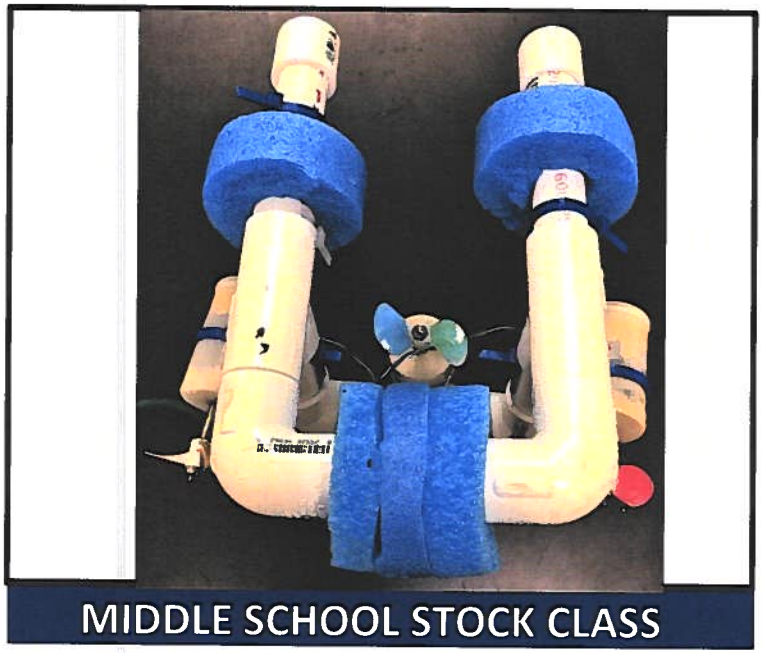
Team Name: Sea You Later

William A. Diggs Elementary School, Waldorf, MD, USA



MIDDLE SCHOOL STOCK CLASS

3 Years participating in SeaPerch

1 Times at the International SeaPerch Challenge

Our SeaPerch is unique because: (100 words MAX)

Our SeaPerch is unique because it is the result of three years of hard work. This SeaPerch reflects our thinking that small kids/ROV's can do great things. Our design is unique because it reflects our need for speed. The smaller design allows for fast bursts and great maneuvering. No matter what challenge you give our SeaPerch its ready! This Seaperch has taught us to rise to challenges, big and small. Our SeaPerch demonstrates our commitment to imagine it, build it, and drive it! Just add water!

SeaPerch Design Overview: (100 words MAX)

Our SeaPerch design was minimal. We wanted it to have as little mass as possible. We turned our ROV upside down and removed what would have been the top part completely. We moved the floats to the front and back to provide stability. The buoyancy was adjusted using Archimedes Principle. We added caps to keep some water out. We arranged our motors to take advantage of trust in the water. The hydrodynamic design is small and allows it to travel through the water quickly, but is also very agile.

Our biggest takeaway this season is: (100 words MAX)

Our biggest takeaways this year was continuing to gain knowledge, working as a team, and solving any problem we faced. As a team, we learned to work together using the engineering design process and continue to improve. We had to learn to communicate online and over long distances. If we believe we can do it, we just have to put in the effort and solve one problem at a time. We learned that not all answers are easy. Just try your best. If you give your best effort then good things will happen.

Abstract

This paper offers an overview of our team's experience with designing and building our sea perch and preparing for competition. We will explain how we used the engineering design process to create a ROV that would help us reach our goal of getting through the obstacle course and mission course with the fastest time possible. This paper will also discuss the challenges that our team faced throughout the process, and how we worked to overcome them. We have shared our data from our practices in the pool, and have discussed how we used that data to make our ROV the most efficient that it could be. When writing our paper, we reflected on our seaperch journey together, and came up with some ideas that could be next steps based on what we have learned. Our team has worked hard this season in a virtual environment and look forward to our future.

