Northstar Marine Tech, Inc.

Staff:

Kayla Rabey	CEO	6th Grade
Hillary Chu	CFO	6th Grade
Harrison Chu	Chief Engineer	7th Grade
Preston Rabey	Test Pilot	4th Grade

Mentor:

Gary Chu, MD FABHP
Dung (Young) Rabey, MD
Sophie Wag

Adreani Elementary, Albiani Middle School, & Brookfield School, Sacramento, CA
NStarMTech@gmail.com

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Message from the CEO

As CEO of Northstar Marine Tech, INC., I think our team has pulled off an excellent rover design that will efficiently explore the ocean and space. As a rookie CEO, learning to manage and keep together a newly developed company has been challenging. I have learned how to deal with difficult situations such as redesign, task failures, budgeting, and meeting deadlines. To keep our team happy and productive, there were many breaks where we played together and interacted as friends. If you would like to invest in our company, you can contact me at: NStarMTech@gmail.com

Kayla Rabey

Kayla Rabey, CEO

Abstract

We, the Northstar Marine Techs, are a rookie team for the 2016 regional MATE ROV competition. We are motivated FIRST LEGO LEAGUE teams with experience in robot building and programming from Sacramento, California. We are lucky to have great sponsorships from Arnold Adrian and Brookfield Schools. Generous investors like our mentors Gary Chu, Sophie Chu, Kevin Rabey, and Dung Le believe in the success of our new company. The simple design of our rover was created to accomplish all of the mission tasks easily by using quick attachments, thus our rover is named HYDRA. Our claim to fame will be the ultimate lego claw that is unheard of at MATE ROV competitions. We have an energetic, playful team that loves to spend time doing team building activities which might include an occasional water balloon fight. Building this company together will help us learn the basic foundations of teamwork, individual progress, meeting deadlines, efficiency, budgeting, and leadership skills.

Theme response:

The theme this year is the exploration of Europa. Europa is one of Jupiter's moons which is covered in frozen crevasses, which underneath are vast oceans. The temperature is usually -210 degrees celsius and it has enough radiation on it to kill a human in a few days. Since we can't roam it, we are sending rovers to do it for us. Our rover have to be suited to go underwater since most of Europa is underwater and is unsuitable for us.

We have made many attachments for completing various tasks in this year's MATE Scout class challenges. Task #1 is to connect the Environmental Sample Processor(or ESP) to the power hub which is a box we have to open. We completed this challenge by using our Lego claw to open the door on top, grabbing the Esp, and to transfer the ESP to the hub. Task #2 is the Equipment recovery which is gathering 4 CubeSats onto an collection basket. To complete this challenge, we also plan to use our claw to retrieve the CubeSats and to release them onto the collection basket. Task 3 is Forensic Fingerprinting in which you have to collect samples from 2 "oil" mats, and once we return them to the surface, we grab the oil fingerprint from the sample and identify it and tell the judge what type of oil we think it is. We have a special hook attachment, which goes on and gets removed easily, to hook the samples for us to identify. Task 4 is the Deepwater Coral Study in which we gather 3 pieces of "coral" and bring them back to our pit area. Again we use our versatile claw to gather each of the corals. The fifth and last task is the Rigs to Reefs, in which we grab a cap and put it on a wellhead, and then grabbing a bolt and placing it on the cap. We plan to use our claw to grab the cap and place it on the wellhead and to grab and secure the bolt. Having a working claw allows us to complete all 5 challenges. Our multi-functional Lego claw is our company's unique response to this year's theme.

Budget

We raised $3,330 and we have spent $1,774 so far. Each team member donated some money to help raise enough money for all our equipment. Our parents also made a generous donation to us. We used our money that we raised to be able to buy all the equipment that we needed.We also saved $1,633 by recycling and renting equipment. For example, for our claw, instead of buying a claw set, we recycled the pieces that we used for our FLL robotics and used it for our claw on our rover. If we didn't recycle our claw kit, then it would have cost us an extra $500. Our CEO also pitches our company's rover to angel investors for a ginormous cash investment.

