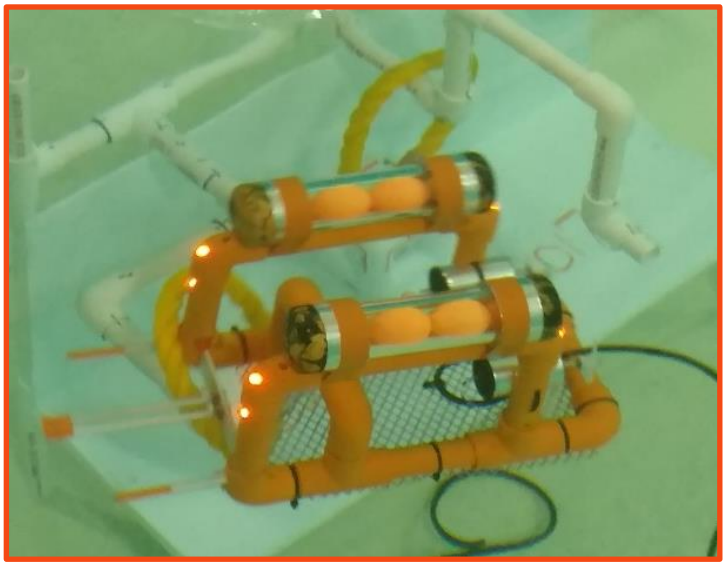
SeaPerch 2017 Engineering Notebook:

A record of events for Team Poseidon

TEAM

POSEIDON



Completed: March 15, 2017

Northumberland Middle School

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Luke

7th grade

Engineer, ROV Captain

Channing

7th grade

Engineer, ROV Co-Captain

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Captain and Co-Captain:

After being fortunate enough to compete at the National SeaPerch Challenge at LSU in May of 2016, Luke began the 2017 SeaPerch program at Northumberland Middle School with high hopes about building a new ROV. His partner from last year is a year older than Luke, and is not in the program this year. Team Green Marine came in 7th at the 2016 National Challenge in the Poster Competition, and 18th overall!

Luke went to the first scheduled SeaPerch build held at his middle school & noticed that there were an odd number of students participating. So instead of building his ROV during the school builds, he helped the other students build their ROV's and built his on his own time.

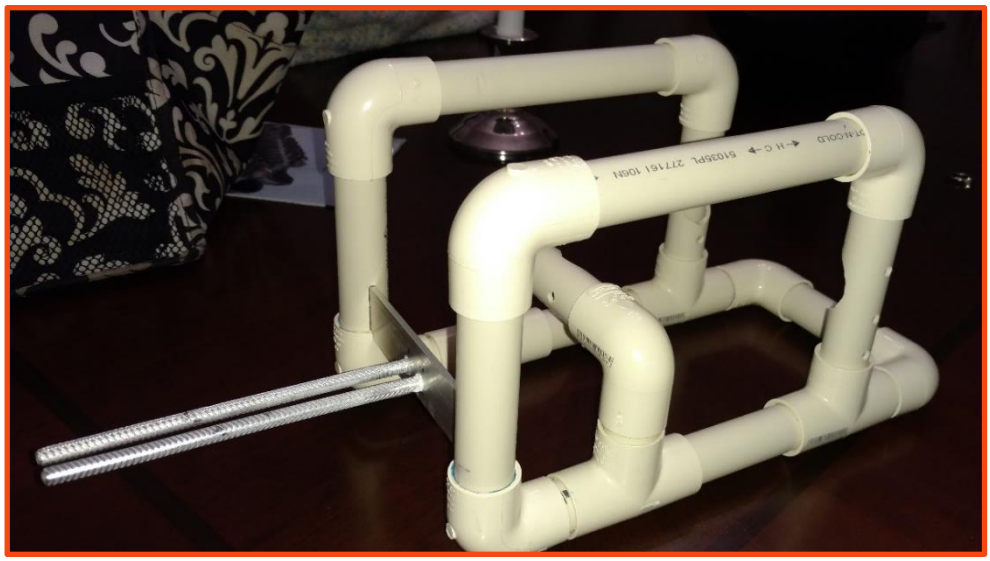
In January, Luke spoke with his teacher about Luke's need for a partner to compete in the 2017 SeaPerch Challenge. Together, they decided that Luke would ask his longtime friend, Channing Reynolds, if she would like to come on board as his co-captain. Channing built her own ROV in 2016 and had attended the 2016 regional competition in Virginia, so she was very familiar with the program. Channing accepted the offer, and she and Luke got together to go over the engineering construction of the SeaPerch, work on their Engineering Notebook, and have a dive practice. She also attended the SeaPerch builds and dive practices held by Northumberland Middle School. Channing took right to the program, and she and Luke make a fantastic team!!

The 2017 Challenge Puzzle:

A new year for the SeaPerch Challenge brings new challenges! When gearing up to begin building a new SeaPerch design for 2017, Luke first went to www.seaperch.org to see what the challenge would be this year. Immediately he realized the first thing he needed to do was to build the challenge puzzle. This was so he could prepare for how best to create and manipulate the SeaPerch Remote Operated Vehicle (ROV) so that he could complete the puzzle quickly and easily while scoring optimum points. Using the instructions on the website, Luke constructed the challenge puzzle along with guidance from his father.

2017 Perch Challenge Puzzle

Once the puzzle was constructed, Luke made decisions about his 2017 SeaPerch ROV Prototype. He quickly learned that whatever he chose to use for the protrusion to capture and manipulate the rings and cubes would have to be low on the ROV so that he could pick the object up straight and level. He chose to use light-weight, but strong aluminum gutter nails in the middle and on each side of the front pipe to have more opportunity for pushing the rings/cubes around. (Hence the name "Poseidon" as it looks similar to a Trident). Luke also decided that the ROV needed to be small enough to be able to maneuver in between the challenge puzzle in order to have better control when placing the cubes and rings on the puzzle.

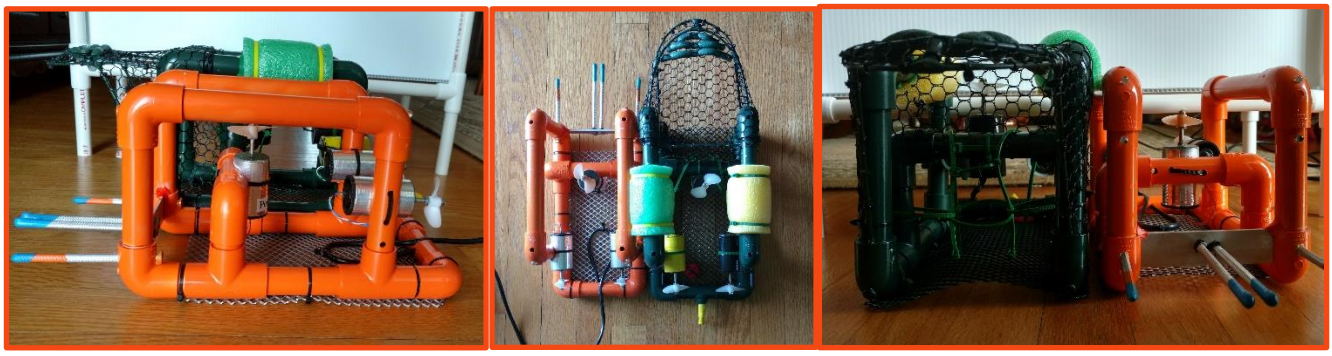


First prototype of the Poseidon! The protrusions were too high on the ROV which made it difficult to retrieve a cube or ring. Eventually we added prongs on the sides too, and lowered them for better control.

