Our World-Underwater Scholarship Society

US Navy Engineering Internship Summer 2006
Final Report

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OWUSS Summer 2006 Intern

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Acknowledgements

I would like to thank the Our World Underwater Scholarship Society (OWUSS), Mercury Marine, and the Naval Surface Warfare Center Carderock Division (NSWCCD) for providing me with a summer internship at NSWCCD. In particular, I would like to thank Jim Corry, Glen Egstrom, and the Board of Directors at OWUSS for making the internship possible, George Wozencraft and Martha Sanders at OWUSS for organizing the scholarship logistics, Jeffrey Krueger at Mercury Marine for providing the funding for my internship, and Dan Dozier at NSWCCD for finding interesting projects for me to work on. I would also like to thank all of the engineers I worked with at Carderock who helped to make my summer internship a worthwhile experience.

1.0 Introduction

In February 2006 I took a week long research diving course at the University of California Santa Barbara (my graduate school) to learn the skills necessary to become a scientific diver for the university. Every day, our diving instructor would post some internship opportunities related to SCUBA diving up on the front classroom table. One of these internship opportunities was for an internship with the Our Underwater World Scholarship Society. Though not all the OWUSS internships involved SCUBA diving, all of the OWUSS internships were naturally related to the underwater world (one of my biggest interests) so I decided to apply. I got a call from George Wozencraft in May 2006 asking if he could consider me for the OWUSS US Navy Engineering Internship at the Naval Surface Warfare Center Carderock Division (NSWCCD) in West Bethesda, Maryland. A little over a month later, I was heading to the nation's capitol for the start of a great internship.

Dan Dozier, Corporate Office Director, became my primary contact at NSWCCD. I told Dan that my primary goal for the internship was to learn as much about Carderock and what Carderock engineers do as I possibly could. To accomplish my goal, Dan helped me find a variety of projects to work on including verifying the data path of the Submarine Acoustic Beamformer Replacement (SABRE) System, analyzing acceleration and pressure data from drop tests of a porous hull design, testing a shaft telemetry system that will be used on a new class of submarines, and revising a legacy peak picking program used for analyzing results of submarine/ship acoustic trials. I also had the opportunity to tour many of the state-of-the-art facilities around the lab, take a ride on the USNS Guardian to collect wave buoy data, and SCUBA dive in the approximately half mile long tow tank used for testing model ships.

By the end of my internship I would say I had accomplished my goal as I now have a better understanding of the type of work Carderock engineers do (and maybe by the end of this report you will too). This report describes each of the projects I worked on at Carderock and the memorable experiences I had while working there.

2.0 The Projects I Worked On

I had the opportunity to work on four different projects during my summer internship at Carderock which helped me meet my goal of finding out what type of work the engineers at Carderock do. The sections below describe each of these projects, and what I accomplished with and learned from each of them.

2.1 SABRE

Project Advisor: Jim Ferraro

The Ship Signatures department at Carderock looks at sonar signatures produced by submarines to determine if a naval sub is quiet enough to move stealthily in the ocean. If the sub is not quiet enough, analysts try to determine what part of the sub is causing the noise to make recommendations to other departments on where to focus design efforts.

In order to determine sub signatures, the Navy has set up a test platform on the USNS Hayes. This test platform is comprised of hydrophones (to listen for the sounds produced by the sub) and a beamformer and signal processing system (to process the data gathered by the hydrophones). During a trial, a submarine follows a specified track between two hydrophone arrays that gather sonar data to be processed by the beamformer and signal processing system.

SABRE, the Submarine Acoustic Beamformer Replacement (SABRE), was designed to replace the existing Beamformer and Signal Processing System on board the USNS Hayes measurement platform. Carderock has a copy of the SABRE system that has now been deployed on the USNS Hayes to act as a backup to the Hayes' SABRE system should the Hayes' SABRE system fail. However, the backup SABRE had never been tested. My summer assignment was to verify that data path of the backup SABRE system worked as expected – taking in the data recorded by the hydrophones and outputting the correct processed data for analysis.

