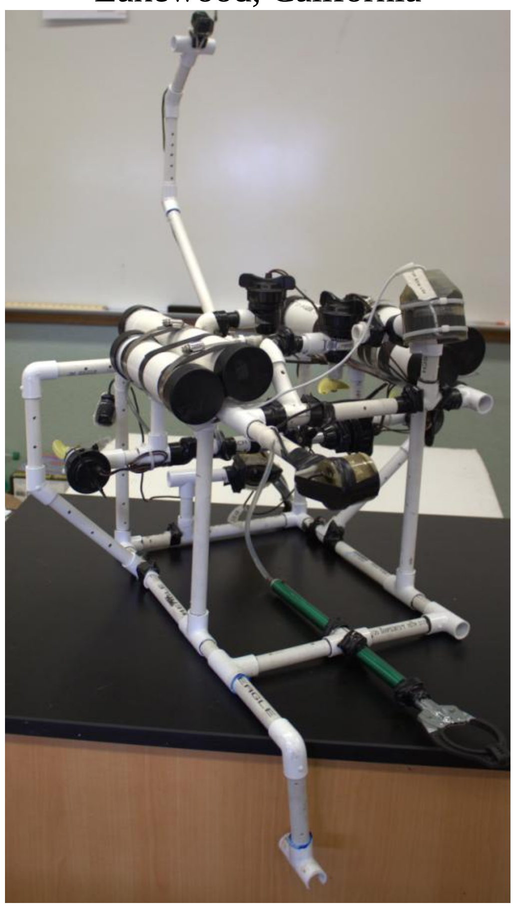
Alvin 2

Lakewood High School
Lakewood, California



The completed Alvin 2

CEO: Carlos Vergara

CDO: Alan Wang

MEDIA & R&D SPECIALIST/CFO/ FUNDRAISING MANAGER: Caitlin Sau & Vanessa Reina

CHIEF PILOT: Vance Howard

ENGINEERING SPECIALIST: Miguel Gonzalez

COMMUNICATION SPECIALIST: Aubrey Yuen

CFO: Matthew Calcanas

INSTRUCTOR/MENTOR: Allen Glover

FLIGHT SURGEON/TECH SUPPORT: Luis Rocha **Co- ENGINEER:** Carlo Soldevilla

Table of Contents

Abstract

The object of the Lakewood High School task force was to design and build the remote operated vehicle, Alvin 2, which would be able to perform tasks necessary to oceanic observatory work. In this year's case Alvin 2 was adjusted to complete a primary node, to install a scientific instrument on the seafloor, install a temperature sensor over a hydrothermal vent opening capable of recording temperature over time, replacing an Acoustic Doppler Current Profiler amidst a mid-water column mooring platform, in addition to possibly removing bio fouling from structures and instruments within the observatory. The design of Alvin 2, was mainly based around the concept of versatility, the ability to remove and attach hardware as needed to facilitate the accomplishment of various tasks. Therefore we used polyvinyl chloride, alternatively known as PVC, as a cost effective way to bolster versatility on the ROV. In addition the PVC allows for easy repairs, by simply replacing any parts that may eventually get damaged. Our ROV is therefore optimally suited for any environment or situation. Our air-controlled claw enables for a simple yet effective way to both grab and move objects with precision. In addition, our magnet attachment is a very effective way to take advantage of the metal hooks which are used to move instruments along the seafloor with ease. Our strategically positioned motors allow precise movement which will ultimately facilitate the completion of the tasks within the allotted time span.

