Abstract

To improve our ROV and meet the challenges of the competitions, we changed and added to the standard SeaPerch design. (The standard SeaPerch design can be found in the SeaPerch construction manual [Nelson, S.].) We shortened our robot's height so it could maneuver better. We added an arm so it could pick up weighted "mines." We put green paint in the front of the ROV and red paint in the back of the ROV so we could see the ROV and tell which way it was facing. We spray painted the tether so we could see it better. We moved the vertical thruster mounting bar behind the vertical thruster to make more room in the cargo area. We used zip ties and electrical tape to keep the floats in place. We timed ourselves to see who could drive the ROV through an obstacle course the fastest. The fastest driver, Tucker, would drive the robot through the obstacle course at the county competition. When improving our robot this year, we learned a lot. Some of the things that we learned are how to replace components that deteriorated after storage, how to store a ROV, and how to polish up last year's design. We also learned how to work as a team. But our biggest takeaway is probably how to use the engineering design process to solve problems. We had fun and enjoyed building and driving our ROV.

Task Overview

One of the things that we must do in the county competition is maneuver through a series of hoops, surface the ROV, and go back through the hoops (Springs Valley Science). We know that our ROV must be easily maneuverable, so we shortened the height of our ROV. During the SeaPerch challenge, we must disarm a "mine" by turning or removing the "arming device" (RoboNation video 2). We must also open a latch, which opens a horizontal gate. We must move floating "trash" to the pool deck, and we must move sunken "trash" and a sunken "mine" through the gate opened earlier, setting them on a "disposal platform." Another "mine" must be hooked on the vault gate to close it. We must then latch the gate. (RoboNation video 3.) We attached a pipe onto the front of our ROV to pick up the "mines." The pipe would go through the loop of rope on each "mine" to hold it. We thought that this arm might get in the way during the obstacle course, so we made it where it would fold into the ROV. We knew that the "mines" were not the only sunken things that we needed to pick up, so we attached the arm to the side of the ROV. This would allow us to still use the cargo net on the bottom of the ROV. We moved the vertical thruster mounting bar to the back of the vertical thruster to make more room in the cargo area. We spray painted the ROV and the tether so we could see them better during the challenge and the county competition.

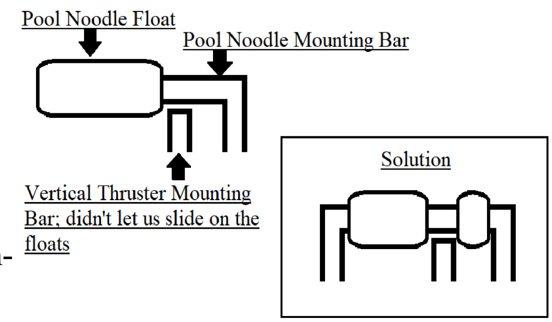
Design Approach

When our team first got out our SeaPerch kit to build it, the first question that we asked ourselves is how we would improve the basic SeaPerch design. We defined our limits. We knew that many SeaPerch teams did not build the basic SeaPerch when they first started out. They soon found that building their own design was too hard, so they went back to the basic design. Based off of this knowledge, we decided not to change up the basic design too much. We decided to try to make the ROV more maneuverable. We began to imagine solutions. We decided to either make the ROV less tall and longer or just less tall. We began to plan the best solution. The second design would be more maneuverable than the first. This accomplished our goal, so we decided to use the second design. We created this design by using it in our ROV. This is a part of our final design and is a part of what makes our ROV unique. When we completed our ROV, this design was more maneuverable compared to other teams using the standard design. This year we thought about making the ROV smaller, but we did not want it to be so small that it was affected by every disturbance of the water.

Predicted Results of Each Design

	Underwater Visibility	**Cargo Room**	**Maneuverability**
Less Tall and Longer	Better	Same	Same
Less Tall	Same	Less	Better

A Problem We Encountered

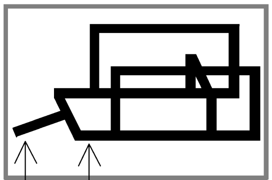


Because of this design, though, we ran into a problem. We had shortened the ROV but not the vertical thruster mounting bar, so the pool noodle floats would not slide on. We imagined solutions. We could either shorten the vertical thruster mounting bar of cut the pool noodle floats in half and put one half in front and one half in back of the vertical thruster mounting bar. We planned the best solution. Shortening the vertical thruster mounting bar would take too much time, so we decided to cut the pool noodles in half. (We ended up shortening the bar anyway.) We created this solution and tested it in the water when we completed our ROV. It caused no problems, so it worked.