Income

Date	Description	Amount
3/1/16	Hillary Chu's donation	$100.00
3/11/16	Harrison Chu's donation	$100.00
1/6/16	Dr. Young's Investment 10% Stock	$1,000.00
4/11/16	Sold T shirt to coach Gary	$30.00
2/1/16	Dr. Chu's Investment 10% stock	$1,000.00
4/1/16	Le / Rabey Sponsorship	$1,000.00
4/2/16	Kayla Rabey's donation	$100.00
	Total	$3,330.00

Recycled Equipment

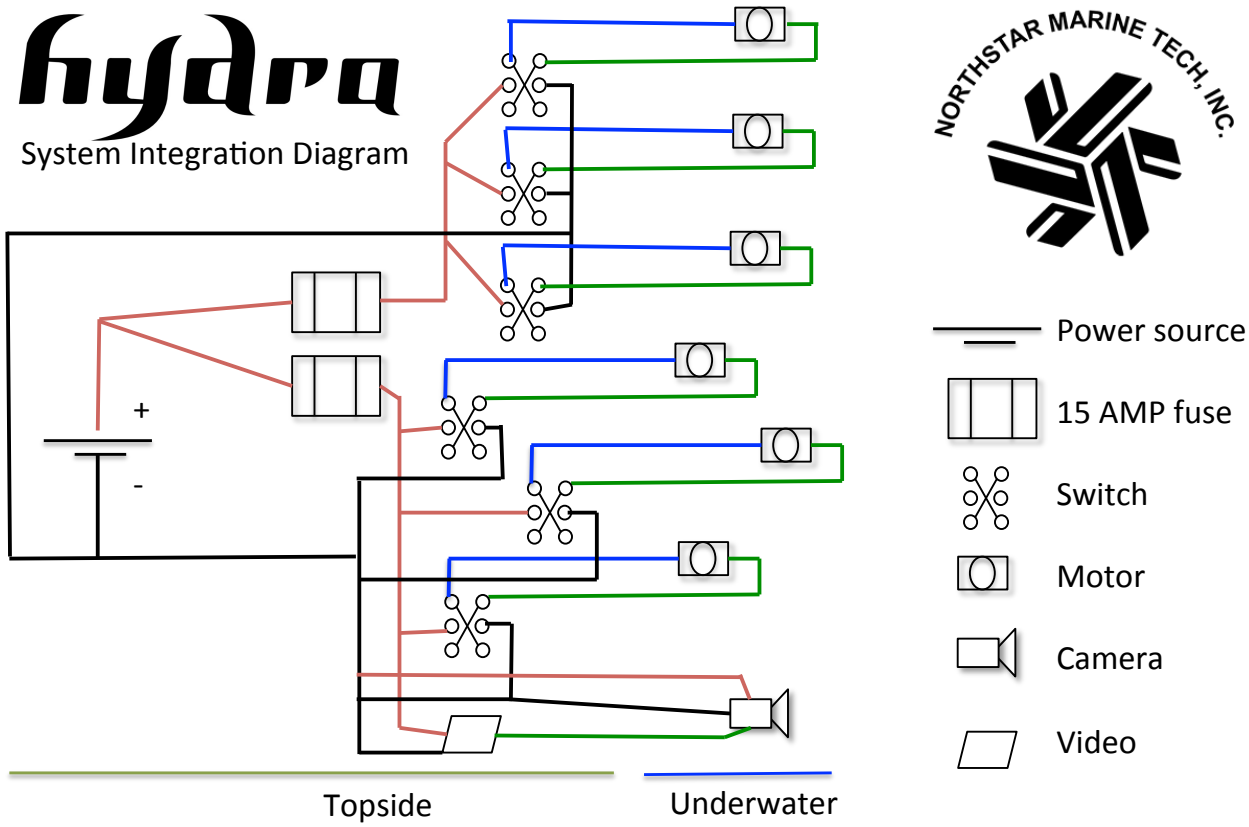
Date	Description	Estimate Cost
2/1/16	Lego EV3 Kit	$500.00
2/1/16	Posterboard	$10.00
2/1/16	Printer	$100.00
2/1/16	Laptop	$1,000.00
2/1/16	Safety Goggles	$20.00
4/5/16	Duct Tape	$5.00
4/12/16	Used Plastic Containers (2)	$1.00
	Total	$1,636.00

