# *`Io o Lalo Kai Loihi*
## *Undersea Volcano Hawk*

# Kealakehe Intermediate School ROV Team

**74-5062 Onipa'a St. Kailua-Kona, HI 96740 USA**


## Team Members:

**Quinlan Tanaka (11), Nikolette Argyris (11),**
**Amy Lowe (12), Philip Moffatt (12), Tristan Ross (12),**
**Kahanu Loy-Rivera (13)James Fisher (13), Aricia Argyris (13)**

## Mentors:

**Lisa Diaz, Michael Hauck, Andrew, Terry & Ileana Argyris, Guin Davenport**

# TABLE OF CONTENTS:

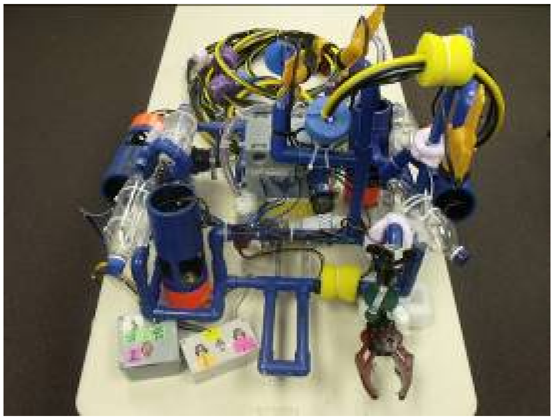

| | |
|---|---|
| Team Spec Sheet | Page 3 |
| Abstract | Page 4 |
| Photo of ROV | Page 5 |
| Mechanical Drawing of Temperature Probe Subsystem | Page 13 |
| Budget & Expenses | Page 5 |
| Electrical Schematic | Page 6 |
| Design Rationale & Safety | Page 7 |
| ROV Systems: | Pages 8-10: |
| Structure & Sensor System | Page 8 |
| Propulsion System & Thrust | Page 9 |
| Ballast System & Electrical Control System | Page 10 |
| Challenges & Troubleshooting | Page 11 |
| Mission Payload Tools | Pages 12-13 |
| Mechanical Drawing of Temperature Probe Subsystem | Page 13 |
| Future Improvements & Lessons Learned | Page 14 |
| Loihi Seamount | Pages 15-19 |
| Reflections & Teamwork | Page 19 |
| References | Page 20 |
| Acknowledgements | Page 20 |

## TEAM SPEC SHEET:

**School & Team Name: Kealakehe Intermediate School ROV Team (returning team)**

**Home Town & State: Kailua-Kona, Hawaii**

**Distance travelled to MATE Competition at UH-Hilo: 306 Km round-trip**



**`Io o Lalo Kai Loihi ROV**

**Kealakehe Intermediate School ROV Team**

**New Team Members:**

**Co- Captain: Tristan Ross** (13 yrs., Gr. 7), **Co-Captain: Nikolette Argyris** (11 yrs., Gr. 6)**,**
**Pilots: Quinlan Tanaka** (11 yrs., Gr. 6)**, James Fisher** (13 yrs. Gr. 7),
**Deck Crew: Aricia Argyris** (13 yrs., Gr. 8), **Philip Moffatt** (12 yrs. Gr. 7), **Amy Lowe** (12yrs., Gr. 7)

## ROV SPECS:

**ROV Name:** ***`Io o Lalo Kai Loihi*** ***(Undersea Volcano Hawk)***

**Total Cost: $1848.13 less $1605.00 in donated & reused items = $243.13 out of pocket 2010**

**Primary Construction Materials: PVC**

**Dimensions: 63 cm long, 52 cm wide and 45 cm high**

**Total Weight: 6 kilograms**

**Safety Features:** 4 custom motor safety housings with caution tape; 25 amp fuse & 2 heavy-duty banana plugs wired into a tether safety harness plug into a safety power with 2 heavy duty battery contact clamps; four 3amp fuses for cameras wired into banana plug harness.

**Special Features: 6 customized tools to carry out 2010 MATE Missions at Loihi-**
#1: Multi Grabber claw, #2: Lifter, #3: Crustacean Sweeper & Net
#4: Bacteria Vacuum, #5: U/W ears microphones, #6: Temp. Probe & Docker

