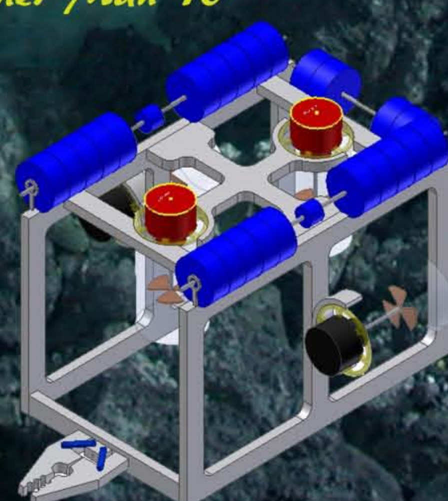
Nimitz High School Robotics

ROV: Ichiban

Gary Rodgers- Mentor/Sponsor

Alfredo Castillo- Team Captain 10'
Raymundo Berlanga- Primary Driver 11'
Eddie Gil- Secondary Driver 10'
Heather Klein- Launcher/Retriever 10'
Jose Perez- Tether Man 10'

CHESTER W. NIMITZ SENIOR HIGH SCHOOL



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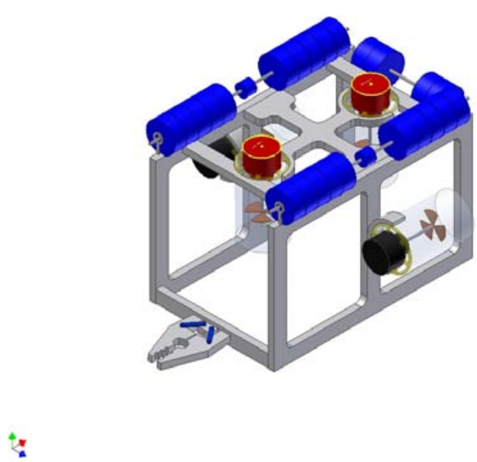
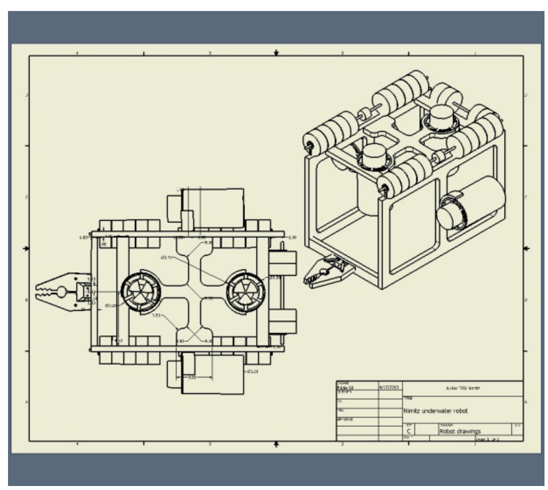
Abstract

Team Ichiban from Chester W. Nimitz High School constructed a ROV capable of competing in the 2010 Marine Advanced Technology Education (MATE) competition. This is the eighth year competing and we had three main goals in mind: First, to use arcade joy sticks, second, to have a fully functional robot by November, and last to compete in the MATE international competition. The robot we have created this year is by far our smallest, most advanced design. The construction of our robot consists of months of rigorous work, careful planning, trial and error, and continuous practice. Our materials were all under $500.00. In order to make sizable headway into the assembly, we opted to design and build a frame that we could adapt to any conditions that the competition set forth. Our second generation ROV is constructed out of Ultra High Molecular Weight Polyethylene. We added four motors of different strength that provide the ROV with vertical and horizontal movement to easily maneuver the ROV. Four appendages were constructed and placed on the ROV to successfully complete the predetermined missions. With the help of the special modifications and the ROV's able bodied team members Nimitz Team 1 will achieve all of its goals.



The second generation ROV



Assembly drawing of our ROV.

The Team

We are a group of ten members that have combined our expertise to contribute in the making of our ROV.

Alfredo Castillo Grade 12

On his fourth year in the MATE competition, Team Captain Alfredo is an expert in problem solving. He not only completely changed our ROV, but has been here to see the transformation. He will attend Texas A&M to pursue a degree in mechanical engineering.

Raymundo Berlanga Grade 11

The backbone of the team, Raymundo makes sure that the job will get done. He is known as the team pack rat, but if he can't find it he will make it. He is an essential team member and will make a great team captain next year.