Rental Equipment

Date	Equipments	Retail Cost
2/1/16	Multimeter	$23.00
2/1/16	Soldering Station	$38.95
2/1/16	Mini Glue gun	$4.35
2/1/16	Heat gun	$18.28
2/1/16	Wire stripper	$4.37
2/1/16	PVC cutter	$18.47
2/1/16	Alligator Lead	$10.98
2/1/16	Solder spool	$23.99
	Subtotal	$142.39
	3 month loan at 10%	$14.24

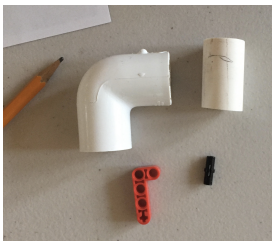
Expense

Date	Item	Cost
1/20/16	Text book - Underwater Robotics	$110
1/20/16	Puffer Kit x 2	$592.33
2/1/16	Equipment Loan fee	$14.25
2/29/16	Car Fuse	$8.64
2/29/16	PVC pipes, screws, etc	$102.70
3/1/16	PVC pipes	$18.31
3/1/16	Battery	$70.00
3/1/16	PVC pipes	$29.69
3/1/16	Supplies	$34.04
3/1/16	Scout Class Registration	$25.00
3/1/16	Plastic Storage Containers (5)	$20.00
3/3/16	PVC pipes	$15.25
3/3/16	Color PVC pipe and parts	$162.35
3/6/16	Anderson Powerpole	$13.34
3/7/16	Screws, ties, misc items	$56.67
3/19/16	Text book - Build Your own... etc	$13.50
4/7/16	Sac Tee (tshirt)	$30.00
4/7/16	Pool self lock kit (quick attachment)	$16.15
4/7/16	Pulse Width Modulator motor control	$5.99
4/9/16	Acrylic Sheet	$3.00
4/10/16	Set Screws	$6.00
4/12/16	Business Cards	$10.00
4/12/16	Stickers with team logo	$10.00
4/12/16	Photos from Costco	$8.00
4/12/16	Prints at Champions	$3.00
4/13/16	Underwater camera kit	$152.55
4/18/16	Handle Replacement Pin (4)	$12.00
4/29/16	Hotel - Hilton Garden Inn	$200.71
4/22/16	Petty cash (misc expense)	$100.00
4/29/16	Travel Estimate - Gas, round trip	$50.00
4/29/16	Travel Food estimate	$100.00
	Total	$1,993.47

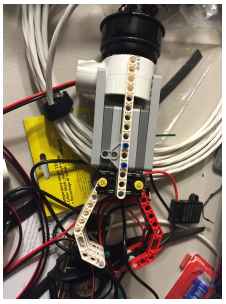


Design Philosophy and Design Cycle

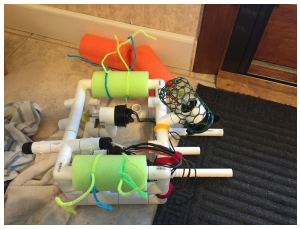
To make our rover, lots of time and thought were used. Our design philosophy we learned from First Lego League taught was K.I.S. or Keep It Simple, after all, complex isn't always better. Also, we want to include the concept of building a sturdy rover to satisfy our clients. We don't want a rover that breaks as soon as people buy it. As you can see, we always try to coalesce our design philosophies with the rovers we build.