The data path of the backup SABRE system is shown in Figure 1. The data recorded by the hydrophones is stored on MELS, the Multi-run ELement Storage. SABRE grabs the data from MELS and processes it to produce both time series and spectral data. The time series data is stored back on MELS and is further processed through a system called MARS to produce different spectral data. The spectral data produced by MARS is immediately stored on the Data Management System (DMS), whereas the spectral data produced by SABRE must be run through a DMS Loader to be stored on DMS. Data analysts can then use the Analyst Viewing Station (AVS) to view, validate, and analyze the beam-based spectral data products produced by both SABRE and MARS.

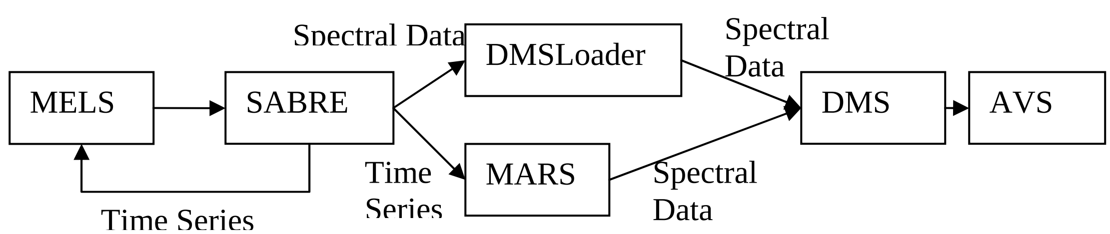

Figure 1: SABRE data path

Verifying the data path for SABRE meant making sure SABRE could communicate with all its auxiliary systems (MELS, MARS, and DMS). This meant setting up accounts and mount points on the systems with appropriate permissions and verifying the systems were on the appropriate subnets. With Jim Ferraro's help, I had SABRE obtaining data from MELS within two weeks and started to work on getting the time series data produced by SABRE to MARS. However, the MARS system was not working. While waiting for the MARS system to be fixed, I met with Lenny Cavalier to learn how to use AVS so that I would be able to view data from DMS when I got it through the DMS Loader and through MARS. Unfortunately, the power to the entire site went down early July which caused many systems to go down. This power outage put me out of work on the SABRE project for a month and by the time all the systems had been restored, MARS still was not working. After a few more weeks, MARS was fixed, but then Jim received word that an updated version of the SABRE software would be coming shortly. The new software came during the last week of my internship and I was not able to verify the entire data path (from MELS to AVS) within that time.

Working on the SABRE project I learned how to facilitate and manage communications between large systems – something I had never done before. I became fully aware that when working with computers, computers rarely act as you expect them to. I learned to appreciate people like Jim who are responsible for keeping computer systems up and running because when a system goes down it can be a very time consuming and frustrating process to bring it back up.

2.2 Porous Hull Data Analysis

Project Advisor: Tim Coats

Small combatant craft suffer harsh, repetitive mechanical shock caused by random and repetitive wave 'slamming.' Mission requirements force these craft to operate at speeds and sea-states that impose the risk of extreme physical injury on the boat crew. Effective shock mitigation is required so that personnel can train and perform their duties without injury and still operate the boat up to its intended design limits. To date, shock mitigating systems have limitations based on space, mission requirements, and modes of operation. [1]

Three Carderock engineers, Tim Coats, Young Shen, and Scott Gowing, proposed a porous hull design to absorb the energy from slamming and therefore reduce the shocks inflicted on the boat crew. For the past year, they conducted simple drop tests to quantify the energy reduction of porous plates to determine if the porous hull concept had merit for further study. These drop tests consisted of dropping a metal crate covered in 4 accelerometers and 7 pressure transducers from heights of 2, 6, 10, 14, and 18 inches into water. The bottom plates of the metal crate could be swapped out with different porous plate patterns and be placed at a 0 degree or 5 degree hull angle. The data collected from the accelerometers and pressure transducers could then be analyzed to quantify the energy reduction of porous plates.