Team Members:

Name	Job	Career and Schooling
Carlos Vergara Grade 12	CEO- As executive officer I oversaw the jobs of others members and made sure all rules were followed.	Will attend CSULB in the fall majoring in Aerospace Engineering
Alan Wang Grade 12	CDO- I was responsible for manufacturing the components located in the pool to allow the team to practice for the competition.	Will attend UCI in the fall majoring in Structural Engineering
Vance Howard Grade 9	Chief Pilot- I was in charge of piloting the ROV and practicing for the competition.	Plans to attend CSULB to major in Graphic Design
Miguel Gonzalez Grade 12	Engineering Specialist- As the Engineer I produced the Electrical Diagram for the ROV Lab Report and was involved in the manufacture of the ROV. I was also responsible for making Alvin 2 presentable for the big day.	Will attend CSULB in the fall and will major in Electrical Engineering and minor in Physics.
Vanessa Reina Grade 9	R&D Specialist, co CFO, Fundraising Manager- As mainly fundraising manager, I set up dates with several restaurants for dinner events. I handled our budget and found us the best deals possible for all of our expenses.	Plans to attend UCLA to major in writing.
Caitlin Sau Grade 9	Media Specialist, co CFO, Fundraising Manager- As mostly the media specialist, I worked on getting pictures of the ROV and helped with the technical report.	Plans to attend Stanford University to major in Chemistry.
Matthew Calcanas Grade 10	CFO, Fundraising Manager, As CFO and fundraising manager, I spoke with many people regarding financial opportunities available to the team.	Plans to attend Yale University in hopes of becoming a Lawyer
Luis Rocha Grade 12	Flight Surgeon, Tech Support- As the flight surgeon, my job was to safely deploy the ROV into the water along with the other underwater equipment.	Will attend United States Naval Academy and plans to become a Trauma Surgeon

Aubrey Yuen Grade 10	Communication Specialist- I worked with the engineering team on the ROV and helped with the technical report.	Plans to attend CSULB and become an Environmental Engineer.
Carlo Soldevilla Grade 10	I was support engineer for the project and I assisted on doing adjustments for the buoyancy of the ROV. However, I did a lot on recreating the tasks for the ROV from writing the PVC to assembling it.	Plans to go to CSUDH and plans to pursue career on some field on Engineering.

Allen Glover Coach	Mentor/Instructor	Currently teaches at Lakewood High School as an AP Physics and Environmental Science teacher. Graduated from UCLA.

ROV Cost Analysis Chart

Item	**Quantity**	**Price**	**Total**
Mueller streamline ½ in. PVC schedule 40 pressure SxS Elbow	20*	$0.28	$5.60
Mueller streamline 1 in. PVC schedule 40 pressure SxS Elbow	20*	$.52	$10.40
Mueller Streamline ½ PVC SxSxS Tee 10- pack	2*	$1.70	$3.40
2in end cap	6	$3.00	$18.00
1/2in. x 10 ft. PVC Sch. 40 Plain-End Pipe	20	$.49	$9.80
Mueller Streamline ½ in PVC Schedule 40 pressure 45 degree SxS elbow	20*	$.79	$15.80
Mueller Streamline ½ in PVC SxSxS	20*	$.59	$11.80
Envirotex Jeweler's Grade Clear Epoxy Resin - 2 oz Kit**	1*	$10.34	$10.34
½ in x 10 ft. PVC Sch. 40 Pain- End Pipe	5*	$1.79	$8.95
Aluminum trash claw (ROV Claw) **	1	$19.95	$19.95
ROV sea motor**	4	$17	$68
ROV crabbing motor sea motor**	1	$80	$80
2in. x 10 ft. PVC Sch. 40 Plain-End Pipe	1	$3.00	$3.00
Hose Clamps	6	$1.69	$10.14
Total ROV Cost: $281.04			

Tethering Cost Analysis Chart

Clear plastic tubing ¼ in. 10 ft **	1	$3.00	$3.00
5 ft. USB extension **	4	$5.00	$20.00
Signal enhancer**	4	$20.00	$80.00
Electrical Tape	5	$2.00	$10.00
Bicycle pump**	1	$40.00	$40.00
Zip tie 500 pack 1	1	$6.00	$6.00
Total Tethering Cost: $159.00			