To build our rover, we went through many prototypes and we used a LONG and elaborate design cycle. We first started doing some research on how to waterproof motors and how to from the basic Pufferfish kit. We also looked at the rover design of Jesuit high school. We then needed a place to test our rover so we decided on using my family's pool. Our rover design is modeled after Lego EV3s, from our FLL experience. We treated preform PVC parts like lego bricks and 3.5 cm PVC pieces as connectors. (see photo) The prototype was basically a LEGO



robot built with PVC pipe. It sank like a rock. Then, we put on large pieces of pool noodle on the frame. It became unsinkable! So we used smaller and shorter lengths of noodle and it worked. but the noodle wasn't very reliable because it kept slipping off. We did more research and we settled on using pontoons as floatation devices. We sealed air in PVC tubes and it has been working every time. After the design was settled on, we had another problem. We couldn't see our rover underwater well so we bought colored PVC pipe and rebuilt the rover by making it colored. We first tried to use a chopstick to do the missions and a hook built from a clothes hanger, but they didn't work as well as we hoped. The hanger was unreliable because we had to be in a precise location to get the objective. We solved that problem by attaching multiple hooks to the robot to give it a larger margin of error. We realized that the chopstick wasn't worth its weight. It only did 1 task and often failed. So, we turned to a design which we knew was simple to make and very reliable… a LEGO claw. The claw could do all of the tasks except 1, so we ditched the chopstick and welcomed the claw. We discovered the rover's 3 motor limit range of motion in water. So we upgraded to 5 motors.



On size of our rover, We try to shrink it into 40 cm cube per suggestion of Hillary for bonus points. But during testing phase, it was very wavy and difficult to control. So we abandoned the concept. Ultimately we settle with original rectangle shape design (30 cm x 68 cm x 9 cm). It is big and heavy (7.8 kg), but it is rock steady in water. We lost points in size. The trade off is we have a rover that's maneuverable, steady and can complete tasks. PVCs were used because it's easy to work with and came with the Pufferfish kit.

Our rover's design process took very long and produced fruitful results.

Safety

We designed our rover to be sturdy enough for our fourth grader team member to handle. The rover also needs to be simple and safe enough for a fourth grader to operate. Fortunately, our fourth grade member, Preston, is no ordinary fourth grader. He is very smart and is our test pilot. All the design features of our rover are tested and approved by Preston. Everything is Preston proof!

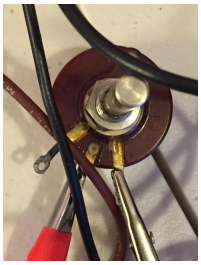
We cover our control board with food wrap to keep switch from getting wet. A switch can get wet and malfunction with just one dope of water. We cover all exposed propellers to prevent damage. We also cover the ventral part of our rover with mesh to prevent puncturing of inner propellers. Each PufferFish controller has its own 15 amp fuse. Rover is brightly colored in yellow. Easy to spot. Anderson Powerpole Connectors were used for power connection, in compliance with current and future tournament regulations.

Challenges / Lesson Learned

Since this is our first year participating at Marine Tech Challenges, we had no idea what to expect. We had many disasters and roadblocks. Many features of our rover came to light due to an unforeseen problem.

Our first challenge was to connect our rover to a power supply. We had no idea how to do this. The manual says go buy a battery jumper pack. So we went shopping. We found one with cigarette charger. It gave us an idea of converting an old cell phone car charger to our rover. Our first attempt to connect power to our rover failed. It just wouldn't turn on. We discovered the cell phone chargers has a hidden 2.5 amp fuse that was blown when we connected the rover to the power supply. A quick trip to local O'Reilly auto parts for a 15 amp fuse fixed this issue. It's alive! It's alive!. We were told to waterproof our wires with shrinking tubes. So we used a heat gun and shrank a few tubes. The rover went dead as soon as it hit water. We discovered water leaking into the wires. After discussing this problem with our coach, we decided to triple insulate our wires using shrinking tubes.

