

St. Martin of Tours IMS



2018 Engineering Notebook



“We are better together!”

SMT SeaPerch

St. Martin of Tours School

Independence Mission Schools

Mr. Andrew Bevilacqua, Mr. Scott Jackson and
Mr. Charles Pavonarius

5701 Loretto Ave.

Philadelphia, PA 19124

(215) 744-0444

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Naval Engineering Research

Naval Engineering is the division of engineering that deals with the operation, construction, and design of ships. ROV stands for remotely operated vehicle. These machines are operated by a controller which can be located above water. There are different types of ROV's that include cameras for researchers to see underwater and various tools depending on which type of ROV being used. They're connected to an energy source, communication cables, and information transfer by a cable or other wireless signal.

These devices are heavily used in marine biology. The United States military uses ROV's to search for ordinances that have been lost underwater.

In our study of hydrodynamics, we learned about drag and Newton's laws. We slanted the front of our SeaPerch to make it have less drag while it is in the water. We also slanted it because slanted surfaces are more dynamic. One of the reasons we chose a slanted front is because we looked and saw that a streamlined body has only a 0.04 drag coefficient against the 1.05 coefficient for the cube.³

We studied thrust. We made decisions based on the angles of the motors. We decided to keep the motors straight. When we tested our perch in the 45 gallon tub, we made small modifications until the Perch traveled straight without tilting.

Design and Engineering Process

We did a lot as a team in order to get to where we are now. Mr. Jackson asked us to think about ideas on improving the perch. Our first change to the perch was an attempt to get more speed when running the perch. We talked about the front of the perch, and how we could change the pipes in order to get more speed. We then decided to take away the 4" pipes, the 5" pipes, the 1.5" pipes, and the three elbows that came with them. We figured out the exact measurements by using the Pythagorean Theorem, which resulted in having the correct length for the pipes and the angles for the elbows and corners.

We replaced these with a 6.5" pipe, two 45° elbows, and a 90° elbow. Some other ideas we had were mostly replacing the front pipe with a tee and certain other materials. We first had to measure the length of the space the tee gives along with the space in between the tee and each elbow. The materials that we were planning to attach were a small water proof flashlight, a long pipe in the shape of a hook, and shorter PVC pipe with a magnet.

Modification 1

12/18/17

We decided to angle the front of the perch using 45° elbows. We had to measure the base and calculate the distance needed without a tee. We calculated it to be 6.5", the 1.5" pipe, the 4" pipe, and 1" for the tee. After that, we determined that the height of the perch is 7.5". We reviewed the tables for scheduled 40 pipe with a 1/2" diameter.² A corner elbow and a 45° elbow are 2.5". This leaves 5" to bridge. Once we had the legs of triangle, we used the Pythagorean Theorem to determine the missing leg of the triangle. We cut the pipe to 6.25". It was too long because we didn't account for the ends of the corner pieces. When we looked at the table, we discovered that it was necessary to take off 3/4" on each end. We cut 1 1/2" off the pipe, and it worked perfectly.



See Figures 1 and 2 for more details.

Modification 2

For this modification, we thought about the challenges we would be facing this year. Since we have to set off a light sensor, we made a flashlight attachment and put it on the front of the perch. We put the 2.5" flashlight inside of a T pipe, then zip-tied them together. We also created space for this attachment by cutting the pipes on the front of the perch.

The calculations can be found in Tables 1a and 1b. See Figure 3 for more details.

