

Circuit Breakers # 60699 - Innovation Journey

Here is our innovation journey with all up's & downs, hope you enjoy the read.

As mentioned in Engineering Notebook page # 6

This season, your challenge is to dive into a problem faced by people who explore the oceans

The day it was announced, the team started exploring different topics & we chose -

1. *Ocean acidification*
2. *Sedimentation*
3. *Vessel strikes*
4. *Oil spills*
5. *Coral Bleaching*
6. *Bycatch*
7. *Overfishing*
8. *Marsh Pits*

Our team went to various ocean museums and places to research our topics. We asked the experts there and they told us many things about what we were researching. Going to these places were very useful. We learned a lot from them. Here are some of our experiences

Meeting Experts -

1. **Sumeet Birajar** - An ex-submarine Engineer from the Indian Navy. On August 23rd 2024 we had a webinar with Mr. Sumeet, we learned a lot from his 1st presentation, topics which he covered during this presentation are -
 - History of Submarines
 - Submarine Design
 - Submarine Construction
 - Submarine Dynamics
 - States of Submarine
 - Sonars
 - Navigation
 - Communications
 - Armament
 - Future of Submarine
 - Points to Ponder



Also enclosed is the PPT printouts he presented during the 1st webinar. Later once we decided to work on a topic for better navigation with Gyro Buoy, we again connected with him for his feedback & guidance.

2. **Mangesh Edla** - An Ex-Merchant Navy Engineer - on the same day (08/23/2024) after Mr. Sumeet's presentation we had a webinar from Mr. Mangesh Edla. Even though we didn't finalize any topic related to Merchant Ships while exploring we learned a lot from this webinar as well. Topics covered in this webinar are -

- Introduction to Merchant Navy
- What is Merchant Ship
- Types of Merchant Ships
- How ships are build
- The Role of Merchant Ships in Global Trade
- Navigating the world's Oceans
- Daily Life on ship
- How shipping impacts Oceans Ecosystems
- Pollution from ships: Oil Spills and waste
- Preventing Marine Pollution
- Freshwater Generators

Also enclosed is the PPT printouts he presented during this webinar.

3. **ETV2(SS) Noah M. Avesta** - Gorton Submarine Museum Navy Officer - During the team's field trip we got lucky to meet ETV2 (SS) Noah M.Avesta, we must say he is a man with such an amazing personality & patience. He answered all of our questions consistently with equal attention. Team asked lots of question based on 2 to 3 topics related to submarines -

- Vessel Strikes between submarine & Whales
- What is ORM (operation risk management)
- Effect of high pitch noise on Whales for our Vessel Strike topic

- Rules of the road - same rules to be followed by submariners - Maritime rules of road #1 to #19

Also have enclosed Maritime rules of road from # 1 to #19 for your easy reference.

4. **WHOI Experts** - In this webinar happened on Oct 2nd 2024, this webinar had different experts participating from NOAA. Listing names of all of them. This webinar was for an hour and all the experts answered different questions asked by different teams. There were approx 1000 FLL Challenge youth participants in this webinar. Unfortunately our team's question wasn't picked up for answering as Ms. Liz Hoadley, the coordinator was randomly picking up the question. But it was an informative session. All the teams attending this session got to see scientists & experts from WHOI. It was very inspiring for us. Below are the names of experts who shared their knowledge in this webinar -

- **Liz Hoadley (NOAA Ocean Exploration - Education)** - She was the Webinar Coordinator who guided the session based on questions different teams were asking to different experts.
- **Molly Curran - (Engineer at WHOI)** - Mechanical Engineer in the deeps emergence lab at WHOI
- **Anthony Tarantino (WHOI Alvin Group)** - Technical program manager & Alvin Pilot in WHOI
- **Philip Hoffman** - Technology Team Lead at WHOI
- **Jonathan Fiely** - Media Producer for Ocean Exploration Trust website is <https://nautiluslive.org/>
- **Samir Patel** - Research Biologist from nonprofit organization called Kunet Farm Foundation

Here is the page link from NOAA with all information & recorded video link -

<https://www.whoi.edu/what-we-do/educate/k-12-students-and-teachers/first-lego-league-challenge/>

Fun fact - During this webinar, all the experts showed pictures of themselves as kids, their childhood aspirations plus also they shared how & what inspired them to be into their current profession.

Overall this season was loads of discoveries, exploring different innovations & impact of them in the real world.

Every group (2 team members per group) researched their topic well but no one could agree upon a topic. After lots of voting & brainstorming we finally agreed on vessel strikes. Some people thought that it was a difficult topic as lots of good existing

solutions were there. Due to this it became more and more complex to come up with a type of solution.

One existing solution was a whale pinger. Team took that idea and tried to make it better. We thought that when the pinger's battery was at its fullest it would make a loud noise to send away animals. But when it was at low battery it would make a quiet sound and some animals might not hear it. That's why our team thought of making it solar powered. The pinger would be just underneath the water so the sun could still recharge it. We decided to drop this topic because the battery life of pingers is pretty sufficient as it lasts for a year. Also, the team was up to taking on a more challenging topic

Even though we had a solution, we had some disagreements on which research topics we should move further on.