2016 Nationals- Ideas and Improvements for the 2017 ROV:

After being able to enjoy the LSU experience in 2016, Luke learned some very valuable lessons that he wanted to implement in the 2017 ROV prototype. Listed below are things he learned and how he carried that into the Poseidon ROV:

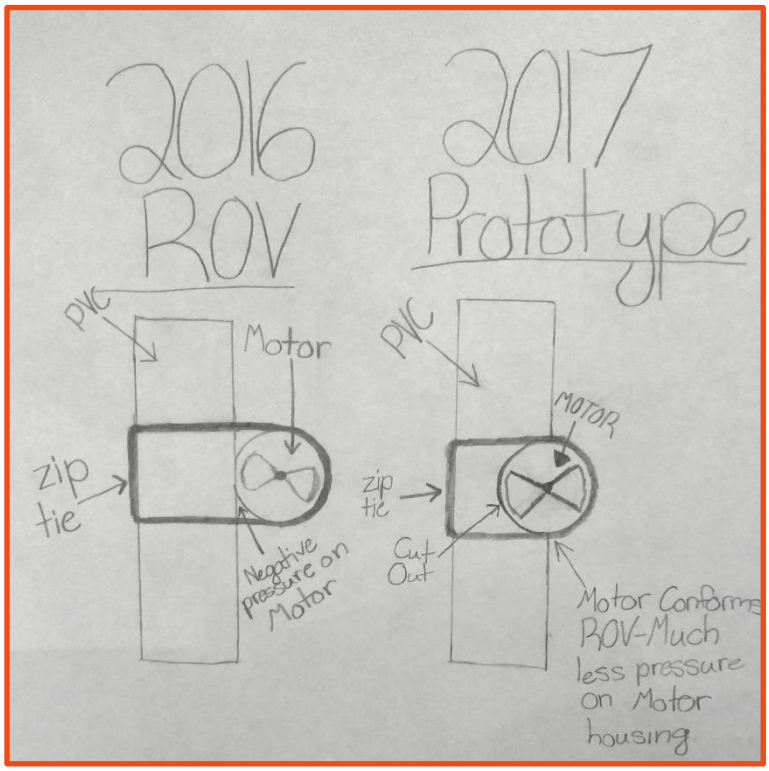
- Smaller ROV: Luke's 2016 ROV was too large and too heavy to move through the hoops as quickly as he needed it to be competitive. To correct this issue, the PVC was cut a half inch shorter in length, and an inch shorter in width & height.



The 2017 Poseidon is shorter than the 2016 Green Marine both horizontally and vertically.

- <u>Cut-outs for Motors:</u> The 2016 motors were never very stable, and the zip ties pushed on the motor housing. This created negative pressure because a round flexible object was pushed against something straight. Luke feared this negative pressure could create a problem with water intrusion into the motor. During Luke's first round of competition at Nationals 2016, one of the motors blew on his ROV. Luke believes it may have been partly because the negative pressure finally caused an opportunity for water to find its way into the motor, despite his efforts to additionally waterproof the motors.

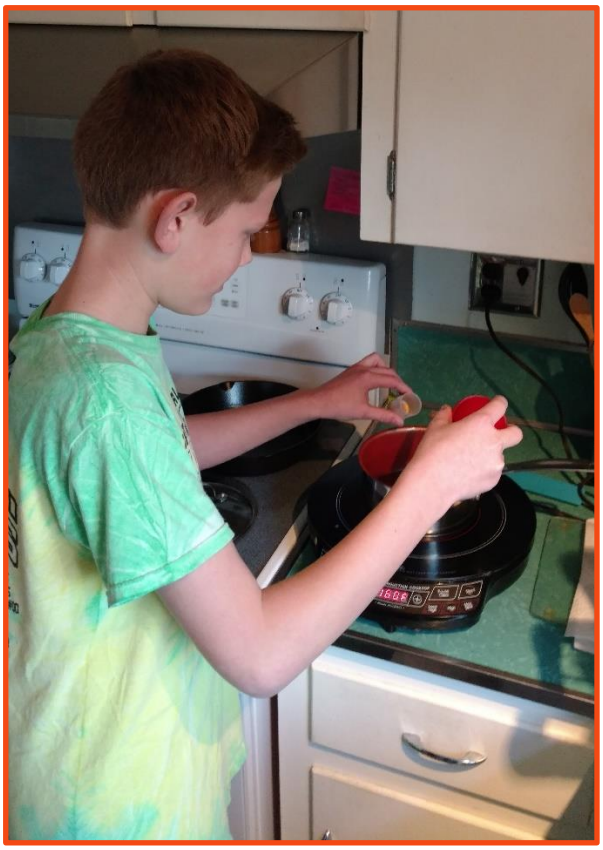
  To correct this problem, Luke introduced cut-outs on the PVC to accommodate design, appearance, and function. He added the cut-outs (half-moons) in the PVC where the motors are mounted so the motors would be more stable with the addition of the zip ties.



Engineering design of how to achieve cut-outs for motors.

Completed cut-out with a motor attached.

- Heated Wax: Because water penetrated a motor during the first competition in 2016 after many hours of use, Luke determined that possibly the water bubbles in the wax made it easy for water to get to the wires and blow a motor. In order to ensure that the wax was air tight, had a consistent density and no water bubbles, Luke melted the toilet bowl wax and sucked it into a syringe. Then he put the warm wax into the motors to make sure there would be no air bubbles.



Filling syringe with melted wax for motor casing.

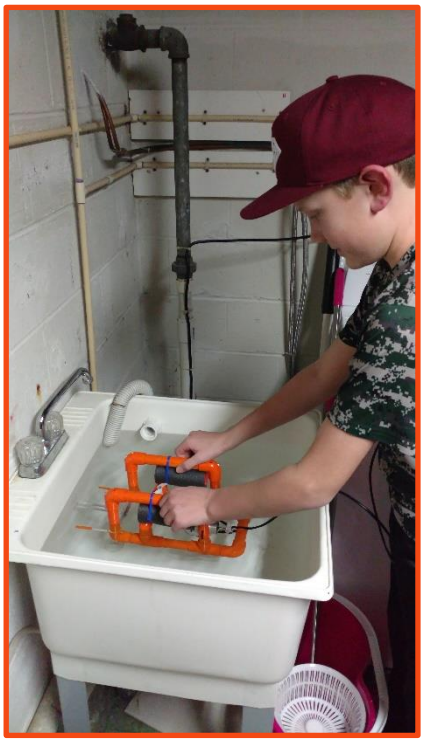
Inserting motor into casing.

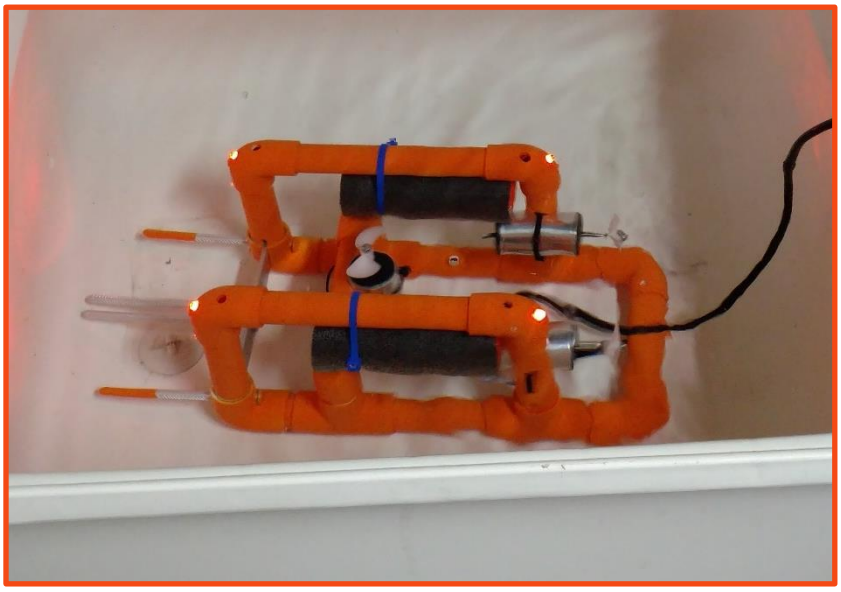
- Flotation devices: Luke wanted to come up with something new and different. The noodles Luke used last year absorbed water and made it difficult to manage when driving upwards because they added weight. He needed the flotation device to only float about ¼ of an inch above the water and maintain proper buoyancy.

  This year, he came up with a new way to make the flotation devices by using 1 ¼" PVC end caps and 1" fluorescent light bulb cover encasing orange ping pong balls (for aesthetic appeal). It took several prototypes before he finally came up with one that worked the way he wanted and gave the ROV stable buoyancy.