The propellers worked great. However, we noticed the tethering wires sometimes get caught by the propeller. We searched the web for ideas. Everything we found is too complicated for us. We tried using parts of one liter coke bottle, styrofoam cups, and plastic cups. They were all too flimsy, after vent holes were punched. Then we saw the garden



fence nettings, left over supply from building props. They turned out great, very flexible and yet durable. We also added netting to bottom of the rover to prevent props puncturing our rover and propellers

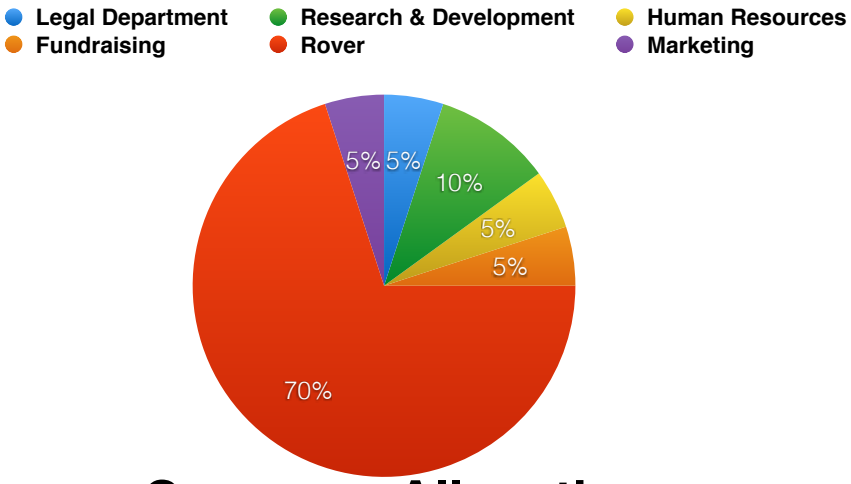
With our background in First Lego League (FLL), designing a claw was organic. We had no problem adapting the claw to our bilge motor. However, unlike Lego robot, we have no precise control of the bilge motor. The motor would turn at 100% strength and loosen the gears. We partly overcame this issue by adding rubber bands to tighten the gears. We also added a pulse width modulator to control the speed of the motor. Unlike FLL lego motors, our rover motor runs only at one speed - 100% full force. We needed to slow it down or it would break our lego claw. Andy Nogaj, friend of our coach, suggests using a voltage potentiometer. It slows the motor down by decreasing the voltage. The first one caught fire. Turns out it's rated for 5 watt only. Our rover's motors run at 30 watt (12 volt x 2.5 amp = 30 watt). We swapped with a potentiometer that's rated for 25 watt. It worked for awhile and then died. Our coach suggests we use a pulse width modulator (PWM) to control the motor. Unlike potentiometer, a PWM, sends out same voltage but at a pulse interval. In theory, it should work. Unfortunately we crossed the positive and negative wires during soldering. The circuit board was fried. We had to order another one on Ebay from China. Luckily, it arrived fairly quickly. **The Lego claw is the pinnacle of our rover design.**

Using lessons learned from FLL, we create mission specific tools for our rover. In FLL, our lego robot is very imprecise and runs autonomously, so we are required to design tools to accommodate imprecision. We also have only 2.5 minutes to do everything, so we develop quick attachments to easily swap out parts for our robot. Using these techniques, we created robotic arms that are fool proof to pick up the oil sample task. We also use a quick release mechanism similar to trailer hitch hookup so we can swap out parts quickly.

We took a research to Aptos High School pool. The trip turned out to be fruitful. We discovered the video monitor was difficult to see under the sun. So the team created a shade for the monitor using recycled boxes. Hillary discovered the power supply was near the ground, where it is often wet. We redesign our power connectors to make sure it's aways above the ground. We don't want to get electrocuted.