That's when we decided to explore other topics. We researched gyroscopes for submarine navigation, submariners mental health, and continued researching vessel strikes.

On a bright, vibrant day our team started on a journey to the Groton Submarine Museum and WHOI in Cape Cod. The Gorton team ventured on the USS Nautilus, as well as explored the unique features it had to offer. We went on the field trip before we voted on this topic so, as a team, we worked together and asked different questions to the navy veteran, Noah M. Avesta, about vessel strikes and gyroscopes. After viewing an actual gyroscope, the team as a whole had a much better understanding of them. Mr. Noah on the submarine told us all about how gyroscopes work and that they sometimes can be wrong. Because of this error in the gyroscope's reading, the mast had been hit by an iceberg. After hearing about this, our team decided we wanted to work together and iterate upon these gyroscopes.

Additionally, we learned that the USS Nautilus has hit many whales and sea animals. If the submariners are aware that they're about to hit a school of fish, they don't need to do anything. They know that the fish are smart enough to run away from the submarine before it hits them. The submarine might see the whale on their sonar but cannot do anything about it because it might be too late to turn. When a ship turns, it takes an extremely long time because they are in water. We also were aware that whilst being water all types of movement are slowed and distorted. Even though most vessels try to move out of the way and not hit the whale there is a high chance that they still might hit it. Due to the increased rate of vessel strikes, North Atlantic Right Whales are now endangered. Scientists & ocean explorers are working on it to make it zero casualty to whales but still sometimes it happens.

Fun Fact - Team kind of got inspired to work on Gyroscope as we were struggling in our robot runs with Python coding gyro sensors. Which we tackled later, again a fun story which you can read in Robot Design Essay.

How field trip + Interaction with experts helped team's innovation

The field trip to the Groton submarine museum, WHOI in Cape Cod and the USS Nautilus helped the team's innovation because we learned that some vessels might not even know that there are sea creatures in their way and might hit them. Some vessels see that there is an animal on their sonar and try to move out of the way or go around it. Sometimes they still hit them.

Our team also learned a lot about gyroscopes. We learned that gyroscopes are constantly *guessing and predicting* where they are. We also learned from Mr. Sumit, a veteran submariner, that the gyroscope needs to be recalibrated multiple times depending on the model of gyroscope. This recalibration takes from a few minutes to a few hours. Gyroscopes used for navigation in submarines can accumulate issues involving drift over time, leading to inaccurate data and causing misreadings for submariners. Submarine engineers have worked on achieving the most accuracy in gyroscope readings. The ring laser gyroscope is considered one of the most accurate ones but requires lots of maintenance and frequent recalibration.

Final Topic of Innovation

After we came back and reviewed all of our new discoveries, the team voted on which topic we should focus on. After voting we finally decided on fixing and iterating upon gyroscopes. **Our team wants to accomplish this because the gyroscope could be a major reason why a part of the submarine gets damaged time and time again. If we fix the gyroscope some parts will not get damaged because of hitting icebergs and other objects that are located in the ocean's depths. Add statements about waste of fuel, additional time added because of deviation.** We thought of making a buoy. The buoy will have a GPS inside it so that when the buoy is released a satellite will detect it and tell the crew on the submarine where they are in the ocean.

Research on the solutions workflow

Explain the mechanism / solution in simple words before we get into the material used for buoy. Can also add a diagram showing the solution.

- **How gyroscopes function**

Gyroscopes function by constantly guessing where they are using yaw, pitch and roll. Yaw is the Y axis. Pitch is the X axis. Roll is the Z axis. When it detects it is

turned the wrong way it will correct itself. How gyroscopes function in submarines

Gyroscopes function in submarines similarly to normal gyroscopes. It uses Yaw, Pitch, and Roll. Unfortunately, the gyroscope is always guessing. Because of this it can be wrong. On one submarine that our team went on the gyroscope was wrong and as a result it hit an iceberg. Because of this the mast got damaged and the submarine needed to resurface and get it fixed.

- What different types of gyroscopes are there

The different types of gyroscopes are FOG, Gas bearing, Mechanical, MEM, and laser ring. FOG stands for fiber-optic gyroscope. It uses a coil of optic fiber, a clear light source, and a photodetector. The photodetector uses light to detect rotation.

- Why the new gyroscope cannot be installed on the old submarines

New gyroscopes cannot be installed on old submarines because it would be very hard to do it. The old submarine machinery would be much more different than the new ones. Because of this they would have to make many changes to the gyroscope to install it. Also the old submarines might be retired because they would be too old. An old submarine would need more maintenance. Besides, it would be more expensive to install new gyroscopes on old submarines. They should be to the newer submarines instead.