We still had not shortened the vertical thruster mounting bar, so we ran into a problem when we were still building our ROV. When we would mount the vertical thruster, it would it would stick up above the water. It would have to push up air instead of water. (Pushing air or water up pushes the ROV down, according to **Newton's Third Law of Motion**.) Air has less **density**, or space between its molecules, than water. This means that the motor has to move more air to move the same amount of **mass** (a measurement of matter). The motor must then work harder, which it cannot do. We imagined solutions to this problem. We could lower the vertical thruster mounting bar. This is the only solution we came up with, so we created this solution by doing it to our ROV. Later, when we tested our ROV in the water, the motor worked.

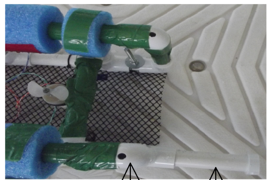
We then asked ourselves, "How would our ROV pick up stuff? The cargo net at the bottom of the ROV would work, but could we create something better?" We defined our limits. We knew that we could not use any motors for the arm. We also had to somehow make it where it would not get in the way during the obstacle course. Knowing our limitations, we began to imagine solutions. Solution 1 is a pipe arm on the back of the ROV. Solution 2 is a pipe arm on the front side of the ROV. We thought about attaching it to the front middle of the ROV, but then we could not use the cargo net. Solution 3 is a wire arm on the front of our ROV. Solution 4 is a wire scoop on the front of our ROV. The first two solutions would be able to fold into the ROV so they would not get in the way during the obstacle course. Design 1 would not work because it is where the tether cord should be mounted. We created prototypes, tested them, and planned the best solution. Design 2 would only pick up the sunken "mines," but it would fold up. Design 3 would pick up everything sunken: the "mines," the water bottles, and the can. It would go through the openings in the water bottles and the can. But we found that

Design 1



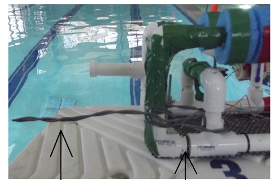
Arm Back of robot

Design 2



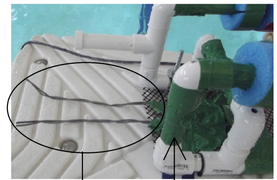
Top front of robot Arm

Design 3



Arm Front side of robot

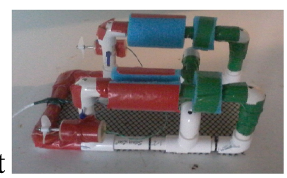
Design 4



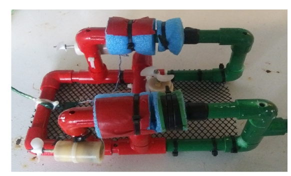
Arm Front of robot

it was impossible to insert it through the opening in the water bottles, and it would not fold up. So this design was not used. Design 4 could pick up all of the sunken trash, too. It would slide under the water bottles and the can. But it was hard to slide it under them, and when you did, it weighted down the front of the ROV because of **leverage**. (RoboNation Video 1) The scoop could not fold in during the obstacle course. So we decided to use design 2. We could use the cargo net for the bottles and the can. Design 2 became a part of our final design and the fact that it folds in and out makes our ROV unique.

We also asked ourselves, "How could we see our ROV and tether better in the water?" We imagined solutions. We could either put paint or duct tape on the ROV and the tether. We also could color the tether with marker. We planned the best solutions. We did the ROV first. We would have to sand the ROV before we painted it, so we decided to use duct tape. We decided to use green in the front and red in the back so we could see which way the ROV was facing. These colors later became our team colors. We later wanted a permanent solution, so we removed the tape, sanded the frame, and sprayed it with spray paint, keeping the same colors. We quickly discarded the idea of using duct tape on the tether cord because it would get caught on things and come loose easily. We started coloring the cord with a marker, but it was taking a long time, so we used spray paint even though it would eventually come off. When we tested the ROV, the spray paint helped us see it better and tell which direction it was facing. This is a part of the final design of our ROV and is a part of what makes our ROV unique.