Heather Klein Grade 12

An expert in technical writing, Heather Klein has put together an excellent report. Although this is her first year joining the Nimitz Robotics, she will be missed. She will attend the University of Texas to pursue a degree in biomedical engineering.

Eddie Gill Grade 12

No one can tell that Eddie is a first year member of Nimitz Robotics. Being introduced to Autodesk Inventor and Gibbs Cam just this year, he has shown great skill in machining parts essential to our team. Eddie will pursue a degree in computer engineering at the University of Houston.

Jose Perez Grade 12

Jose is a hard worker who has yet to miss practice. Not only does he show excellent work in Underwater Robotics, but he is skilled in AutoTech. This second year member plans on attending University of Houston next fall to pursue a degree in Mechanical Engineering.

Team 1 ROV

Frame Design

Before the year started, we opted to build our ROV frame with a material that would put us at an advantage with its durability and flexibility. We used a strong material with low coefficient of friction that is easy to machine. Ultra High Molecular Polyethylene (UHMW) is our most noticeable change from the ROV we presented last year; we got the idea from Texas State Technical College in Waco, Texas, who used this same material to build their ROVs in their SubSea Robotics Training Center. Unlike PVC, which we used last year, UHMW has positive buoyancy. The frame was designed in Autodesk Inventor. We used a wooden template to cut the UHMW with a collet placed on a router that had a 6 mm mortising bit. We attached the pieces of our frame together with 4 cm screws. After drilling the holes for the screws, a countersink was made to keep the screw head flush with the frame. Our frame also includes our motor mounts to hold all four motors. Also, our robot had to be able to attach and detach appendages to the frame without dismantling the entire structure.

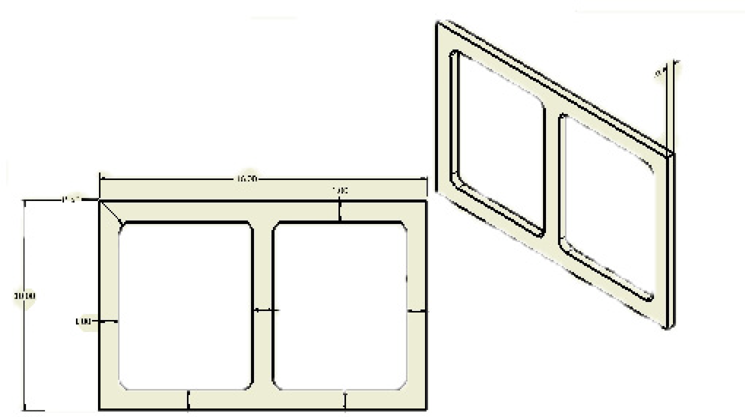
Measurements:

Thickness- 1.27 cm

Length- 40.64 cm

Height- 25.4 cm

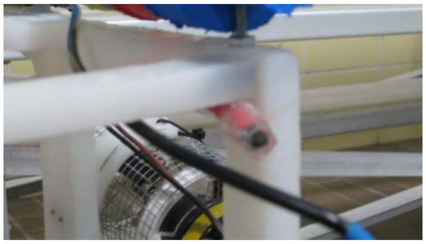
Width- 25.4 cm



The frame

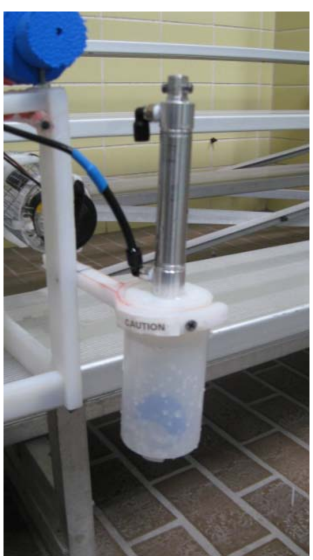
Appendages

Hydrophone: To complete one of our missions, an underwater microphone was needed. We waterproofed with hot glue and a piece of CD plastic it to function underwater. It connects to our audio and comes out of our speakers in order to hear the sound that needs to be located.