**Tether:** 15 meter SOSI (Sound Ocean Systems International) Category 5 cable with 8 conductors.

**Depth:** `Io o Lalo Kai Loihi can dive up to 8 meters

## ABSTRACT:

'Io O Lalo Kai Loihi was designed by a team of 8 intermediate school students. In preparation for the 2010 MATE missions, we interviewed the 2009 team, reviewed previous ROV designs and examined competitors and commercial ROV designs. We designed six tools around the 2010 MATE missions: a multi purpose grabber claw, an HRH Lifting tool, a crustacean sweeper with net, a bacteria vacuum, two underwater microphones, and a temperature probe with a docker. The frame is made of PVC (polyvinyl chloride) with the dimensions of 63cm long, 45cm high, 52cm wide, weighing 6 kg. The ROV is able to safely dive to 8 meters. The ROV tether is 15 meters long with 16 conductors. The propulsion is operated by 3 heavy duty SPST center off switches through 6 conductors to 4 bilge cartridge thrusters via relays in custom safety housings. The tools are operated by 3 SPST switches through 6 conductors to 6 DPDT relays to 3 bilge pump cartridge motors used as custom waterproof tool actuators. The ROV uses 4 underwater rated cameras to monitor the tools and navigation. Four recycled plastic bottles are used for adjustable ballast to fine tune the ROV to neutral buoyancy and prevent list. The ROV's maximum draw is 20.87 amps. All thrusters and tool motors are protected by a 25 amp main fuse with the cameras protected by their own three amp fuses for additional safety.

***`Io o Lalo Kai Loihi (Undersea Volcano Hawk)***

**Ready for mission testing.**

## 2010 KEALAKEHE INTERMEDIATE SCHOOL ROV BUDGET & EXPENSES:

| Items: | Category: | Amount: |
|---|---|---|
| **NEW PARTS:** PVC pipe, T's, elbows, end-caps, couplers, zip-ties, | **Frame** | **61.34** |
| PVC, T's, elbows, couplers, wire, screws, zip-ties, hose clamps, all-threads, VEXplorer claw, surgical & aquarium tubing | **Mission Tools** | **85.48** |
| Toggle switches, relays, wire, cable, solder, shrink wrap, electrical tape, control boxes, banana plugs, 5 & 7 screw propellers, 4 Johnson pump 4732 LPH bilge motors, shipping on SOSI cable, 1 Rule 1363 LPH (360 GPH) marine bilge pump | **Electrical & Propulsion** | **1189.88** |
| Lights Camera Action High U/W camera | **Sensors** | **300.00** |
| $H_2O$ bottles, pool noodles, tie-wraps | **Ballast System** | **10.79** |
| **NEW '10 ROV PARTS EXPENSES** | **SUBTOTAL** | **$1647.49** |
| PVC, ABS, elbows, couplers, caps, epoxy, grub lures bolts, screws, zip ties, plastic netting, milk crates, tarp, plexi-glass | **Mission Prop Supplies** | **102.93** |
| PVC saw, pliers, drill bits, pipe cutters, sand paper**,** PVC glue, silicon | **Tools & Supplies** | **97.71** |
| **TOTAL '10 NEW ROV PROJECT EXPENSES:** | | **$1848.13** |

| DONATED ITEMS: | DONORS /GRANTORS: | |
|---|---|---|
| **Funding for parts** | **AFCEA Grant** | **500.00** |
| **Propulsion Motors:** 2-1893 LPH (500 GPH) bilge motors | **ROC BIRR KIT** | **60.00** |
| **Sensors: 2 u/w Lamensco cameras** | **ROC BIRR Grant** | **200.00** |
| **Mission tools: Jabsco Par-Max 3 pump** | **ITT/Jabsco** | **180.00** |
| **SOSI ROV Cable** | **SOSI** | **170.00** |
| **'10 DONATIONS & GRANTS TOTAL:** | **SUBTOTAL** | **$1110.00** |

| RE-USED ITEMS FROM '08-09 ROV PROJECTS: | Category: | Estimate: |
|---|---|---|
| Temperature Probe & Data Logger ('08), 4 Lamensco cameras | Sensors | ~300.00 |
| PVC pipe from '08 Lava trough prop, '08 Hydrothermal Vent | Mission Props | ~65.00 |
| 12 volt Marine Battery | Power/Electrical | ~30.00 |
| Tool box & basic tools | Larry Rice '06 Grant | ~100.00 |
| **TOTAL RE-USED ITEMS** | **SUBTOTAL** | **~$495.00** |