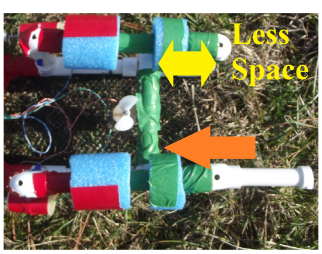


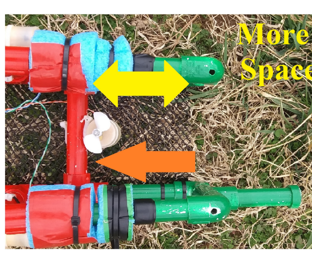
Duct tape



Spray paint

This year, when we were considering how we could improve our ROV, one of us asked, "What if we moved the vertical thruster mounting bar *behind* the vertical thruster? The vertical thruster would be in the same position, and this would give more room in the cargo area in front of the vertical thruster." We saw no problem with this, so we created this design. There was more cargo room as a result of this. This design also caused no noticeable problem when we tested it, except that there was more room in the openings on the sides of the cargo area. It was very difficult to pick up water bottles because they would easily fall out of these openings. We will probably put something on the sides of the cargo area in the future to solve this problem.



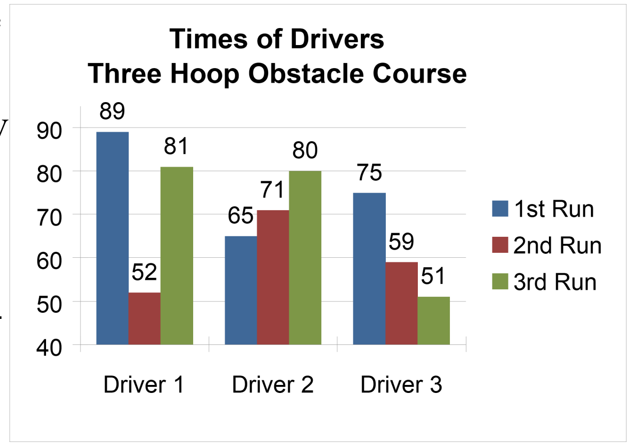


★ **Vertical thruster mounting bar moved behind motor; motor stays in place**

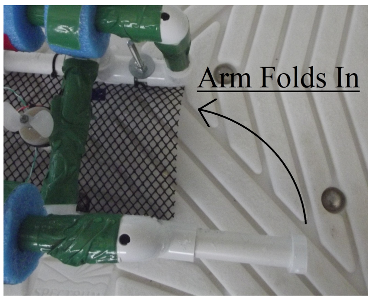
When we were driving our ROV, we noticed that the floats slid forward on their mounting bars, changing the **trim** (balance) of the ROV. We "temporarily" solved the problem by wrapping tape on the bars in front of the floats. We also put zip ties around the floats because we had trouble with the floats coming off of the bars. (We had slit them so we could add and remove them easily.) We want to use Velcro in the future to solve both problems. This will allow us to adjust the floats easier.

Experimental Results

When we were practicing driving our ROV, we wondered who was going to drive it in the local competition. We decided to time ourselves several times and the person with the best time would drive the ROV during the obstacle course. We had an obstacle course with three hoops that we must maneuver through, so we timed ourselves going through it. Each person got three tries. The person that had the fastest time was person three, Tucker. He completed the course in fifty-one seconds, so he will drive the robot through the obstacle course at the competition. The other two will take turns driving during the challenge course.



We then wondered how we could get our ROV to pick up things. We thought that the cargo net on the bottom of the ROV would not be enough, so we began thinking of an arm. The first design we had was putting the arm on the back of our ROV, but that is where the tether cord should go. We began to think of other designs. The second design that we came up with is a pipe arm on the front right side of the ROV. It could fold into the ROV during the obstacle course so it would not get into the way. We tested it by attaching it to our ROV and by trying to use it to pick up the "mines" under the water. It would go through the loops of rope in the "mines." The "mines" were the only things that it could pick up. There was no way for it to pick up the other items. We wanted an arm that could pick up all of the sunken trash. We bent an arm out of wire that could go through the openings in the bottles and the can and attached it onto our ROV. This was our third design. We tested it by trying to pick up the bottles and the can under the water, and we found that it was hard to insert it through such a small hole. It was like trying to thread a needle under water. We did not test it on the "mines," but even if it could pick up the "mines," it would still not be able to pick up more items than design two, and it could not fold up, so we did not use it. We tried to use something that could scoop under the bottles and the can, so we bent a scoop out of wire and attached it to our ROV. This was our fourth design. We tested it by trying to pick up the bottles and the can under the water. It was hard to position the ROV just right before trying to scoop up the items, and it could not fold up, so we decided to use the only other option, design two. We could use the cargo net for the other items.