With 4 accelerometers, 7 pressures transducers, 5 porous plate patterns, two hull angles, 5 different drop heights, and repetitive drops with the same height, hull angle, and plate pattern, the drop test data set became huge. Tim Coats asked me to organize and analyze the data set by using Matlab to create a database of, and plot the Power Spectral Densities (PSDs) of, the accelerometer and pressure transducer data from each drop test.

[1] This paragraph contains sentences from Tim Coats' abstract in "Porous Hull Form for Reducing Combatant Craft Shock Loads"

I talked to Dr. Su, a PSD expert at Carderock, to get a better understanding of what the PSD is and how the PSD function in Matlab works. I learned the PSD of a signal, when multiplied by the appropriate factor, gives the power carried by that signal, per unit frequency. The integral of the PSD for a given frequency band gives the energy of the signal for that band. The PWELCH function is the preferred PSD function in Matlab and requires five parameters chosen appropriately to fit the data set.

I talked to Scott Gowing to get a better understanding of how he stored all the data sets for each drop test so I could effectively create a database that grouped all the drops with the same porous hull pattern, hull angle, and drop height together so that these data sets could be averaged to reduce experimental error. Scott also informed me that I would have to truncate each data set before finding its PSD because the data set contained unwanted noise from the chain rattle as the metal crate was falling through the air before its initial impact with the water.

I wrote a script in Matlab to truncate all data sets appropriately and then created a database with all the truncated data sets. I wrote another script to compute the PSD of each truncated data set and wrote some more scripts to average and plot the PSDs of the data.

The plots I created, like the one shown in Figure 2 below, show an energy reduction when using porous plates over solid plates. Quantifying the exact energy reduction and determining the effect of drop height, porous plate pattern, and hull angle have yet to be determined. However, because the energy reduction is obvious, Scott, Tim, and Young have proposed a second year effort to build a model ship with a porous hull to test how to deal with the drag associated with holes in the hull as the ship moves through the water and test the energy reduction associated with repetitive slamming rather than by a single impact.

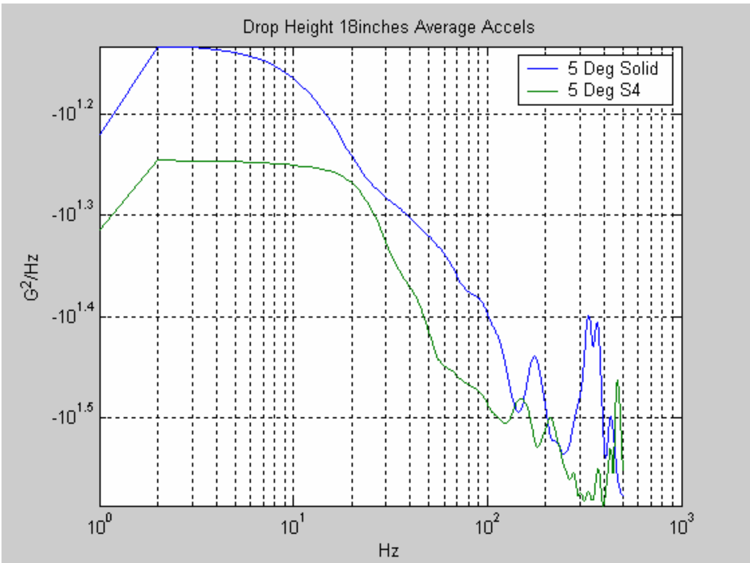

Figure 2: Shows the power/energy reduction for using porous plates (5 Deg S4) over the solid plates (5 Deg Solid)

I enjoyed working on the porous hull project because its application was directly related to protecting people from bodily harm. Though I have not experienced the intense slamming experienced by soldiers on combatant craft, I have experienced uncomfortable slamming on research diving trips and understand what a benefit shock mitigating hull designs could be for the people on board the craft. Working on the porous hull project I learned about PSDs and gained more experience using Matlab. I learned how to collaborate with engineers working in different codes (departments) and gained insights on how to manage large data sets.