Camera Cost Analysis Chart

5.7" B/W CCTV Monitor System gsm monitoring system **	3	$30.00	$90.00
Microsoft LifeCam HD-6000 for Notebooks (7PD-00008) **	2	$30.50	$61.00
**Day Night Vision Outdoor CCD CCTV Security Dome Camera 3.6mm Wide View Angel Lens 420TVL ** **	1	$35.00	$35.00
6 channel 2 mode transmitters ROV controller**	1	$350.00	$350.00
Total Camera Cost: $536.00			

*** The quantity specified was the quantity bought but not necessarily the amount used**

**** The material/component was reused from last year's ROV.**

Total Component Cost: $976.04

Safety

As important as a company's project is to its success, equal emphasis must be placed on the safety of the work environment and the well-being of its team members. In the creation of Lakewood High School's Alvin 2 we observed a heavy emphasis on the use of safety precautions. We used a large amount of sharp equipment such as saws, and knives, in addition to several power tools, notably a drill. During the usage of all types of tools that could potentially cause injury, all team members were notified, and the tools were operated securely and very carefully with adherence to all specified precautions found within the user's manual. Sharp tools such as saws and knives were only used when the item being altered was secured on a platform, and whenever not in use were safely contained in a sheath.

Pool safety was also an important factor in the development of our ROV. Our Divers, Luis Rocha and Alan Wang both are trained divers, and alternated to avoid overexertion in any form. Further, all team members were notified whenever a diver was in the pool. Pool rules were always observed e.g.: no running around pool. Further with respect to safety, no sharp tools were ever used at the pool site. In addition, whenever at the pool site toolbox use was strictly enforced to ensure no unused tools, sharp or otherwise, remained outside to potentially cause injury. All technology was placed on a table to eliminate possible shock hazard, and all plugs were kept as far away from the water as possible or were on the table, even when not in use.

On the actual ROV itself many safety precautions were observed. Electrical tape was used liberally around all sharp edges, such as zip tie cuts, and hose clamps were always wrapped around with electrical tape to eliminate all possibility of injury. In addition shields were placed on the left and right side of the ROV to reduce the chance of injury caused by the motors even though the ROV was always powered down prior to removal from the water.

When handling the ROV certain safety procedures must be observed, such as the assurance that all team members are aware that the ROV is being used, and making sure that all motors and cameras are functional prior to placing it in the water.

Shared Safety Checklist

Concern:	Yes	No	Justification:
Are all sharp edges covered by electrical tape?			
Is all electrical equipment safely distanced away from the water?			
Are all team members aware of the operations about to be performed?			
Has all equipment been properly connected and is functional?			
Has all equipment been waterproofed such that it is not a potential hazard to anybody/thing?			
Has the ROV been inspected for any type of damage on the infrastructure that could potentially be a safety concern?			

What is the mission plan for the tasks about to be preformed?

Are there any concerns regarding today's Mission?

-
-
-
-

Notes:

Design Rationale

Altering the Design:

Our process began with the designing of an effective ROV. Last year, we had a similar design, a cube like structure with the motors inside. We found this to be the most effective primarily because it allows for a reasonable organization of the operations found on the ROV. We can easily attach parts to the cube, such as hose clamps, cable ties, and cameras. We knew from last year that PVC is the most viable option for our ROV because of its light weight, easy to cut and cheap. However unlike last year, the compression foam used to create a positively buoyant ROV was not a viable option. While it proved to be effective, it limited the versatility of our ROV, and tended to fall off creating potential dangers for the ROV itself. Therefore, we experimented with the buoyancy properties of air filled PVC. By taking a 2 in PVC tube and sealing it on both sides, we created an airtight container that would be easier to manage than compressed foam, in addition to having a much preferred cosmetic appearance. However the process behind balancing the PVC proved to be an issue, as unlike the compression foam we were unable to simply add or remove at will, but rather we had to cut the PVC if we needed to make changes, in addition to making sure that the buoyant force was equal on both sides of the ROV to avoid any tilt that may occur in the water. Altogether the change to using PVC as buoyancy was a good choice. While it involved a large amount of trial in error ultimately it proved to be successful.

