

MYP Personal Project Cover Sheet

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Title of the Project:

In Sharks We Trust

Goal of the Project:

To research, learn about and prototype two types of electronic tagging devices with the potential to aid researchers in tracking sharks in the Red Sea.

Length (word count and/or presentation time):

3500

Included when submitting the project:

- A completed academic honesty form
- Process Journal extracts
- Any supporting visual aids used during the presentation, if applicable
- Works Cited

In Sharks We Trust

Nabiha Khan

Year 5 Personal Project Process Journal

The KAUST School

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1.0 Investigating

1.1. General Introduction to the Personal Project

The IB Personal Project is an 11-month compulsory enterprise, accumulative of the acquired MYP ATL skills that revolve around the a topic of student's choice. They independently complete an action while applying the IB Learner Profile traits.

1.2 Goal and Global Context

Focusing specifically on Elasmobranchii (Appendix A), the goal is “to research, learn and prototype two types of electronic tagging devices with the potential to aid researcher in tracking sharks in the Red Sea.” This goal is highly challenging as the expansion on limited, but broad, shark related prior knowledge will require extensive research at a highly professional and academic level. As a beginner, developing and building a full embedded electronic system would require soft skills of dedication and perseverance. Inspired from personal passion, excellent communication skills are additionally required to spread the message to the general public.

The Global Context of “Scientific and Technical Innovation” refers to the interaction between people and the natural world. The global lack of responsibility and understanding of the natural world has caused a dangerous misconception about the stereotypes of sharks, which fuels an overexploitation of their populations. A thorough understanding of the Elasmobranchii subclass allows for tag designs to cater to the specific environment and host. Additionally, a firm grasp of scientific principles is needed to create a functioning prototype in hostile conditions. Overall, the project highlights mankind’s ingenuity by using their mastery on technology to undo the environmental harm they have caused.

1.3. Prior Learning and Subject-Specific Knowledge

The beginning of MYP was the beginning of a continuous passion for sharks. The catalyst was the realisation on the vital role sharks play in the global ecosystem. Prior statistical knowledge relating to the population decline provided motivation into species identification and behavior. However, only well-known sharks such as the Great White, Hammerheads, and Whale sharks were researched.

The following year, enrollment in the school's robotics club exposed me to engineering and design skills. Basic tutorials were successfully followed and a shallow understanding on the application of sensors was formed. The code, simplified as connecting boxes, was readable and simple commands could be programmed.

In Design Technology class (Appendix J) during an Arduino (Appendix A, F) Unit, the fundamentals were recovered and the base solidified. The syntax of the coding language, C was understood along with further exploration of beginner components. Manipulation of code and hardware wiring was done on a small scale.

1.4. Research

A wide range of resources, were utilized to acquire greater depth and breadth to existing knowledge.

Firstly, research on the motive of shark overfishing was conducted to fully justify the need for conservation. Videos from WIRED and The Humane Society of the United States were utilized to understand the scale of exploitation. The videos raised awareness and advocated against shark finning (Appendix D) and claim that "10s of millions of shark are killed each year for their fins" (The Humane Society). The lack of regulations or empathy is the leading cause of their population decline. However, because a popular Asian dish, shark fin soup (Appendix C) is "served as a symbol of class and wealth" (Shark Truth), the

demand, and by extension, price on shark meat; fins specifically. Although these statistic were discussed in several text-based sources, the videos provided perspective and context on the act allowing for valuable visualization on severity of this issue.

The majority of the shark-specific research came from an online course called “Sharks! Global Biodiversity, Biology, and Conservation”; run by the University of Queensland and Cornell University. It focused on anatomy, evolution, and population of sharks. It was scientific in nature and provided sophisticated knowledge on the biology of sharks (Appendix K, L). With “over 400 shark species.” (WWF), each species as its own characteristic and role in the ecosystem. It provided background understanding on factors such as habitat and behavior, to shape the technology around. Because “some sharks migrate over great distances to feed and breed” (Basic), isolating these species would allow for a very specific tag (Appendix E) design to the host animal and the environment.

Websites and scientific journals were used to gain knowledge on existing shark tracking technology. As “the first large-scale tagging programmes on sharks were initiated in the 1940s” (Stevens), the urgency of this technology increases as the shark populations decrease. With such rapid decreasing numbers, this technology “provided scientists growing opportunities to resolve previously unknown spatial ecology of marine predators” (Hammerschlag). Webpages from the Hawaii Institute of Marine Biology, and scientific journals such as, Journal of Experimental Marine Biology and Ecology, gave specifics as to the functionality of the tag and its application. This provided a level understanding of existing technologies and models on which to base the prototype of.

Additionally, well-versed individuals such as Royale Hardenstine (Appendix M), Jesse Cochran (Appendix N), and Andrew Mahon (Appendix O) were interviewed. Hardenstine and Cochran are students from the Red Sea Research Center specializing in

whale shark tracking. The interviews with Cochran and Hardenstine pertained to existing technology used in the Red Sea Research Centre to learn about the local technologies and resources available. Because there are “different tags for different questions” (Jesse), satellite tags are used for short term and long range, while acoustic tags are used for long term and short range. Information regarding tag application and design learnt from the two interviews directly influenced the criteria. Once the tag specifications were decided, and interview with Andrew Mahon, an engineer from the Coastal and Marine Resources Core Lab (CMOR), was conducted. During this interview technical and manufacturing details of the tag were addressed. This helped predict future disadvantages as “the GPS does work very reliably, if at all, underwater.” (Andrew).

Books such as Telecommunications (Technology All Around Us) by Anne Ronney and Wireless Technology by Mary Firestone were used to understand the physics behind the electronics. Since “most wireless communications use radio” waves, knowledge on its properties provides understanding on wave interactions in different mediums. Due to refraction, “ bending of a wave when it enters a medium” (Refraction), the transmission of data from the device to the researcher. This information highlights limitations in this technology which have to be worked with.

Online forums such as Reddit were utilised for subject specific questions relating to hardware components. Questions were posted on the Adafruit and Arduino subreddits (Appendix Z). The respondents to the posts helped fix tiny problems such as errors in the code or libraries (Appendix A) which limits the device’s functionality

Due to the diversity of individuals who came to the November Exhibition (Appendix B, P), feedback received was analysed and taken into consideration. The collective feedback

helped direct focus in designing by prioritising certain functionalities and overall communication skills.

2.0 Planning

2.1. Criteria

1. Prototype a device that can track the movement of an object using hobbyist electronics.

1a. Electronics components must be available for purchase online.

Justification: Limited in terms of both skill and electronics, components available online are accessible to the public ensuring greater online resources.

1b. Must record latitude and longitude through a GPS module.

Justification: The basis of a tag is a GPS. The data from the GPS tells location of the host animal.

1c. Must fall into an existing tag category (data-logging/transmitting).

Justification: The tag has to fall into an existing category of shark tags as it is more feasible than attempting to create a new design from scratch.

1d. Final components mounted onto a PCB.

Justification: For reliable connections to final prototype must be mounted onto a custom made PBC.

1e. Feasible candidates must be decided for the final prototype.

Justification: This gives context regarding the application of the prototype and the species its suited to track.

2. Feedback on process should be collected at the November Exhibition for feedback.

2a. At the exhibition, the tag should be less than 50% completed

Justification: If the tag was completed prior to the Exhibition, it would be harder to implement feedback received. For time optimisation, feedback

received can be implemented immediately without conflicting with existing plans.

2b. Should include a 6 item questionnaire

Justification: Six questions allows room for adequate data, without taking too much time or attention.

2c. The questionnaire must pertain to a variety of individuals.

Justification: To receive a greater diversity of data, the questionnaire has to appeal to different aspects of the project. This ensures minimal loss of communication

2d. Must include a simple, minimalistic, informative poster which should be referenced during presentations.

Justification: The poster made should contain information about shark population and preface the presentation. Overall, it should evoke thought into the viewer.

2e. Analyse feedback received and adjust or improve upon the product as well as communication/presentation skills.

Justification: The feedback received from this exhibition has to be analysed in charts. It should give an indication on the overall engagement level of project and the focus of the tag.

3. Completed tag must be presented at WEP Science Fair and Final Personal Project Community Showcase.

3a. Must contain completed tag, with demonstration of functionality and features.

Justification: The tag must be demonstrated to the general public as a promotion method for conservation. It should establish the link between

technology and conservation and demonstrate work done throughout the process.

3b. Must include a simple, minimalistic, informative poster which should be referenced during presentations.

Justification: Used to draw attention to the table. The information on the poster should be referenced throughout the presentation.

3c. Should speak to at least 15 individuals from a variety of backgrounds about the tag and shark conservation

Justification: With the overall purpose of the project being awareness, it is important to speak to a variety of individuals concerning the topic. This includes, community members, children, university students and professors.

2.2. Development Process

The Process Journal was used to document research and the prototyping process (Appendix B). It helped structure and organise thoughts and provided a place for reflections on mistakes and research. The prototyping process was all documentation and was frequently referred back to during troubleshooting. The informality and uniqueness of the process journal ensured self motivation as goals and future thought were documented.

Prior to the beginning of summer in 2016, a Summer Action Plan (Appendix Q) was created to track and keep us with research. It provided a constant reminder of the work that needed to be complete by the end of the summer to stay on track. It also helped organise and prioritise the time needed for different sections of research.

Supervisor meetings were scheduled beforehand either in the form of emails (Appendix R), or verbally. Meetings often involved discussion of the balance between action

and report. Supervisor meetings always kept check on the focus of the project and connection to the global context.

After scrutinizing the main aspects of the tag, the functionalities were broken down and an attempt was made replicate them with basic electronics (Appendix B). The decision making process included the availability of the component, the cost, and the existing online relating to it (Appendix B).

2.3. Self-Management Skills

Often time in electronic projects, a situation arises in which, an issue cannot be troubleshooted, despite constant reflection and analysing. It is at times like these that the feeling of frustration has to be controlled and persistence and perseverance had to be demonstrated. Breaks were taken between prototyping sessions for composure and reflective purposes before attempting again. Additionally, eliminating possible distractions such as Skype and Reddit helped redirect focus.

A large amount of reflection is required and techniques and strategies developed for effective learning. After much repetition, a habit as been made to carefully note down all the steps taken. An example where this habit is applied was during the transmission test between the two radio modules (Appendix A). After due time and reflection, the problem was the first configuration was done incorrectly.

3.0 Taking Action

3.1. Creating an outcome and a product in response to the goal, global context and criteria.

The first steps involved understanding the functions of each respective component.

Firstly, the Arduino GPS Library was installed into the IDE (Appendix A) to simplify coding.

The functionality of the GPS was tested by compiling an empty code and opening serial monitor (Appendix A). Next, the SD card was incorporated. Simple text files were saved onto the card to ensure functionality. Finally, the APC220 radio modules (Appendix G) were tested. Since they were not used in a long time, they had to be configured to the same frequency. They were tested by sending a simple “Hello World” to serial monitor.