According to NASA website (see reference), there is a formula to calculate propeller thrust. It is way over our heads. Our coach came up with an idea while watching a Youtube video on measuring drag force. We tie a rope to our rover on one end, and attach the other end to a Newton spring scale. Then we run one motor and see how far the rover pulls the scale.

On size of our rover, We try to shrink it into 40 cm cube per suggestion of Hillary for bonus points. But during testing phase, it was very wavy and difficult to control. So we abandoned the concept. Ultimately we settle with original rectangle shape design (30 cm x 68 cm x 9 cm). It is big and heavy (7.8 kg), but it is rock steady in water. We lost points in size. The trade off is we have a rover that's maneuverable, steady and can complete tasks. PVCs were used because it's easy to work with and came with the Pufferfish kit.



Company Allocation

Future Direction

Our CEO believes that if we have a successful competition with additional investors then the future direction of the our company allocation is depicted in the following chart as we move our company forward. Next year, we hope to accomplish and learn about many things to enrich our next competition experience. One thing we would like to accomplish is to make a way to rotate the camera from the surface. Also, since us boys are good at video games, a joystick controller could be easier for us to operate with than a board of buttons. So we would like to attach a joystick to use as a controller for the rover. To incorporate the joystick, we have to use Arduino programming language to program it. As you can see, we have lots to do next year.

Schedule and Assignment

Kayla: CEO and robot operator. Leads the team. In charge of writing the abstract, CEO Message, assembling poster board. Final proof read all documentation.

Harrison: Chief engineer. Design and maintaining rover. Supervise product demonstration. Writes SID. Author the technical part of the documentation.

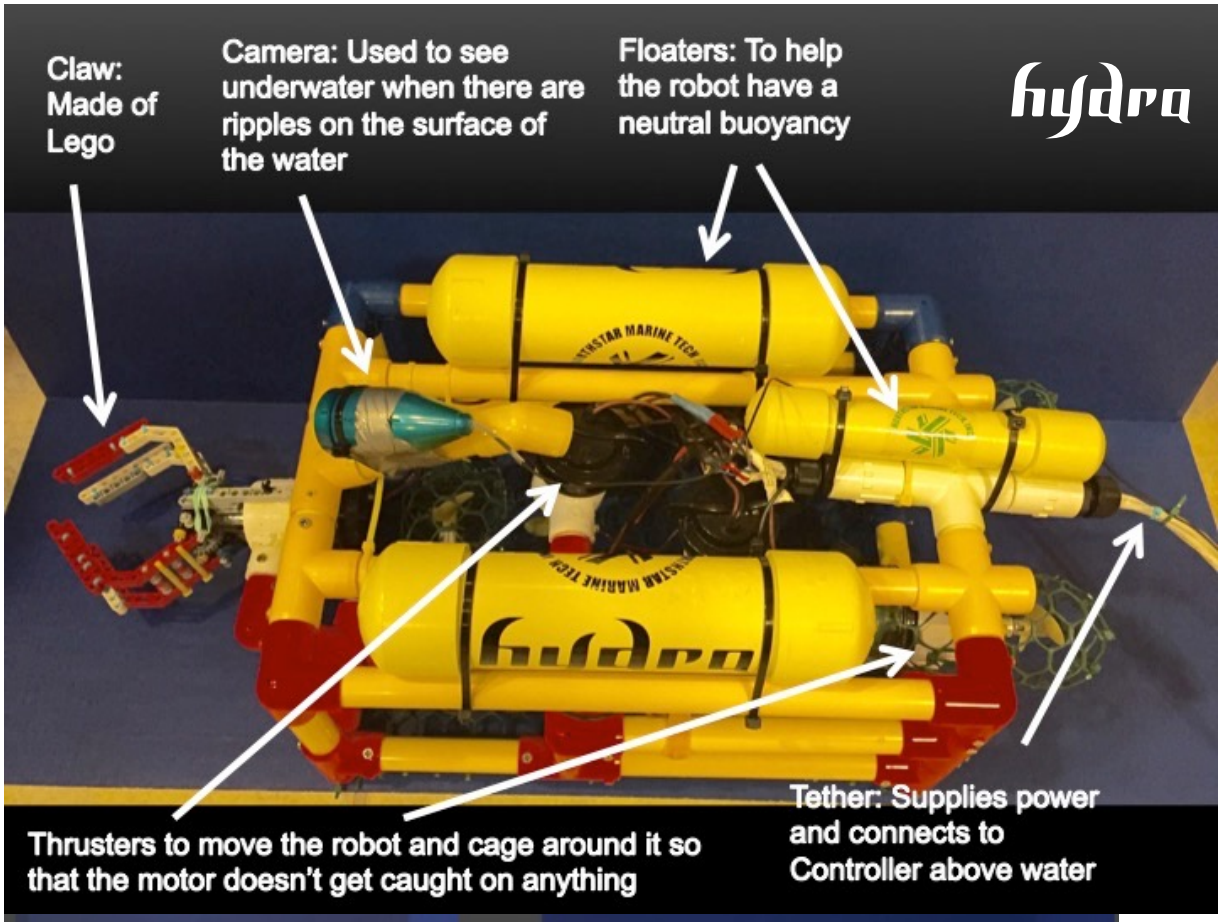
Hillary: CFO. Maintain budget and study all rules and regulations, including rubrics for every part of the competition. Rule keeper of the team. Proof read all Harrison's written documentation.