**TOTAL GRANTED & RE-USED PARTS, EQUIPMENT & PROPS: $1605.00**

**TOTAL COST TO BUILD '10 ROV: New parts** ($1848.13) **LESS** granted & re-used parts ($1605.00) **$243.13**

**STUDENT HOURS:**

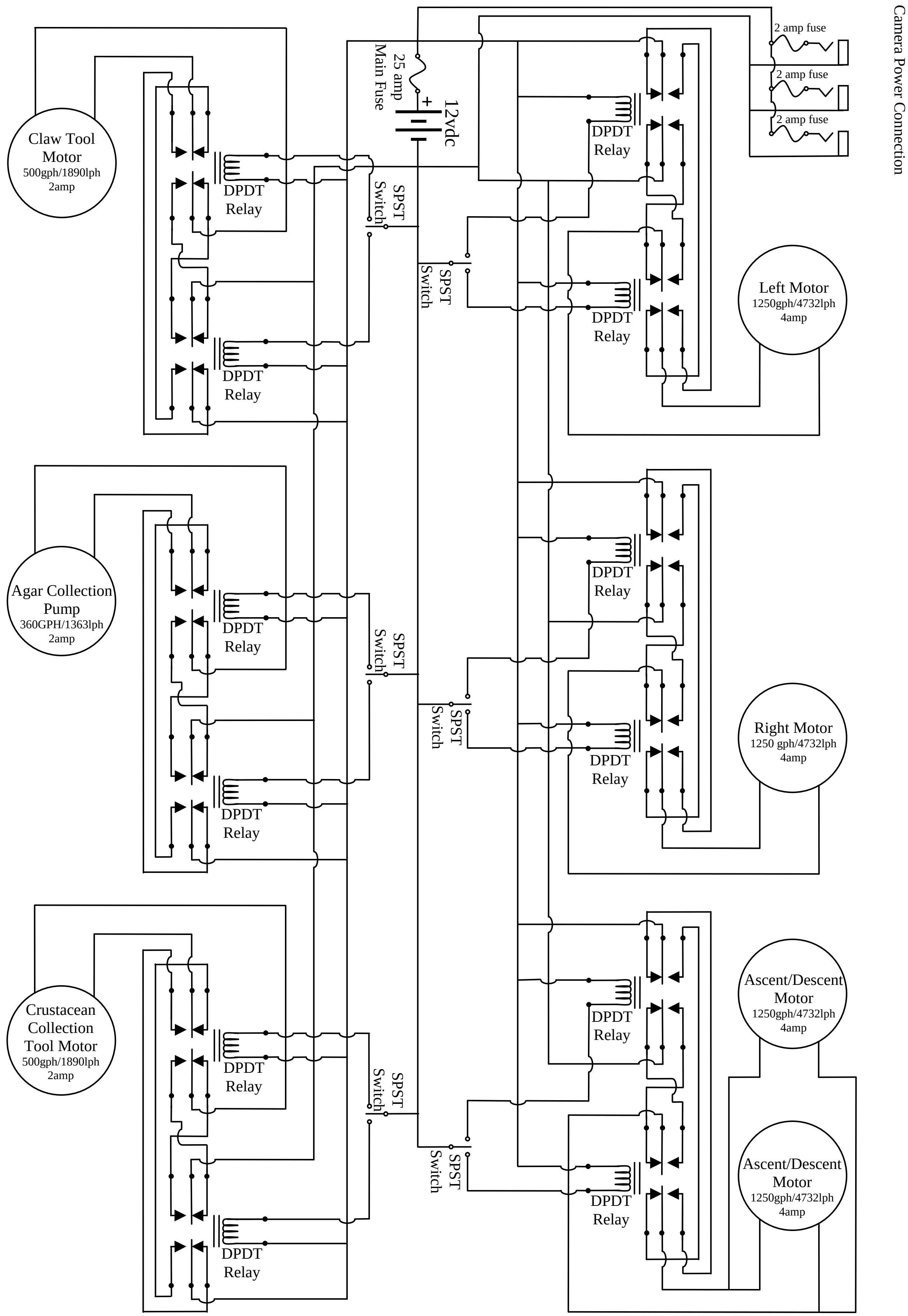
| | | |
|---|---|---|
| **TOTAL ESTIMATED STUDENT (8 STUDENTS) DESIGN/CONSTRUCTION** | **HRS:** | **400** |
| **TOTAL ESTIMATED STUDENT (8 STUDENTS) RESEARCH/TECH REPORT/DISPLAY** | **HRS:** | **80** |
| **TOTAL ESTIMATED STUDENT (6 STUDENTS) POOL PRACTICE HOURS:** | | **190** |
| | **TOTAL STUDENT HOURS:** | **670** |

**ADULT HOURS:**

| | |
|---|---|
| **TOTAL ESTIMATED MENTOR (2) /PARENT (2) (Safety supervision) HOURS:** | **200** |
| **TOTAL ESTIMATED TEACHER (1) (Shopping, supervising) HOURS:** | **200** |
| **TOTAL ESTIMATED ADULT HOURS:** | **400** |

# ELECTRICAL SCHEMATIC





## DESIGN RATIONALE:

We designed an original, safe, efficient, and low maintenance ROV to quickly complete all missions. We built our ROV frame around the tools required to safely accomplish the 2010 Loihi tasks. To accomplish our timeline, we used a step by step design process, scheduling tasks by priority and breaking into design and construction teams for the frame, tools, electrical and ballast systems. We designed custom motor safety housings to improve water flow and upgraded our motors and propellers to improve speed. We chose 7 screw propellers for ascent/descent motors and 5 screw propellers for forward/reverse motors to achieve better thrust. We added relay switches to reduce tether size and weight, and a high resolution, wide angle camera to improve navigation. Our tools and relay switch box are innovative, original designs. Our claw grabber is a multi-task tool for 5 tasks which is modified from a VEX robotics part that costs only $28.00. We were able to re-use 3 cameras, 2 motors and many PVC parts, plus employ recycled plastic bottles for our ballast system to save on cost. We chose a hardware only electrical system to actuate tools for simplicity, and low cost. We used Hobo-ware brand programmed software to record temperature readings with a Data Logger.