An incomplete prototype was demonstrated at the November Exhibition. The device showed the GPS and transmission functionalities as at the time the SD card reader was unavailable. A poster was made for the fair along with two questionnaires. The general questionnaire was directed at community members with little knowledge on electronics or sharks. The questions pertained to their opinion on sharks after the presentation and the engagingness of the presentation. This gave insight as to communication skills and whether or not the message was effectively conveyed (Appendix I).

The completed prototype incorporated an Arduino Uno, and Adafruit Ultimate GPS Breakout (Appendix H), two APC220 Radio modules, and an SD card shield (Appendix X). Due to a limited understanding of coding, the amount of time spent troubleshooting increased. Eventually the final functioning prototype recorded parsed (Appendix A) latitude and longitude in the SD card and transmitted raw NMEA sentences (Appendix A) to a PC (Appendix A) via radio waves (Appendix P). The wireless functionality of the tag was tested by connecting a 9v battery to the Arduino. With no wires connecting the PC to the Arduino,

the recorded latitude and longitude was transmitted with minimal delay. An accuracy test and robustness test was also conducted to ensure reliable functionality (Appendix B).

3.2. Thinking Skills

Ideas from multiple perspectives were considered and thorough analysation required while designing the tag and factors, such as resources and cost were taken into account. Research was conducted on specific shark candidates, taking into account factors, such as habitat, behavior, and conservation status for the completed prototype. Furthermore, the tag functionalities had to be taken into account and possible inefficiencies in the hardware and manpower researched. With all this in mind, it was critical to link it back to the purpose of the project which is conservation. Considering the tag functionalities, specific species, such as the Carcharodon carcharias, Sphyrna lewini, Cetorhinus maximus, Rhincodon typus, Alopias vulpinus would be ideal candidates (Appendix T, U, V, W, X)

Mistakes in the code required a lot of scrutinization to fix and as a beginner in coding, systematic skills aided troubleshooting. Additionally, the feedback received directed the focus on the data storage and retrieval as opposed to adding additional sensors. The subject-specific questionnaire results were directly in line with the original intention, of focusing on a reliable method of data retrieval. This directed focus and the specific skill of coding was utilized and developed.

3.3. Communication and Social Skills

Effort was taken to overcome the initial fear and discomfort of speaking to a new person, however collaboration was vital to the project. Collaboration with university members, using a variety of digital environments and media, broadened knowledge and the very point of the project relies on the communication to the general public. While working with the university members, emails written to new individuals were formal and direct.

Emails written to familiar individuals, such as Hardenstine and Cochran were slightly informal as it seem out of the ordinary. However, when invitations to the November Exhibition were sent, regardless of familiarity, the emails were thoroughly drafted to ensure professionalism and formality (Appendix Y). To ensure focused conversation, guiding questions and acknowledgments were made.

A variety of media to communicate with a range of audiences was demonstrated. One of the questions in the general questionnaire of the November Exhibition pertained to engagingness of the presentation. During the exhibition and the science fair (Appendix P), a variety of individuals were present. As a result, the delivery of my explanation had to vary. With children, smaller, less scientific vocabulary, analogies and connection to their daily lives were techniques used to keep interest. When individuals with little to no prior knowledge approached, certain terms, such as microcontroller and radio module were explained prior to presenting the prototype. Whilst talking to professors, and university students, the explanation was scientific and technical in nature.

4.0 Reflecting

4.1. Evaluate the quality of the outcome against the criteria

Referring back to the criteria, evaluation is as follows:

1. Prototype a device that can track the movement of an object using hobbyist electronics.

1a. Criterion met. Specification 1A was met components were available online

1b. Criterion met. The completed device recorded global positioning. In the future, further research should be conducted on existing depth sensors and its integration in terms of both hardware and software.

1c. Criterion met. The final device falls into both the data-logging and transmitting category as data was stored in the SD card and transmitted to the computer.

1d. Criterion not achieved. In the future, a custom PCB should be made using the available software in the school for stable connections.

1e. Criterion met. Feasible candidates were discussed in appendices

2. Feedback on process should be collected at the November Exhibition for feedback.

2a. Criterion met. Prototype presented only comprised GPS and radio modules working separately.

2b. Criterion met. Each questionnaire was under 6 questions. The general questionnaire was 4 questions long, and the subject-specific questionnaire was 3 questions long

2c. Criterion partially met. Questionnaires mainly pertained to adults due to the formality. Most children did not complete the questionnaire. Responses from the subject specific questionnaire suggested focusing on the storage and retrieval of data, which improved upon.

2d. Criterion partially met. Specification 2d was partially met as a poster was made to aid in the presentation, however it was not referenced while communicating with the audience.

2e. Data from the specific questionnaire stated focus should be on data storage and retrieval. PBC mounting was put on hold as a result.

3. Completed tag must be presented at WEP Science Fair and Final Personal Project Exhibition.

3a. Criterion Met. The completed tag was presented at WEP Science Fair

3b. Criterion partially met. Specification 3b was partially met as the same poster utilized in the November exhibition was displayed, but not referenced throughout the presentation.

3c. Criterion met. Specification 3c was met as a variety of individuals came to the table. This ranged from children, to adults. School students, university students, professors, and community members.

4.2. Reflection on completing the project

This project has stretched and challenged not only my command on electronics and understanding of sharks, but it has also tested my perseverance and work ethic. There is now greater depth as scientific names, evolution and specific population declines are understood. These understandings along with critical thinking were utilized in deciding candidates for the tag. Electronically, pre-made code can now be read to understand hardware specifications before building.

Respect for biologists and engineers has grown as I previously underestimated the complexity in both fields. Skills utilized, such as critical thinking and analysation, are transferable from one field to the other. Above all, the importance of specificity and attention

to detail is now understood. In electronics, the smallest of mistakes can cost the functionality of the device, and thorough reflection and perseverance is required to troubleshoot.

A range of scientific concepts were researched and understood prior to the completion of the prototype. The bigger picture, involved justifying the need for a solution, giving the technology a greater importance. However, the project gets meaning when these learnings are communicated to the general public. Statistics and visuals were utilized to educate the public on the natural world and humanity's responsibility and the consequences of our actions.

4.3. Reflection on development as IB learners through the project

I grew as a risk-taker as the goal I set for myself involved complex electronics and embedded systems. I did not know where to begin as I had never attempted a project of this magnitude. Furthermore, I knew from experience that the likelihood of failure in an electronics project is high. From choosing the components to incorrect wiring, the chance of damage and lack of functionality was great. To complete the challenging task of embedding a system, extensive research was conducted to expand knowledge in the fields of marine biology and engineering. Because of the research and the prototyping process, I have become more knowledgeable. This included how a GPS works, to shark population statistics, to simply formatting the SD card. Even the smallest of errors can cost the whole prototype and troubleshooting involved very specific knowledge on the components. My knowledge on sharks has become much more scientific in nature and I'm pleased I could spread a message about their conservation.

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Appendix A

Glossary

- Elasmobranchii - A subclass of Chondrichthyes (cartilaginous fish) referring to all sharks, rays and skates.
- Arduino Uno Microcontroller - A hobbyist microcontroller board
- Code Libraries - A collection of resources (commands, terms, etc.) used by a program in a single file
- IDE - Integrated Development Environment or software
- Radio Modules - Small device with the capability to transmit and receive data
- NMEA Sentences - Stands for National Marine Electronics Association. It is data specification for communication between electronic devices.
- Parse - Analyse a string of symbols
- Serial Monitor - Connection between computer and electronic components. It allows you to send and receive text commands.
- PC - Personal Computer
- Carcharodon Carcharias - Great White Shark
- Prionace Glauca - Blue Shark
- Cetorhinus Maximus - Basking Shark
- Rhincodon typus - Whale Shark
- Alopias vulpinus - Thresher Shark

Appendix B

Process Journal Extracts

Extract 1: April 25th

I just came from my first supervisor meeting with Ms. Rasha. It started off very casually as I explained to her what I hoped my project would be. She seemed pleased about my vision, however she gave me a very important piece of advice. At the time, my only concern was my product, the tag. She spoke about her advisee last year and although he had a nice product, because of his lack of commitment to the report, he had lost marks. While I have taken her advice, for some reason I'm still only focused on the product. I suppose it's natural since it is where my interest lies.

She also spoke about the possibility of a mentor and getting in touch with the university, I had spoken to her about my previous internship at the Red Sea Research Centre and she asked if I could do something like that again. I suppose I could, but I don't really see how it would help with the project. It would definitely be considered as research, however, the main challenge is to have a balance between biology and engineering. I feel like in a time with so much work (and possibly more work in Grade 10), that I'd rather avoid the stress. She understood this and suggested that I still get in touch with them for research purposes. I already did, but I see that the more resources the better.

Towards the end of the meeting she highlighted a concern of hers. I was completely focused on the product. She said that because of my knowledge, I knew the connections between the biology and the technology; most people don't. See also mentioned that the overall message is still shark conservation and that I should always bring it back to that, otherwise the point of the project is lost in translation. I did think about this while writing. I guess I should make part of my action presentation then. I know making a prototype is hard,

but I guess to make things harder I should present to the community. It links back her point about shark conservations and message spreading. I'll have to sort out the technicalities later, but for now I think I've got a lot more to do.

Extract 2: April 29

In an attempt to fully understand the type of tag I'm making, I looked into the different categories of shark tags. The two main kinds are data-loggers and transmitters. Data-loggers, as the name suggests stores data within the hardware. The tag has to be physically retrieved in order to retrieve the data. That's a bit of a gamble as there is a really high chance you wouldn't find it again. The other kind is called transmitters and Jesse spoke about the two types. But they're classified by their ability to transmit data via either acoustics or satellite to researchers. Most tags are a combination of these two for reliability. The best kinds of tags are generally ones which store data and transmit a summary of the data when the tag breaks the surface of the water. Maybe I should incorporate a water sensor into this. At least then battery life isn't lost trying to transmit underwater. But then again, I'm thinking ahead of myself as I don't even know how I'm going to transmit the data. I thought via bluetooth, because it's technically radio waves but, I still don't know how to program it. I have this envision in my head of a perfect tag, component mounted on a PCB (printed circuit board) and housed in a custom case. I know this isn't going to happen, but ehh. I just want to make it perfect...

Extract 3: June 17

So for the past few days I've been busy researching different types of GPS modules to use. I've looked at so many tutorials online for Arduino GPS tracking. I got results about car tracking, pet tracking, and loads of other stuff. There was one tutorial on Youtube which used the Skylab GPS Module SKM53. It looked like the perfect solution. It just required the

TinyGPS Arduino Library to read the data. I also thought the guy who spoke about it in the video gave quite a lot of information regarding the reading of data. The only issue was that when I tried to look for a place to purchase it, I couldn't find any online stores. I looked it up on Amazon, and there was nothing except one particular guy trying to sell his. No price, nothing was given, not even on the official website. So the search continued.