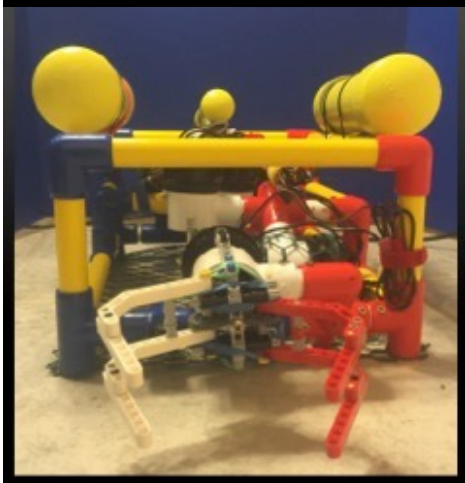
Preston: Test pilot. Test all designs for safety and durability. Handles reference and acknowledgment part of the documentation.

Schedule		Kayla	Hillary	Harrison	Preston
Date	**Assignment**				
3/1/16	research on tasks	x	x	x	x
	research on waterproofing motor			x	x
	brainstorming ideas for fundraising	x	x		
	practice sodering	x	x	x	x
	Shrink wrap	x	x	x	x
3/9/16	put together first robot		x	x	
3/11/16	Trial Run 1		x	x	
	Connect power supply to rover		x	x	
	Shrink wrap		x	x	
	Swap blown fuse			x	
3/13/16	Trial Run 2	x	x	x	x
	Attach different floaters	x	x	x	x
	Built props	x	x	x	x
	Trial Run 3	x	x	x	x
	Enter Expenses		x		
	Research on motor placement	x	x	x	x
3/15/16	Trial Run 4	x	x	x	x
	Adding chopsticks	x		x	
	Adding hook made of a hanger				x
	Building claw			x	x
	Prop Building	x	x	x	x
3/16/16	Improving claw			x	
	Building Props	x	x	x	x
	Building ROV 2	x		x	x
	Learn about SID	x	x	x	x
4/8/16	Brainstorming ideas for rover name	x		x	x
	Work on SID			x	x