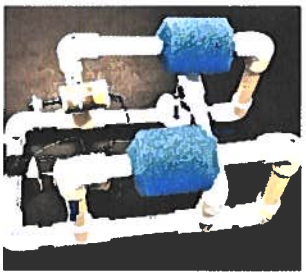
Task Overview

Our task for the mission sea perch challenge is to complete 4 different challenges as quickly as possible. The first obstacle called "the active mine" requires us to disarm the mine by turning it from the armed position to the off position. This obstacle requires us to maneuver our ROV delicately to disarm the mine. The second obstacle "the disposal vault" requires us to open a vault by hitting a latch. The latch then floats up and we have to retrieve a mine and hook it onto the latch to make it close. This requires a lot of maneuvering and your ROV must be able to pick up and drop the mine in certain locations. The third obstacle is "the garbage patch" and for this task, we must remove all the floating debris from the floating patch by any means necessary. The last obstacle is "the sunken waste" and for this obstacle we must pick up the sunken debris, drive it around the course, and deposit it in the correct area. Obstacles three and four require us to maneuver our ROV and pick things up. The goal of the mission course is to complete it in the fastest time possible, and the task will require our ROV to move through the water with agility. The ROV must be able to go up, down, left, and right with precision. The design of the course influenced us to make our sea perch with less mass. The smaller size would allow it to maneuver more easily because the motors would have more power to push through the water. The smaller design would also allow our ROV to contact the water less and decrease friction. The less friction would allow it to move faster. The driver must be able to maneuver the ROV through the course, which took a lot of training.

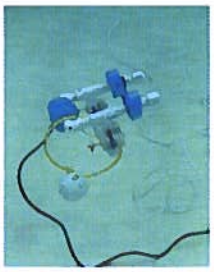
Design Approach

We designed our original seaperch to be able to complete the obstacle course with hula-hoops as fast as possible for our county's regional competition in 2019. This perch was able to complete the course in 2019 in one minute and twelve seconds, which helped us win second place in speed that year. We decided that we wanted to make our perch smaller in order to reduce the mass and size so that we could increase speed and agility. We made the perch weigh 15.18 ounces with the motors. We also modified the frame design to make it more hydrodynamic. Hydrodynamics is a branch of physics that deals with the motion of fluids and the force acting on solid bodies immersed in fluids. By making the perch smaller, we also improved our buoyancy. We had to improve the buoyancy because the buoyancy makes the perch be able to go up and down in the water. We made the perch be upside down because the motors must stay underwater water until

we surface and go back to the wall. We also had to waterproof and stabilize the motors. We cut down 31.5 inches of the PVC pipes down. We paid close attention to Archimedes principle where the upward buoyancy forces is equal to the amount of water displaced by our seaperch. This principle allows us to maneuver our seaperch more easily through the courses.



Our original SeaPerch from 18-19.



Final SeaPerch Design

When designing and redesigning our perch, we followed the steps of the engineering design process. The first step of the process is to ask questions and define the problem that we are trying to solve. One of the first questions that we asked was how can we design the perch to quickly maneuver through the hoops? We also had to figure out how small the perch had to be in order for it to move quickly through the water. To help us find the answers to these questions, we used the second step of the engineering design process, which is research.

We first researched buoyancy and how it would affect our perch and Archimedes principle. Buoyancy is the ability, or tendency to float in water. Based on this research, we were able to move into the third step of the process, which is imagine. In this step, we took time to develop some design ideas for our perch. Some of these design ideas included a cube shape, a triangular perch, and the upside-down perch that ended up being the chosen design. We thought that the triangle shaped, and cube shaped perches would be small enough to drive fast in the water. In the plan step of the engineering design process, we decided against the first two designs because we were unsure of how we were going to be able to place the pool noodles and the motors on them. We knew that the upside-down perch would be a good size, and that we would be able to easily control the buoyancy using the placement and size of the pool noodles. When on the create step of the engineering design process, we built the first prototype of our perch.

