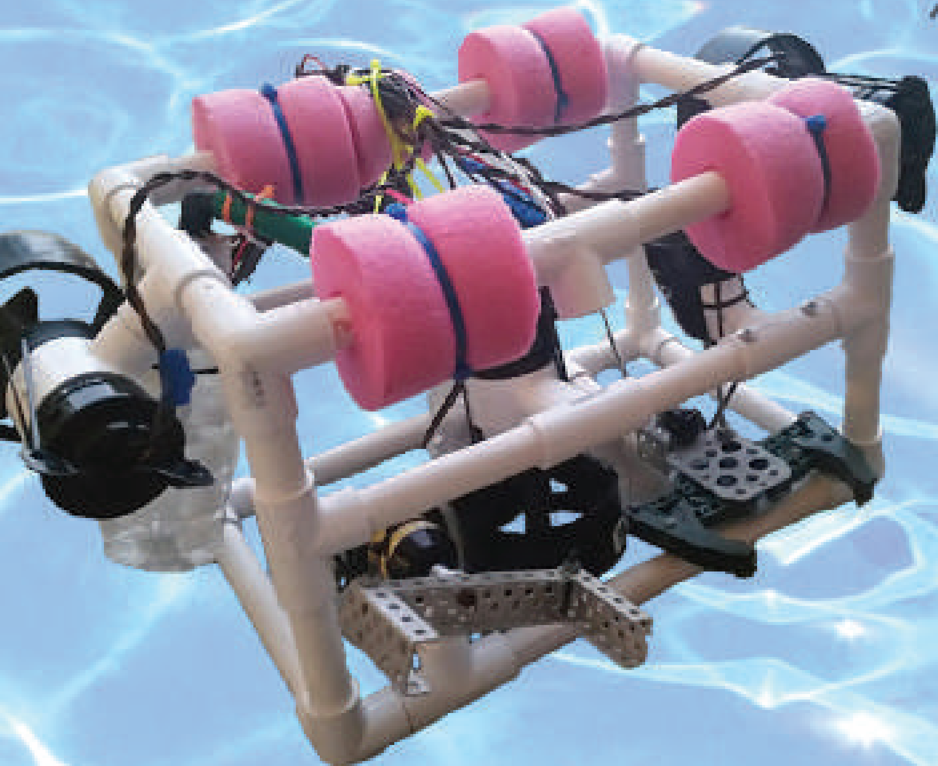
TECHNICAL DOCUMENT

LĀLO KĀ WAI

"Under the Water"



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MATE ROV 2017 - RANGER CLASS

TABLE OF CONTENTS

ABSTRACT

This technical document describes the design aspects of remotely operated vehicle Lopaka, which has been designed for the 2017 MATE ROV Competition. Lopaka was designed and constructed by the company Lalo Ka Wai, who are based at Kealakehe High School. As first year competitors in the MATE ROV Competition, Lalo Ka Wai works with the goal of maintaining an environment where every company member can gain as many different experiences as possible in order to strengthen the company as a whole. Since the company is currently very small, each company member can help out with a variety of tasks. Every person has more than one role or task underneath their main job title.

Lalo Ka Wai company photo

Lopaka offers an affordable yet convenient take on the world of remotely operated vehicles. It’s PVC based frame makes it easily adjustable in and usable in salt or freshwater. The spinner and claw tools offer solutions to a variety of problems, along with the bilge pump which is effective for collecting samples.

PROJECT FINANCES

To fundraise for our project, our team along with the two other STEM Academy teams set up a Donor's Choose to help cover most of the more expensive items, such as our cameras. The rest of our smaller items, including all of the PVC, came from personal funding & other individual donations. We aimed for a total spending of $500-$700, but only spent approximately $476. This included marketing and company merchandise. We may make more purchases relating to marketing closer to the national competition.

Luka, our CFO, logs all of the data related to budget and financing of the company.