## SAFETY:

Our team is focused on safety. We wear safety goggles and closed toed shoes during all our workshops and practices. We developed a 10 point safety checklist for operating our ROV and have clear communication between the control shack pilots and deck crew. We verify all ROV switches are off before connecting power. Pilots give specific orders to the deck crew, who report back with operational status on motor and tool checks, before launching. Pilots are careful to communicate to the deck crew before power and motors are switched on to avoid injury. Our control switch boxes are clearly labeled. We waterproofed our electrical system with liquid tape and shrink-wraps, to ensure safe, reliable, electrical controls. We installed a 25 amp fuse in our tether harness plus 2 heavy-duty banana plugs connecting via a power safety box with 2 heavy duty battery clamps to safely contact the 12 volt marine battery. Our 4 cameras are wired into the banana plug harness with four 3 amp fuses, to safely enable powering the cameras via a 12V marine battery. Our propellers are shielded in custom motor safety housings to prevent injury and entanglement. All motor housings are clearly labeled with orange caution tape.

# ROV VEHICLE SYSTEMS:

## STRUCTURE:

Our frame measures 63 cm long, 52 cm wide and 43 cm high. We designed the PVC frame around the MATE competition mission tasks and created the tools needed to carry out the mission to Loihi.

## SENSOR SYSTEM:

We have 1 high resolution Lights Camera Action Model 7705-CW-23 camera, plus 3 Lammensco # C420 u/w security cameras on our ROV:

Camera #1 (High Res. Lights Camera Action) is at the front for wide angle viewing for navigation and front tool operation. Camera #2 is also positioned at the front to view the claw and the bacteria vacuum tool. Camera #3 is a bird's eye view camera for the crustacean sweeper and the bacteria collection bottle. Camera #4 is used for navigation and viewing rear tool operation.

The Lights Camera Action Camera # 1 is depth rated to 66 meters (200 ft.) and uses 12 volts DC at a maximum of a .33amp (300 mA) draw and has a net weight .49 kg (~1lb).

It transmits 380,000 pixels and has 6 white LED lights. Its field of vision is 92 degrees in air- 54 degrees diagonal in water. Each Lamensco camera (#2, #3 & #4) is depth rated to 18 meters and has standard RCA output, 20-meter tethers and white LED lights. The Lamensco cameras use 12 volts DC at a maximum of a 3 amp draw and have a net weight of 1.3 kg each. All cameras have a 3 amp fuse and are wired into our tether after the 25 amp main fuse for additional protection.

Tool #5, the Underwater Ears (waterproof microphones) and Tool #6, the Temperature Probe, are also sensors. Please see page 13 for a full description of these sensor tools.

Our ROV with Custom Motor Safety Housings

## PROPULSION SYSTEM:

**`Io o Lalo Kai Loihi** has 4 thrusters configured as follows: 2 opposing corner-mounted thrusters, for ascent and descent power and 2 side mounted motors for forward, reverse, left and right propulsion. All motors are surrounded by custom safety housings that direct propulsion in a steady stream. Each motor draws 3.0 amps under a full load and spins at a rate of 4,732 LPH [liters per hour] or 1,250 GPH [Gallons per hour]. The Johnson Pump heavy duty bilge cartridge motors are depth rated to 8 meters and outfitted with stainless steel drive dogs and Bonzi Sports brass RC boat propellers.

The thrust of each of our two 4,732 LPH Ascent / Descent motors, outfitted with 7-screw propellers, is .80 kg forward and .72 kg reverse. Each of our Left / Right motors, outfitted with a 5 screw propeller, generates .70 kg forward and .62 kg reverse. We constructed a thrust tester out of a cross of 2 lengths of ½ inch PVC pipe in 30 cm lengths joined in a "+" formation. We zip-tied a 4,732 LPH bilge pump motor with a propeller on a cut PVC "T" and made a custom 16awg wire harness to ensure safe electrical connection for the test. We attached the thrust test cross to the top of a garden trash container and filled it with water. A digital luggage scale was used and secured to an opposing PVC “T” for the readings. We measured the forward and reverse force in kilograms. We also tested for amperage use of the motor under load with various propellers designs with a multi-meter. The propeller that performed best in both force and amperage use was chosen for the ROV.

## BALLAST SYSTEM:

***`Io o Lalo Kai Loihi's*** ballast system consists of pool noodle sections and 4 recycled plastic bottles used as pontoon floats positioned on the topsides of our frame for an easily adjustable system to achieve neutral buoyancy at launch. We zip-tied pool noodle sections onto our tether, and adjusted the floats and filled the plastic bottles with a small amounts of pool water to achieve neutral buoyancy. We drilled holes in our frame to keep the ROV from trapping air and listing. We always test the buoyancy and adjust the ballast before launching for missions.