The next module I looked into was the GY-NEO6MV2. Its original intention was a flight controller GPS module, means it was to be used on quadcopters and stuff like that. Considering that, I can already assume the specs. would be relatively good, though it didn't say anything about the sensitivity. At this point though, am I really that concerned with sensitivity? I don't think so. I was priced at \$11.09 (why the .09, I'm not sure), but the only thing is that it would be shipped from the CN warehouse. That means the shipping cost is completely separate and that it would have to family in the US before being shipped to Saudi Arabia. It was available on Amazon, but with only one customer review and an increased price of \$16.98. While this could work, I don't think I should be risking something like this. I'll have one last look and if I can't find anything else to my liking I'll just go with that. Though I'm sure that there must be more modules to choose from. I'll just try again tomorrow.

Extract 4: June 18th

I may have found the perfect solution. So again, on Youtube this guy made a video for Arduino with data-logging capabilities. He used a GPS module called the Adafruit Ultimate GPS Breakout. Bit of a mouthful, but anyways, it's available on Amazon and does nice shipping and what not. Although its \$41.39, there are so many online resources about it and there is even a very specific Arduino Library about it. So, I think for the increased price, it should be a good purchase. It is made almost specifically for the Arduino, breadboard

friendly and as 165 dBm sensitivity, 10 Hz updates and 66 channels. What more could I want? I showed this to my mum and asked her opinion on it. She was really impressed with the specs. And placed an order for it. Additionally, she had placed an order for an Arduino kit so I would not be dependent on borrowing the school's Arduino. This is partially because, I'm an idiot and forgot to ask the design technology teachers, Ms. Molloy and Mr. McEwen to borrow a kit for the summer. Now I'm Arduino-less. Hopefully that problem can be fixed soon.

Extract 5: July 10th

It is currently 12:16 am and all may not be lost, but I'm also an idiot. In my electronics box I had two modules with antennas. I knew that they were some form of transmitter which solves half of my problem, but then what about the receiver? Well, I actually looked up that specific module and realised it is an APC220 Wireless RF Modules. Upon further inspection of the specs, I realise they are radio sensors! Sensors, that means they suffice as a transmitter and receiver. At this point it doesn't matter to me whether or not it is only one way communication, even if it was, it would suffice. But guess what? You remember the module I had used to practice my soldering on? Well, surprise, surprise, it was one of those APC220 modules. I didn't power it up or anything, so I just desoldered my "handiwork" and hopefully it should be as good as new. I'm not sure how long they've been in that box or whether or not they work, but for now this is an amazing discovery. A project I found on the internet used these APC220 Modules to wirelessly connect an Arduino to a computer. Now to connect the module to a computer, one would require a USB to TTY converter. Basically, you would require this USB like module with female header pins so you could directly connect the module into it and then to the computer. Trouble is, I don't have such a module. I could experiment and see if I could convert a cable of a sort into a module. I

have yet to research on this topic. I despite this, I could still do communication from Arduino to Arduino wirelessly. What I'm thinking of right now is having the GPS module connected to and Arduino. The information from the GPS would then be transmitted to the next via the APC220 modules. When the next Arduino receives this data, it could display it on an LCD screen. Far from a shark tag, but still a lot of work to be done. I would first need to experiment and familiarise myself with the GPS module and APC220 modules. I can do that separately and see if I can integrate them together later. As for my data logging problem, I may have solved that as well. Since I had looked up a DIY USB to TTY converted, I thought what if I looked up a DIY SD Card reader. Thankfully, Instructables came to my rescue. Someone had exactly the same problem as me in which he needed to store mass amounts of data but waiting for an SD card reader in the mail took time. So, his solution? Pure genius, he solders male header pins directly onto the SD card and simply plugs it into a breadboard. Done, just like an SD card reader. The drawback here is, if you solder the pins directly onto the SD card, there'd be no way you could use it with any other device, a computer for example. You'd have to extract the data via Arduino. I'm still not too sure how that'd work, but again, it's a solution. I think I'm on a roll now that I've managed to find some solutions for both the transmission and data logging problem. I'm going to still do a little bit more research on the topic. I found another great Instructable in which someone makes a wireless weather station. He connected a temperature and humidity sensor to an Arduino Nano and then transmitted it to an Uno with an LCD screen. My product would be very similar, except instead of the humidity sensor, it would be the GPS module. Someone else had already uploaded a schematic for the Adafruit GPS breakout and an Arduino Nano and LCD screen. I'll have to merge these two projects someone to come up with my final product. I've not touched any of the electronics yet, because I want to be absolutely certain of what I want to

make first. For the past week I've been bouncing back and forth. Why, just yesterday I thought I'd do communication via bluetooth. Now that I've managed to find a way to solve my problems in a more reasonable and reliable manner, I'm going to first figure out a schematic and download all the libraries and merge some of the codes together. Once I have all that set, then, I will move onto the electronics. At least by then, my thoughts will be extremely clear.

Extract 6: September 26th

Today I looked at possible methods of data storage. I knew almost certainly it would be with an SD card as that is the most reliable method of data storage with an Arduino. The thing is, how do I get the Arduino to communicate with the SD card when I do not have an SD card reader? I saw an instructables saying I can solder pin headers directly onto the conductive pads of the SD card and plug it into a breadboard. I think this is the most reliable option for now. I'll have to go and purchase an SD card for somewhere, but that isn't too much of a hassle, though considering my previous experience with soldering, I have my doubts. The Arduino has a built in SD card library for data-logging projects. Additionally, the very first video I saw about the Adafruit GPS already had a perfect explanation on how to connect an SD card with that particular GPS model.

Extract 7: September 29th

After much confusion and several revisions I have decided how my tag would look like. The tag would be powered externally via 9v battery. It would power an Arduino with the GPS, SD card, and radio modules attached to it. The GPS will collect a signal and store it within the SD card while simultaneously, the data will be transmitted via radio waves to the computer. Done. This is how I want to that to look like. Hopefully if I finish it soon, I can mount all the components on a custom PCB (printed circuit board) and it will look beautiful!

Extract 8: November 16th

I doubt I've ever designed and edited something so quickly. Straight after school I went to the university library, took out my computer, closed Gmail, closed Skype, closed Reddit and just worked. I had found a nice template on powerpoint with a blue gradient that I originally intended. I scaled up the paper and began work. I decided that the images on the poster drew away from the text, so I primarily used silhouettes. I still think the idea of the magnifying glass over the whale shark exposing the tag was super clever. Since I was presenting to the community I decided to base the project almost entirely on sharks and only mention the tag. Because most of my table is electronics based, there needs to be a balance. I used the word selachophobia to catch the attention of people, maybe even people who suffer from it. I then proceed to explain using facts why this is irrational. By going down, the numbers are in increasing order and harsh words like "killed", "die", and "endangered" were done in blood red for emphasis. Towards the end however, there was just a huge blob of blue next to the whale shark, so I decided to give a summary of the information present if people didn't already understand the message. I simply put "No sharks. No oceans" to remind them of the importance of sharks. Below you can compare my first poster draft and final poster.

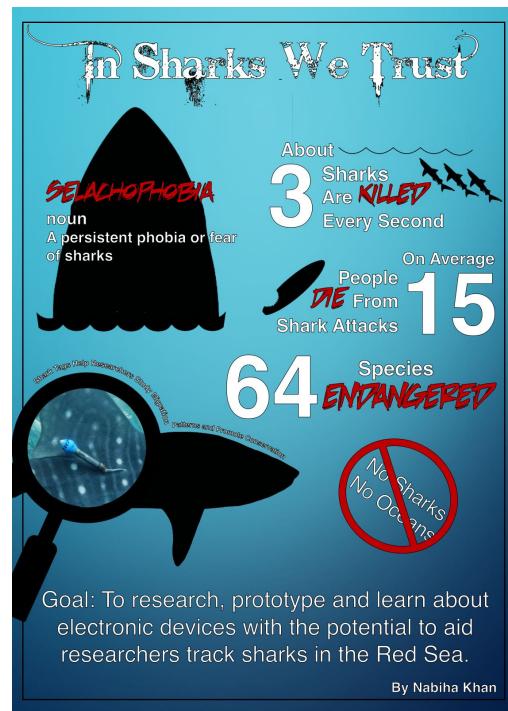
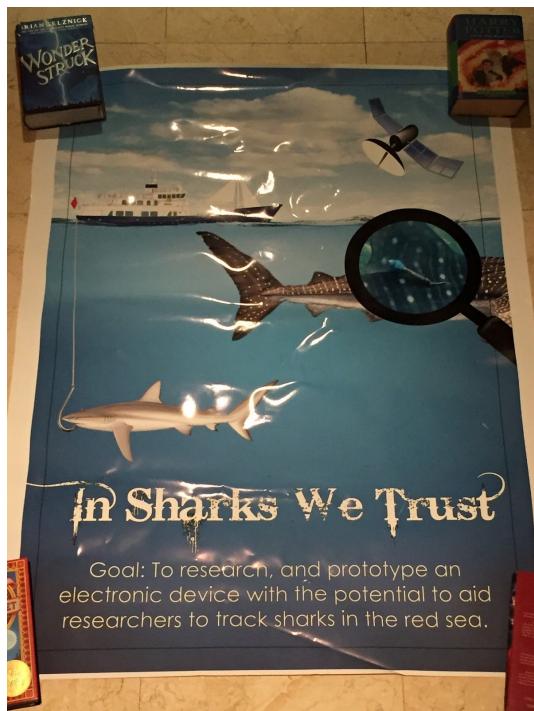


Figure 1: This is the first poster draft

Figure 2: This is the final poster

Extract 9: November 23rd

Yesterday I gave the raw results, today I'm going to talk about it. Firstly I'm extremely glad that majority respondents in the subject specific questionnaire said that either waterproofing or data storage/retrieval or data recordings should have priority. I think I'm going to choose data storage and retrieval as a priority. Firstly, there is no way, I'm going to have enough time or resources to add any external sensors. Additionally too many sensors may result in power shortages. I'm no where near done to begin waterproofing, there isn't any point waterproofing if I don't have a functioning prototype. Hopefully if I manage to get the tag to work, I can walk around with it and check my GPS coordinates as most suggested in the second question of the subject-specific questionnaire. Looking at the general questionnaire, I can see that most people agree that technology can promote conservation. At least that means I did my job. The communication of the project however, is what I'm interested in. Majority have rated the presentation an 8/10, a lot more than what I was personally expecting. I can only assume this means that it was interesting but there must have been some points where I lost their interest. Second highest and third highest responses rated 6/10 and 5/10 respectively. So I can only assume this means the project was interesting but the presentation wasn't so. I should've added a section asking how I could improve, but no matter. I think the main thing I can take from this is that, I need to have my product done to be fully engaged and comfortable with my audience. I also need to prepare before hand how I'm going to address little children.