Date Recieved	Item	Quantity	Cost per Item	Description	Sources/Notes	Amount	Type
				ex: pvc pipe, tees	ex: Lowes	$ USD	*purchased, reused, parts donated,cash donated*
04/26/17	Sony CCD Underv	1	$246	360° view, 7in LCI	amazon.com	$246	Parts Donated from DonorsChoose.org: https://www.donorschoose.or
04/26/17	Camera/LCD Mor	1	$89.99	30m cable 720P i	amazon.com	$89.99	Parts Donated from DonorsChoose.org: https://www.donorschoose.or
04/26/17	Submersible Pool	1	$6.04	Solar,DC12V, 3m	amazon.com	$6.04	purchased
04/26/17	Motor Cartridge	1	$36.19	1250 GPH Motor	amazon.com	$36.19	purchased
04/26/17	Replacement Car	1	$19.82	500 GPH	amazon.com	$19.82	purchased
04/26/17	3/4"x10ft PVC	3	$3.60	need 8 meters	Lowes	$10.80	purchased
04/21/17	3"x1/2" ABS Cou	4	$45.16	used to hold mot	Lowes	$20.64	purchased
04/22/17	1 1/2'X 1/2" SCH	4	$1.36	used to hold mot	Lowes	$7.36	purchased
4/26/17	VEX Claw	1	n/a	used for our claw	Already available	n/a	reused
4/30/17	500ft- 18 gauge v	1		500ft- not all use	Lowes	$57.24	donation
4/30/17	Hose	1	n/a	Re-used piece of	Already available	n/a	reused
Marketing EXPENSES							
Lalokawai							
Date Recieved	Item	Quantity	Cost per Item	Description	Sources/Notes	Amount	Type
				ex: pvc pipe, tees	ex: Lowes	$ USD	*purchased, reused, parts donated,cash donated*
05/18/17	Avery Stickers Pack		n/a	stickers to be pri	OfficeMax	$20	purchased
05/18/17	Company Business Cards		n/a	company busines	OfficeMax	$24.99	purchased

The spreadsheet used to log all of our company's finances.

DESIGN CRITERIA

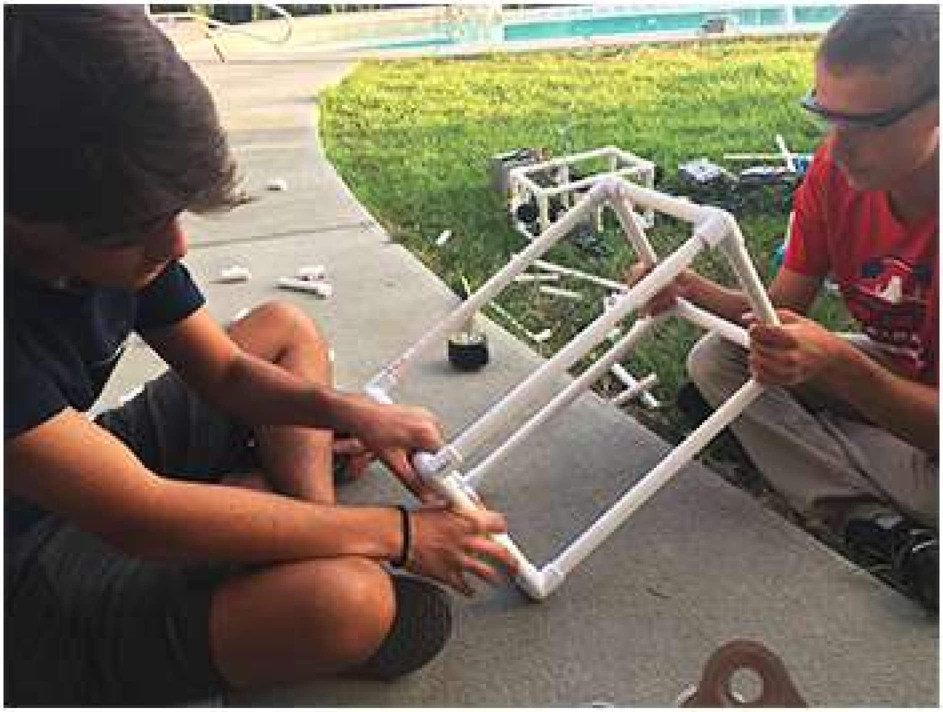
Our team's design criteria was very loose when we first started building the ROV. We knew we wanted to score as many points as possible, but we didn't agree on how. We started watching videos on what previous winners did, and how to do it. We eventually agreed that we needed a claw, a spinner, and a bilge pump to make our strategy work. We wanted to build a square bot with all of the tools coming out of the front, for easy camera positioning, and to be able to use the other tools to help with the same task. As we went along, we were able to change things based on a size constraint, or a change that we saw that presented a great opportunity. Overall our design was a great team effort that taught us all how to collaborate and come up with a design.