Luke began with great hopes of using painted PVC with end caps, wrapped with black styrofoam noodles and placed underneath the top pipes of the ROV.

Unfortunately, as seen below, it was too heavy and had negative buoyancy. It sunk straight to the bottom. Back to the drawing board!





Poseidon SUNK to the bottom of the sink!

Luke found some old fluorescent light casings in his basement and thought if he capped them, they may have enough air to create floatation. He added the orange ping pong balls inside because they looked cool!

The first set he tried was a fail. After gluing on the end caps with super glue and leaving them to dry overnight, he awoke to find them cracked. Apparently, the gases from the glue built up internal pressure and cracked the light-weight tubing. He tried again, but this time cut a hole in the end caps, glued them on and let them sit. Later he capped the hole with liquid electrical tape and painted the caps orange. It worked! However, once tested in the sink, it still had some negative buoyancy, and it still was not strong enough to be able to lift the cubes.

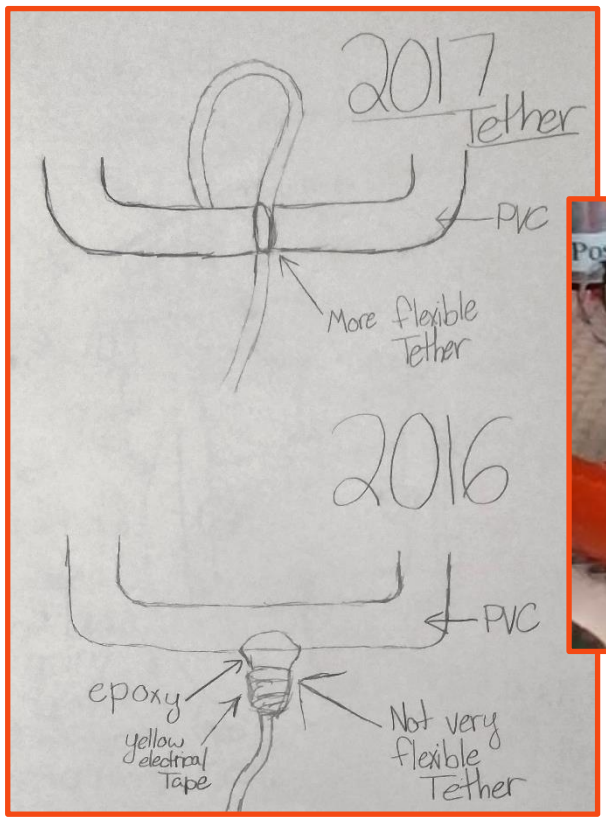
By this time, Channing had joined Team Poseidon. The next floatation prototype was similar, but larger, which offered a little more volume for float. This set also utilized silicone instead of super glue, which worked much better. Luke decorated the end caps by painting them silver, but then put drywall tape around them and spray painted it orange for the design. These floats worked great in the sink, and we were eager to take them to dive in a pool to see it worked well in a larger body of water.

In the meantime, we made an extra set of floatation devices to take with us to our dive practice just in case. We made them a little bit longer, and we decorated the end caps by painting them orange, and we hydro-dipped it in black paint.

On Saturday, February 25th we took the Poseidon to the pool in Kilmarnock to see what she could do. It worked great! However, it was a little sluggish coming back up out of the water. Therefore, we decided to try out our spare flotation devices. The spares made the difference and ultimately are the ones we have chosen to use.

The evolution of our floatation device prototypes:

- Tether Cable: The tether cable attached to the back of the ROV was too stiff and not flexible in 2016. For the Poseidon, we made a cut-out where the CAT5 cord (tether) goes into the ROV so that it would have more flexibility.

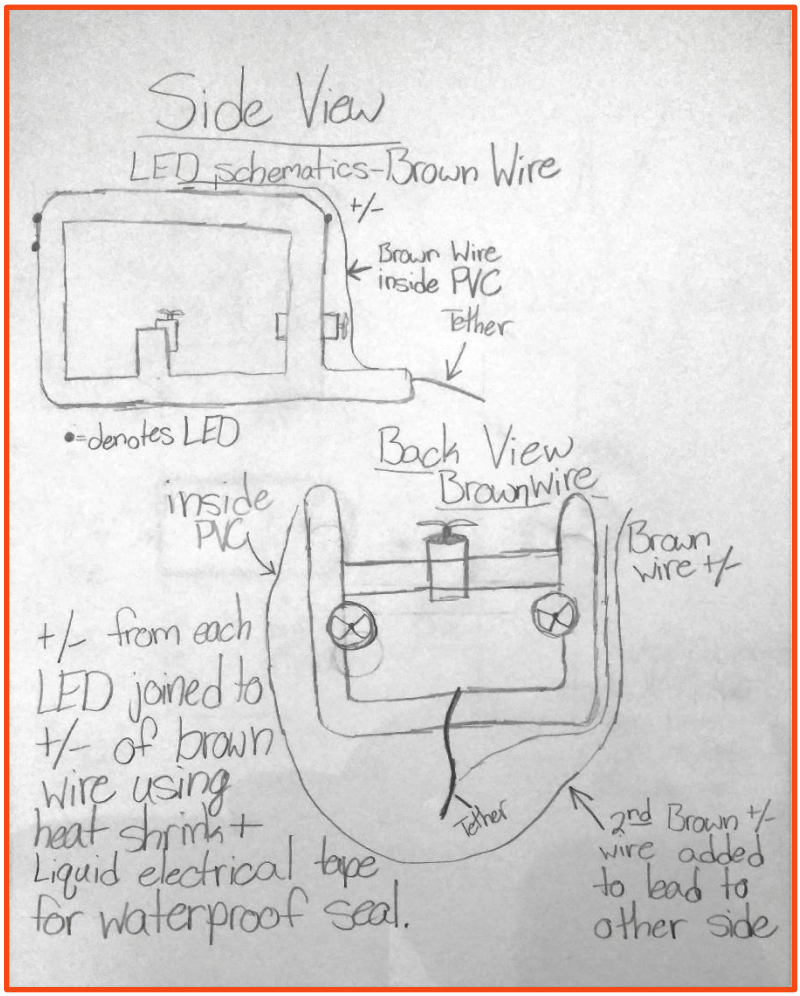


Tether cable installed on the Poseidon. All the wiring for the motors and lights enter the PVC on the opposite side to allow the tether cable to move in various directions for better mobility of the ROV.

2017 ROV Modifications for the Poseidon:

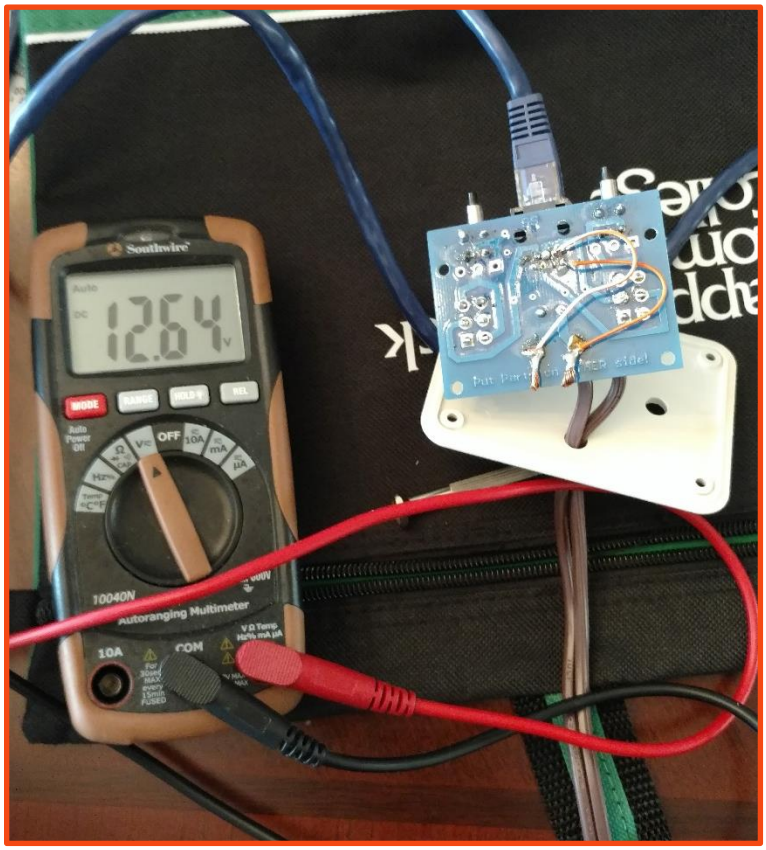
- Color: We decided to paint the Poseidon orange so we could hopefully see the ROV better when it is in the water. We were thankful to see that our tether wire this year was black, because the blue one last year made it difficult to see the difference between the wire and the hoops during competition. We think the orange and black colors are bold and make a statement about our ROV.