In order to test our prototype, we brought it to our first practice at the pool. We drove the perch through the obstacle course and recorded the time that it took to go through the course and back. After analyzing the times from this first practice, we decided that our perch should be smaller in order for it to go even faster. When completing the final step of the engineering design process, which is improve, we made the perch smaller by cutting off some of the PVC pipe. We had also noticed that the perch was tilting when driving it through the water, so we had to adjust one of the motors that was off-center. After several design iterations including changing the size of the PVC pipe to make it smaller and removing the front of our ROV, we were finally happy with its design. We continued to analyze our ROV after every pool practice to see if we can improve our

time. This included checking our battery strength and controllers. The design iterations allowed our ROV to go faster and have more agility in the obstacle course while working at maximum capacity.

The final design has a very small mass and allows us to have full control of the direction of the ROV. We learned that the up/down motor must be in an exact spot or it would cause your ROV to drive tilted. Our side motors also had to be aligned to help maximize the amount of the acceleration rate. Our upside-down perch changed our vision of how a Seaperch could be built and allowed us to imagine more creative ways to build. We used this seaperch at our county regional competition in 2020. We did two obstacle course runs with 6 hoops and our times at the competition were 42 seconds and 37 seconds. We placed first by 16 seconds.

For the 2020-21 season, we were virtual. We didn't make any modifications to our ROV because we felt it would be successful on the mission course. We did have one pool day to test on April 25th, 2021. On this date, our ROV was able to do all the obstacles, but we felt we needed to modify our ROV by adding some netting to help pick up items on the bottom of the pool. In the future, we want to try a flat perch with the up/down motor upside down. Our final design allows us to move quickly and pick up objects if needed. We even practiced by picking up rings from the bottom of the pool.

Experimental Results

Over the course of two months in Jan. 2020- March 2020, we tested our ROV using obstacle courses consisting of two, four, and five hoops. The obstacle course changed at each practice using vertical, horizontal, or slanted hoops. Our goal for 2019-2020, was to complete the obstacle course in under one minute.

Before our first practice, we analyzed the results from the 2018-2019 year. We knew our ROV could go as fast as 1 minute and 14 seconds through the obstacle course. This was our top competition time the year before. We decided as a group to make our ROV smaller with the goal of increasing speed. We tested our prototypes at school in our classroom sinks and eventually our cafeteria sinks. This allowed us to correct our buoyancy before we tested our ROV at the bigger pools.

Pool Date Data

Date	Driver	Time	# of Hoops	Date	Driver	Time	# of Hoops
1/12	Kayden	:45	2	2/9	Tylor	2:20	5
1/12	Tylor	:32	2	2/9	Tylor	:50	5
1/12	Tylor	:29	2	2/9	Tylor	1:02	5
1/12	Steven	:57	2	2/9	Tylor	:52	5
1/12	Tylor	1:00	4	2/9	Tylor/Kayden	:52	5
1/26	Tylor	:58	4	2/9	Tylor/Kayden	:46	5
1/26	Kayden	1:34	4	2/23	Steven	1:32	5
1/26	Tylor	1:12	4	3/1	Tylor/Kayden	:55	5
1/26	Kayden	1:02	4	3/1	Kayden	1:18	5

1/26	**Tylor**	**:51**	**4**	**3/1**	**Tylor**	**:46**	**5**
1/26	**Kayden**	**1:01**	**4**	**3/1**	**Tylor**	**:58**	**5**
3/7	**Tylor**	**:42 (Competition)**	**6**	**3/7**	**Tylor (Competition)**	**:37**	**6**

After each pool date, we analyzed our data and made changes to our ROV to increase our speed. On 1/12 our fastest time was one minute. We decided Tylor was our fastest driver and Kayden would be our alternate. We cut one inch of PVC pipe from the top of each side of our ROV and our time decreased to 51 seconds on 1/26. Then we removed the front PVC pipe and replaced it with two caps. We thought this would reduce the mass and allow us to pick up objects. Our fastest time decreased to 46 seconds on 3/1. The many iterations helped our ROV go faster, and our times became more consistent. At competition, our times decreased to 42 seconds and 37 seconds. Placing us first overall at the 2020 regional competition.