Completing the Tasks:

The tasks changed dramatically from last year. This year we needed to be able to move many objects, which meant that we would have to become much more maneuverable. The PVC buoyancy device helped greatly with this. Further we removed one claw from our design, enabling the remaining claw to enter spaces much smaller, and in doing so we also increased our precision. Also, taking advantage of the fact that metal hooks were used on many of the tasks, we knew that if we utilized magnets in our design then we would be able to attach onto objects with ease, thereby bolstering our performance.

Camera Placement:

The placement of cameras proved to be a very important factor in improving our design, especially considering that the tasks required a large amount of precision and accuracy. One important decision we made was to add a third person camera, seen overhead on the ROV because it would ultimately allow for a much greater span of vision. Therefore, we could see not only the specific task we needed to attend to, but also where we could move to improve our performance. Further, certain cameras had specific functions, allowing for increased precision.

Electronics Overview

One important factor in the creation of the ROV was the ability to control and view the cameras; such falls into the electronics section. The ROV only has two digital viewpoints. We needed to make sure that they were optimally placed because they provide higher quality view that would be very helpful in performing our tasks. The remaining three cameras are all analog and have lower quality vision, so they are considered less reliable.

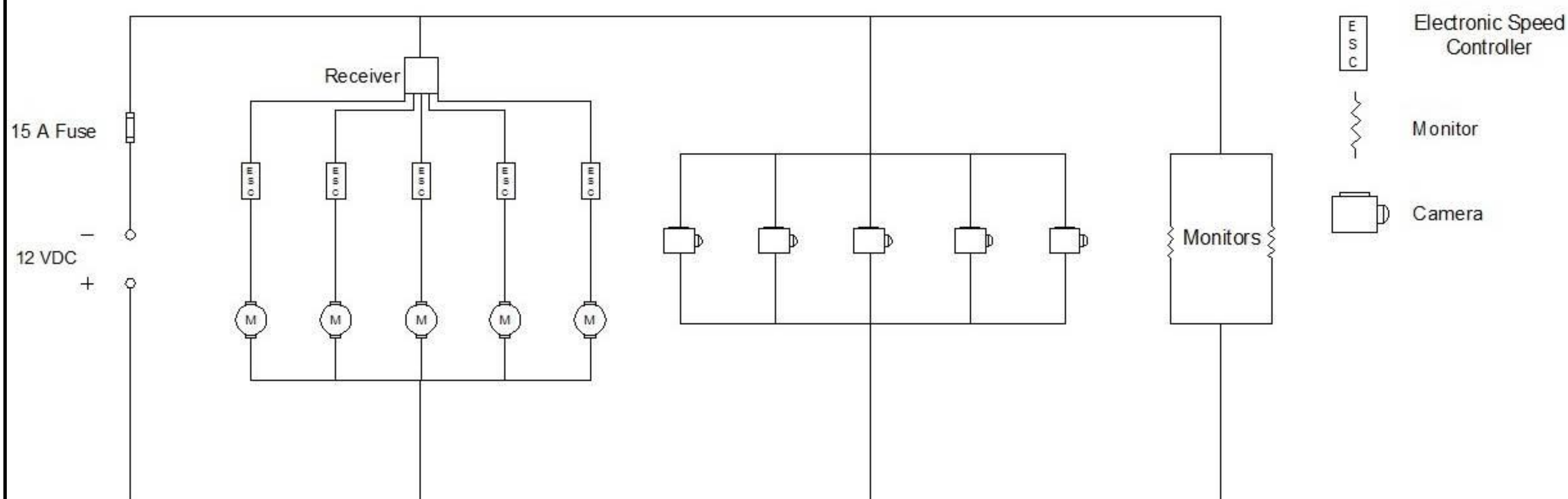
Control

For optimal control we used five waterproof motors; chosen largely in part because of their strength and ease of control. Four motors control vertical and horizontal movement and the fifth, also known as the crabbing motor, controls lateral movement. Our controller is a default airplane controller, programmed to adhere to our specific commands. However, one important factor to note is that our controls are actually inverted, meaning that the putting the controller up will actually bring the ROV down. This is a technical fault that while originally limited our performance quickly allowed for improved maneuverability.