- Lights- Using the Brown Wire: Luke knew that this year he wanted to do something with the leftover brown wire that is inside the remote. Therefore, he chose to use it to add orange LED lights on the front and back of the ROV to help identify it while underwater and for appearance. He also added a switch to turn the LED lights off and on so there wouldn't be added drain on the battery. Adding a toggle switch created a major modification to the remote and constituted a complexity to overcome. Below demonstrates Luke's plans to run the brown wire.

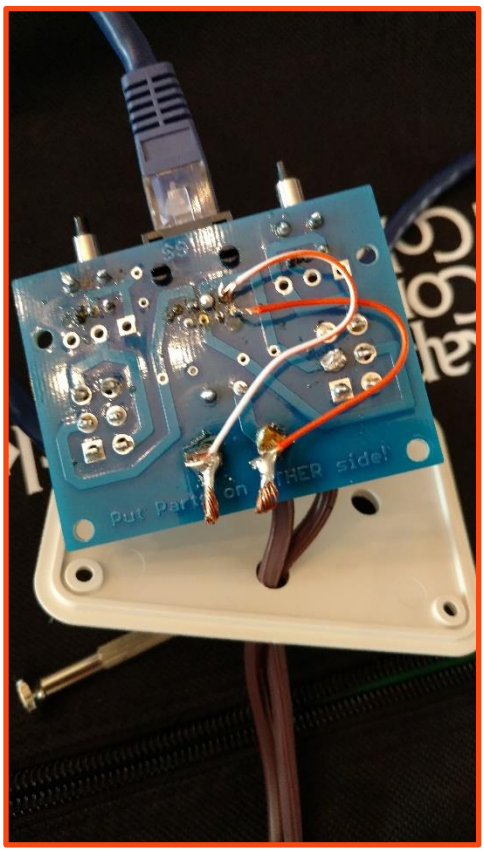


BUT FIRST…

Luke had to test the brown wire to make sure there indeed was voltage. With help from Luke's dad, Luke learned how to use a voltage meter to measure current to see if the brown wire experiment worked. Luke stripped one of his dad's spare CAT5 cables and pulled out the brown wire. Then he connected the CAT5 cable to his 2016 ROV remote and battery. Using his dad's voltage meter, Luke tested the brown wire and there was zero current. This led Luke to the conclusion that a connection needed to be made on the circuit board inside the remote for the brown wire to run current.



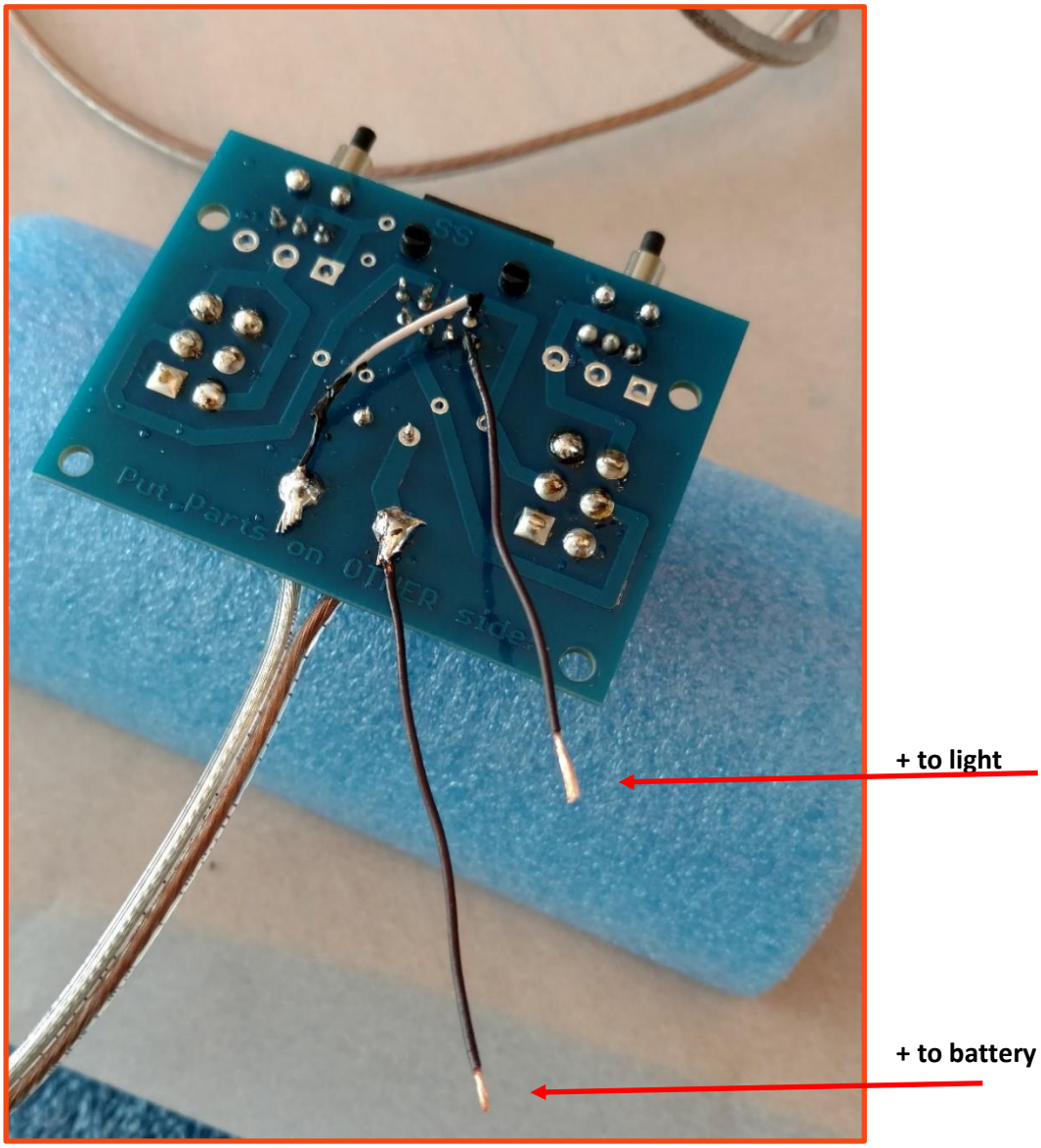
Testing the 2016 remote after Luke hardwired it to use the brown wire.