Extract 10: December 29

So my sister is currently in 9th grade and her class if doing the Arduino unit. Today she brought home her Arduino it and miraculously, it contained a 9v battery holder. None of the 9v batteries I had at home worked so I went to tamimi and got a new one. I had an idea on the way there. So the test code for the radio modules just used a simple serial command like `print();`

The code from the tutorial I followed yesterday also included a functionality in which the NMEA sentences would be displayed on the serial monitor. By that logic, I should not need to code anything more to get the data from the GPS transmitting. Additionally since the code had assigned two different pin outputs to the GPS (pins 2 &3 not 0&1), that means I had room for adding the radio module to the whole system. The only issue right now is power, I'm not sure if it will be enough. When I came home, I tried just transmitting my simple “In Shark We Trust wirelessly and... it didn't work. This means that the whole time during the November Exhibition the module wasn't actually transmitting anything. Now, I have to figure out why.

Extract 11

January 18th

My action is now finished. I completed the prototype, and I presented at both the November Exhibition and the Science Fair. The Science Fair went well yesterday. Most of the people who came to my table confused me for a university student, asking me what my major was. While I thought that this should've been a simple project, most people were surprised that I managed to pull it off. In all honestly, with my carelessness, so did I. The day before the fair I had emailed Royale asking if I could borrow a broken shark tag to compare and contrast devices. I went to her this morning and she had the tag with her. I still can't believe how she managed to find it so quickly, but I'm still grateful. I even managed to keep the interest of

children. I used simple terminologies and asked them questions. As a result, it was overall a hectic yet pleasant experience.

Appendix C

Shark Fin Soup

Shark fin is the main ingredient in the popular Asian dish, shark fin soup. This dish is known for originating from the Ming Dynasty, China's ruling dynasty, and was considered to be one of the

eight treasures of Chinese cuisine. It is rumoured to have been served to kings and nobles. As a result, this superstition has made it a symbol of wealth and luxury. Feeding on one of the most feared animals in the world certainly shows a sign of power. Most claim to eat the soup for its genuine taste, but according to world renowned chef Gordon Ramsay has deemed the dish is "bizarre". He claims that the soup broth, flavoured from ham tastes "really good" and that the physical fin itself tastes of "plain glass noodles" (Ramsay). The preparation of the fish involves skinning the fin to remove the tough skin and then soaking and bleaching until a gelatinous texture. While the demand of this dish is massive in Asian countries, often served for weddings and banquets, it's also been getting a lot of attention in the Western world.

Experts believe that consumption of shark meat in large quantities can be detrimental to health. A study conducted by the Sharkproject organisation estimated that there is up to "contained 1400 µg/kg (± 0.13) methyl mercury" (POISON) Mercury is a toxic element and can have detrimental effects to human health. It particularly affects the nervous system and brain functions in developing children.

Appendix D

Shark Finning

Shark finning is the process of removing the fins of a shark and throwing the rest of the carcass back into the water. This inhuman wastes 95% of the meat while only targeting the valuable 5%. The main cause of shark finning is shark fin soup (Appendix). Shark finning is considered one of them most inhumane acts of animal cruelty as the shark, often still alive while being thrown overboard. The animal then either dies due to blood loss, or suffocation as most sharks need to swim to constantly force water into their gills. Their death is slow and painful, often times their carcasses littering the sea floor. The motive for shark finning involves ease in transportation. Since the fin of the shark is priced higher than majority of the flesh, going up till \$1,100 a kilogram. To increase the amount of fins sold, the carcasses are dumped to allow for more room. If the bodies were brought with the fins attached, the fisherman would gain less of a profit. According to the Food and Agriculture Organization of the United Nations, “global shark catches reported to FAO have tripled since 1950” (International Plan). The shark fin trade is a large underground and unregulated black market. Most private organisations ban reporters and are managed internally under a private licence. Because of this, often times authorities turn a blind eye to their doings partially because their efforts would often be in vain. Costa Rica is quintessential. Despite having regulation imposed on shark fishing, the Chinese mafia always manages to slip by due to a major loophole. Landing sharks with fins still attached are allowed and skinned and meat-stripped carcasses appear at docks, with fins still attached. The shark fin trading industry is a billion dollar industry and loopholes in regulations always let unregulated fisheries operate. This is seriously detrimental to the shark population and is considered to be the leading cause of their population decline.

Appendix E

Shark Tags

The first prototype of an electronic tag was invented in the 1940s in Australia with the intention of shark population monitoring.

Pingers: Pingers are considered to be the original shark tag. Classified as transmitters, the tag sends out ultrasonic pings which are picked up by a hydrophone (that is normally either attached to a boat or held in the water manually).

Satellite Tags: There are two types of satellite tags. A SPOT tag or Smart Position or Temperature Transmitting Tag needs to have air contact in order to send data. This is because the tag uses radio transmissions and waves sent out by the transmitter would be reflected by the surface of the sea or ocean or wherever the shark is. This tag is great for giving quick indications as to the geographic location of the shark. There is another variation of this is the Pop Up Archival Transmitting, also known as the PAT tag. This tag is arguably the most commonly used tag. The tag collects and stores information such as the angle and speed at which the host animal is swimming at, the temperature of the water, and even the light intensity. At a specified time and data the tag will send out an electric current through a wire. The wire will then quickly corrode due to the salt in the water and then detached from the host animal. It floats to the surface and from there, the tag sends its calculated geographic location and summaries of the collected data. If the tag is retrieved physically, all the data can be retrieved.

Acoustic Tags: Acoustic tags use sound waves for data communication. The tag, is equipped with various sensors. Receivers have to be implemented in the water prior to tag deployment. When the tag nears a receiver the data is transmitted underwater. The receiver then sends the data via satellite to the researchers for examination.

Appendix F

Arduino Uno

Arduino is a programmable micro-controller which is based on an ATmega328P datasheet.

Created by Atmel, the ATmega328 is a chip micro-controller that is programmable with C.

Hence the Arduino is programmed using C. The Arduino isn't used so much in industrial areas and are generally used by hobbyists. Arduino is a great way to familiarise oneself with

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

electronics.

Figure 1: These are the specifications of the Arduino Uno taken directly from the official website.

Arduino Specifications. Digital image. Arduino. Arduino, n.d. Web.

<<https://www.arduino.cc/en/Main/ArduinoBoardUno>>.

Appendix G

APC220 Radio Module

The APC220 Radio Communication Module is branded and sold by DFRobot. Its costs \$40 and comes with two radio modules, two antenna, and a USB to TTL serial converter. The modules are semi-duplex which allow for two way communication. The antennas help boost signals between the modules which can transmit up to 1000m at 9600bps. TTL (Transistor-Transistor Logic) “employs transistor/s with multiple emitters in gates having more than one input.” (What Is Transistor). This module can transmit heavy loads of data, making it an ideal component to incorporate in the tag.

Appendix H

Adafruit Ultimate GPS Breakout

The Adafruit Ultimate GPS Breakout was the chosen GPS module for the prototype. The \$39.95 component is breadboard compatible. It has a -165 dBm sensitivity, 10 Hz updates, 66 channels with build in data logging capabilities. The module comes with an external antenna to boost satellite signals. When 5v power supply is plugged in, the GPS is programmed to immediately start looking for a satellite fix. When the GPS gets a fix, the raw NMEA can be seen via serial monitor by uploading a blank code to bypass the Arduino chip. To parse information, codes can be uploaded using the Adafruit libraries to parse the data. The module has a built in MTK3339 chipset allowing for the module to track 22 satellites on 66 channels. The power consumption is only 20 mA, possibly increasing battery life. Additionally for backup the module comes with a CR1220 coin cell holder.

Appendix I

November Exhibition Raw Feedback

What was your opinion on shark prior to this presentation? (16 responses)

They are cool and we need a save it
 They are cool and we need a save it
 They are dangerous
 They are dangerous
 That they were not as endangered as they were in the past.
 I was aware before
 I like them
 Good but from a distance
 They are scary.
 Scary, viscous and awsome
 Good

Figure _: First question of general questionnaire

**Has your opinion on sharks changed or expanded throughout the presentation? If yes, how so?
(11 responses)**

Yes she made me realize they are endangered
 Yes she made me realize they are endangered
 Yes I learnt they are not so deadly
 Yes I learnt they are not so deadly
 Yes, as sharks are endangered and more gentle creatures.
 Yes
 It changed the day you kept blabbering about them at home.
 In the value of information we can get form them
 Yes. They are not as scary. They actually need protection.
 Not really, since I areldy knew about sharks
 Yes. I thought they were more important

Figure _: Second question of general questionnaire

Do you think this technology promotes shark conservation? (11 responses)

Yes
Yes indirectly
Yes indirectly
Yup!
Yes definitely
Of course
Yes, because it prevents fishermen from hurting them

Figure _ : Third question of general questionnaire

On a scale of 1-10 how engaging was this presentation? (28 responses)

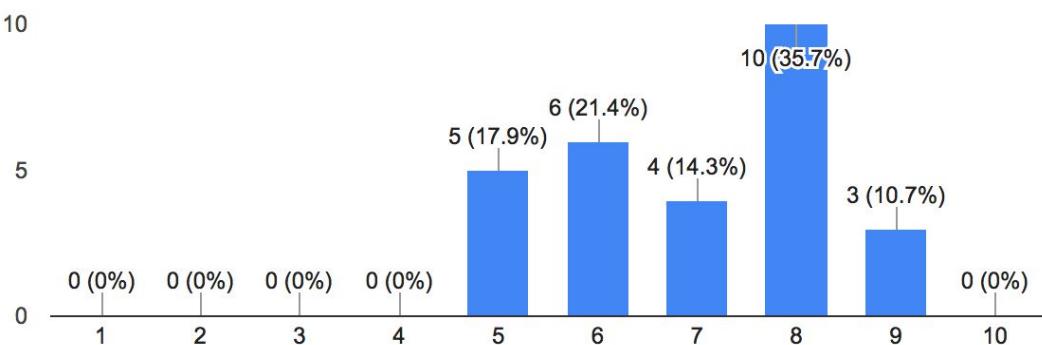


Figure _ : Last question of general questionnaire

Which factor do you think I should focus on while designing my tag?
 (7 responses)

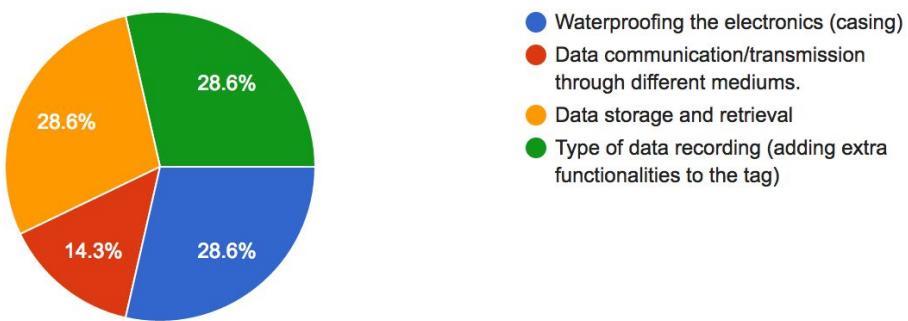


Figure _: First question of subject-specific questionnaire

Based on your previous answer, how can I improve the design of the tag?
 (7 responses)

Focus on it functioning underwater, with deep depths.