Schedule		Kayla	Hillary	Harrison	Preston
Date	**Assignment**				
4/10/16	Trouble Shooting Performance of Rover		x		
4/12/16	Assigning Roles	x	x	x	x
	Cont. practicing doing tasks	x	x	x	x
	Took photos for poster	x	x	x	x
	Fixing potential meter	x	x	x	x
4/16/16	Researching at Aptos High School		x	x	
4/17/16	Go over point value and rules		x		
	Budget Update		x		
	Practicing doing all the missions	x	x	x	x
	Finalize SID			x	
	Spec Sheet		x		x
	Technical Documentation	x	x	x	
4/18/16	Sub 40 cm Rover		x	x	
	CEO Message	x			
	Abstract	x			
4/22/16	Work on poster	x	x	x	x
	Practicing the missions	x	x	x	x
	Work on buoyancy for rover	x	x	x	x
	Technical Documentation	x	x	x	
	Claw modification			x	
	Practice prensentation	x	x	x	x
4/23/16	Budget update		x		
	Technical Documentation	x	x	x	
4/24-4/29/20	Practice challenge	x	x	x	x
	Practice presentation	x	x	x	x

Photo of our rover - Hydra





Front View

Quick Attachment

Top View

NORTHSTAR MARINE TECH, INC.

Specification:
Width 30 cm
Length 68 cm
Height 9 cm
Weight 7.8 kg
Thrust 2.5 Newton / motor

Reflection

This season in the SCOUT class MATE competition, we learned many skills. We learned to solder, cut PVC pipe, and waterproof motors. We also learned responsibility and time management skills since we had deadlines with a lot to do. We also learned valuable skills in organization and math so we didn't lose track of our budget. Lastly, we learned to cooperate better as a team so we won't have any major or minor mistakes. we have learned a lot since the start of the year. We learned many skills this season during the MATE SCOUT class competition.

Improvements

One improvement that we made was changing from pool noodle floaters to sealed PVC pipe floaters. Before, the way the pool noodles were attached let them come loose and sometimes fall off. We had to cut open a section, slip it around the sides of the frame, and tie it down, but since 1 side was still open, it would fall. We did more research and decided to essentially "bottle" air and tie it onto our robot. The canister of air would give our robot neutral buoyancy and also stayed on. One person, Preston, wanted to use the foam, but we voted to stick with the canisters since it was more reliable because it would stay on and in the same position. We were lucky because in all of our voting sessions, it has been 4 to 0 or 3 to 1 which applies to this situation. For example, our name for our robot was very controversial so I, so we voted and we had a three way tie between Hydra, Presto, and Skidmark. After further deliberation, we settled to the name Hydra. In conclusion, changing from pool noodle floaters to PVC pipe canisters of air was a great improvement.

Acknowledgement

We cannot have pulled this company together without the generous time and money that has been invested and donated to our newly found company. We would like to thank our awesome coach Gary Chu, mentors Sophie Chu, Kevin Rabey and Dung Le. A shout out to Sac- Tee and Champion Prints for their services. If you would like to invest or sponsor in the future of our company, please send inquiries to our CEO Kayla Rabey at NStarMTech@gmail.com.

References

MATE ROV Pufferfish Workshop 1/30/2016
https://sites.google.com/a/sau50.org/rover/making-rov-posters
https://www.grc.nasa.gov/www/k-12/airplane/propth.html
- Underwater Robotics: Science, Design & Fabrication, Steven W. Moore, Harry Bohm, Vickie Jensen, 2010 by Marine Advanced Technology Education Center Monterey, CA
- Build Your Own Underwater Robot and Other Wet Projects: 12th Edition, Harry Bohm and Vickie Jensen 2010 Published by West Coast Words, Vancouver, B.C. Canada
- *Make: Electronics*, Second Edition, Charles Platt, 2015 Helpful Corporation, Canada
- 20 Minute Manager: Managing Time, Harvard Business Review Magazine*, HBR.ORG, 2014 Harvard Business School Publishing Corporation, Boston, Massachusetts*
- 20 Minute Manager: Presentations, Harvard Business Review Magazine*, HBR.ORG, 2014 Harvard Business School Publishing Corporation, Boston, Massachusetts*