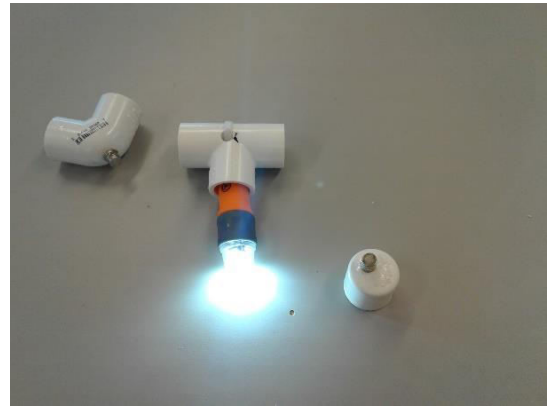


Figure 1

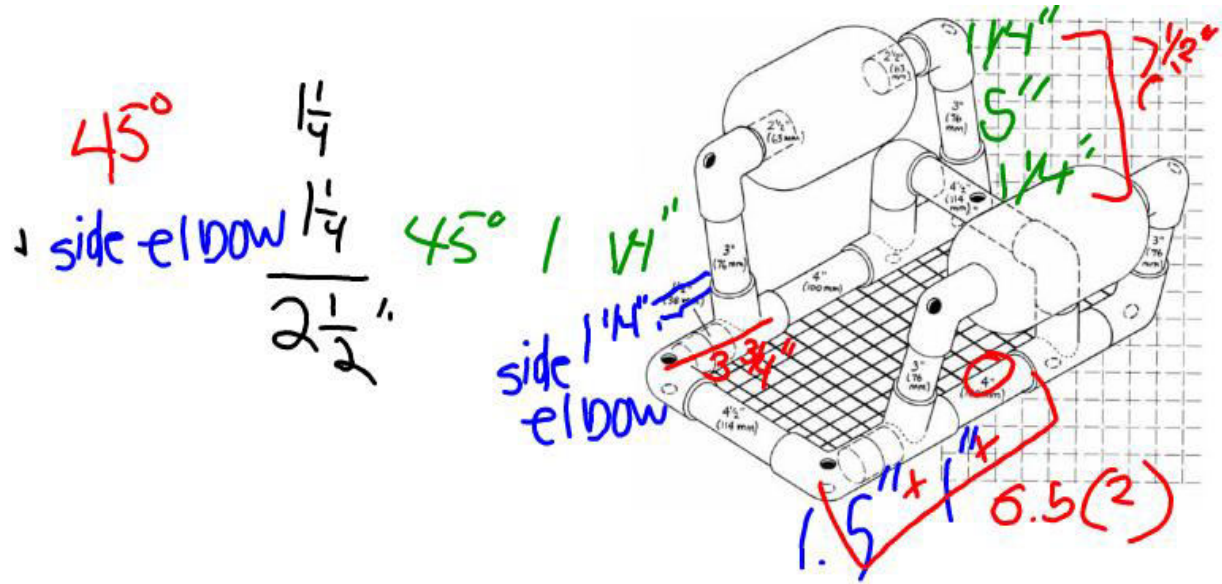


Figure 2

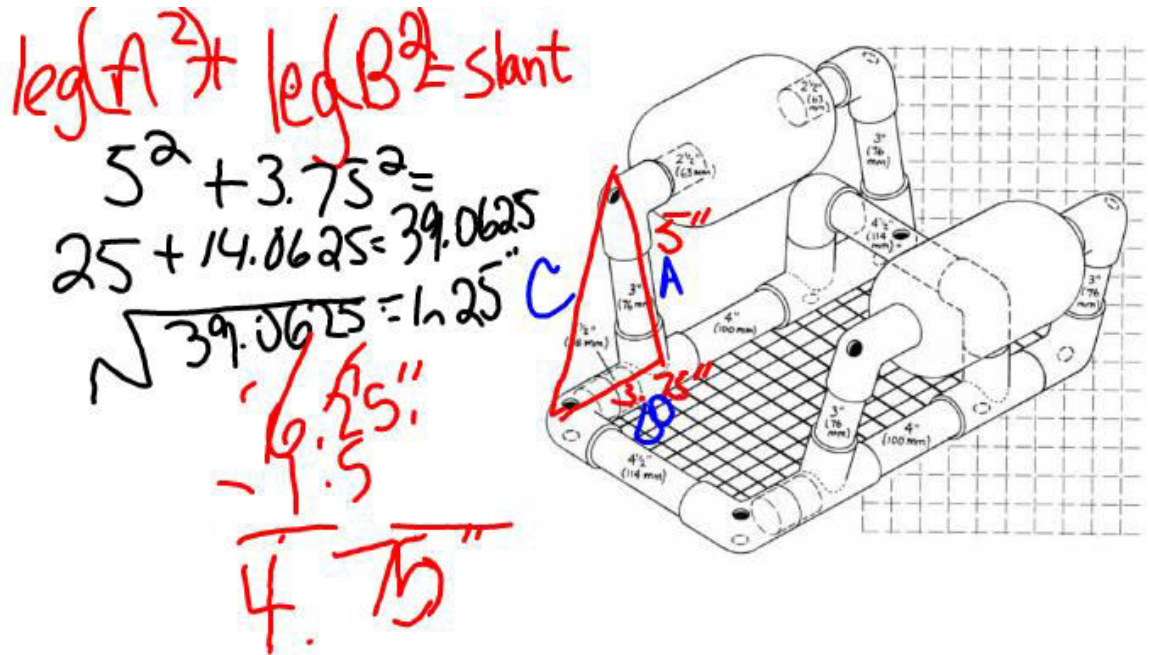
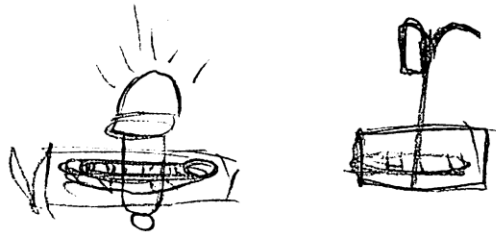
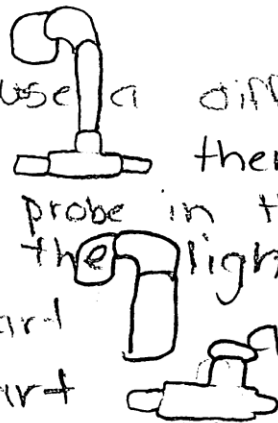