Look for more sensors that meet your original plan

To improve you will need to Make t water proof or none of the functions will work well.

Think about important sensors - begin with temperature (easy), salinity (harder) and chlorophyll (measure of plant biomass)

Onboard storage of the data would alleviate the need for quick or sustained communication

Looks great as it is! Throw it on something and track it. The applications and refinements grow from there.

Try to get reliable contact which is not dependent on uncontrolled factors

Figure _: Second question of subject-specific questionnaire

What possible test methods can you suggest for testing the tag's functionality

(7 responses)

Place It on a rock or sinkable object.

Pets!

Go to the pool when you have finished creating the tag, and test the casing, but do this without all the mechanism out.

Use with human subject for first test

Always a good idea (and fun) to "tag" someone on land and have them move around and see how well you can track them!

Follow a bus, water taxi, pet or pizza delivery scooter! Link that into google earth. CMOR could pop it on a mooring or our AUV so we know when it surfaces... And where... So we can pick it up.

Great stuff!

Figure _: Last question of subject-specific questionnaire

Appendix J

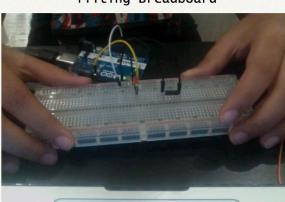
Design Technology Class Unit Workbook

SECTION 11 Project 5: Tilt Sensor

COMPONENTS

- Arduino Uno
- USB Printer Cable
- Arduino Software
- Breadboard
- Tilt Sensor
- Jumper Wire
- 300 Ohm Resistor
- LED

Tilting Breadboard



To add a new component to the itinerary, we'll be using a tilt sensor. In this project we'll make an LED turn on by tilting the breadboard

```
// This code was taken from Adafruit
#include <avr/sleep.h>

// Initialize variable with the pin numbers we'll be using
int led_pin = 11;
```

15

SECTION 2 Parts of the Code

```
// the setup() function runs once when you press reset or power the board
void setup() {
    // initialize digital pin 13 as an output
    pinMode(13, OUTPUT);
}

// the loop() function runs over and over again forever
void loop() {
    digitalWrite(13, HIGH); // turn the LED on (HIGH is the voltage level)
    delay(1000); // wait for a second

    digitalWrite(13, LOW); // turn the LED off by making the voltage
    delay(1000); // wait for a second
}
```

void setup()

Parent-handles hold arguments or bits of code. These arguments will be associated with the command that follows before them. E.g. `delay(1000)`. This means that there will be a delay and the time is specified within the parent-handles. Meaning there there will be a delay for 1000 milliseconds.

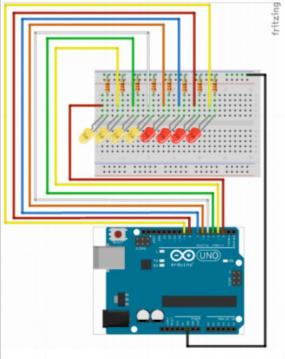
void loop()

Comments allow for the author of the code to make said comments directly onto the sketch without it affecting the code. There are two types of comment that can be made, single and multiple line. This means that either you can have a single line or multiple. In this example, there are only single line comments. To make a single line comment the symbols `//` need to come before the text.

Multi-lined comments can be written too. Instead of putting the double slashes at the start writing `/*`. This is at the start of your comment. Once you have finished be sure to close the comment by writing `*/` (in which the star is before the slash)

19

SECTION 10 Multiple LEDs: Continued



STEPS:

- The first step of every project is pretty repetitive, simply follow the schematic
- Then upload the code onto the Arduino board

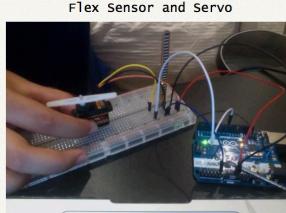
Troubleshooting:

- Because this project has so many components, it is easy to insert the wrong component into an incorrect slot in the breadboard.
- To overcome this, I suggest setting up the LEDs one by one, making sure that the circuit is completed every time.

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SECTION 4 Project 2: Flex Sensor and Servo

Flex Sensor and Servo



In this project, we'll be making a circuit that controls a servo motor with a flex sensor. This is the end result

COMPONENTS

- Arduino Uno
- USB Printer Cable
- Arduino Software
- Jumper Wires
- 10k Resistor
- Breadboard
- Flex Sensor
- Servo Motor

`// This is the code for the flex sensor and servo motor circuit`

`// Include the servo library to add servo-control functions:`

```
#include <Servo.h>
```

8

Figures 1, 2, 3 & 4: These are screenshots taken from my summative workbook during the grade 9 Arduino unit.

Appendix K

Shark Course

The Big Shark Picture > Sharks Everywhere > Habitats and Biogeography

Habitats and Biogeography

[Bookmark this page](#)

HABITATS AND BIOGEOGRAPHY

When we think about shark habitats, several factors come to mind. First, we need to consider where sharks live with respect to structures in the environment such as features of the bottom, reefs, or the water column itself. We use four terms to describe the associations between sharks and habitat: pelagic, benthic, epibenthic, and reef-associated.

Figure 1 & 2: These are screenshots taken from the online course

Transcripts

[Download SubRip \(.srt\) file](#)

[Download Text \(.txt\) file](#)

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Check Your Understanding

1.0/1.0 point (graded)

In which zone of the ocean would you find the fewest sharks?

Bathypelagic

Photic

Abyssopelagic ✓

Mesopelagic

[Submit](#) You have used 1 of 1 attempt

Appendix L

Ms. Julia Email

I just came across this and thought it could be interesting to you:

Sharks! Global Biodiversity, Biology, and Conservation

Learn about the most fascinating animals on Earth, their sophisticated senses and how sharks and their relatives have impacted human history and culture.

About this course

Did you know that you can track some sharks' movements on Twitter? Or that the scales on their skin have influenced the way humans design boats, planes, and even swim suits? Or that sharks have more senses than humans?

In this biology course, you will learn how scientists study sharks. You will join researchers on location in labs, aquariums, and oceans across the globe to learn about the biodiversity, biology, and conservation of sharks, rays, and chimaeras.

In this activity-rich course, you'll track movements of a wild shark, observe shark habitats and behavior, and dig deep into the fossil record. You will also examine topics in the functional anatomy, sensory biology, reproduction, behavior, and ecology of many of the 1,200 living species.

This is an exciting time to be a shark biologist. An explosion of new research methods and technologies are leading to a surprising world of discovery. We will introduce new, as well as traditional techniques, for classifying sharks, understanding behavior, and unraveling the mysteries of shark evolution. You'll be invited to explore global shark populations and consider shark-human interactions and their impacts on history and culture.

You'll be rewarded by your ability to see virtually any animal with new eyes. Practice thinking like a biologist while honing critical skills that can lead to broader observations about the ongoing history of life on Earth.

What you'll learn

- Habitats and distributions of sharks from around the world.
- Evolutionary history and relationships of sharks and allies.
- Functional anatomy of swimming, breathing, and feeding.
- Aspects of sensory biology, reproduction, and behavior.
- Ecological roles of sharks.
- Key ecological aspects of shark-human interactions.
- The impacts of human behavior on shark populations.
- How biology informs conservation efforts.

Enroll: <https://www.edx.org/course/sharks-global-biodiversity-biology-cormelx-ux-bioee101x#>

I am no longer in French Polynesia but have just started a position at Cambridge in the UK. If you ever happen to visit England let me know, it would be great to catch up!

Hope all is well!

Please send my regards to your mom.

Best wishes,

Julia

 Nabila Khan <nabila.khan@thekeaukschool.org>

Hi Julia,

It's wonderful to hear from you again. I'm sorry for the late reply, my family went on a holiday to the US and I've only just seen your email. How have you been?

What's there to say about KAUST life? I suppose it just goes on. School is now finished and summer has started. The difference this time is, as a finishing 9th grader, I have a lot of work to do this holiday. Starting in 9th grade, students are required to do a year long project based on the topic of their choice. Naturally, I chose to do sharks. This time however, I'm more interested the shark tag device and the engineering behind it.

The goal of my project is to possibly prototype a shark tag. It won't be overly complicated, it's just along the lines of coding and displaying the data from a GPS module with a micro-controller such as Arduino. This, however, is simply not enough for the IB. They are constantly stressing us to look at the bigger picture and how, in my case, such technology would help sharks and scientists. Well, I believe, you've just made a huge contribution to my project. This online course is invaluable and I will most certainly enrol in it. Thank you so much for sharing it with me.

6/17/16

Figure 1: This is a screenshot of the email Ms. Julia wrote to me regarding the course.

Appendix M

Royale Interview

Nabiha: So, my first question to you is, in terms of research, regarding the Red Sea Research Centre, how do you actually get your tag. Where does it come from

Royale: Ok, so, it depends on which kinds of tags we are using. So there are several companies that provide tags that are made for marine environments and stuff, because the first time, I'm sure you know is that saltwater is corrosive.

Nabiha: Yeah

Royale: It destroys everything in its path. And because of that, it's really specific, like engineering that has to go into making them. So, the one company, most of them are based out of the US. And I think that's just because of (word inaudible) and scripts and all that. That kinda stuff. Like there are some really big marine science centres there. So, I know that some of the satellite tags we had were wildlife computers.

Nabiha: Ok

Royale: It's one of the companies that, their emblem is a little penguin. So, that is wildlife computers, and um. There is another one called like Desert Star Tags, we haven't used those. But some of the other whale shark people use that. And then, like the acoustic tags, come from a company called Vemco, which I think is actually out of Canada. Um, so like Vemco and Wildlife Computers are the major ones that we use and then there is different varieties of tags in there depending on what you want to do. But the most of our tags that have gone out are the Vemco ones.

Nabiha: Right

Royale: They tend to be cheaper. Actually, they're much cheaper. Especially if you're not...so there are some that have depth sensors, but those are a little bit more expensive. For the most part it's easier to say no to those

Nabiha: And just do location based?

Royale: And just do location based and then with..so with the acoustics, you can get like 3 or 4 of those for the price of one good big satellite tag.

Nabiha: Wow.

Royale: So it pays off in the long run depending on what you want to do for a study. And then, the 3d tags that we have.

Nabiha: What are those?

So the 3d tags are the ones that use accelerometers, so it tells you like pitch and yaw and like angle of ascent and angle of descent.

Nabiha: Ah, alright.

Royale: So those are...those are ones that basically have um accelerometers in them. It has...I can't think of any of the other names of the sensors. Oh, it has like a gyroscope in it and different stuff. So it can measure acceleration, and it's also just like the same thing that's in your phone that tells you that the screen is turning. It's just the example everyone uses.

Nabiha: ahh, yeah

Royale: So those are an open source tag.