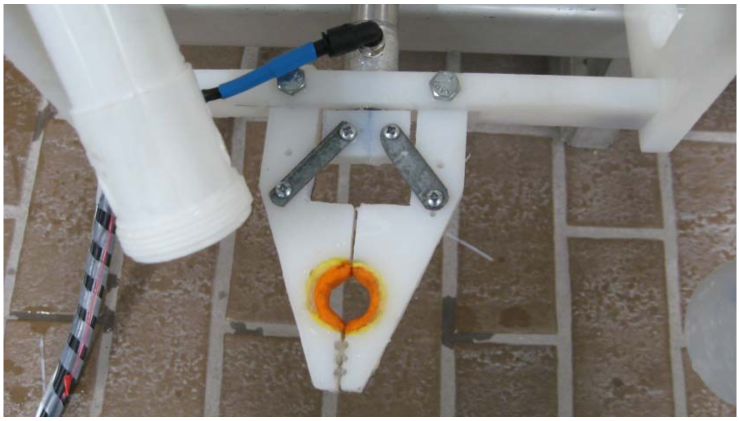


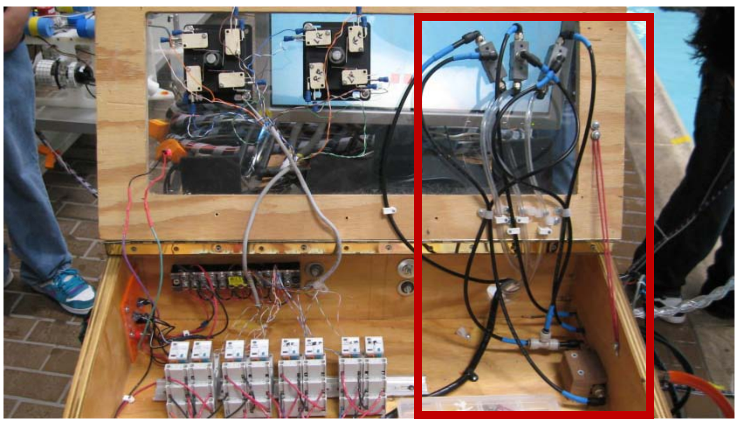
Temperature probe: This takes temperature underwater with the help of the CBL2 and a TI-84 calculator. It is placed inside a PVC drain pipe to make it easier to get the probe in the designated areas at different heights.

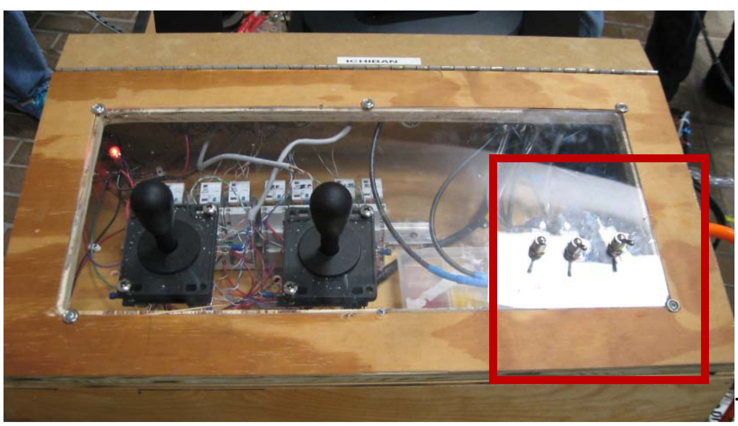
Agar Vacuum: Machined from UHMW plastic, the vacuum is used to retrieve a sample of agar for a mission. It is made out of a squeeze bottle, a dual action piston, UHMW, and a check valve. The check valve is to keep the sample of agar from leaking out which is just a simple marble.



Jaw: Drawn in Autodesk Inventor and machined. It runs with a dual action piston and our pneumatics system which makes the jaw open and close. They are needed for many of our missions. They help to pick up and move any object necessary.