Figure 3

alejandro, yuri, Javier
The flash light at front with zipper attached
then take the flash light off then put the magnetic



We are going to use a different method
the "elephant trunk" then we will
put the magnetic probe in the hook then
when we need the light we would
take off this part and put the
light in this part



Tables 1a and 1b

Complete the table below. You can use a calculator.

We know:

Tee = 27.2 g

1" PVC = 2 g

$$\begin{array}{r} + 14.2 \\ 27.2 \\ \hline 41.4 \end{array}$$

	Modification	Tee	Total	Weight to be added
Light	31.4 g	27.2g	58.6g	0g
elbow + magnet	25.9 g	27.2 g	53.1 g	5.5g
cap + magnet	14.2g	27.2 g	41.4	17.2g

Calculate the necessary pipe length needed to balance. Remember that 1" = 2 grams.

	Weight to be added	Pipe Length
elbow + magnet	5.5 g	2.75"
cap + magnet	17.2 g	8.6"

Experimentation

We conducted two major experiments, the first of which was with magnets and weights for the light and probe modification. The other major experiment was to modify the frame by slanting the PVC pipes and using 45 degree elbows rather than 90 degree elbows.

We constructed a chart of the weights of the parts that made the tee modification. We added the parts together to determine the weight of each modification. We added a small piece of PVC pipe to make the modifications even. We used the flashlight modification as our control in the experiment. Once we determined it had a mass of 58.6 grams, we calculated the needed weight to be added to the perpendicular piece of the tee.

Our calculations were off because we misread the amount for 1" of PVC. After using a small digital scale, we re-measured and we were successful in balancing the weights of the tee modifications. Our tee and cap combination was 58.9 grams, our tee and elbow combination is 59.1 grams, and our flashlight and tee was 58.6 grams. Since we were within 1% of the weight, we determined they were even for our purposes.

We also decided to slant the front of our frame. To do this, we had to measure the distance from the top to the bottom of the frame using a slant. We deleted the front vertical pipes. To achieve the goal, we used the fittings and dimensions chart from Aetna Plastics to recalculate the distances. Once we had the legs then we could use the Pythagorean Theorem to figure out the hypotenuse of the triangle.

Our team did not account for the overlap where the PVC pipe enters the fitting. We attempted to put the frame together but realized it was too long. Once we cut the 1" of overlap, the new pieces fit perfectly. Please see Figure 1 for more information.

