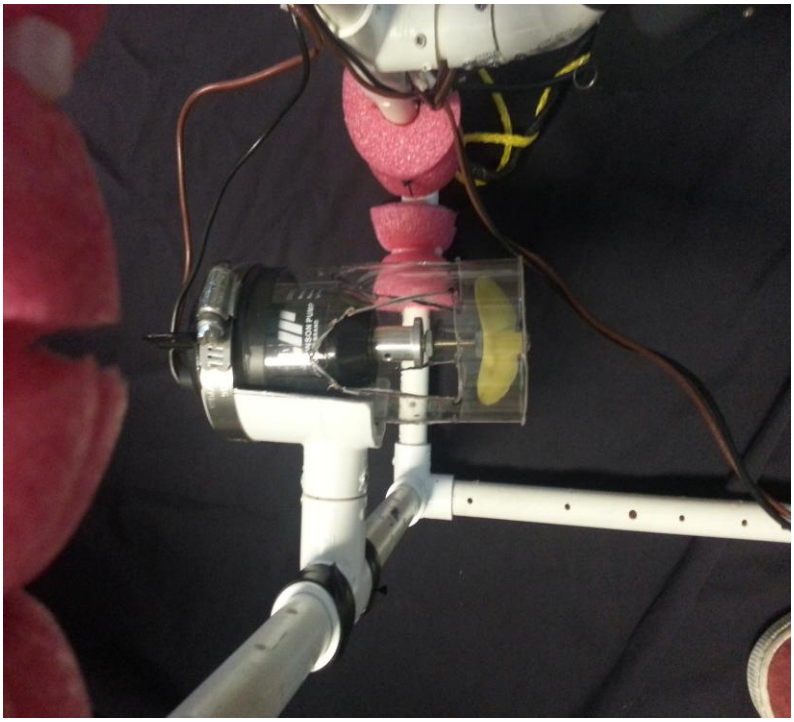
- Buoyancy



Neutral buoyancy was a rather difficult factor to achieve. ROVs function properly when there is a balanced buoyancy that is distributed evenly throughout it. The design team kept this factor in mind when adding certain attachments. The team made sure that some parts would not weigh a certain side of the ROV down more than necessary. The weight on the frame is added by accessories like the camera, mission tools, and motor. To our surprise the weight of the frame is not a big factor. This is mainly due to that fact that some of the PVC pipes do not have holes in them and the air positively adds to the buoyancy.

Even though the PVC adds to the buoyancy that is still not enough. Flotation tubes are attached to the PVC frame and are strategically placed to keep the ROV perfectly horizontal when underwater. The flotation tubes make sure that the weight 8is evenly distributed throughout the HERO-V. We also had to add some of the tubes in what look like random spots of the ROV. This is because during our first test at the practice day we realized that the ROV was still neutrally buoyant but was at an angle when placed underwater. To quickly fix this problem we placed the flotation tubes onto the PVC pipes that were sinking in the water. Now the ROV stays horizontal when put under water.

- <u>Propulsion</u>



To propel the ROV, four 500 GPH motors were attached inside the frame. Two have the fan of the motor facing down and the other two have the fan of the motor facing the back of the ROV. This allows for a steady control of the ROV while underwater. In addition, the motors allows the ROV to move within all 3 axis. Another point to add is that each of the motors are controlled separately with four different switches on the control box. Each one of the motors are placed strategically

- <u>Control System</u>

The ROV is controlled with a switches on a control box. The switch box has 4 different switches that controls one motor respectively; the switches move left to right which are programmed to switch the motors' rotation allowing motions like forward and backwards. By using different combinations of the switches, we are able to maneuver the ROV in rotation. For example, by making the right motors move forward and the left motor backwards, the rover rotates counter-clockwise. Because of the way the motors are places, we are unable to move diagonally which does not pose a problem. Vertical and horizontal movement will suffice.

- Cameras

Having visual in the ROV is critical for the pilot to operate the ROV and for [illegible] attached a fishing camera in the center of the HERO-V’s body. It

was attached to a piece of PVC using the straps for the weight that the fishing camera uses to sink to the bottom of the lake. The camera is placed the camera at a 45° angle to provide a visual of the front of the ROV and on the ground below. The cord comes from the camera and runs through the tether, the cord attaches to the appropriate monitor which provides power to the camera and receives the feedback. The monitor only delivers a black and white image. We added an additional color monitor to receive feedback in color.

Challenges

- Technical challenges

We faced many design problems when constructing the ROV. There were various options for attachments, yet many would simply extend the length of the ROV. This would cause the ROV to move vertically due to the water current. The ROV first started with hooks as limbs. They worked efficiently but we faced a challenge of picking up objects. So we decided to make a hydraulic claw; unfortunately, it added too much weight to the ROV which caused us to add more flotation tubes to return to neutral buoyancy. The claw had many restrictions because of its bulk. We were unable to open doors with it and it made the ROV drop vertically as it moved through the water. It made the ROV harder to control leading us to return to our initial design with two hooks.The bulk of the ROV often times causes it to bump into various objects or get stuck; our brilliant pilots try their hardest to avoid such collisions with a great success. We had problems with our camera as well. Our fishing camera only showed image in black and white which wasn't quite helpful. The Shedd Aquarium provided us with a second camera but it sadly refused to turn on rendering us to rely on the original. Later we noticed that the monitor was the one showing us discolored images. We then used a new monitor that did, in fact, showed us images in full color. This added another problem unfortunately. The new monitor had to be connected to the old monitor because the fishing camera was permanently attached to the old monitor. This variable causes the camera to consume an abundance of energy. We fixed this by keeping the old monitor off while we use the new one.