## ELECTRICAL CONTROL SYSTEM:

Our original control system is housed in 2 electrical, surface control boxes, plus 1 submersible, waterproof relay switch box centrally mounted on the ROV. Our submersible relay box is mineral oil-filled, marine epoxy sealed and contains 6 relay switches for motors, and 5 relay switches for the claw, bacteria vacuum and crustacean sweeper motorized payload tools.

The relay switch box is wired to our 2 surface control boxes and each DPDT **(double pole, double throw)** relay responds when a corresponding surface control switch is activated. Surface Control Box #1 controls propulsion and Surface Control Box #2 operates the payload tools. Box #1 has 3 heavy-duty SPST **(single pole, single throw, center off),** toggle switches to simplify our controls for the pilot. Switch #1 controls the left motor and switch # 2 controls the right motor. Activating switches #1 & #2 forward together, the ROV propels forward. Switching #1 & #2 both backwards propels the ROV in reverse. Alternating the switches causes the ROV to rotate. Switch # 3 controls the ascent/descent motors and is switched up to ascend and down to descend. Box #2 has 3 SPST center off switches. Switch #1 controls the crustacean sweeper with an 1893 LPH (500 GPH) motor to operate the sweeper paddle. Switch #2 operates the "Bac Vac" bacteria collection pump, via a 1363 LPH (360 GPH) marine bilge pump. Switch #3 operates the Claw Tool, powered by another 1893 LPH (500 GPH) motor.

## CHALLENGES:

Our most difficult challenges were using time wisely and waterproofing the relay switch box. Time management was extremely difficult, as we had many scheduling conflicts with furlough Fridays, the Hawaii State Science & Engineering Fair, our NOAA Kohala Center Reef Ecology Project, as well as State HSA Testing, and sports. We are all new ROV team members this year and communicating clearly and using time efficiently was challenging. As middle school students, sometimes we lost focus and had to keep each other on track. To solve our time crunch, we divided up the construction tasks (electrical, propulsion, frame, tools) into small teams and scheduled extra ROV workshop sessions. We learned the importance of teamwork, discipline, safety, and not giving up. Waterproofing the submersible relay switch box was a difficult technical challenge. We found that the marine silicon we first used to seal the cable hole was dissolved by the mineral oil we poured into the relay switch box to waterproof it. This caused the oil to leak, and we needed to dig out the old silicon and use marine grade epoxy to seal the cable hole. Fortunately, the epoxy worked, and we were able to smile again.

## TROUBLE SHOOTING:

Our motorized claw tool ceased functioning several times during practice, and these trouble-shooting techniques were used to diagnose and correct the problem:

#1: We verified power was on and battery was fully charged.
#2: We checked that fuses aren't blown by examining all fuses in the tether harness.
#3: We checked current flow to the motor with a multi-meter to identify any shorts.
#4: We Verified alignment of the claw gears, and re-aligned them. We lubricated the gears.
#5: We re-attached the claw tool to frame with PVC glue, replacing the zip-ties to reduce play.

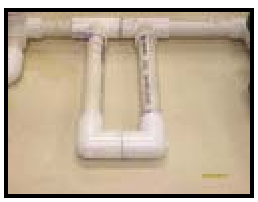
Testing repeatedly with the mission props helped us design better tools. We completed time trials to test which claw tool design worked best.

## `IO O LALO KAI LOIHI MISSION TOOLS:

**We designed 6 original, effective, low maintenance tools for the Loihi mission tasks.**

### Tool # 1: "Grabba" Grabber Claw:

The **"Grabba Claw" is a multi-task tool,** front positioned, to enable us to pull the "J" Bolt pin to release the HRH (high-rate hydrophone) from the elevator, remove HUGO's junction box cap & HRH connector, plus grab the hydrothermal vent spires. Our Grabba Claw is a modified VEXplorer claw adapted to open and close via a geared all-thread turned by an 1,893 LPH (liters per hour) (500 GPH) bilge pump motor. **Tool #1 can be used as an alternate tool to collect crustaceans, and lift the HRH.**

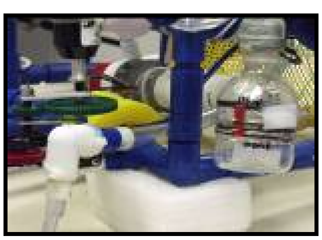


### Tool # 2: "Lifta" Lifting Tool:

The **" Lifta"** is attached to enable us to lift the HRH (high-rate hydrophone). Our lifting tool helps us install the HRH within the .5 meter square at the site that is rumbling.

### Tool # 3: Crustacean Sweeper & Catch Net:

Rear positioned to catch the crustaceans, the **"Sweeper"** is powered by a 1,893 LPH bilge pump motor. Our sweeper consists of wire ties on an all-thread connected to a bilge pump motor. The **Catch Net** is made out of a nylon mesh dive bag, and fits under the sweeper.