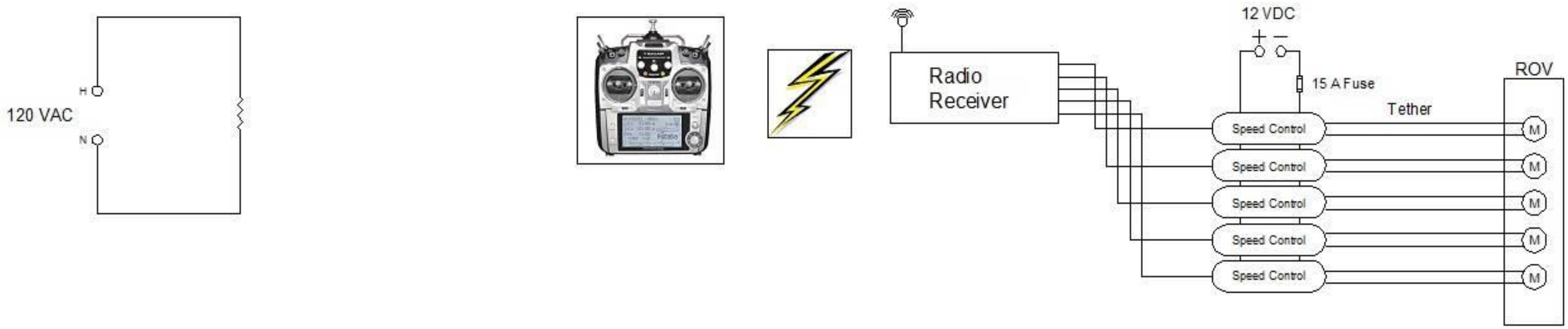
Vehicle Systems

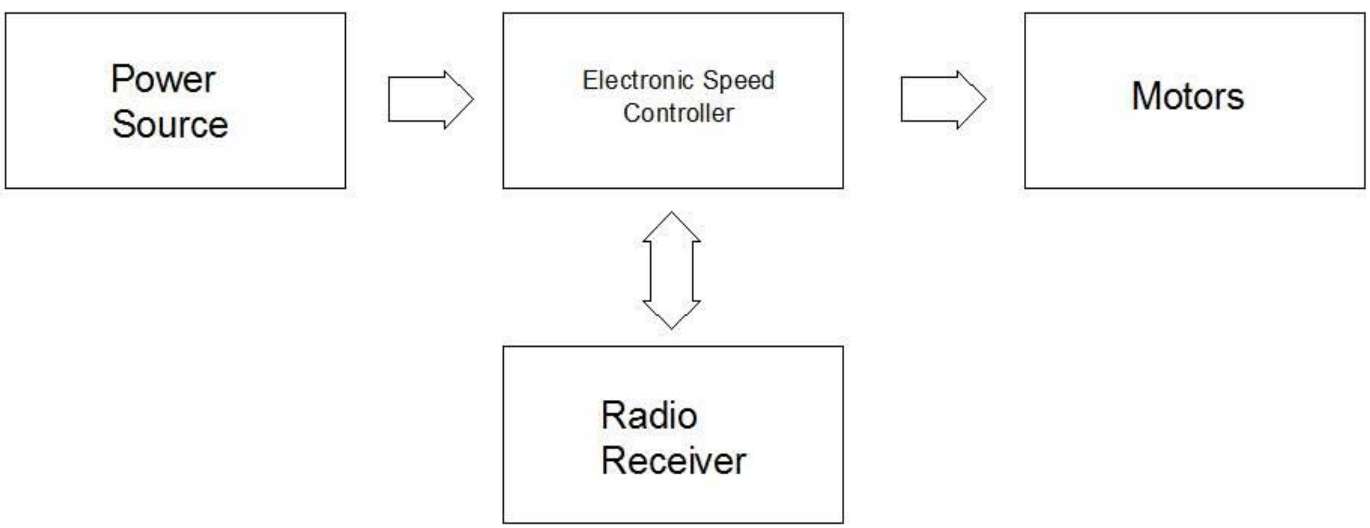
Most of the components were not commercially purchased, but rather made. The exceptions include the electrical equipment. Several components were reused from last year because it was cost effective. Attachments such as the claw, cameras, and motors were reused because they served the same purpose as last year.