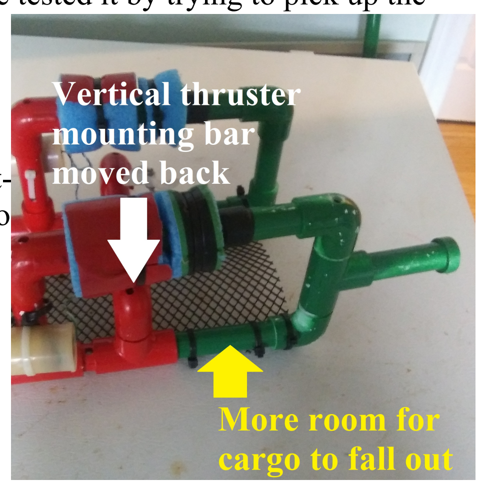


Final Arm Design

Abilities of Designs

	Big Mine	Small Mine	Can	Big Bottle	Small Bottle	Folds Up
Second Design	X	X				X
Third Design	X	X				
Fourth Design	X	X				

We then had the idea of moving the vertical thruster mounting bar behind the vertical thruster to make more room in the cargo area. When we tested the ROV in the water, there was no difference in the way the ROV drove, but there was more room in the sides of the cargo area for cargo to fall out. We decided to use the same kind of netting that is on the bottom of the ROV to cover up the openings. However, we probably will not do this until next year.



Reflection and Next Steps

During the past few months, we had fun and learned a lot. Even though we did not make any major changes to our ROV this year, we learned how to troubleshoot and replace components that deteriorated during storage. We replaced a motor that rusted and replaced the other two just in case they had started to rust. Knowing how to do this is helpful in real life, because everything wears down over time. We also learned how to polish last year's design. We replaced the tape on the robot with more permanent paint. We also moved the vertical thruster mounting bar to make more room for cargo on the cargo net. Just like last year, we learned how to use the engineering design process to solve problems, which is useful if any of us chooses a STEM career. The engineering design process is not only useful for a STEM career, though. It can be used to solve problems in everyday life (KQED QUEST). We did not follow the engineering design process step-by-step when building our ROV, but we naturally used a version of it. We learned its steps anyway, which could be helpful if we encounter a situation that we are not used to solving. We continued to learn how to solder when replacing the motors. Soldering is useful if one of us chooses a job that involves electronics, which is a growing industry. Another thing that we continued to learn is to work as a team. Everything that we learned this year can help us if we have to repair something, because most things have an electronic circuit of some sort. We all enjoyed driving our ROV and practicing for the courses when the ROV was completed. For fun we made a trailer for our ROV that we can attach to a waterproof RC truck; we can use this to back the ROV into the water. Next year we will probably put netting on the sides of the cargo area of our robot so cargo does not fall out. We will probably also attach the floats to the frame with Velcro. This prevents them from moving but lets us adjust them.

Acknowledgments

This project would have been impossible without the support of the Madison County Extension Service: Darrin Henderson, Caramie Edwards, and Jerry Jo Hamm.

We appreciate the generosity of our financial supporters: Ozark Cleaners, Pine Creek Lumber, and Madison County Hardware.

We would not have been able to have as much SeaPerch teams if Ozark Electric and Carroll Electric had not donated SeaPerch kits. Thanks a lot.

We would not have been able to practice if the Berryville Community Center had not let us use their indoor pool. Thank you for your generous support.

Thank you again to Caramie Edwards, who, among many other things, made team t-shirts and helped with team registration.

Thank you to Jim Houchins for donating spare batteries, solder, and wires.

Thank you to Carl Stewart and Todd Franklin for donating material for our obstacle course.

Thank you to our coaches, Brittany Stewart and Stephanie Franklin, who gave up many hours to make this club possible.