- Non-Technical challenges

Our lack of resources led to more problems. We didn't have a pool available to us, so the only time we could test the buoyancy would be during the club event at NorthWestern University where the competition took place. Unfortunately, the pool time would also be the only time we would have to practice controlling the ROV. Another one of our main challenges we had to overcome was the overall attendance of the group members. Due to the members overall involvement within the school, we held a busy schedule. Besides the busy schedule, we still made an effort to come to several work sessions throughout the year.

Lessons learned

- Technical

The majority of the team didn't have an engineering background so we had to rely on our mentors and other members who had previous experience to teach us. We learned how to strip and solder wires, and how to waterproof them. We also obtained knowledge that would help the team in certain circumstances; how buoyancy works, how water current affects an object, and how to distribute weight within an object evenly. During competitions, we also spent time talking with some of the other teams to gather a couple ideas or thoughts to improve our rover. They gave us amazing ideas on ways to improve our controller which we took to consideration; nevertheless, we kept the original, since we are more accustomed to it.

- Interpersonal

The Seagles ROV team learned to develop a certain form of communication and trust with each other. We individually learned and demonstrated several problem solving skills that helped accomplish tasks in order of importance. The team as a whole also learned to make certain decisions between two ideas by choosing one and keeping the other idea in mind.

Safety

Our project involved numerous fail safes to help keep things safe. If it couldn't be done safely, it was not done at all. At all times tool usage was either done by professionals or under extreme adult supervision. Students were required to wear goggles when operating upon the ROV. All testing was done in a safety proofed environment with heavily enforced safety guidelines and supervision at all times. We also implemented a separate set of safety rules for machine operation, meaning we limited as much as possible the chance of getting hurt during operation of the ROV. Electrical appliances were handled with the most care when around water and handled otherwise. All electronics are handled by the pilot or deck team that are specially trained to deal with the delicate electronics inside our ROV.

Safety Checklist

Company

- No loose clothing
- Wear facial safety gear (Goggles, filter mask)
- Aprons
- Loose articles should tied back (Long hair, sweater strings)

Physical

- Our ROV does not have sharp edges that would harm team members during reconstruction or while on deck
- Every motor has shrouding cover to prevent any injuries
- All shrouding is buffed out to prevent sharp cutting
- All wires secured in wiring wheel and taped together to prevent knotting
- All items are screwed in and tightened to prevent falling apart

Electrical

- Wires secured with electrical tape
- All wires secured in wiring wheel and taped together to prevent knotting
- All wires moved away from motor to prevent any tangles
- Wires zip tied to the rover to make it secure

HERO-V Expenses

Items	Estimated Cost ($)
Frame	
1/2 inch PVC tubing and connectors	40.00
machine screws, 5 boxes	5.00
buoyancy tubing	3.00
assorted electrical parts, wiring, fasteners	80.00
Propulsion	
waterproof bilge motors, 4	112.00
propellers , 4	12.00
propeller adaptors, 4	20.00
motor shrouds, 4	4.00
Optics	
underwater fishing camera with monitor	80.00
extra monitor	35.00
Payload	
hooks, 2	12.00
fishing net	3.00
measuring tape	5.00
velcro tape	7.00
Total	418.00

Travel Expenses for International Competition

Estimated airfare for 10 members	**7,000**
Memorial University dorm lodging for 10 members for 4 nights	**2,400**
Meals for 10 not provided by MATE or included in lodging, and miscellaneous expenses	**1,000**
Total Estimated Travel Expenses	**10,400**

Teamwork

Throughout the competition, team-work played a major role in our progression. No matter what unfortunate circumstance we faced, our high spirits and cooperation allowed us to advance with smiles on our faces. Not only do we pick each other up when things are looking gloomy, but we also use our high spirits to resolve any issues involving the building and/or fixing of the ROV. Whenever faced with an issue during the construction of our ROV, every member was asked for input before making any final changes, if necessary. When done, all available team members contribute to making desired changes to the rover.

References

1. MATE Center, Underwater Robotics Science, Design & Fabrication
2. Harold Washington Library Center. http://www.chipublib.org/locations/15/
3. Dollar Bay SOAR, shared 3d shroud design and file at www.thingiverse.com/thing:196345

Acknowledgements

We would like to thank Matt from the Harold Washington Library for helping us print our ROV shrouds; as well as, the Harold Washington Library for providing us with the 3D printers we used to print out our shrouds provide by DollarBaySOAR at Thingiverse. We would also like to thank Rachel Patten, Hillary Eggers and the Shedd Aquarium for providing us with the right tools to construct the ROV. Major thanks to John Hancock College Prep for providing us with the space to renovate our ROV between competitions. We would also like all those who donated to the team's Go Fund Me page, as without their contribution the team wouldn't be able to even go to International.

Seagles HERO-V
Systems Integration Diagram