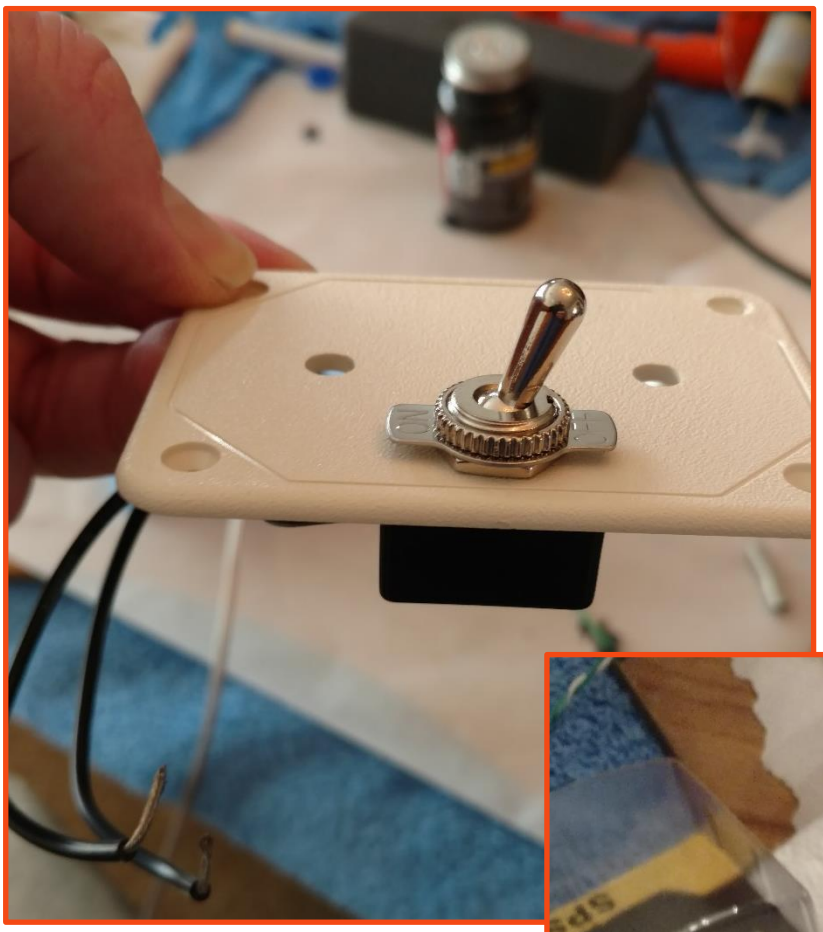


Close up view!

- **The Toggle Switch:**

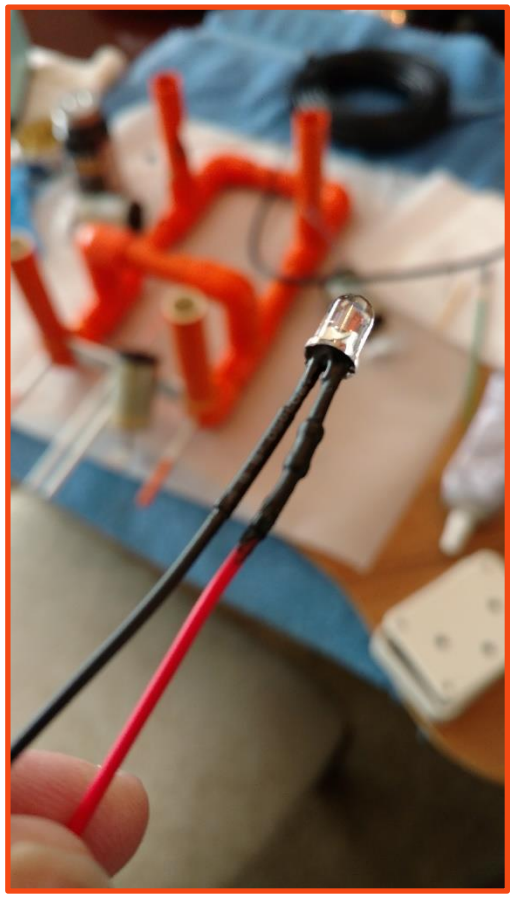
Pictured below, there are two positive wires soldered to the circuit board. One positive wire is connected to the + battery lead, and the other is connected to the positive brown wire pin for the CAT5 cable. The positive leads were then connected to a toggle switch which allowed the lights to turn off and on. Also, as seen, Luke soldered a patch wire for the negative connection between the – battery lead and the CAT5 brown wire negative connection. Luke and Channing also have Luke's 2016 ROV remote as a backup. Luke direct wired it without a toggle switch, so the lights would have to remain on at all times in the event they have to use that remote.



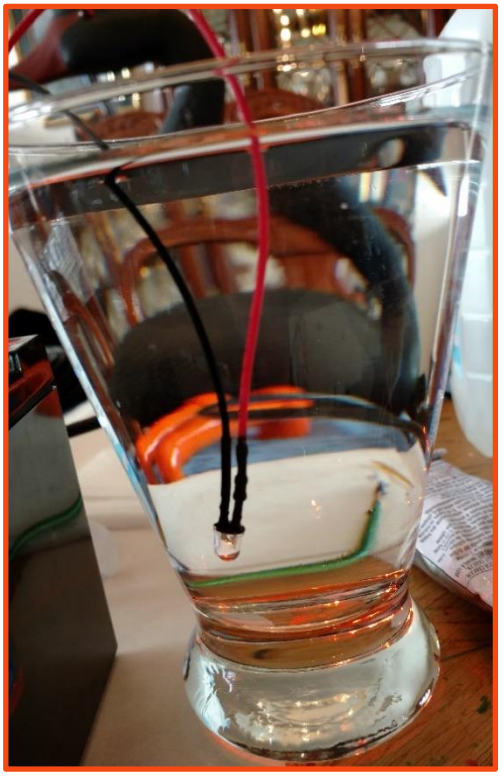


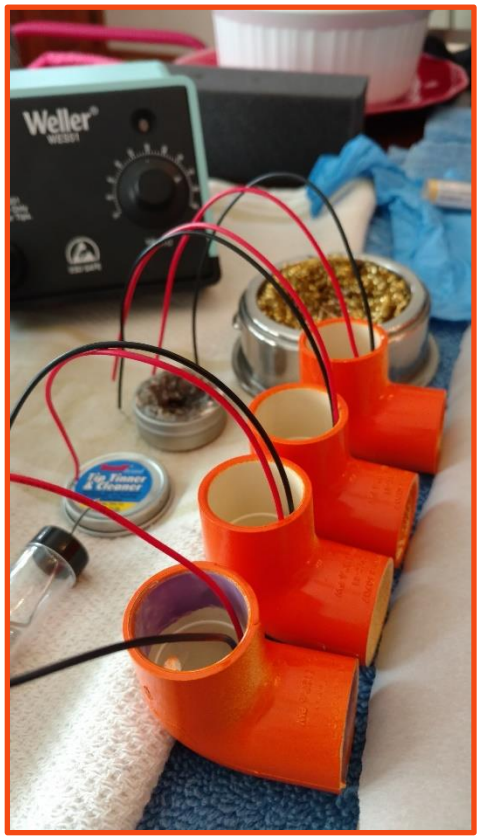
Toggle Switch Installed- side view of switch and components. The toggle switch is located where the DC Cable was originally.

Final remote with toggle switch and wires connected. The DC Wire had to be relocated to the base of the remote to make room for the toggle switch.



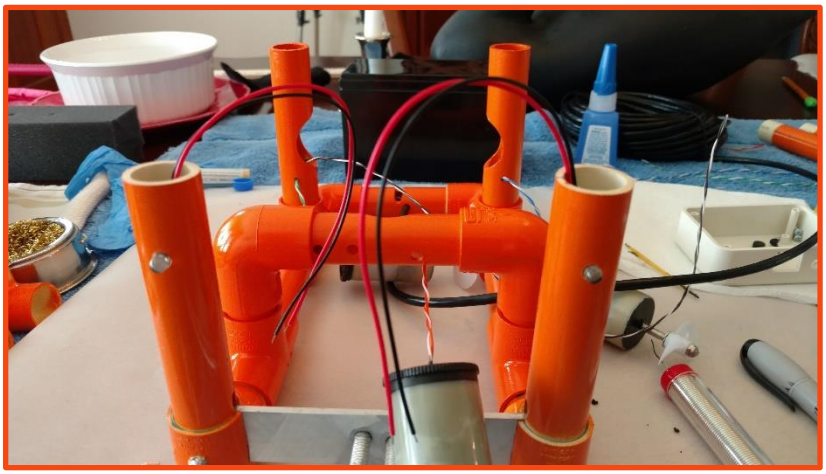
LED light wires water proofed with additional liquid electrical tape. Tested in glass of water.





Four corner LED lights installed by drilling a hole into the PVC, inserted from the inside and glued in place with superglue.