Nabiha: Really?

Royale: Um, yeah.

Nabiha: Cool

Royale: They're kinda cool and if you know things about coding, I'm sure there is a lot of school stuff you can learn about them. Uhh, and a guy named Jack Leveson designs them,

designed them initially. And so, I think LoggerHead Technologies is the company that makes, like, the whole package with those. So be basically made like the motherboard or whatever.

Nabiha: PCB.

Royale: Yeah he made like, just the board. And then they made the tag housing.

Nabiha: Anything specific about the tag housing that you know of?

Royale: So um, they're actually pretty flexible. So those, I don't mean flexible like that I mean flexible in design.

Nabiha: Oh, I see, ok.

Royale: The design for those kinda flexible because they, they have like the basic housing, right? And then it's just like a little block that goes around them. Yeah, so it's a block and then you just have an O ring and a screw that tightens down.

Nabiha: Hmm.

Royale: If you mess it up, it floods, and then the tag explodes and you only get 5 minutes of data.

Nabiha: So I've been thinking of just modeling a case using 3D programs. And so I was just wondering, for the case is there like any sort of preferences for the shark. Like, does the type of case make the shark less or more comfortable?

Royale: I think the main thing you have to consider, and the thing we had to consider with it is...so it comes with... so basically, the ones that we have, are rectangles. So the tag goes inside and then the O ring around it. And then there was this flat part that kinda went around it. So, there were holes in it and we just put zip ties through it.

Nabiha: Why?

Royale: Basically what the original intention for these were and when they were designing them, is the company thought that ok. So we have this square platform and then they kinda pointed the tip of the rectangle. Because with these accelerometer tags... You've seen one of these?

Nabiha: Yeah, I've seen one of those tags when we went to the whale shark tips

Royale: Yeah, and you've seen the acoustic tags as well and you know that they're just tethered onto the shark.

Nabiha: Mhm

Royale: And they just sort of, flow in the breeze and that's fine. With these, because you want to be able to measure things like tail beats and how steep and how they're moving, they need to be as tight against the shark as you can get them, to get rid of any wiggle. Which is why we always try to attach them to their dorsal fin. Cause you can throw a clip over their dorsal fin and then it's stuck to their fin. So these need to have a very stable attachment.

Nabiha: Makes sense.

Royale: And the satellite tags, the same thing. So you tether the tag and then you have like a little floaty guy up here. So that when they get close enough to the surface, it can start talking.

Nabiha: That is really smart, I didn't even think of this.

Royale: And, so the ones that they need to talk, and the ones that doesn't matter how much they do, they do that. Though they do have some issues with other sharks hitting them and bigger predatory fish, hitting it and then eating it. But yeah, those are the different types and the reason we resorted to using rubber bands is because the tag along with the spear. Majorly affects hydrodynamics. Even with our strongest field worker, swimming his hardest, it was difficult to deploy the tag. So that's why we had to resort to the rubber bands...

Nabiha: Well, thank you so much Royale, for your time.

Royale: You're super welcome, yeah. Just let me know if you have any other questions. I'll be happy to help.

Nabiha: I may take you up on that, thank you.

Appendix N

Jesse Interview

Nabiha: I'm also familiar with the shark tag but could you please talk about what the purpose of the tag is?

Jesse: So, we've got multiple different tags for different questions. So, um, the tags we use, we use acoustic tags, and those are very good for long term but short range. So, they only really tell us when the sharks are in a target area. So, for instance with the whale shark stuff the sharks are coming into this one reef; just off of Al Laith. So we've got sensor stations all round that reef and in a little bit of the surrounding area. And when one of our tagged sharks come into the area those listening stations can detect the shark. Those are good for long term studies, the tag lasts, um, depending on the number of sensors attached to it, it lasts for several years, 5 years if it's getting depth data, 10 years if it's just, "I'm here". Um, shorter term, in terms of time, but much longer range, we have satellite tags. So, satellite tags are really good for describing long distance, broad movement. The only last, hm, our tags we program them to pop off after about 6 months or 9 months, so we had two different programmed deployment times. And uh, what they do is they use a satellite ur, again, satellite tags are a bit more complicated. And there are multiple types of satellite tags. As we actually sure two differnt types of satellite tags, three different types. So the first one and probably the most simplest one is called a SPOT tag. And thats surface position only tag. So when the shark comes up to the surface, the tag has a wet-dry sensor and it goes "oh I'm dry, try and talk to a satellite" and it tries to talk to the argos network of satellites and get a position. And then we get that position almost in real time. Because the tag talks to the satellite and the satellite transmits that position to us, we can look it up on a computer. "Oh this shark was sighted, here, this tag said this shark was here." And we can check that everyday, and Agros

updates very regularly. And we can get, information almost in real time. The other type of satellite tag is called an archival tag. And some archival tags pop off, some don't. We use the ones that pop off. The ones that don't pop off, you actually have to resight the shark again and get the tag off. It's a hassle, depending on how you set the, how often it collects data, you can get, you know if you resight the shark a few years later, and you get the tag back, you have two years worth of data. It's a bit of a risk, you never see the shark again, you don't get any data. But you could also win the lottery and see the shark two years later. It's a trade off. The pop offs- there's supposed to pop off at about 6-9 months, depending on how you program them, you can program the pop off time. And what they basically do is there is a wire at the programmed time, the tag sends an electric current through the wire

Nabiha: And it corrodes

Jesse: it corrodes. Extremely quickly once that electric current is going. And then so, the wire corrodes, that destroys the attachment, the tag pops off. Now while the tag is on the shark, it's been using light levels to estimate time of sunrise and time of sunset and to estimate the length of day. So once you have time of sunrise and time of sunset, you have a day length. And from that data, you can try and estimate global positioning. Now as you can imagine, that has a lot of error involved. Now, there are mathematical formulas, mathematical programs that you can try and take the data, and run, through those programs and make the data more accurate. But you have to have some additional data to work with otherwise you're not adding anything to the existing data. For example, those tags they also take water temperature, so you take the positioning data, plus the water temperature data, and then you look at a global map of sea surface temperature. So those are generated almost everyday, I think everyday. Global maps of sea surface temperature and they are generated from satellites. So if you take, if you get a fine enough scale, on sea surface temperature you can

start to make your positions better aware. "Well it says it was here, but that doesn't match the temperature data. Lets try and get the temperature data and the track to line up to produce a more likely track. Also, we're pretty sure the shark didn't go over dry land, so let's take the areas that are underwater, that are actually in deep enough water that a whale shark can transferase in, and limit the track to those areas. And then produce a more likely track. Also another thing you can do, so there is another set of data, so you like you know where you tagged the shark, right? We take a GPS point, fairly close to where we tagged the shark. We usually use, where we dropped the person off to swim before we get the tag on. So maximum, that's going to be a hundred, two hundred meters off, right?

Nabiha: Yeah

Jesse: Which, in term of satellite error, is 0 error. So, we've got the known point, where we tagged it. You also get a known point where it starts talking to the satellite. When it pops off it goes to the surface and starts sending data back to the satellite, you get a pretty decent estimate of position.

Nabiha: Ahh, I see, well thank you for that valuable summary.

Jesse: You're welcome.

Appendix O

Mr. Mahon Interview

Due to minimal computer battery, this is a transcript of recorded section of the interview.

Mr. Mahon: Lloyd Smith, he used to work at wildlife computers and he works with a lot of the tech. I work. And he did a lot of work with the design of this tag.

refers to tag

Mr. Mahon: This tag looks like a GPS antenna over here.

Nabiha: Yes, I see. I have a similar module for Arduino

refers to different tag

Mr. Mahon: This one here will record light underwater, because the GPS does work very reliably, if at all, underwater. And from light, you get sunrise and sunset. And then if you have a clock, you can plot where you were.

Nabiha: So this GPS will not work underwater.

Mr. Mahon: No. It does work when you break the surface. And I thought we could talk about what you want to accomplish.

Nabiha: So the goal of my project was just so I could do something electronics with my personal project. I have a passion for sharks, but during 8th and 9th grade I got interested in electronics. And I figured that this would be the best combination of the two.

Mr. Mahon: You did some work over at the Red Sea?

Nabiha: Yes, so I attended one of the whale shark trips, that the host every year in, um, April. And since I knew the researchers well, they showed me their tags.

Mr. Mahon: So that I guess was a few years ago?

Nabiha: Yes.

gestures to table of tags

Mr. Mahon: You might recognise some of these because these are leftovers from that.

Nabiha: Are they being used, these ones?

Mr. Mahon: These ones haven't been used. They bought a lot of tags, I think it was like hundreds.

Nabiha: Oh, ok.

Mr. Mahon: It was one of the largest single orders this company has every had. So, it's a big deal. Because these things cost thousands of dollars. Yeah, generally. If it's a satellite tag it'll cost a couple thousand easily.

Nabiha: I was wondering how is a satellite tag made? What's the process of actually fabricating and designing it? Because, that's the stage I'm at. I have to two APC220 radio modules. And I know that's not the best means of communication underwater, but it was the best I had. I also have an Adafruit GPS. So, it's probably not very close to what the original tag is like.

Mr. Mahon: Well... sure. And these are kinda very specific to commercial tags. What you may want to do is demonstrate things. Though it may not be the same, may not last for a year, it might just last for a day. And it's, quite a great idea, but I'm bias. So how do they make them? Generally, well they, often they're soldered together with basic components, antennas, batteries, circuit boards, sensors.

gestures to pressure sensor

Mr. Mahon: There is a pressure sensor here.

gestures to different sensor

Mr. Mahon: This is probably going to be a temperature sensor because its metal, that what the conduct the temperature though. That little thing underneath is also probably a pressure sensor.

Nabiha: What kind of batteries are there?

Mr. Mahon: You get different types. Generally, it'll be a lithium based battery. Primary lithium, it's one that it can't be charged. Some of these you can, generally not. But, people like it when they have rechargeable batteries. Because, these you have to throw away.

Nabiha: Right

Mr. Mahon: If I were to look at how to do something neat, I'd probably look at lithium polymer kinda batteries. These are lithium batteries you might find in a cell phone. An Ipod kinda thing and they come in different sizes. They're dirt cheap and these are...

Nabiha: Rechargeable?

Mr. Mahon: Rechargeable. This is what you'll find in all the remote control cars helicopters and things. Various sizes, with the same kind of technology where they lay up the chemicals, mainly they just come up fold it up and seal it. And, it can catch fire if you overcharge them. There are certain basic rules with lithium batteries that you kinda need to find out. Otherwise you leave them and they can explode.

gestures to floor

Mr. Mahon: That black spot on the floor?

Nabiha: Yes?

Mr. Mahon: It was from a lithium that got caught on a bench and got swept under the floor and the got put out. The main cause of that is running them completely flat and then charging them, and then over charging them. So how are they made? So these are all encapsulated in urethane and sometimes epoxy. There are different types of polymers.

Nabiha: And you can't get to the electronics once that has formed? Or, can you just break it?