Some of our company members brainstorming the frame design.

FRAME

We first started off with cutting 12- ½” PVC pipes 20 cm each. We used PVC as it is a cheap alternative to creating an ROV and works well with creating neutral buoyancy by creating holes.

We had many options to choose from to create our ROV frame. It could be a 40cm by 40cm cube, which just fits the 48cm restriction. Another option that we could do is either cut the height or width to 20 cm or 15cm. We could also create another cube bot but with smaller dimensions such as 20 cm or 15cm so it could be more maneuverable. After collaborating these ideas, we decided that a 20cm x 20cm x 40cm would be ideal, as it fits in the size requirements for the extra points as well as it is not too small and maneuverable, and lastly fitting all components inside also getting the bonus points.



Luka & Nathan construct the main frame of the ROV out of PVC pipe.

CLAW TOOL

The claw tool was an idea that was formed after the need for something to grab and move objects around, and to also move props around. This multi-use attachment is one of our key point scoring tools during the product demonstration portion of the competition.

Our custom made claw attachment.

This tool was constructed mainly from a modified vex claw, with the addition of a motor. We took the spring out of a VEX standard claw to make it easier to open and close. Then, we added a small gear on the underside of the claw, which we mounted an axle to. The axle then had a notch cut into the top to keep it in the threaded motor adapter. Afterwards, it was mounted to the robot by a ½ inch tee pipe, attached to another ½ inch tee pipe that was cut in half lengthwise. The motor was then mounted to the tee piece that was cut in half. The claw itself was connected to the motor via the axle, but was supported on the robot by a piece of ½ inch diameter pvc that then was attached to the main frame of the ROV.

SPINNER TOOL

The spinning tool was a tool that was created out of the necessity to have something to we could use during the task that required spinning the valve underwater. This spinner is an important part of our strategy, and so we needed to come up with a way to make it function efficiently.

Motor attachment for the spinner tool.

The way that we constructed the spinning tool was by taking a standard VEX robotics kit C channel, then bending it so that it had equal lengths on both sides. After that, we mounted it to a motor with the motor adapter in order for it to spin. To mount the motor onto the robot, we used a ½ inch diameter tee pipe that was attached to the frame, then connected to a second tee that was cut in half lengthwise. The motor was then zip tied onto the tee, and attached to the ROV.

Brainstorming how to attach the spinner tool.

BILGE PUMP

The bilge pump system is a necessary component and is very important to or success in the water. Our hope is that the bilge pump will extract the agar from inside the cup and store it inside the bottle that is attached to the pump. The bilge pump is mounted to the frame with a ½ inch tee pipe, that then has another pipe that is cut lengthwise. The bilge pump then is zip tied to the tee that is cut. To suck up the agar, we cut a water bottle in half and taped the nozzle end onto the bilge pump. The other end of the bilge pump is attached to a hose that carried the agar into a removable water bottle for storage. The water bottle has hole in it to encourage the flow of water until we can suck up the agar and stop the flow of water through the bilge pump.

The ROV'S bilge pump.

The storage portion of the bilge pump.

MODIFIED PARTS

The first of the modified parts our company fabricated was our custom propeller shrouds. We made four of these in order to protect the four propellers on our ROV. To do this, a dremel was used to create spaces in ABS couplers. These spaces allow water flow through, but still leave enough material to protect the propellers.