### Tool # 4: Bacteria Vacuum:

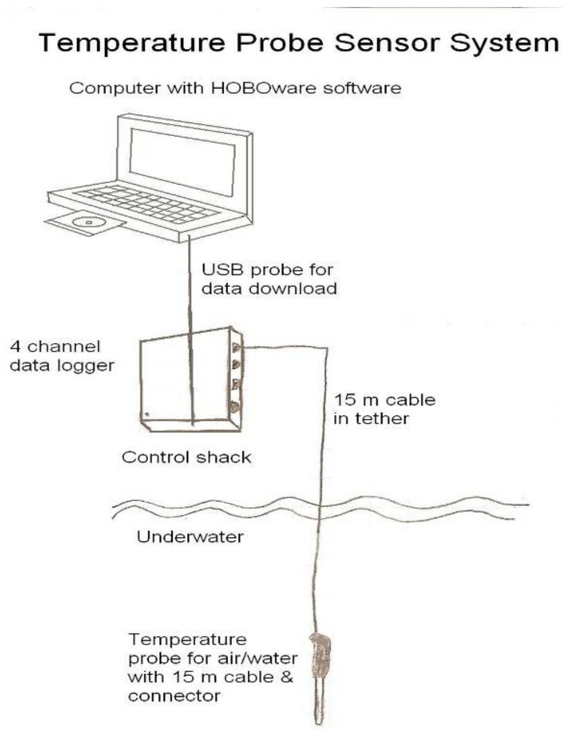
We designed the **"Bac Vac"** tool by modifying a Rule 1363 LPH (360 GPH) marine bilge pump that enables us to collect a 101-175 ml sample of a bacterial mat into a 250 ml plastic bottle via plastic tubing. The Bac Vac runs on 12 volt DC, pumps 3 liters/minute, and draws a maximum of 3 amps.

**Tool # 5: "Underwater Ears" microphones:**

Positioned in front, **our U/W Ears** enable us to hear vibrations from the rumbling site to station the HUGO. Our 2 underwater microphones are made out of computer microphones that have been waterproofed in film canisters, with mineral oil and marine epoxy.

**Tool # 6: Temperature Probe & Docker:**

Our Temp. Probe Sensor & Docker allows us to take accurate temperature readings at Loihi's hydrothermal vents. The docker is made from a modified plastic funnel. An empty BIC pen sheath holds a u/w stainless steel temperature probe and cable connected to a surface Data-Logger and computer to obtain accurate readings of the hydrothermal vent fluid. The computer is equipped with Hobo-ware data logger programs to graph our temperature readings.




**Mechanical drawing of our temperature probe sub-system by Aricia Argyris and Tristan Ross**

## FUTURE IMPROVEMENTS:

Next year, we would like to try joysticks to make the pilot's job easier by simplifying the controls, and add another wide angle, high resolution camera to improve rear navigation. We hope to try Servo motors to control some of our tools better. A code is sent to the Servo and it responds, angling itself to the command. Pneumatic motors are another option we wish to explore to improve tool function. Pneumatic motors use compressed air and are powerful, efficient, and durable. Servo and pneumatic motors have the disadvantage of being difficult to waterproof and can be very expensive.

## LESSONS LEARNED:

We learned the importance of measuring twice, and recording accurate measurements before modifying our materials. We also had to rally in the last month to catch up and improve our time management and teamwork skills to get the job done so we could compete. It was difficult to listen sometimes to our mentors and team mates, however we learned that listening to every team mate's ideas paid off with more creativity and innovation. We learned the importance of being thorough with research, so we could obtain better equipment to build our ROV. Not wasting time was a big lesson that we hope to take to heart and apply. Time management is very difficult at our age (11-13 years old). We also had to learn to be positive with each other to make sure that each team mate could do their best work.

We learned new technical skills such as soldering, safe electrical wiring, waterproofing, safe tool use, troubleshooting, piloting and proper tether management.

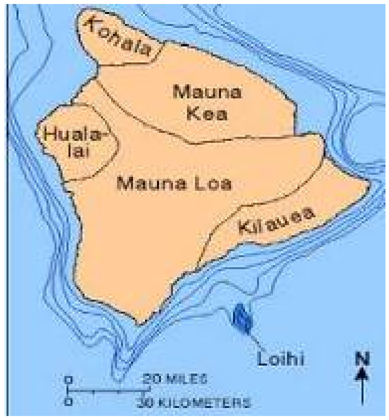



Photo: http://www.vulkaner.no/v/vulkinfo/tomhaz/loihi.jpg

**Loihi: GPS Location 18.92 N 155.27 W**

**Elevation: -975 Meters Below Sea Level**

## LOIHI SEAMOUNT:

Loihi is an active, submarine volcano, ~35 kilometers offshore of Mauna Loa and Kilauea volcanoes on the Big Island of Hawaii's southeast coast. Every Island on the Hawaiian chain was formed by shield volcanoes. All the volcanoes in Hawaii, including the 5 on the Big Island and Loihi were created by a "hotspot", which is a crack in the Earth's crust where hot magma erupts from the seafloor. Loihi means long in Hawaiian. It is believed, Loihi started to form about 400,000 years ago. Scientists predict that Loihi may erupt above sea level around 10,000 - 100,000 years from now.