In 2021, we met virtually as a team. Our driver, Tylor, had to move to Texas. We finally got to test our ROV for the mission course on April 25th, 2021. At this pool date we were able to deactivate the mine, open and close the disposal vault, clear the garbage patch, and move some sunken debris in 5 minutes.

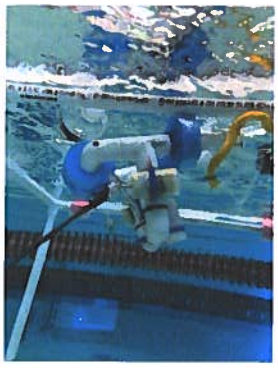
Reflection & Next Steps

This season, was a challenge for our team to work virtually. We started the 2020-2021 season at a new middle school but decided to continue working as a team. In October, one team members dad was military transferred to Texas. We had to learn to work remotely. We focused our efforts on learning how the ROV moves through the water. We met virtually every few weeks and discussed the challenges of the courses and how to improve. We tested our ROV one time the whole year with Tylor attending the pool meeting via FaceTime. We developed our plan to complete the mission course. This year has been a struggle, but we continue to grow and learn.

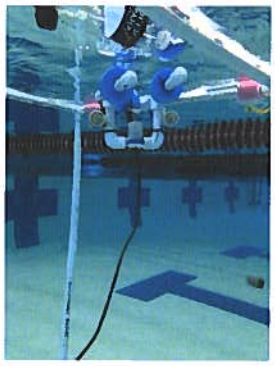
After reflecting on this season, we were able to come up with many ideas for applying our learning to future projects. One idea is that we could build and use a sea perch to conduct research of the ocean. We could study coral reefs and discover underwater plants and animal species. We would like to help the environment by designing a perch that could pick up trash in the ocean. A perch could also be used for marine search and rescue missions. If redesigned to be larger, a perch could be used to help people, including young children and people with disabilities, learn to swim. They could hold on to the perch while it guides them safely through the water.

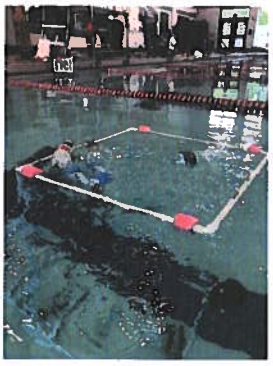
If we adapted the perch for land by adding wheels, it could be used to assist law enforcement agencies. We could also use the perch to clean up trash and pollution on the ground. Our team also believes that an ROV could be built to assist with satellites and other aspects of research in outer space. It could be used to take pictures and videos, as well as make repairs to satellites and space crafts. Overall, we have learned that there are many ways that our knowledge from sea

perch has real-world applications. As a team, we would like to continue working together to expand our knowledge of sea perch.



Picking up rings





Clearing the Garbage Patch

Budget

Part	Cost
Original SeaPerch Kit	Provided- $0
2- LASCO 1/2-in x 1/2-in dia Cap PVC Fitting	$0.98

Total Spent: $0.98

Acknowledgements

Thank you to our supporters, coaches, parents, and pool volunteers.

Special thank you to:

Principal Debbie Calvert

Vice Principal Missy Withrow

Vice Principal Robert Opiekun

Sponsors: Mr. Johnson, Ms. Davis, Ms. Bliss, and Ms. Lambiase

Helpers: Ms. Lilymar-Torres-Santana

Pool Help: Mr. Ogle, Gianna Chang, and Kyla Grooms

St. Charles High School and Lackey High School Pool Staff

Resource Section

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