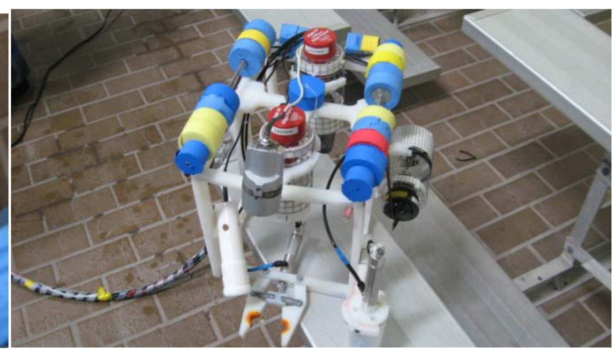

The Jaws


Inside the Control Box. Pneumatics


Toggle Switches

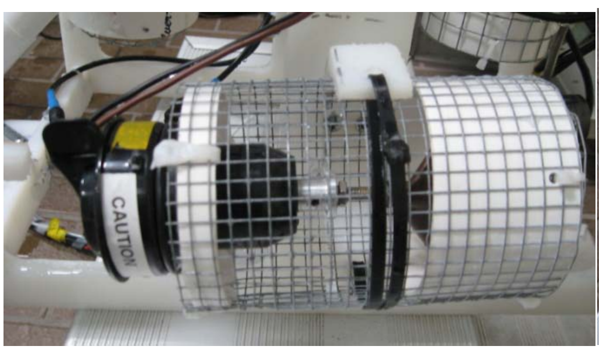
Propulsion System

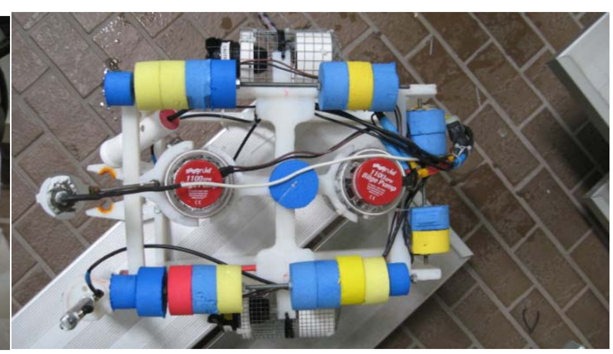
The propulsion system consists of four bilge pumps (motors), two vertical at 1,100 gallons per hour located in the middle of the ROV and two horizontal at 500 gph placed on the arms on the left and right side of the ROV. For this year's housing, we started off designing pods that we could create in Autodesk inventor to which we could build prototypes and test. After a couple of days of designing housings, Alfredo discovered that the greatest amount of intake that the motors had, the greater trust they would put out. So to receive the greatest intake, the smallest amount of housing should be used. He designed a collar to place around the propeller end to channel the output. To keep the motors in place with the polyvinyl chloride (PVC) collar, a motor mount was designed out of Plexiglas which was machined using an Expert Mill. Holes were cut in the mount to provide the propeller with a greater amount of intake area. While designing each pod, we came to a conclusion that the largest intake area would give us the greatest amount of thrust. For this reason we opted to not create a pod, but in order to channel the water in one direction without overspill, we placed a three inch PVC collar over the propeller. This decision cut the building time for the housing significantly. To hold everything together, chicken wire was placed around the housing for safety.



Vertical Motors

Isometric view





Horizontal Motors

Top View

Buoyancy

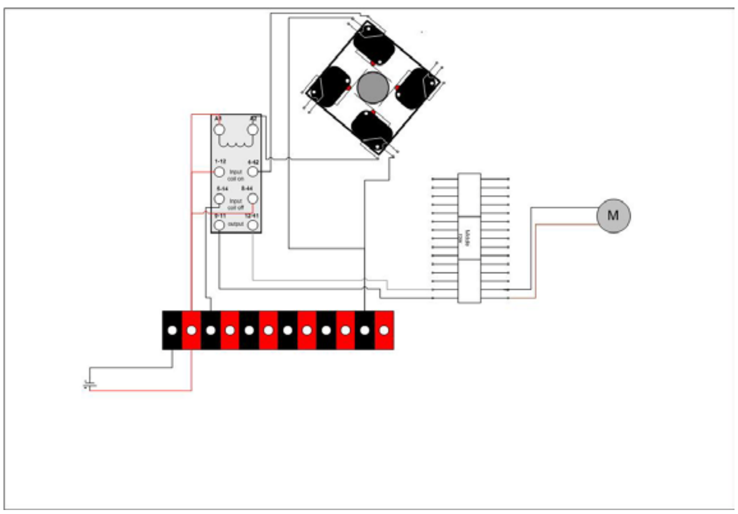
To keep our ROV upright, we cut doughnuts made of kickboard and placed them above the center of gravity. Even though we decided to move away from last year's design, we continued to use kickboard, knowing the advantages that it would bring. The kickboard does not compress with water pressure. It also is relatively cheap and easily pliable. With the specific placements of the doughnuts, the ROV is able to maneuver smoothly. The doughnuts are mounted on the top side of the ROV using fisheye bolts, all thread, and locknuts. The doughnuts vary in size so the buoyancy can be easily adjusted.