Loihi has not surfaced yet, however once it does, Loihi will be Hawaii's newest island. More than 3000 meters tall, Loihi lies 975 meters below the sea surface. Pele's Pit, a caldera on Loihi where frequent hydrothermal vent activity is found, is 600 meters in diameter.

Loihi is monitored by Hawaiian Undersea Research Laboratory (HURL), NOAA (National Oceanic Atmospheric Administration), FeMO (Fe-Oxidizing Microbial Observatory), USGS (United States Geological Survey, SOEST (School of Ocean and Earth Science Technology at the University of Hawaii, Manoa).

The manned submersible Pisces V (operated by HURL) and the ROV Jason II (operated by Woods Hole Institute) have explored Loihi.

## History of Loihi

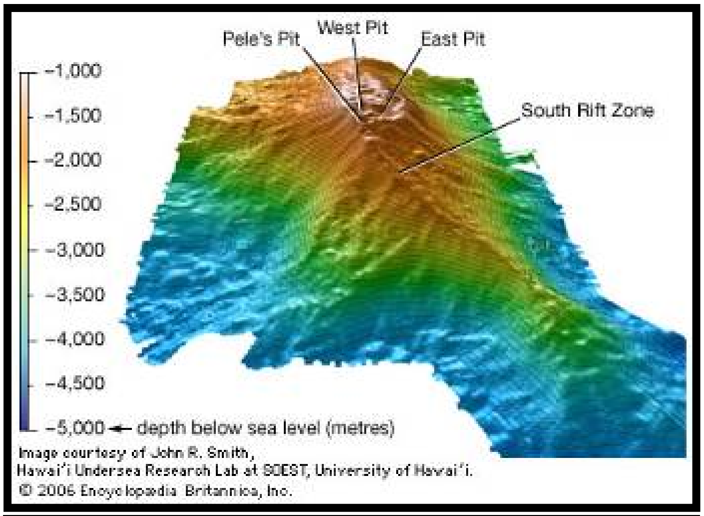
Loihi was discovered in 1940 by the U.S. National Geodetic Survey (now under NOAA) with eco-sounding sonar. In 1963, geo physicist, John Tuzo Wilson created a theory that Loihi was tapping into an undersea hot spot. Later it was confirmed that Loihi was indeed using a hotspot, connected to active, shield volcanoes, M. Loa and Kilauea. Dating of rock samples taken from Loihi, estimate that Loihi started to form around 400,000 years ago.

## Seismic and Volcanic activity at Loihi:

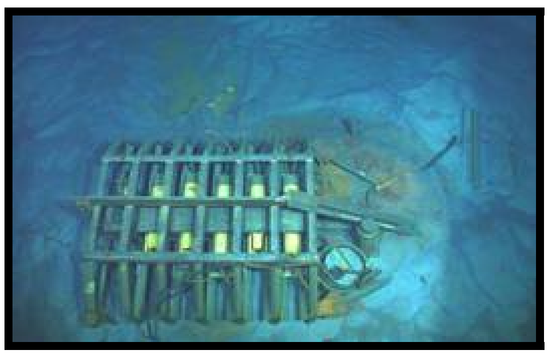
On November 10-11, and January 21st of 1985, three eruptions with magnitudes of 2.0 through 4.2 were recorded at Loihi. In 1990, 300+ earthquakes were documented at 4.0 magnitude or higher. On December 19, 1991 an earthquake swarm was recorded at Loihi with more than 400 events at the 10-15 km depth.

**On July 16, 1996, a massive *earthquake swarm***, a series of hundreds of multiple quakes, one after another, was recorded at Loihi emulating over 4,000 earthquakes. The largest 1996 earthquake had a magnitude of 5.0. *Pele's Vents* sank 980 meters below, meaning the hydrothermal vents previously documented by HURL, were no longer present. $H_2O$ samples taken at the site were highly acidic- as low as a pH of 5.6, showing Carbon Dioxide saturation, and $H_2O$ temperatures were 2.5 degrees C warmer than the surrounding water. On Aug. 8, 1996, 23 days after the big swarm, the HURL submersible Pisces V explored a new crater at Loihi, and scientists on this mission named the new, 300 m. deep crater *Pele's Pit.* From Pisces V, scientists saw pillow lava and jagged rocks as evidence of a new magma eruption and a massive landslide caused by the earthquake swarm. New hydrothermal vents have formed in Pele's Pit. The vent *“Forbidden”* was discovered in 1996 after the massive swarm, at a depth of 1160 meters, where temperatures exceed 200 ° Celsius.

In 2005, a small swarm of ~100 quakes occurred at Loihi with magnitudes up to 4.0, plus 2 more 5.0 quakes in May and July, 2005.