References

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RoboNation (Video 2) (2020 Feb. 18) 2020 SPC Mission Course Animation [Video file] Retrieved from https://youtu.be/p-nLmM5nJwo

RoboNation (Video 3) (2019, September 2019) Disposal Vault Underwater View 1920x1080 [Video file] Retrieved from https://youtu.be/658famitpdo

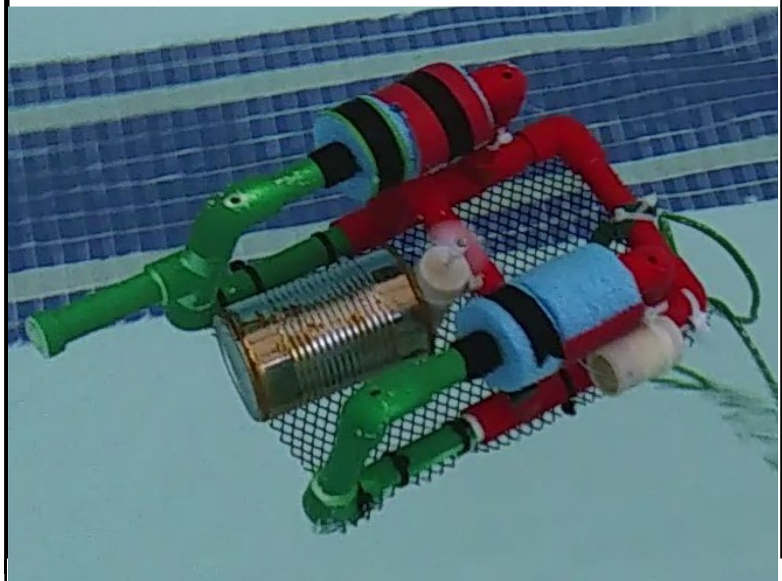
Springs Valley Science (2016, March 9) Sea Perch Obstacle Course 2015 [Video file] Retrieved from https://youtu.be/hIMgyABN2vk

Budget

Component	Vendor	How Component was Used	Cost (in USD)
Duct and electrical tape	Wal-mart	Placed on floats as part of now-rejected designs and never removed; might help see floats better	$.10
More electrical tape	Wal-mart	Placed in front of floats to prevent them from sliding forward	$.40
Some of several cans of spray paint	Wal-mart	See the ROV and tether cord better and tell which way the ROV is facing	$4.25
Pipe	SeaPerch	Arm on ROV	$1.15
Cord reel	Lowe's	Keep cord untangled	$8.98
4 zip ties	Wal-mart	Keep floats on the ROV	$.40
		Total Cost	$15.28

RoboClovers

Huntsville, Arkansas, USA



2 Years participating in SeaPerch

2* Times at the International SeaPerch Challenge
*2020 challenge cancelled

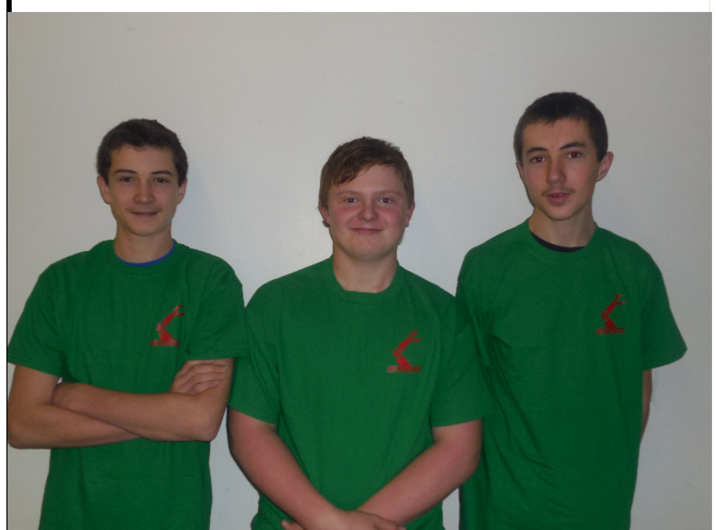
Our SeaPerch is unique because: (50 words MAX)

We shortened its height. Its arm can swing in so it will not get in the way. The ROV and tether are painted to make them visible. The ROV has different colors so we can tell where it is facing. The frame is slightly redesigned to make more cargo room.

SeaPerch Design Overview: (100 words MAX)

We shortened our ROV's height so it will be more maneuverable. We added a pipe arm onto the ROV. It can swing into the robot's cargo area during the obstacle course. We spray painted the cord and ROV so we can see them better under the water. We put green on the front of the ROV and red on the back so we can tell which way it is facing. We moved the vertical thruster mounting bar to the back of the thruster so there will be more room for cargo.

Our biggest takeaway this season is: (50 words MAX)



Our biggest takeaway is how to work as a team and use the engineering design process to solve problems.

Team Members:
Tucker, Grade 10
Laven, Grade 10
Austin, Grade 8

Mentors:
Stephanie Franklin, 4-H
Brittany Stewart, 4-H
Todd Franklin, 4-H
Carl Stewart, 4-H