Jose Perez adjusting the ROVs Buoyancy.

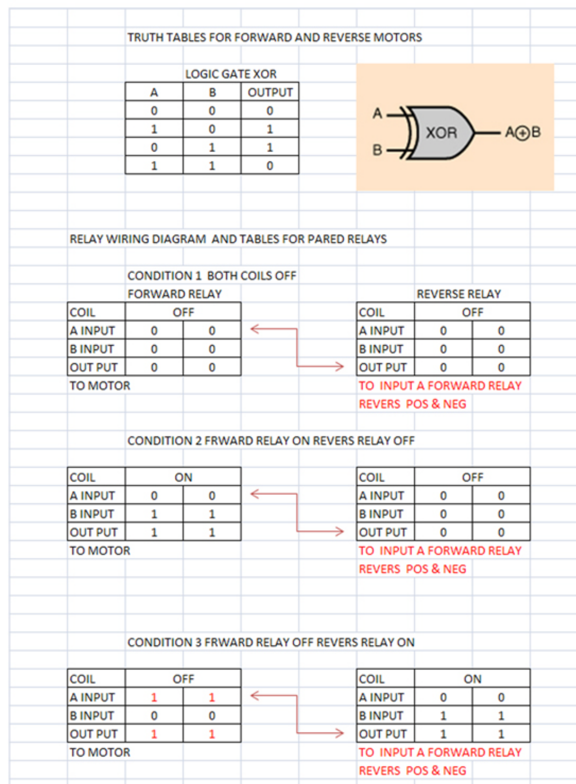
Control Box

Our most important goal for this year was to stray away from using toggle switches to control our ROV. To do so we opted to use 8-way Arcade Joysticks. After some research we discovered that the use of relays would be necessary to complete our goal. Relays, joysticks and power buses make up our control box.

With the use of carpentering skills we built our basic control box frame with a hinge to provide ease of access to the guts of the electrical system. Both joysticks were installed on the topside of the control box to allow the driver easy maneuverability. More than just one setup can be used to operate the ROV but we opted to run each horizontal motor on separate joysticks. After Raymundo's father threw in this idea we decided to stick with it because its setup had a more natural feeling to it.



Relay, Joystick, power busses, motor electrical drawing



TRUTH TABLES FOR FORWARD AND REVERSE MOTORS

LOGIC GATE XOR

A	B	OUTPUT
0	0	0
1	0	1
0	1	1
1	1	0

RELAY WIRING DIAGRAM AND TABLES FOR PARED RELAYS

CONDITION 1 BOTH COILS OFF

FORWARD RELAY

COIL	OFF	
A INPUT	0	0
B INPUT	0	0
OUT PUT	0	0

TO MOTOR

REVERSE RELAY

COIL	OFF	
A INPUT	0	0
B INPUT	0	0
OUT PUT	0	0

TO INPUT A FORWARD RELAY
REVERS POS & NEG

CONDITION 2 FRWARD RELAY ON REVERS RELAY OFF

COIL	ON	
A INPUT	0	0
B INPUT	1	1
OUT PUT	1	1

TO MOTOR

COIL	OFF	
A INPUT	0	0
B INPUT	0	0
OUT PUT	0	0

TO INPUT A FORWARD RELAY
REVERS POS & NEG

CONDITION 3 FRWARD RELAY OFF REVERS RELAY ON

COIL	OFF	
A INPUT	1	1
B INPUT	0	0
OUT PUT	1	1

TO MOTOR

COIL	ON	
A INPUT	0	0
B INPUT	1	1
OUT PUT	1	1

TO INPUT A FORWARD RELAY
REVERS POS & NEG

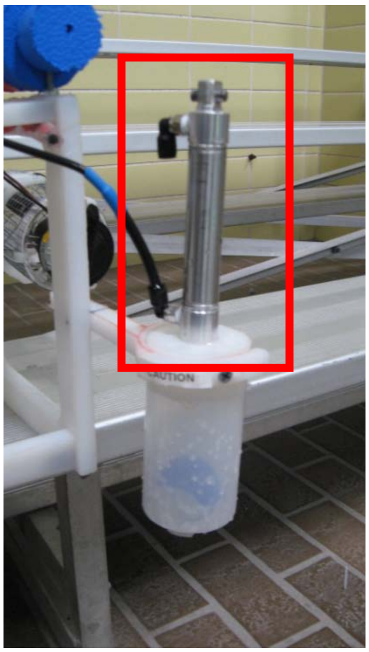
Truth tables of how the relays and motors work.