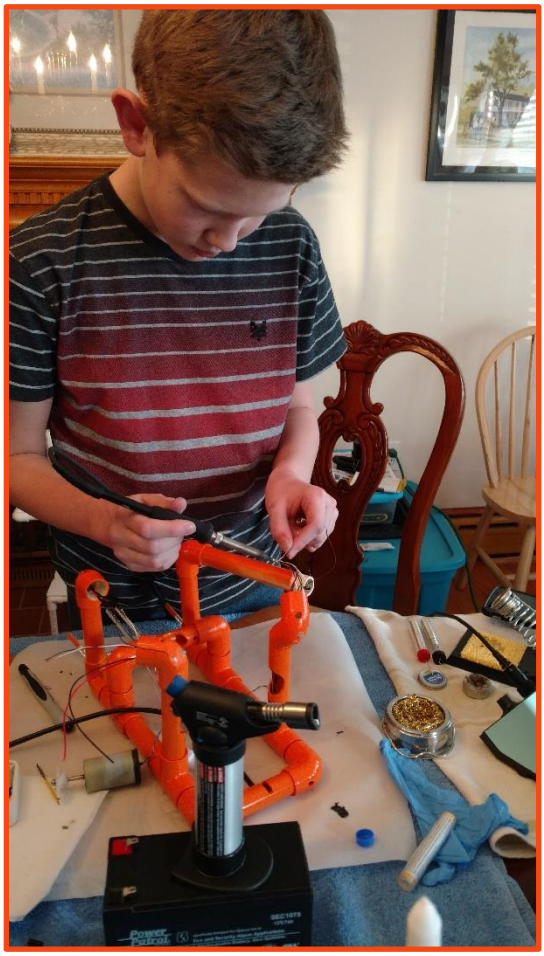
Pictured below are Poseidon's secondary LED lights positioned in the front of the ROV.



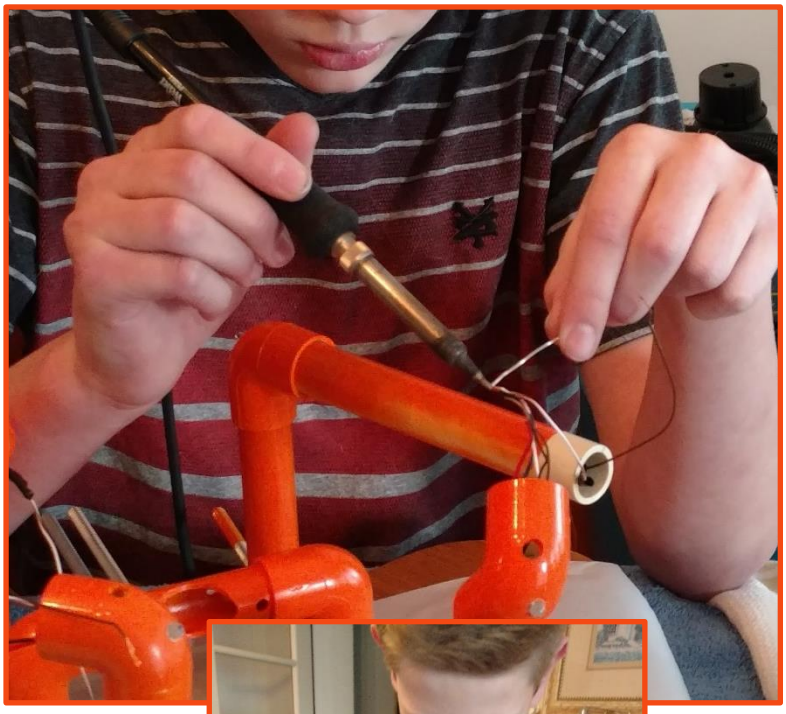
The four lights placed in the front of the ROV are also a distinguishing visual cue to help us recognize the front from the back when driving it remotely in the water.

- **Back to the Brown Wire:**

After inserting the lights into position and running the positive and negative wires for the lights through the PVC pipes, Luke connected all the positive red wires and negative black wires (+ to +, - to -). These were then soldered to the two +/- brown wire leads. Liquid electrical tape and heat shrink tubing was used to waterproof the seal as seen below:



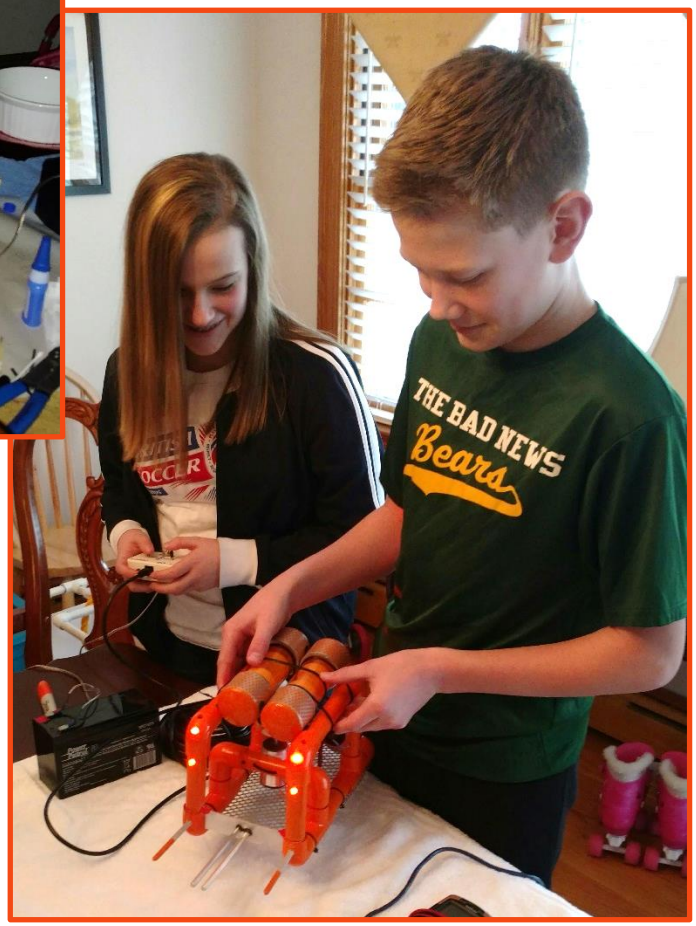
Close view of soldering light wires to the brown lead.



Using a torch to activate the heat shrink tubing which adds additional waterproofing to the wire connections.

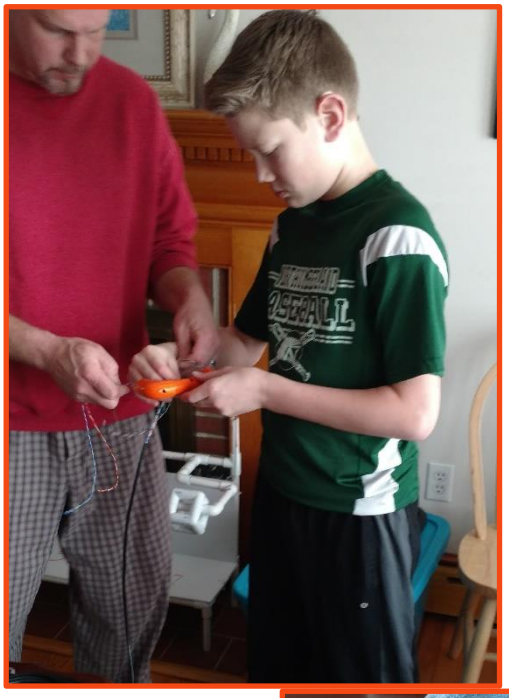
- **And There was Light…**

Luke was thrilled to turn on the toggle switch for the first time and see that the lights indeed worked!

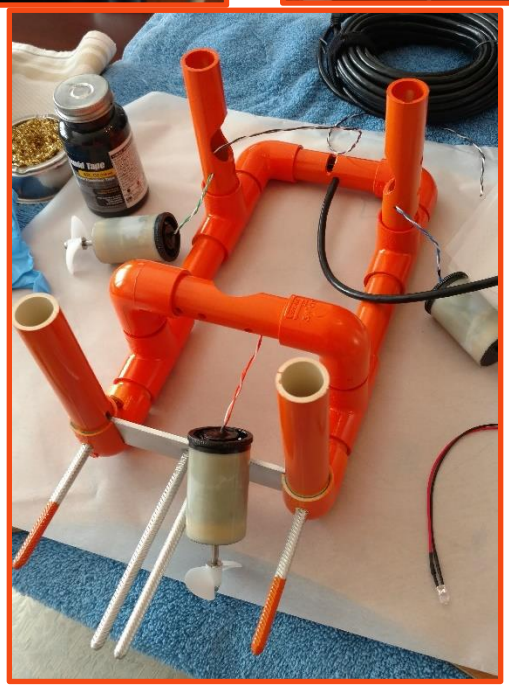


Channing was excited to test the lights too!