2.3 Shaft Telemetry

Project Advisor: Tom Joynt

As part of Carderock's mission to provide in-service engineering for submarine hull, mechanical and electrical systems, engineers at Carderock perform acoustic trials to evaluate what parts of a ship or sub are in need of repair/replacement. These trials consist of recording data from accelerometers, strain gauges, etc. placed on machines inside the submarine and then processing and analyzing the data to locate problem areas on these machines.

The torque and thrust dynamic strain measurement system (also referred to as the shaft telemetry system) was designed by engineers at Honeywell/Sensotec to measure the torque and thrust of the 24 inch diameter rotating propeller shaft on the Virginia Class submarines. The system is capable of monitoring four strain gage bridges (2 for torque and 2 for thrust) and transmitting the data to stationary receivers where the data is output as a high level analog signal to be processed and analyzed by engineers to monitor the proper operation and life of the shaft.

When I arrived at Carderock, the shaft telemetry system had been sitting in a drawer for a year and had not yet been tested to verify its proper operation. The system consisted of a DC power supply, four receivers, a 4-way splitter, an Induction Power Supply (IPS), a stationary brass loop antenna and a high speed collar with 4 transmitters each connected to a strain gauge bridge. For better visualization of the system, the system wiring diagram, provided by Honeywell/Sensotec is shown in Figure 3.

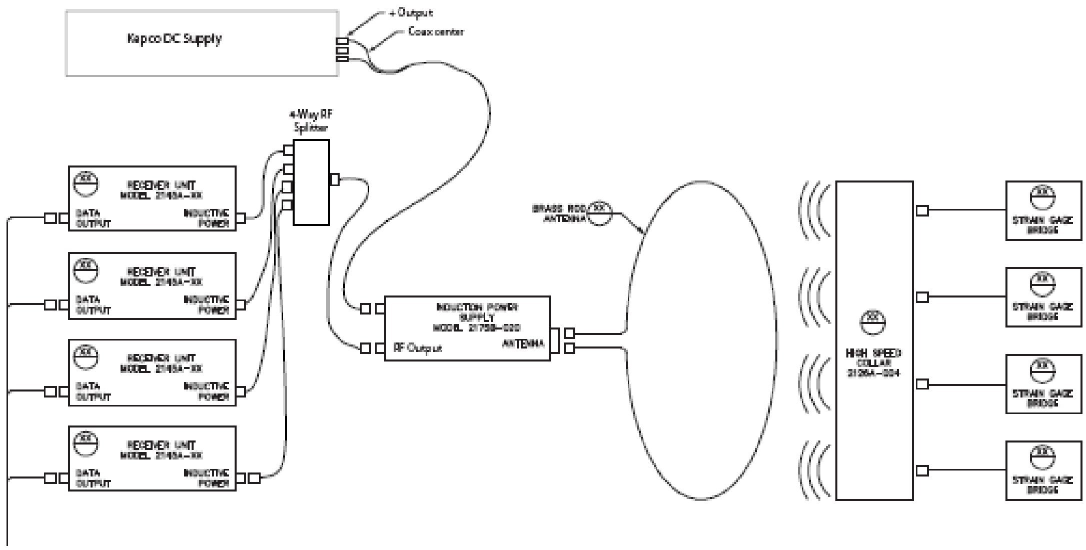

Figure 3: Shaft Telemetry System Wiring Diagram

After I located all the pieces of the system and wired everything together according to the wiring diagram (shown above), the system did not work as expected. I spent the next two weeks working with Bob Hines and Tim Cullis trying to figure out what was wrong. We discovered the four way splitter was broken and a couple of connections were loose. We had the system working for an hour, went out to lunch, and came back to a seemingly fried Induction Power supply unit. Because we could not bring the system back up, I held a conference call with the engineers at Honeywell/Sensotec who designed the system to get some advice on how to get the system to work.