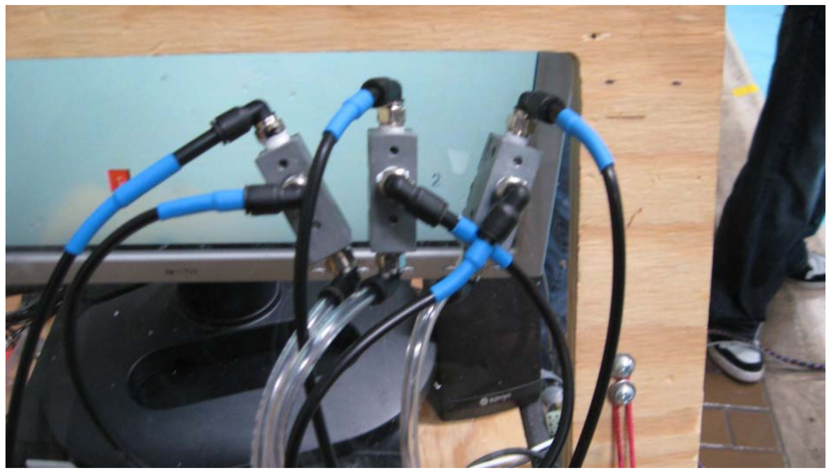
Drivers controlling the ROV.

Pneumatics

The use of unlimited air in the MATE competition helped us to realize the value it has in completing the competition. This resource became useful in multiple ways, from running air pistons, lifting heaving objects, or simply completing the missions faster for bonus points.

We have a 1.9 liter air tank that is rated for 150 PSI but regulated to a max of 20 PSI. This is all that is needed to run our appendages. We used 3-way toggle switches that have an input, output, and a vent. The toggle switches are mounted on the control box and have 150 PSI hose running through the tether to the ROV. The air fittings allow us to connect our pneumatics system very quickly and efficiently.





Air Lines connected to the toggle switches. The clear hoses provide the vents and the black provide the air pressure.

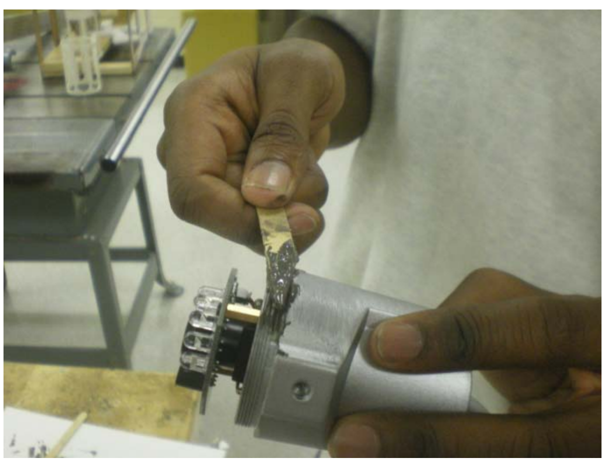
Dual action Piston.

Challenges

Our motto is if we can't find it we will make it. A huge majority of parts are made using the CNC machine and this year it broke down on us a little before mid year. We had to overcome this challenge and create our parts using the band saw. This didn't slow us down but did increase the chance of human error is our ROV.

Cameras

One of the biggest problems that had to be solved was to waterproof our cameras, and find a way to be able to see in the dark. Our dark problem was solved really simple by just buying security, inferred, cameras. Our water problem took a little more thinking because we had to find were the water could get inside the camera. So we waterproofed our camera the best we could with JB Weld in every possible gap. It appeared to be perfectly waterproofed, but water still got in the camera. The camera was already damaged so we decided to drill holes on the side of the camera and pass compressed air through those holes. This made any water that got inside the camera, to come out through any other gap that the water would go through. The problem was in a Y that had some tiny holes were the water leaked into the camera. Our most simple solution was to just see how the camera's wires were connected inside the Y to make the camera function. Then just by taking off the Y, soldering the wires back together, and using heat shrink to water proof the wires, our camera was water proofed and ready to go.



Using JB Weld to seal the camera.