Electrical Diagram



Software Flowchart





Payload Description

Metal Claw attachment: The claw was designed to increase precision and increase the adaptability of the ROV to any situation. The claw has a piston so when air is place into the chamber, the claw opens. Air is placed into the chamber by a standard air pump located outside of the pool. The claw was originally made from a standard aluminum trash collecting arm.

Tail Camera: This second picture denotes the third person camera view, which helps to give a full-scale view of the ROV and its location.

Magnet Attachment: The second payload tool includes a magnet hook attachment. The *I* shaped PVC object seen in the image is actually cut open on the top and is fitted with magnets to enhance the ability to pick up various metal objects with ease. On the upper left hand side of the picture, the waterproofed camera is seen, strategically positioned to assist with the full visual of the ROV.

Troubleshooting

When undergoing any type of problem concerning the ROV, our team had a specified set of rules that would be followed to outline the problem.

1. We would identify the nature of the problem
2. We had the most experienced members work on outlining the problem.
3. After identifying the problem, the party who outlined the problem consulted the rest of the group and together, a solution was proposed and carried out.

By following this set of troubleshooting techniques we managed to minimize the time taken to find the problem, and maximize the amount of time we could spend organizing and carrying out solutions to the problem.

A particular instance in which we applied these troubleshooting techniques is when our third-person view camera failed. Using the aforementioned steps, first we identified that the camera had a hardware problem and assigned our Engineering Specialist, Miguel, to work on the problem. Once he found the problem and consulted the group, we came up with plausible solutions and implemented the one best suited to the circumstances.

Challenges

Technical Challenges:

A technical challenge we faced involved the controller aspect of the ROV communication interface. The controller was initially programmed to control a model airplane, thus when we switched the output responses to the motors rather than the elevators on an airplane, we found the controls to be inverted. Therefore, controlling the ROV proved to be quite tricky because up meant down and right meant left. Because of this, our pilot had to adjust to many of the changes that were affected by the controller settings.

Non-Technical Challenges:

We had challenges finding days to go into our schools pool to test our ROV. There were days in which the swim team was using it so that meant that we could not go in it. Also, there were days in which the pool was being maintained and treated with chlorine which meant that we were not allowed anywhere near the pool. So basically the main construction of the ROV took place in a classroom during most of the week days. We were only able to test the ROV in the pool once or twice a week.

The Lesson We Learned

Our initial design involved the use of compression foam to account for the buoyancy of the ROV. This idea worked remarkably since we were able to trim the foam until the wanted buoyant force was reached. Later on, however, we decided to replace this form of flotation because we discovered that this method required a greater volume to provide the same buoyant force other methods could provide with less volume. We found air ballasts were an alternate method that performed very well. Because they were lighter, the air ballasts required a smaller volume to provide the same upward force as compression foam. This method was also convenient since it was built using materials we already had: PVC and glue. We used a few cylinders made from PVC and PVC caps to enclose air and prevent it from escaping or changing in internal pressure, which would cause a fluctuation in the buoyant force at various depths.