Top and perspective views of one of the modified propeller shrouds

The other major part modification we made was removing the inner rims of four tee pipes. These tee pipes were used as an attachment piece that could hold the propellers & their motors together. In order to get these parts to fit properly, we had to remove the inner rim so that they could slide through all the way. To do this, we used a spindle sander.

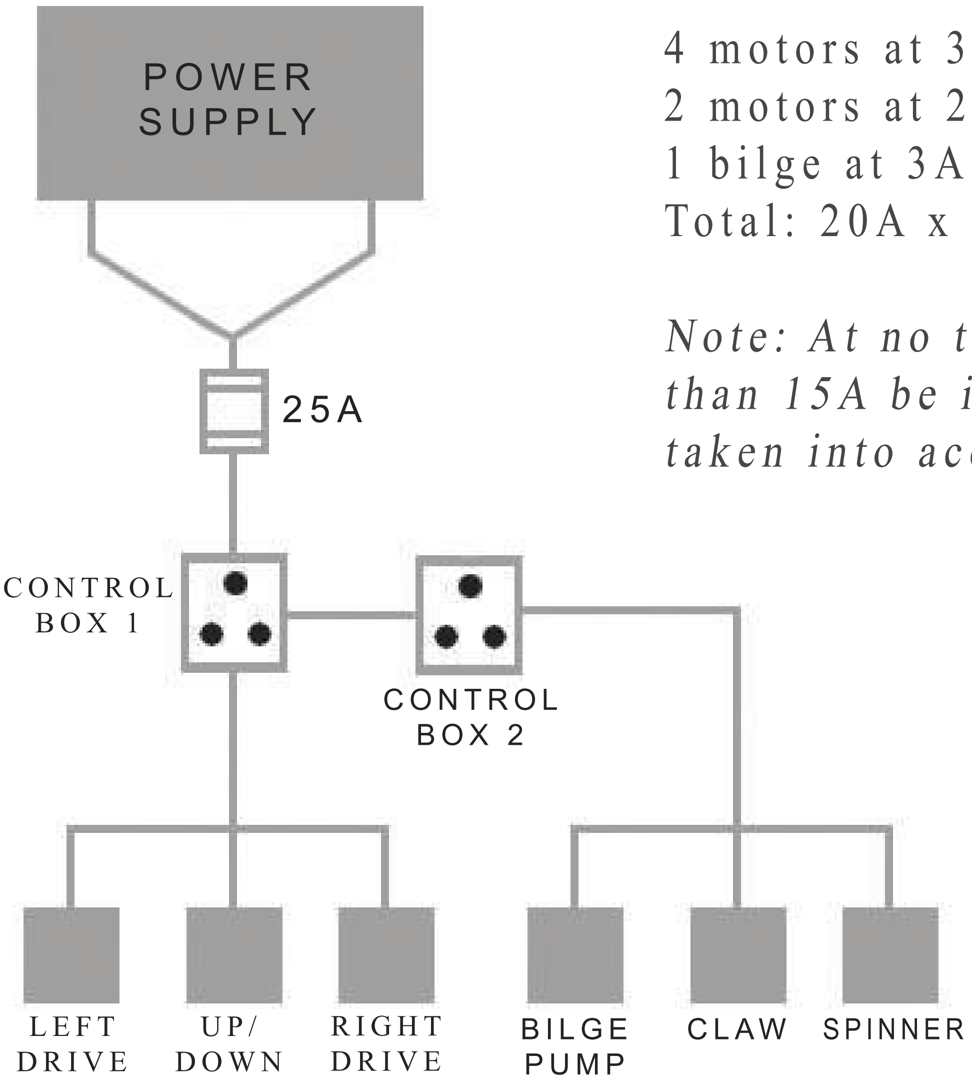
Nathan using the spindle sander to modify tee pipes.