- What is our solution

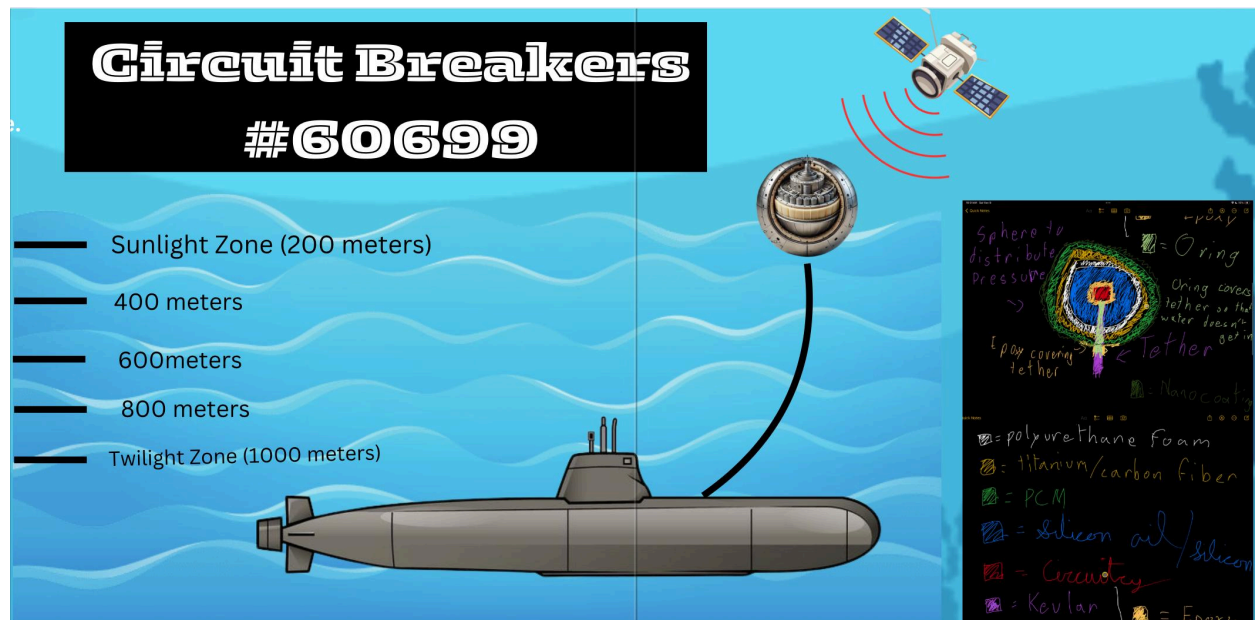
Our solution is to make a buoy. The buoy would have a GPS inside of it.

- What are pros of our solution

Real-time Data Transmission: Frequent real time feedback from Satellite for submarine course correction. Durability: Constructed from Titanium or Carbon Fiber to withstand harsh ocean environments. Microcontroller allows for flexible programming and potential upgrades. Adaptable to various applications. Saves time, resources, fuel. Cost effective for older submarine models. Simple & effective use of technology without compromising position of submarines in the ocean. Helps avoid accidents

We developed a GPS-equipped buoy using durable, waterproof materials. To make the buoy we would need silicone oil/ silicone, polyurethane foam, o - ring, titanium, epoxy, and a gps. There will be several layers starting from the inside. The first layer will be the gps. We need that to track where we are. The second layer is silicone mixed with epoxy. The next is silicon oil. We need it because it is buoyant and will protect the gps from getting crushed. The third layer is Phase Change Material that

helps reduce its thermal footprint. Next we have titanium/carbon fiber. These have a very good strength to weight ratio. Next is specialized polyurethane foam. We will need that to be more quiet and stealthy. The fourth layer is nanomaterials. These help reduce capillary waves. Now we have the tether. The tether will be made out of kevlar so that it does not get severed. For extra protection we are covering the tether in epoxy. The entrance that the tether gets to the buoy will have an o-ring to make sure there are no water leakages. The buoy would be connected to the top of the submarine.



Some of the advantages of buoy are

1. **Durability** - It is made from titanium/carbon fiber built to withstand the harsh ocean conditions. It reduces maintenance and replacement costs.
2. **Real time data transmission** - Wired communication modules provide instant access to location of the submarine and data.
3. **Scalability** - The buoy can be modular & can be used to provide different types of data to the submarine

Over all Teams journey of Innovation Project taught us a lot in all different aspects of FLL Challenge Core Values i.e -

- **Discovery:** We explore new skills and ideas.
- **Innovation:** We use creativity and persistence to solve problems.
- **Impact:** We apply what we learn to improve our world.
- **Inclusion:** We respect each other and embrace our differences.
- **Teamwork:** We are stronger when we work together.
- **Fun:** We enjoy and celebrate what we do!

Hope you enjoyed the read as much as we enjoyed this journey.

- Thank You
Team Circuit Breakers
#60699