We tested the strength of our magnets, first using paper clips, then using marbles.¹ We constructed a simple frame to hold the items above the ground then measured how many magnets would hold the number of paper clips or marbles. We used a small digital scale to measure the mass. We created a torpedo similar to the one on competition day making it larger than the one the website. We measured its mass. If our magnets could hold more than the mass of the torpedo, they should work at the competition.

Afterwards, we started testing if the motors were functional. Our up and down motor stopped working. We went into troubleshooting mode, hoping we would not have to find a new motor. Luckily, a wire came loose from a terminal. We scooped out some wax to get to the terminal, we stripped the wire and soldered it again. Finally, we had three working motors.

Before competition begins, we will take the Perch and test it in a 45 gallon plastic tub in the school yard since our school doesn't have a pool. We will take our washer kit and make balance modifications.

Naval Scenario

1. Saving Submariners

While it doesn't happen often, ships can sink, or workers and sailors can be swept overboard in ocean storms. ROVs can be used to save sailors who have gone overboard. They can be used to save many lives that are normally lost in disasters at sea.

The ROVs are a big important part in saving sailors in an emergency.⁴

2. Hull Inspections

A hull is the main part of any oceanic vehicle/submersible. Hulls of these vehicles can be damaged when in use. If this goes unrepaired, the ship can take on water or sink. ROVs can be used for checking the parts of the hull that are submerged for any sort of damage. If there is damage, they can also be used to make any necessary repairs.⁵

“A hull is the main part of a ship or other vessel”. Without water robots the Navy wouldn't be able to do a lot of jobs they do now. The Deep Sea Trekker ROVs are the best robot for the job.

3. Explosive Ordnance Disposal

These tasks usually include the disarming of underwater munitions (bullets and bombs) and explosives. The robot makes it safer to disarm explosives. It is safer because if the bomb explodes then it won't take a humans life. Also it is safer to have the robot go underwater because of the depth and the depth and pressure of the water will kill the diver but not the robot because the robot can go to the depths of 10,000 feet. It would also be easier to have a robot to work in the dark because when you go deeper into the ocean the less light and the robot has powerful flashlights, thermal vision, and night vision.

4. Special Operations

ROVs are incredible machines that can be used in many different ways. There are sure to be other special operations that the Navy can use ROVs for.

Why is our Perch a great choice for the Navy you may ask? Well here is why, our Perch has a slanted front which will make it faster in the water, making underwater operations a lot faster which could be important in let's say a rescue mission.⁶

References

¹ www.wikihow.com/Determine-the-Strength-of-Magnets

² www.charlottepipe.com/Documents/DimensionalCatalogs/Pressure_Pipe_Fittings.pdf

³ www.engineeringtoolbox.com/drag-coefficient-d_627.html

⁴ www.deeptrekker.com/top-3-uses-for-mini-rovs-in-the-navy/

⁵ www.naval-technology.com/features/

⁶ www.navy.mil/navydata/fact_display.asp?cid=4300&tid=87&ct=4

Teamwork

Team Members:

Javen Beasley	Grade 8
William DeLeon	Grade 7
Yuri Faison	Grade 6
Kennedy Fuller	Grade 7
Kevin Gomez	Grade 8
Bryant Howe	Grade 8
Allendy Jaquez	Grade 8
Zyon Magalhaes	Grade 7
Michael Pham	Grade 8
Quintavius Phillips	Grade 7
Javier Rodriguez	Grade 6
Iris Sanchez	Grade 7
Alejandro Vidot	Grade 6

Advisors:

Andrew Bevilacqua
Scott Jackson
Charles Pavonarius



SeaPerch Agreement

At our first meeting, we signed off on the following agreement. It is included here as a kind of “constitution” about teamwork.

As part of the 2018 SeaPerch club I agree to the following statements:

I will practice science lab safety rules.

I will treat the equipment, tools, and kit as if it is my own.

I will arrive prepared to learn and perform at every session.

I realize that this is a school activity and should be treated as such.

I recognize time is valuable and I will make the most of my time in SeaPerch.

I will remember that the teachers are volunteering to be here with us.

I will treat my teammates with respect.

I will work hard because my teammates expect me to work hard.