**A bathymetric map of Loihi after the 1996 Earthquake swarm.**



**HUGO on the undersea summit of Loihi,** (http://www.soest.hawaii.edu/HUGO/update.html).

**HUGO:**

**HUGO (Hawai'i Undersea Geo-Observatory)** was a research station deployed in October of 1997 on the summit of Loihi. SOEST (School of Ocean and Earth Science Technology at the University of Hawaii, Manoa) operated HUGO from 1997-2002. HUGO transmitted real time data on Loihi's seismic and volcanic activity to SOEST scientists on the Big Island from 1997-2002. HUGO became temporarily non-operational in 1998, and permanently disabled due to an electrical short caused by a seawater leak in the power transmission cable.

(Hawaii Center for Volcanology, 2010: www.soest.hawaii.edu/GG/HVC/oihi.html)

**Photo # 1:** **Photo # 2:**

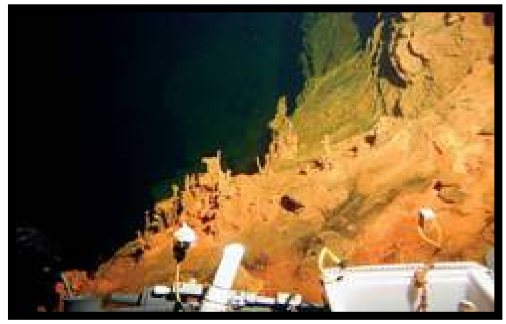


**Photo # 1: ROV Jason II at Loihi: recovering HUGO. Woods Hole Institute Photo**

**Photo # 2: ROV Jason II measures hydrothermal vent temps. at Pele's Pit: Woods Hole Institute, 2007.**

**Pisces V** and crew repaired HUGO's power cable in 1998, and HUGO operated 4 more years until the cable failed again in 2002, making HUGO non-operational.

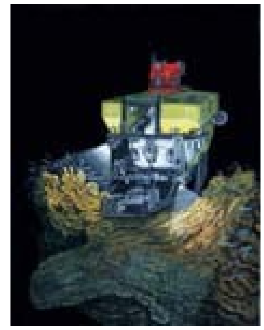
**The ROV Jason II** was used to recover HUGO to the surface in 2002. Dr. Frederick Duennebier, a Geologist and Geophysicist with UH SOEST, who helped develop HUGO plans to re-deploy a new, improved, HUGO at Loihi (Star Bulletin, 11/17/02)**. Jason II** returned to Loihi in 2007 to collect hydrothermal vent temperatures and chemical analysis of the vent fluid at Pele's Pit by FeMO in conjunction with HURL (earthref.org)**.** Jason-II can carry 1 scientist and 1 pilot and can be maneuvered easily, diving to depths of up to 6500 meters. Jason II has 2 hydraulic manipulator arms, plus sonar imaging, video cameras, chemistry probes, water samplers and temperature recorders. Jason II also collects bathymetry data to profile the ocean floor, and has a payload capacity of 143 Kg. Jason II is owned by the National Science Foundation and is operated by Woods Hole Institute.

**Terry Kerby** is HURL's Chief ROV Submarine Pilot and Director of submersible Operations. He leads scientific expeditions to Loihi. Terry is also an accomplished photographer and artist, who sketches and paints scenes of Loihi that he has viewed from Pisces V.

**How Our Loihi Research Relates to the MATE 2010 Missions:**

We researched Jason II's tools and capabilities to get design ideas for our ROV. We have designed our ***`Io o Lalo Kai Loihi ROV*** to help re-deploy and resurrect HUGO by installing a high rate hydrophone to transmit real time data again to SOEST. Terry Kerby's paintings have inspired the Kealakehe Intermediate ROV Team to explore Loihi and complete our mission tasks to re-start the real time monitoring of what will be our newest Hawaiian Island.





**Paintings of Pisces V exploring Loihi, by Terry Kerby, HURL Director of Submersible Ops.**

## REFLECTIONS:

### PERSONAL, ACADEMIC and PROFESSIONAL ACCOMPLISHMENTS:

We learned a lot about Loihi and how scientists use submersibles and ROV's to explore what will be our newest Hawaiian Island. It was very interesting to study Loihi, since it is right in our backyard. We learned about electrical systems, and how to solder and make safe connections. We learned an accurate method to test motor thrust. We feel proud of what we have accomplished to learn all about ROV's, Loihi and to compete at the BIRR and MATE competitions. For personal accomplishments, we improved our academic grades, we competed at the 2010 Hawaii State Science Fair, and we also completed a reef ecology field study. The MATE ROV project and competition has helped us gain new confidence, technical skills, and career aspirations. We have learned the importance of discipline, hard work and team spirit.

### TEAMWORK

All of our team members are new to ROV this year, and we are a young team of middle school students. We asked for help from former team members from the high school for advice on ROV construction. When we had problems with our design and tools, we had to re-group and stay late until we found workable solutions. We had to tell each other not to argue. We scheduled small group job teams to get more jobs done simultaneously. Some groups worked a specific tool, another on motor housings, others on the frame and electrical to be able to complete ROV construction. We all worked on the Tech report and we learned a lot from each other.

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