The finished and sealed camera, it still includes the Y that later had to be removed. This camera ended up breaking because of the Y.

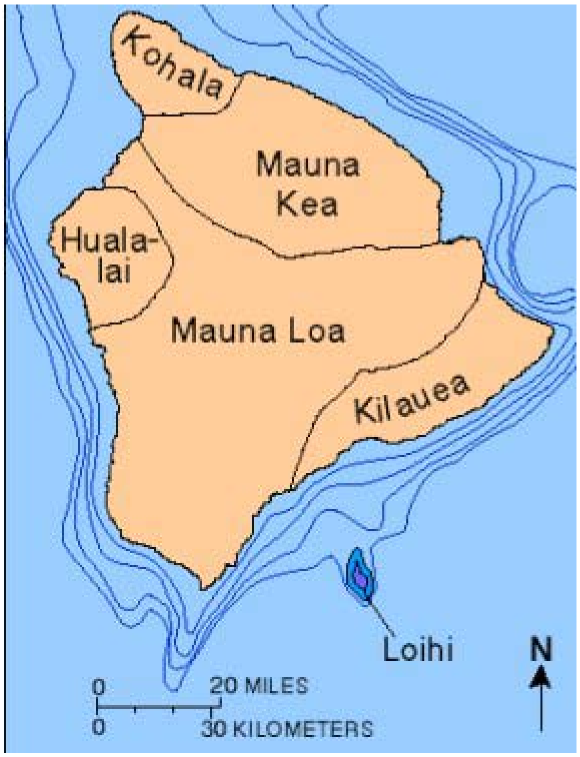
Troubleshooting

The most important troubleshooting technique that we have it in our control box is the use of idiot lights. We purchased these relays in order to know what relay was on and working. We also made sure that the plexi glass was clear in order to always know if our control box was working. With our expertise in problem solving we were able to accomplish all of the missions assigned in more than one way, this has been by far the best way to troubleshoot, just getting it right the first time. The reason we accomplished this was because our team likes to follow one main rule, K.I.S.S., as long as it gets the job done well we will stick with it no matter how goofy, cheap, or even ridiculously simple.

Loihi Seamount Volcano

“Hawaii is one of the places where volcanism occurs away from a plate boundary. This is because of two reasons. Firstly, Hawai'i is situated at a point where the crust thins to about 5 km; secondly, beneath the Hawaiian island is a rising plume known as a hotspot. Although most textbooks theorize that these hotspots remain fixed in position, there is evidence that the Hawaiian hotspot has moved slightly.” (Valkaner)

LOIHI



Location 18.92 N 155.27 W
Elev. Below Sea Level 969 m
Loihi is Hawaii’s latest active submarine volcano, and its most notable eruption was in 1996.

Courtesy of www.vulkaner.no

Budget Sheet

Donated	**Recycled**	**Expenses**	**Total**
UHMW	2- 500 GPH pumps	2 cameras	207. 89
2- 1100 GPH pumps	3 ft_2 Plexiglas	Recorder	45.22
Monitor	Spiral wrap	(10) 50 ft. 18 gauge wire	45.03
3 Kick Boards	3 inch PVC	2 Mollusks connecter	3.99
plywood	3 toggle switches	2 joy sticks	21.52
Power surge	1 Camera	8 relays	37.33
nuts	Fuse holder	solder	5.99
washers	12 volt battery	I squeeze bottle	.99
Self taping screws		Air hoses	26.55
Air tank		microphone	7.89
CBL 2		Temp. probe	18.22
TI- 84 plus		Heat shrink	18.47
Speakers			
Total			$439.09

Acknowledgements

Nicolette Berrios:

Mrs. Berrios was a supporter of our team and the loving mother of Davonnas Berrios, a member of Nimitz's Robotics. We would like to thank her for her encouragement in this competition. She will be greatly missed.

Gary Rodgers

Oma Cummings

Archer Daniel Midland

Greg Gonzalvez

The Castillo Family

The Berlanga Family

Michael Johnson

Albert Nick

Mike Tulsan

Brian Vestal

Lights, Camera, Action Inc.

Texas State Technical College

SubSea Robotics Training Center

Alex Jordan

Nimitz Senior High School

Aldine Independent School District

MATE

Neutral Buoyancy Laboratory

Marine Technology Society - Houston Chapter

Technip

Humble CATE Center

VideoRay

Houston Police Department

Jill Zande

NASA