I recognize that this is a challenge.

I was chosen because my teachers believe that I can rise to this challenge.

I know that everyone makes mistakes and that I might even make some.

I agree to encourage my teammates.

I will remember last season’s challenges and adapt to new challenges.

I realize I will not always get to do the job that I want to do.

I believe that we can win but the treasure is being able to take part.

I realize that none of this is life and death.

I will learn and have fun.

By signing below we agree to these statements.

Distribution of Tasks

From the SeaPerch teacher's guide

In middle and high school, we recommend that each student take a particular area of engineering and apply it to their team and their SeaPerch ROV build. They can then prepare short lessons on their particular area of expertise in order to share with their teammates. The following student "specialties" are recommended:

- *Mechanical Engineer: In charge of motors and mechanical systems.*
- *Materials Engineer: In charge of structural systems. Checks quality of structure on daily basis.*
- *Electrical Engineer: In charge of control box and control systems. Maintains battery charge.*
- *Systems Engineer/Project Overseer: Maintains positive flow, oversees project and maintains a record of the build.*
- *Presentation Designer: In charge of creating the final SeaPerch presentation.*
- *Technical Writer/Illustrator: In charge of maintaining the engineering notebook.*

Mechanical Engineer – Bryant, Assistants – Zyon, Alejandro

Materials Engineer – William

Presentation Engineer – Yuri, Assistants – Alejandro, Javier, William, and Michael

Systems Engineers – Kennedy and Quintavius

Electrical Engineer – Javen

No assigned job, Michael, Iris, Kevin, Allendy

-William and Zyon worked on the design and engineering process

-Iris, Kennedy, and Quintavius worked on teamwork which is list of the members, how team members work together, responsibilities, and discussion of challenges

-Alejandro, Javier, Yuri worked on Naval Scenario is how the navy can use the Sea Perch

-Javen and Bryant worked on Naval Engineering, Principals, and Mechanical Engineering

-Allendy and Kevin did experiments

Discussion of Challenges

The team worked together and helped each other out when we were working on the building of our SeaPerch. Each of us helped out during this. A few of us helped find pieces and fit them where they are supposed to go, some other the other members put the pieces in place. Like, putting the tubes in place and making sure they stay in place. Everyone was doing something and participating in the making of our SeaPerch. Challenges we faced early on was with our measuring. We want to be exact with measuring and how everything was going to fit. We had to remodel it to see if the upgrade will be better. Our motors had to be taken apart to figure out why the motor wasn't functioning. Another thing everyone worked on together was then the members worked on the assembling of the motors. The members put the wax in the tubes so that they would stay in place. We put too much inside so some other members took them out and redid it. They worked together to redo it. We had an issue with one of our motors. It wasn't working when we tested; even though, it worked the week prior. After checking the motor, we realized that one of the wires had been disconnected. To fix the issue, we simply had to re-solder the wire to the motor.

List of Materials

Materials

- PVC pipe
- Tape
- Toilet wax
- Zip tie
- Wire

Tools

- Drill
- Pipe cutter
- Vice
- Soldering iron

Extra (for our modifications)

- 4 PVC elbows (10 for \$3.60, \$.36 each, total \$1.44)
- 2-5" PVC pipe (One 5' length of pipe, \$2.08)
- 4-1" PVC pipe
- 2 PVC side outlet elbows (\$.98 each)
- 1 PVC tee (10 for \$2.97, \$.30 each)
- 1 PVC cap (10 for \$2.62, \$.26 each)
- 10 rare earth magnets (tube of 10, \$2.99)
- Misc. washers and wire ties (pending testing)

Total expenditures \$9.03. Washers and wire ties will not exceed the balance of \$10.97.

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 Description

- Conforms to meet Standards: ASTM D 1784, ASTM D 2466, NSF 14 and 61
- Used to turn the pipe 90 degrees; also called a 1/4 bend

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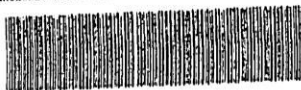
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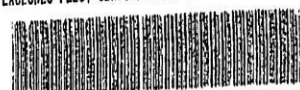
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