Left: unmodified tee pipe
Right: modified tee pipe

CAMERAS

The first camera we started to mount was the one that focuses on the tool challenges. We had three locations where the camera could be mounted. We decided to rule out the first level of the bot (bottom layer) as that is where the tools are located, not leaving room to attach the camera. The second area that could have been an option is the middle PVC, either having an upper or behind view of the tools. The upper view on the second PVC would not be able to view all of the tools in the camera frame. We couldn’t attach them in either places due to the motors taking up too much room to place the camera body. The third PVC pipe has a view of both of the tools and the area has enough room for it to be mounted, this location would be in the middle of the third PVC pipe so that the driver will be able to have a wide view of the tools.

ELECTRIC SID



4 motors at 3A = 12 Amps
2 motors at 2.5A = 5 Amps
1 bilge at 3A = 3 Amps
Total: 20A x 150% = 30 amps

Note: At no time will more than 15A be in use (25A max taken into account)

BUOYANCY TECHNIQUE

In order to achieve neutral buoyancy needed to complete many of the tasks, our company attached pool noodles to the ROV. At the ideal amount of pool noodles, the ROV will neither float or sink, but become the same density as the water. The pool noodles were already available to us, so we didn't have to pay for them, making them a very cost effective component. However even though we didn't need to purchase them, the noodles are also very cheap, which lowers the overall production cost of the ROV.

We also made small holes in the ROV so that water could flow through and help it float better. This combination of using pool noodles and drilling holes into the ROV is what made it possible to achieve natural buoyancy.

Testing the buoyancy of the ROV in the water.

One of the holes in the PVP, used to acheive buoyancy.

Pool noodles used to acheive buoyancy.

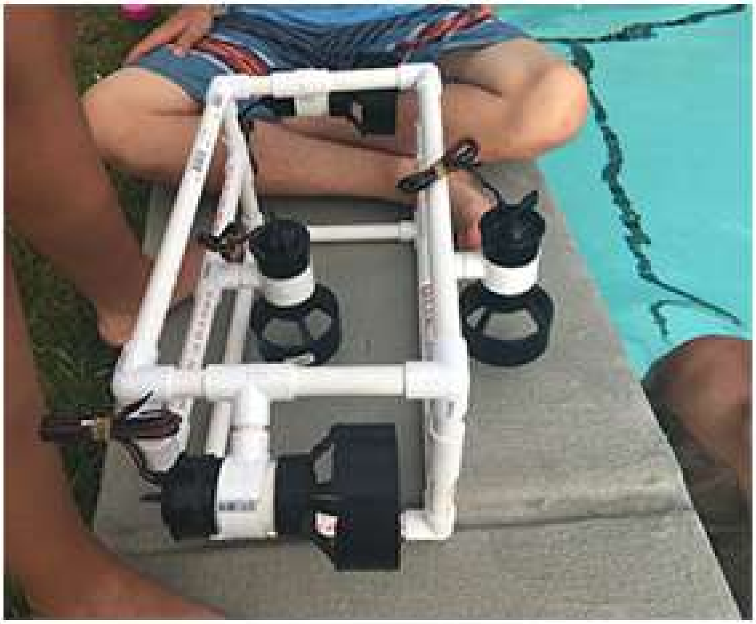
TETHER

The tether system was very possibly one of the most important parts of the bot. Without our tether, our bot would not receive power, or be able to connect the systems to switches in order to drive our ROV.

The tethers are made out of 4, 18 gauge wires kept together with shielding. Our bot needed 3 tethers total going from the boxes to the robot. Tether 1 was connected to the claw and spinner. That tether ran into the tool box and to the left and right switches respectively. Tether 2 is connected to the up and down motors and the bilge pump. Because our team was using two vertical motors, we figured that they would never be working separately, so we linked them together to take up less wire. This tether went into the tool box, but then took the extension of the up and down motors out of the box and into the drive box. Tether 3 was connected to the left and right drive motor. This tether went right to the drive box and connected to the left and right switches respectively. From the battery, we ran a wire into the drive box, which then had a wired that connected it to the tool box.