- Hidden Wires: One other thing that Luke loved about his modifications on last year's ROV was that all the wires were hidden inside the PVC piping. That worked fantastic, and so Luke decided to keep that modification on this ROV. However, instead of doing it as an after-thought this year, he did it from the beginning which allowed him to reduce the amount of internal connections to zero for the motors.



Running the wires through the ROV.



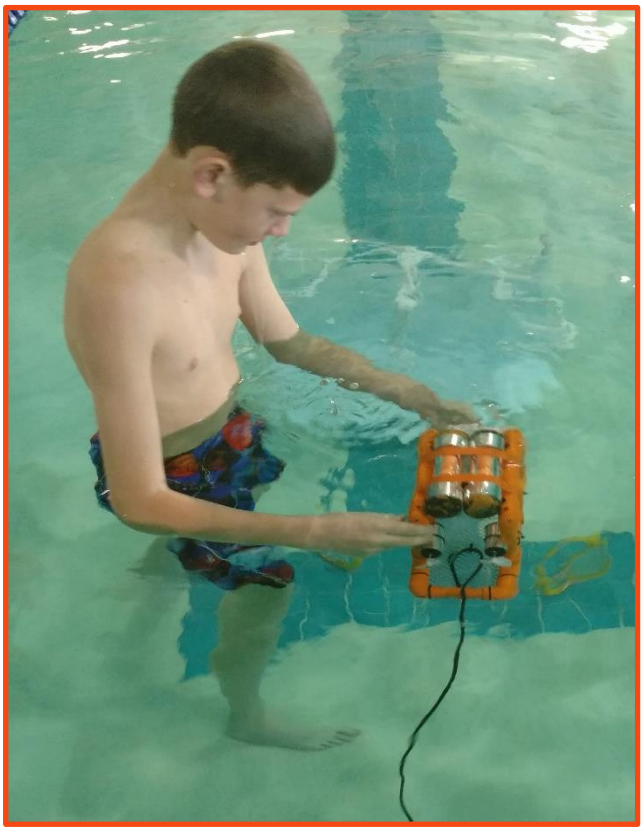
2017 Team Poseidon Dive Practice:

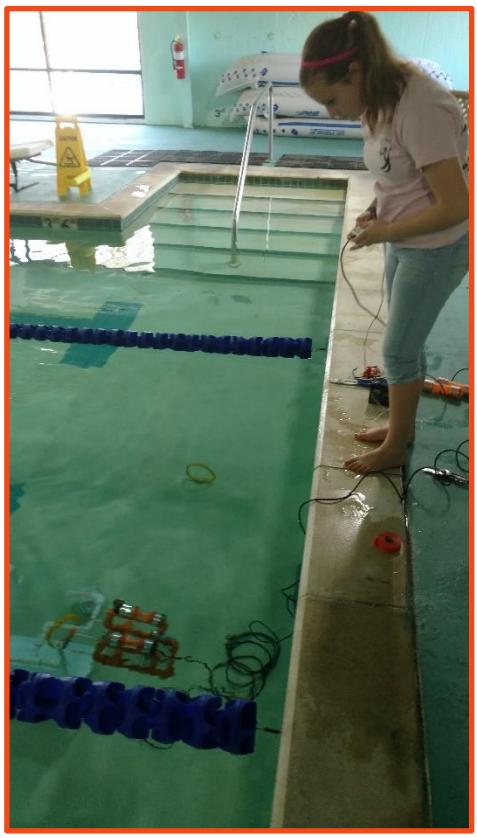
February 25th was our first dive practice. We were delighted to learn that all our careful considerations to our 2017 ROV came to fruition. It worked beautifully in the water and was strong enough to maneuver both the rings and the cubes. We did, as mentioned earlier, change our floatation devices at the pool and chose to use the bigger spare ones instead. We also decided that it would be in our best interest to make an extra spare pair of floatation devices in the event we need them at competition.

The dive proved that the Poseidon is indeed easier to see in the water with its vibrant orange color and orange lights. We hope that will benefit us in competition, especially with the rings event. Luke will captain the ROV, and Channing will navigate and manage the tether cord.

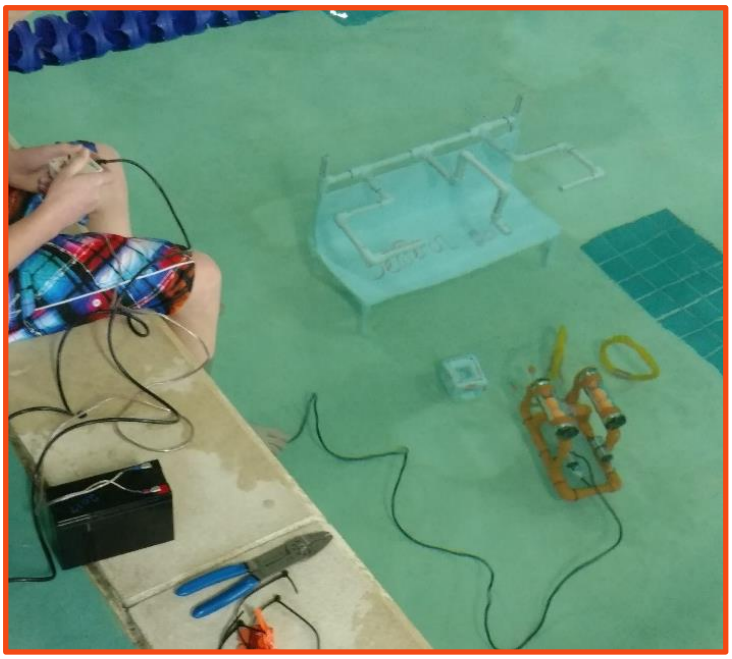
See below for pictures of our first dive practice. All other practices will be with our school and are scheduled for after the due date for the engineering notebook.

Channing and Luke working together on the Engineering Notebook.

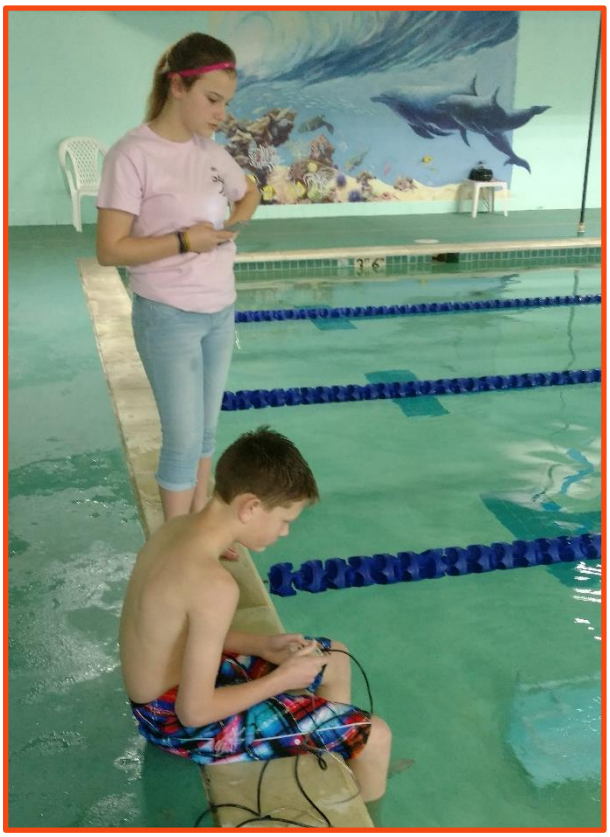




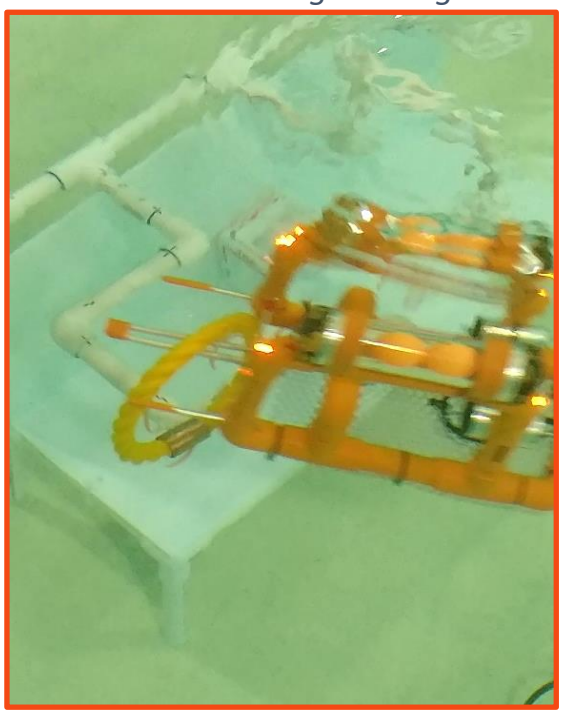
Channing gave Poseidon a try!