We learned many lessons throughout the creation of the ROV. For example, we learned early on that our initial design was not perfect and the overall success of the ROV would rely on the process of trial and error. This was especially the case when it came to components such as the buoyancy devices on the ROV, where we would have to adjust the buoyancy of our ROV every time we added a different attachment.

Future Improvements

Lack of funding took a lot of work to overcome. Traveling to Internationals was the toughest for us because we had to get everyone and Alvin 2 up to Washington. The time the team spent brainstorming ways to fundraise could have been spent designing and implementing new ideas. When we compete next year, we definitely need to do start fundraising earlier and frequently so we can acquire new and improved materials and so we can focus on building our ROV.

Reflections

Carlos Vergara: It was fun putting my knowledge to work and in the process, meeting great people.

Miguel Gonzalez: I have been in the ROV Competition for two years now and I can honestly say that this year has been the best year from the two. This year I had the pleasure of meeting a new group of people that were part of the ROV team. We spent many months working together allowing us to know each other very well. We were then able to use each other's strengths to set positions for each other. This allowed the ROV to be the best as it can be.

Luis Rocha: It has been a pleasure working with such an amazing team. I will never forget the time when I was under water and trapped under a weight used for one of the tasks.

Vanessa J. Reina: Working on the ROV has been a wonderful experience all around. I met a great group of people. They taught me how to enjoy the small things in life and to be thankful for what I have. I really enjoyed being able to spend the last few months with them working on this difficult but fun project!

Vance Howard: I used to be really shy but now I feel like I have been less shy towards my team and other people in the world. Also I have learned how to get along with people better.

Carlo Soldevilla: I am really grateful for having the opportunity to learn about the basic elements that affect not just the ROV underwater but the basic principles that affect any mass underwater. Above all that, I am really thankful to know and work with these people and to be able to have fun with them all day, everyday.

Allen Glover: I was pleased to see how the students overcame the difficulties they encountered. Their enthusiasm and determination made me very pleased and delighted to provide the opportunity for them to show their talent.

Alan Wang: I that the most exciting part of this whole project was learning about buoyancy and how it is affected at larger depths. This gave me experience for my future career by allowing me to work with different people that have different ways of thinking.

Caitlin Sau: Building the ROV was a great opportunity for me to learn even more about Physics and put my skills, along with everyone else's' to the test. The most rewarding part about participating in the competition was getting to know my team mates who are now my closest friends and mean the world to me.

Matthew Calcanas: The ROV experience was one that I will never forget. The experience of working with a team such as this one was very memorable. I learned a great deal about science teamwork. I can happily say that I look forward to participating in the ROV challenge next year.

Aubrey Yuen: This experience taught me a lot about the engineering designing process. I enjoyed it and look forward to using what I learned this year in next year's ROV competition to expand and build a more efficient and effective ROV.

Acknowledgements

Alvin 2 would like to thank the many people who supported us, through moral and economic means. We appreciate all of our supporters that are here today. We would like to thank Allen Glover for being our outstanding mentor throughout this project and we wish to work with him again. He has provided us with insight into how to test run Alvin 2 and he contributed many materials we needed. We cannot thank last year's Lakewood ROV team enough, who passed to us their knowledge and frame of the ROV that we expanded and improved on. From last year, we would like to acknowledge Ronald Hebert for allowing us to use his equipment to build the claw. Although the claw was built last year it still survives as a vital part of our ROV. During our previous year, Scott Fraser also helped us by providing initial materials and advice on waterproofing, and we would like to thank him as well. Another thanks goes out to Tyrone Black for being a supportive friend and bringing us all together as a group. Tyrone not only brought us together as a team, but helped our friendship blossom from nothing to something beautiful. Our company thanks Lakewood High's custodian for staying late on school days to ensure us that we would not be locked in or out of the school while we worked on our ROV. We would like to acknowledge Lakewood High School for allowing us to use the school pool when it was available. Our final thank you goes out to our dear friends and family for supporting us throughout these few months. Without them, none of this would have been possible.