WORK LOCATIONS

While working on our ROV, we completed tasks at two main locations; our STEM classroom at Kealakehe, and occasionally at our CEO, Nathan's house, specifically his back yard since he has a pool. We did a lot of the work in class, so most of our time working on the project was spent in the STEM classroom. Here, we had access to all of the tools and supplies we needed to develop our ROV. We also were all able to be here so we could work on our ROV as a team instead of just a couple of us. Because STEM is one of our classes, we could easily get assistance from our teacher if we had any questions or issues. The classroom is relatively big and gave us a lot of work space to complete our project, which ads to the reason why we did most of the work here. The work done at the CEO's house was extra work that we weren't able to finish in class, as well as drive practice. For these sessions, only some of the team could usually make it which made it a bit odd because the people who were there would have to fill the people who weren't in on what was completed.



ROV work being done at our CEO's house.

ROV work being done in the school's workshop.

SAFETY

While working on the construction of the ROV, our company always made sure we were being safe and taking the correct precautions in order to avoid harm. In order to this, a JSA (Job Site Analysis) was created.

Job Step	Potential Hazards	Safety Check
Control Box	• Damaging hands • Damaging eyesight	• Wore safety glasses • Made sure we had others help drilling
Sanding	• Damaging eyesight • Damaging hands	• Wore safety glasses
Soldered	• Damaging hands or other body parts	• Wore safety glasses • Kept solder a safe distance away from harm
Dremel	• Damaging hands • Damaging eyesight • Harming others	• Wore safety glasses • Checked our surroundings
Band Saw	• Damaging hands • Damaging eyesight	• Wore safety glasses

When working on the control box, we had to make holes to fit the joystick. We had to use the drill press to make the holes. But, just in case of an accident, we had two people hold down the cover for the control box. We had to sand the PVC pipes to fit it to size. While we sanded, we made sure we had safety glasses on and checked our surroundings for other people just in case any dust goes in their eyes. We had to solder the wires together and in order to avoid any accidents, we kept it on a stand when we finished and kept a safe distance away from it so we can avoid any burns. We used the dremel to make our mounts for the motors. To avoid any accidents, we made sure when we used the dremel, that no one was near it and we wore safety glasses. The band saw was used to cut certain pieces of PVC and we wore safety glasses to protect our eyes from any dust or debri.

CONTROL BOXES

Our controls for our ROV is actually comprised of 2 smaller boxes that will both be wired to the ROV. One box is for movement controls, an up/down switch, 1 switch for the left motor, and 1 switch for the right motor. The 2nd control box is for tools, 1 switch for our claw, 1 switch for our pump, and one switch for our spinner. Each box has 3 switches, all 1 inch apart from each other, with 1 switch higher than the other 2 on each box, as to avoid accidental contact which would result in a short circuit. The box we put the switches into is 4 inches long by 4 inches wide, and there were 3 holes drilled into each box lid to fit the switches. The switches we are using have 3 different positions, but only 2 different actions. The neutral, or middle position is off, while the up and down positions are both on.

The inside wiring of one of the control boxes.

One of the two control boxes used to maneuver the ROV.

PRODUCT DEMONSTRATION STRATEGY

For the product demonstration we want to use the claw, the pump, and the spinner to do all of Task 1, Commerce: Hyperloop Construction (60 points), all of Task 2, Entertainment: Light and Water Show Maintenance (60 points), all of Task 3, Health: Environmental Cleanup (60 points), and a portion of Task 4: Safety: Risk Mitigation. Tasks 1, 2, and 3, fully completed will net us 180 points.

With these tasks completed, we're hoping to achieve the maximum number of points using our available tool collection in a fair amount of time. We believe this route will help us achieve that goal in an efficient and point achieving fashion.

FUTURE IMPROVEMENTS

Our bot was made to the best of our abilities, with the time we had available. Some of the things that we would like to do in the future to expand our potential is get started with the CAD earlier in order to plan the design ahead of time and to get a stronger plan going for the team. Another thing that would have helped with the building is making sturdier mounts in order to make sure our tools are on strong enough. Another thing that could use improvements was the system that we mounted our cameras to. This was a big learning moment that our team was lucky to be a part of.

An engineer works on the ROV.