Mr. Mahon: You could dig in with a knife. You could maybe burn some away with a soldering iron. But that creates smoke so you might want to do it under these vent hoods that suck it all away. In my previous life in Canada, when I worked at Lotek, we would dig away...if something broke on the tag or if there was data in the memory, we would dig in and we'd often lose a knife.

Nabiha: So you put the electronics in a mould you put the epoxy over it...

Mr. Mahon: It just completely floods it and you don't want any air bubbles. So, you want it to get underneath and around everything. If there is an air bubble, then that's a weakness because air compresses.

It was at this point the laptop battery ran out and the recording ended.

Appendix P

Proof of Action



Figure 1: This is a picture of me presenting at the November Exhibition. Bowes, Timothy.

Presenting Project to Guests. 2016. Discovery Square Exhibition, Jeddah.

<https://www.youtube.com/watch?v=Kj5grmySdfY> - This is a video of the Science Fair in which I present my final product.

Appendix Q

Summer Action Plan

2016-2017 Personal Project

Summer Action Plan

*Note: This can be reviewed throughout the process.

Month	Action Plan - What are you going to do? <small>Add info in each of the boxes to make the Step more specific</small>
June	<p>Action: Figure out a method of GPS tracking. Research different types of available GPSs compatible with Arduino. Take into account price, specification, and available resources (existing codes/tutorials) on the specific module.</p> <p>Process Journal: Fill in your GPS findings and justify your final choice. Be sure to write about the skills you used while making your choice. Continue reflecting about the individual components to complete prototype.</p> <p>Supervisor Meeting: Meet with Ms. Rasha prior to leaving and find a means of communication over the summer. Talk about managing time for prototyping and research. Check in with supervisor once in this month.</p> <p>Research: Existing types of tags and how you can apply certain features to your own tag. Learn about the disadvantages and challenges of underwater communication.</p>
July	<p>Research: Complete online course and continue researching shark behavior and population. Focus more on shark related research rather than technology. Link this to existing research about technology</p> <p>Process Journal: Combine the two fields of engineering and biology making sure to always link the action back to the bigger picture of sharks. Document thought and any ideas relating to prototype.</p> <p>Action: If a method of tracking has been finalised, begin tampering and familiarising yourself with the components. Do not forget about researching and do not be completely absorbed in the action portion.</p>

August	<p>Action: By now, if a method of tracking has not been finalised, stop everything and figure out a means of attaining latitude and longitude. If a means has been finalised, begin prototyping tag using Arduino. Start with understanding GPS tracking, then transmission, and then datalogging.</p> <p>Process Journal: Always record thoughts and prototyping process. It's fine to document challenges and thoughts on the prototyping method. Record skills attained or skills tested during the process.</p> <p>Research: While not specifically for the project, any research required to continue prototyping should be documented. If not specifically documented, copy all the links used. If given time, MLA cite all links.</p>
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Appendix R

Supervisor Emails

Possible Meeting  **Inbox** 

 **Nabiha Khan** <nabiha.khan@thekaustschool.org>
to Rasha 

8/4/16    

Hello Ms. Rasha,

Hope your summer has been well. I received an email from Ms. Rweyernamu saying that she'll be here in school next week. I'm going to make the assumption that that is the case for all teachers. If so, could I please meet with you some time before school starts? I would like to show you my research thus far. I've been also writing emails to you kaust.edu email, though I'm not sure if you've received them. Hence, I write this email to your kaustschool mail. I hope to hear from you and I'll see you soon.

With all due respect,
Nabiha

 **Rasha Hamid** <rasha.hamid@thekaustschool.org>
to me 

8/7/16    

Hello Nabiha,

I am sorry I couldn't write to you before, I had difficulties logging into my email. I hope you had great summer :) mine was wonderful :).

We are back at school today and from what I can see from the schedule we can meet anytime between 3 to 4. Just send me an email when you can and I will make sure I am in the classroom .

Regards

Personal Project Introductions  **Inbox** 

 **Nabiha Khan** <nabiha.khan@thekaustschool.org>
to rasha.hamid 

4/24/16    

Dear Ms. Rasha,

As you know, this year I am your supervisee and I can genuinely say I look forward to meeting with you in the near future. I am quite excited for my personal project as you know, it is about sharks. My project primarily revolves around the technology that can help scientists learn more about these misunderstood creatures. I plan on prototyping a device that consists of several features of a real tag to learn more about shark research and improve upon my engineering skills.

Would be possible to meet after school on Monday? I would like to discuss mentor possibilities as I realise I may need some guidance in the technical aspect of this project. Additionally, I would like you to go over my goal and global context to ensure I am headed in the correct direction. I look forward to a great year with you.

With all due respect,
Nabiha

 **Rasha Hamid** <Rasha.Hamid@kaust.edu.sa>
to me 

4/24/16    

Dera Nabiha,

I am so excited to work with you and guide you on your personal project. Let's meet after school tomorrow so you can tell me what you have in mind.

Regards,
Rasha Hamid
Math Teacher- TKS

Meeting Tomorrow    

 **Nabiha Khan** <nabiha.khan@thekaustschool.org> Jan 15   

to rasha.hamid, Rasha 

Dear Ms. Rasha,

Would it be possible if I could meet you tomorrow after school. I'd like to go over my science fair presentation. Additionally, I'd like to show you my completed tag, which now fully functions! Please let me know if this time is suitable for you. Thank you.

With all due respect,
Nabiha

 **Rasha Hamid** Jan 16   

to me 

Hi Nabiha,
I am planning to go to Jeddah at 3 today so I don't think we can meet. Lets try for tomorrow.

Regards,
Rasha Hamid
Math Teacher- TKS

Figures 1, 2 & 3: These are screenshots of some of the emails sent to supervisor, Ms. Rasha Hamid over the course of the project

Appendix X

SD Card Shield

The specific model of shield that Mr. Mahon lent me was the Adafruit Assembled Data Logging shield for Arduino. Manufactured and sold by Adafruit, the shield fits into all pins on the Arduino, making it “another layer” of microcontroller. Other components can be inserted in the pins on the shield. Because the pins on the shield are connected to the pins on the Arduino, all the external components are still programmable. The shield comes with an SD card slot so that SD cards can be implemented within projects.

Appendix T

Carcharodon carcharias

The *Carcharodon carcharias* or in simple terms, the great white shark is an incredibly misunderstood creature. In the United States, on average, there are only 15 shark attacks annually. Yet, on average 93 Americans are killed with a gun, daily. With *Jaws* painting a blood thirsty image on sharks, this species in particular, their current IUNC conservation status is vulnerable. In the past 15 years, their population has declined by 79%. While some may deem this reasonable, being the apex predator of the ocean, serious consequences can arise due to population imbalance. Their geographical distribution makes them a candidate for tagging. They inhabit most of the world's temperate waters ranging from coastal shelves to pelagic waters. Due to this pelagic nature, they make ideal candidates for tracking as relatively little is known about their breeding nature.

Appendix U

Sphyrna lewini

The *Sphyrna lewini*, or the scalloped hammerhead is considered an endangered species on the IUCN Red List. Its population has declined by over 85% in the last 15 years. Because of their social nature and migratory schools, once found a large number are eradicated. Additionally, hammerhead pups are also targeted for meat. Even if released carefully, hammerheads are generally unable to survive the stress of capture as lack of movement asphyxiates them. Being a semi-oceanic species, they inhabit both coastal and open waters in temperate and tropical conditions. This wide range is also a contributing factor to their decline as large scale industries fish in primarily international waters of the ocean. Their large geographical range, and endangerment make them excellent candidates however, the deployment of the tag must be done with caution as they are a fragile species.

Appendix V

Cetorhinus maximus

The *Cetorhinus maximus*, or basking shark is the second largest fish in the world. It is a filter feeder from cold, pelagic waters. Although widespread, their sighting is neither rare nor common. This migratory fish is also a filter feeder; it has to surface to feed. Because of this, we can ensure that air contact on a semi-regular bases can be made to connect via satellite. It is considered vulnerable on the IUCN Red List. Although not targeted for fins, their liver oil is highly valued for industrial use and the meat is considered a delicacy in some countries. Basking sharks also get their name by their tendency to bask in the sun during suitable weather conditions, increasing the chances of a satellite fix. Their rare sightings make this a valuable species to study, yet a difficult animal to locate.

Appendix W

Rhincodon typus

The Rhincodon typus, the whale shark, is the world's largest fish. The longest length recorded being 12.65m. Unfortunately, this species is considered endangered by the IUCN Red List. While most countries no longer specifically targeted, it is often caught as bycatch by large nets and bottom trolling. Whale sharks are often used as an indicator for tuna. As a result the large nets deployed often result in accidental entanglement of the shark. Additionally, since they are filter feeders, who feed on the surface, they are also at risk of vessel strikes. In most instances shipping lanes are placed close to their feeding ground resulting in possible strikes. Having a circumtropical distribution, they inhabit warm, tropical water. Being migratory species they cover a large geographical range. However, being filter feeders they are also at risk of asphyxiation by plastic contaminants in the seas. Whale sharks are already commonly tagged, making them a reliable species to study.

Appendix X

Alopias vulpinus

The *Alopias vulpinus* is addressed by a great many names. The fox shark, the green thresher, the big-eye thresher but for simplicity, it will henceforth be addressed as the common thresher. The thresher shark is characterised by its long whip like tail. Because of this, it catches the eye for fisherman targeting shark fins. It is considered vulnerable by the IUCN Red List. Often times they are also caught as bycatch, and their “slow life history characteristics, hence low capacity to recover from moderate levels of exploitation” (*Alopias vulpinus*) make them worthy of study. They are considered both oceanic and coastal sharks and inhabit a range of tropical and temperate waters. Because of their slow population recovery studying these species could be critical to their numbers, however, their shyness towards divers makes tag deployment difficult.

Appendix Y

Formal Invitations for Exhibition



Nabiha Khan <nabiha.khan@thekaustschool.org>
to carlos.duarte ▾

11/3/16 ★ ↻ ▾

Dear Professor Duarte,

I trust that this email finds you well. My name is Nabiha Khan and I'm currently a grade 10 student studying at the KAUST School. I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square. The MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. My goal within my project is to prototype a device similar to a shark tag using relatively common electronics.

This event will allow me to collect feedback on the technicality of my tag design, which will, in turn, allow me to reflect and improve upon my prototype. As I understand it, you are currently part of the Red Sea CAASE Study and as such, your expertise surrounding my project will provide me with additional direction to develop my design. While I have a relatively clear idea of the direction I'm going in, I lack the valuable experience which would affect my take on the project. I have been working on this project for over 8 months and would be delighted to share my progress with you on this evening. I hope that you can attend to provide some insightful wisdom. I look forward to seeing you there.

With all due respect,
Nabiha



Carlos M. Duarte <carlos.duarte@kaust.edu.sa>
to me ▾

11/3/16 ★ ↻ ▾

Dear Nabiha,

I accept with great pleasure the invite. I will be there to see your developments.