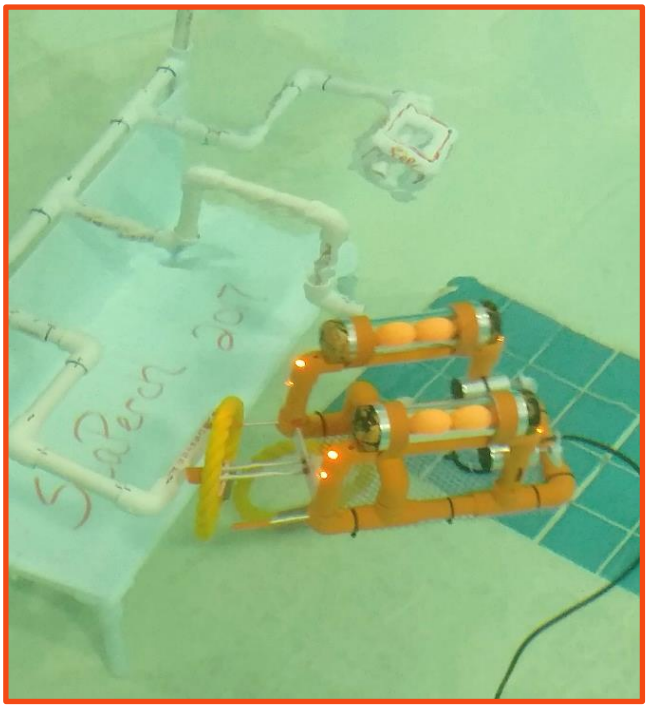


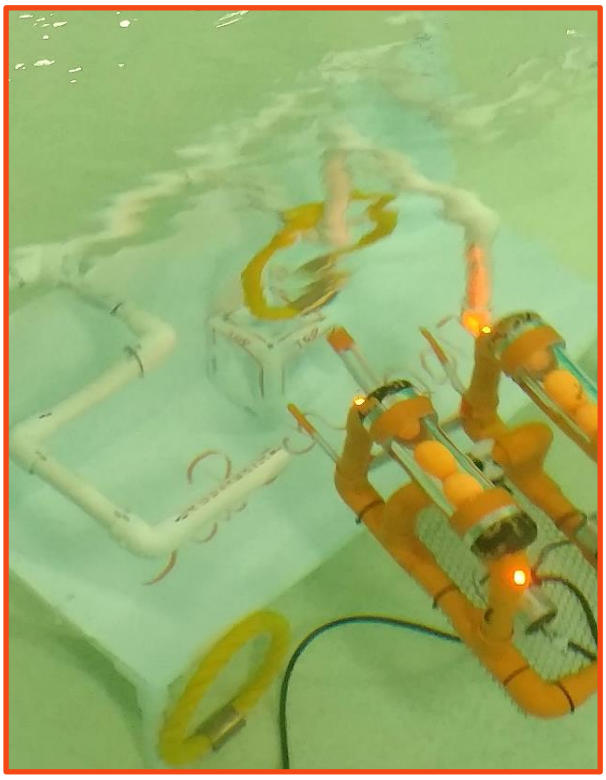
Luke practicing how to manipulate the rings and cubes!



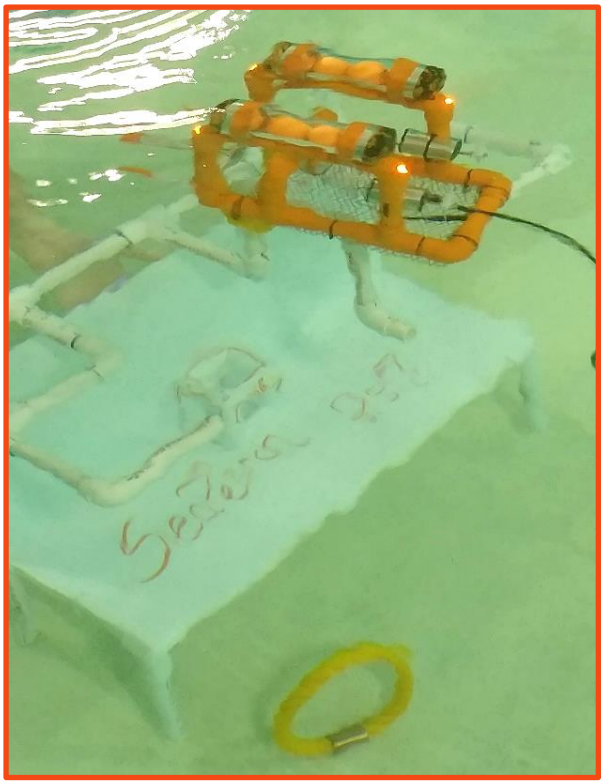
Maneuvering the ring!!







Success!!



The Poseidon is surfacing.

Our BIG Take Away –

In 2016, at the regional competition, the judges asked our team,
"What will you do differently to your next SeaPerch?"
Our reply at the time, remember this was before any competition,
"Nothing, we think it's perfect!"

Fast forward 2017 – there was a lot to do differently!

- Smaller size = lighter weight and better maneuverability
- Improved tether design
- Improved motor mounting and waterproofing
- COLOR! – better visibility
- Pre-planned wiring schematics
- LIGHTS!! – love those!
- Improved flotation design and functionality

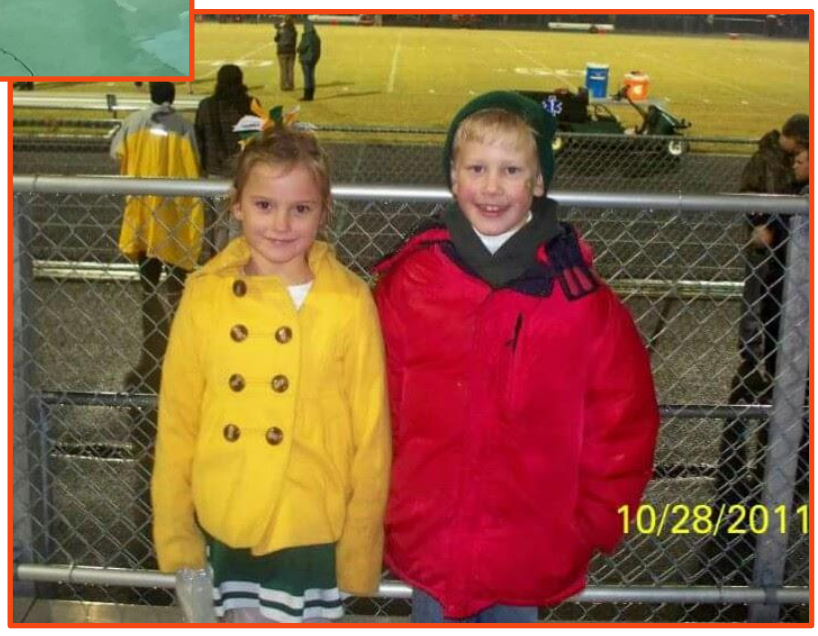
Really, it just doesn't get any better than this!

OH WAIT... 2018 will be here before we know,

and we will need to come up with something new!

Thank You for the opportunity to be

National SeaPerch Competitors… oh, we mean *Engineers*!

Channing and Luke: 2017

Channing and Luke: 2011