Best regards,

Carlos



Nabiha Khan <nabiha.khan@thekaustschool.org>
to Lloyd.Smith ▾

11/3/16 ★ ↻ ▾

Dear Mr. Smith,

My name is Nabiha Khan and I'm currently a grade 10 student studying at the KAUST School. I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square. The MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. My goal within my project is to prototype a device similar to a shark tag using relatively common electronics.

This event will allow me to collect feedback on the technicality and implication of my tag design, which will, in turn, allow me to reflect and improve upon my prototype. Your expertise and support surrounding my project will provide me with additional direction in terms of the tag's application and possible design improvements. I have been working on this project for over 8 months and would be delighted to share my progress with you on this evening. I hope that you can attend to provide some insightful wisdom. I look forward to seeing you there.

With all due respect,
Nabiha



Lloyd Smith <lloyd.smith@kaust.edu.sa>
to me ▾

11/3/16 ★ ↻ ▾

Sounds great, see you there.

Lloyd

 **Nabiha Khan** <nabiha.khan@thekaustschool.org> 11/3/16   

to Jesse ▾

Dear Jesse,

I trust that this email finds you well. I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square. The MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. My goal within my project is to prototype a device similar to a shark tag using relatively common electronics.

This event will allow me to collect feedback on the technicality and implication of my tag design, which will, in turn, allow me to reflect and improve upon my prototype. Because of your expertise and experience surrounding my project will provide me with additional direction in terms of the tag's application and possible design improvements. I have been working on this project for over 8 months and would be delighted to share my progress with you on this evening.

I understand, you must be confused reading the email, especially since you're no longer in KAUST. Truth be told, you were such a valuable insight to my project, I felt it necessary to invite you regardless of whether or not you're able to attend. If you are, by some coincidence in KAUST, please feel free to join me. In any case, I hope you're doing well wherever you are and I'll be sure to send you some pictures of my completed project.

With all due respect,
Nabiha

 **Nabiha Khan** <nabiha.khan@thekaustschool.org> 11/3/16   

to brian.parrott ▾

Dear Mr. Parrott

I trust that this email finds you well. If you don't already know, my name is Nabiha Khan and I'm currently a grade 10 student studying at the KAUST School. I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square. The MYP Year 5 Personal Project is an 11 month project which every 10th grade student is currently working on. My goal within my project is to prototype a device similar to a shark tag using relatively common electronics.

This event will allow me to collect feedback on the technicality and implication of my tag design, which will, in turn, allow me to reflect and improve upon my prototype. Your expertise and support surrounding electronics and design will provide me with some additional direction in terms of the tag's application and possible improvements. I have been working on this project for over 8 months and would be delighted to share my progress with you on this evening. I hope that you can attend to provide some insightful wisdom. I look forward to seeing you there.

With all due respect,
Nabiha

 **Nabiha Khan** <nabiha.khan@thekaustschool.org> 10/30/16   

to Andrew ▾

Dear Mr. Mahon,

I trust that this email finds you well. I would like to start off by thanking you for your time and the previous interview. While it only an hour, it provided me with new insights that I hadn't considered before. Because you've been an extremely valuable asset to my project, I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square. Officially, the MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. This exhibition gives us students a chance to present our projects thus far to the community.

This event will allow me to collect feedback on the technicality and implication of my tag design, which will, in turn, allow me to reflect and improve upon my prototype. Your expertise and support surrounding my project will provide me with additional direction in terms of the tag's application and possible design improvements. I have been working on this project for over 8 months and would be delighted to share my progress with you on this evening. I hope that you can attend to provide some insightful wisdom. I look forward to seeing you there.

With all due respect,
Nabiha

 **Nabiha Khan** <nabiha.khan@thekaustschool.org>
to song

10/30/16   

Dear Song,

I trust that this email finds you well. I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square. The MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. My goal within my project is to prototype a device similar to a shark tag using relatively common electronics.

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With all due respect,
Nabiha

 **Song He** <song.he@kaust.edu.sa>
to me

10/30/16   

Dear Nabiha,

I'll put that into my calendar. And could you please send me a reminder on the day before that exhibition as well?

Thanks!

Good luck!

 **Nabiha Khan** <nabiha.khan@thekaustschool.org>
to xiangliang.zha.

10/30/16   

Dear Professor Zhang,

I trust that this email finds you well. My name is Nabiha Khan and I'm currently a grade 10 student studying at the KAUST School. I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square.

The MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. My goal within my project is to prototype a device similar to a shark tag using relatively common electronics.

This event will allow me to collect feedback on the technicality of my tag design, which will, in turn, allow me to reflect and improve upon my prototype. As I understand it, you are currently part of the Red Sea CAASE Study and as such, your expertise surrounding my project will provide me with additional direction develop my design. While I have a relatively clear idea on the direction I'm going in, I lack the valuable experience which would affect my take on the project. I have been working on this project for over 8 months and would be delighted to share my progress with you on this evening. I hope that you can attend to provide some insightful wisdom. I look forward to seeing you there.

With all due respect,
Nabiha

 **Xiangliang Zhang** <xiangliang.zhang@kaust.edu.sa>
to me

10/30/16   

Dear Nabiha,

Thanks a lot for the invitation.
Definitely, I will be there.
Look forward to seeing your project results!

 **Nabiha Khan** <nabiha.khan@thekaustschool.org>
to lu 

10/30/16   

Dear Lu,

I trust that this email finds you well. I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square. The MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. My goal within my project is to prototype a device similar to a shark tag using relatively common electronics.

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With all due respect,
Nabiha

 **Lu Sun** <lu.sun@kaust.edu.sa>
to me 

10/30/16   

Hey Nabiha,

Good afternoon!

I didn't know you were working on this, but it sounds very very promising! Sure I'll be there for the exhibition. Good luck with it and see you soon.

 **Nabiha Khan** <nabiha.khan@thekaustschool.org>
to jurgen.kosel 

10/30/16   

Dear Professor Kosel,

I trust that this email finds you well. My name is Nabiha Khan and I'm currently a grade 10 student studying at the KAUST School. I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square.

The MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. My goal within my project is to prototype a device similar to a shark tag using relatively common electronics.

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With all due respect,
Nabiha

MYP Personal Project Exhibition



Nabiha Khan <nabiha.khan@thekaustschool.org>
to burton.jones ▾

10/30/16 ★



Dear Professor Jones,

I trust that this email finds you well. My name is Nabiha Khan and I'm currently a grade 10 student studying at the KAUST School. I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square.

The MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. My goal within my project is to prototype a device similar to a shark tag using relatively common electronics.

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With all due respect,
Nabiha



Nabiha Khan <nabiha.khan@thekaustschool.org>
to srosoman ▾

11/3/16 ★



Dear Mr. Sam,

I trust that this email finds you well. If you don't already know, my name is Nabiha Khan and I'm currently a grade 10 student studying at the KAUST School. I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square. The MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. My goal within my project is to prototype a device similar to a shark tag using relatively common electronics.

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With all due respect,
Nabiha



Sam Rosoman <srosoman@gmail.com>
to me ▾

11/15/16 ★



Hi Nabiha,

Thank you for taking the time to explain your project to me and inviting me to come to the up coming exhibition.

Unfortunately we had already planned to go camping in the desert on this night.

Please feel free to keep in touch about your project. I understand there will be another presentation at the end of the project and I am looking forward to that event.

 **Nabiha Khan** <nabiha.khan@thekaustschool.org>
to Royale 

10/30/16 



Dear Royale,

I trust that this email finds you well. I would like to start off by thanking you again for interview. While it only an hour, it provided me with new insights that I hadn't considered before. And since you've been an extremely valuable asset to my project, I write to cordially invite you to attend the 3rd annual Personal Project Exhibition, on Thursday, November 17 from 5-7pm in Discovery Square. Officially, the MYP Year 5 Personal Project is an 11-month project which every 10th-grade student is currently working on. This exhibition gives us students a chance to present our projects thus far to the community.

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With all due respect,
Nabiha

Figures 1-12: These are all the formal emails written to highly academic individuals prior to the November Exhibition.

Appendix Z

Reddit Posts

This screenshot shows a Reddit post on the Arduino subreddit. The title is "Library Issues" (self.arduino). The post was submitted 5 months ago by cyborg_shark404. The content asks for help with an Arduino library error. It has received 1 point and was upvoted. The sidebar shows the post was submitted on 18 Sep 2016, has 1 point (67% upvoted), and a shortlink to the post.

Post Content:

Hello Reddit,
I've had a bit of an annoying problem lately in which I've had a recurring error about an Invalid Library found. I installed the Adafruit GPS Library and received this message every time I uploaded the code. Is there a way to fix this problem? If not is there a way I can uninstall an Arduino Library and reinstall it (hopefully the next time correctly)? If you've got any ideas, I'd really appreciate it. Thanks a ton.

Comments:

- [+] birdbrainlabs Electronics in Theatre 1 point 5 months ago
 - 1. What is the exact error you are getting? Maybe the whole error dump from the compilation attempt.
 - 2. Where is the library installed?
 - 3. What operating system are you running?
- [+] cyborg_shark404 [S] 1 point 5 months ago
 - It uploads fine, but it says:

Subreddit Information:

Submit a new link | Submit a new text post | arduino | unsubscribe | 74,033 tinkerers | ~57 tinkerers

This screenshot shows a Reddit post on the Adafruit subreddit. The title is "Adafruit Ultimate GPS Breakout Troubleshoot" (self.adafruit). The post was submitted 5 months ago by cyborg_shark404. The content asks for help with a GPS module issue. It has received 1 point and was upvoted. The sidebar shows the post was submitted on 20 Sep 2016, has 1 point (99% upvoted), and a shortlink to the post.

Post Content:

Hello Reddit,
Lately I've been experiencing a problem while attempting to use the GPS module. I've installed the Adafruit GPS Library and opened the parsing example. I uploaded it into my Arduino with no problem, however when I open serial monitor, I always end up getting the character ý infinitely. I assume this is a problem reading the collected data. I've also checked if the GPS module works by bypassing the Atmega chip and its receiving data just fine. I've had some library issues in the past and I'll link my other reddit post to give some more context, if it's useful.

<https://redd.it/53di7>

Does anyone have any ideas? Being fairly new to this, I don't have the slightest of clues what is wrong and I'd greatly appreciate the help. Thanks!

Comments:

- [+] airbornemint 1 point 5 months ago
 - In 99% of cases, serial monitor garbage means that the baud rate in serial monitor is set to a different number from baud rate on the microcontroller. Look for Serial.begin(number) in the code and make sure the number in the bottom right of the serial monitor is the same, then close your serial monitor, reset your device, and reopen the serial monitor

Subreddit Information:

/r/ScienceFiction | Submit a new link | Submit a new text post | adafruit | subscribe | 497 readers | ~1 user here now | Show my flair on this subreddit. It looks like:

Figures 1-2: These are screenshots of posts that I posted on Reddit