After weeks of sending parts of the system back and forth from Honeywell and Carderock we finally determined that we had to use a smaller stationary loop antenna and tune the IPS (change its capacitance) to match the inductance of the system. The larger brass loop antenna did not work because its inductance properties are such that the large brass loop antenna required far more power than was reasonable to provide enough power to drive all 4 transmitters. After we received the smaller brass loop antenna, Chris Heller helped me tune the IPS and we had the system up and running. I was then able to calibrate the system and write a report describing its functionality and set-up procedure.

We were going to test the system on a rotating shaft mock-up in the lab to make sure it still worked as expected while rotating. However, it took 6 weeks to decide to spend the money to make the shaft mock up and therefore I was not able to test the system on a rotating shaft during my internship.

This project proved to be fun and hands-on. I learned how to troubleshoot problems with electronics, how to make connectors, how to measure strain gage bridge outputs and how to tune an IPS. I became the 'resident expert' on the shaft telemetry system and enjoyed working with and learning from other engineers to solve problems to get the system to work. I learned that financial decisions can take a very long time and you can only accomplish as much as your available resources allow.

2.4 Peak Pick

Project Advisor: Tim Cullis

Because I had a bit of downtime in my other projects (i.e. power outage, waiting for parts to be returned, etc.) Tim Cullis, an engineer I was working with on the shaft telemetry system, gave me a programming project to work on during these times. Tim wrote a program many years ago to assist him in analyzing acoustic trial data (like the data obtained from the shaft telemetry system). The program takes the processed spectral data and finds the location of the peaks in the data. If the level of a peak at a specific frequency for a specific machine is above some pre-determined level, the engineers can recommend that the specific machine needs repair/replacement.

Tim asked me to update the program to match a more modern 'look and feel.' I used Microsoft Visual C++ to create a new modern graphical user interface and looked to Alex Noerr's code (a new hire who rewrote a more complicated program for Tim last year) to learn how to use Microsoft Visual C++ and how to manipulate the acoustic data file.

By the end of the summer I successfully completed the Peak Pick program and learned how to use Microsoft Visual C++ in the process. I also fully tested Alex's program and wrote a list of fixes and possible improvements for him to implement.

3.0 Memorable Experiences

While working at Carderock I had some rather memorable experiences: my method of commuting to work, seemingly setting off the fire alarm three times, diving in the David Taylor Model Basin, spending a day at sea. I will talk about each of these experiences in a short story format, to add some humor to this report.

3.1 The Red String

Because I did not feel like driving across country nor spending my internship money to ship my car from LA to DC, I figured I would rely on public transportation to commute to work.

The public transportation commute consisted of :

1. walking from my apartment to the bus stop (5 minutes)
2. taking Metro Bus 7A from my apartment to the Pentagon (30 minutes)
3. taking the yellow line on the Metro to Gallery Place/China Town (5 minutes)
4. switching to the red line (5 minutes)
5. taking the red line to Bethesda (25 minutes)
6. waiting for Montgomery Transit Bus 32 that only ran every 30 minutes at the Bethesda station (15 minutes)
7. taking Bus 32 from the Bethesda station to the Naval Warfare Center (30 minutes)
8. walking from the bus stop at the Naval Warfare Center to my building (5 minutes)

and doing everything in reverse on the way home for a grand total of 4 hours commute time per day. Now one might think that riding on public transportation would give me the opportunity to read a book, but sadly trying to read on the bus and metro made me very motion sick, so I spent the four hours starring into space.

After my first day at Carderock, I decided that I would have to find some alternative way of getting to work. I thought I could handle the 4 hour starring into space commute maybe once or twice a week, but surely not every day.

I shipped my bicycle across country because I am an avid recreational cyclist and heard there were a lot of great biking trails in the DC area. I had not planned on using my bike to commute to work, but after spending 4 hours starring into space, riding 40 miles round-trip somehow sounded more appealing.

I had no idea how to get from my apartment in Alexandria to work on a biker friendly route so I started to ask my co-workers if they had any idea how I would accomplish such a task. Jim Ferraro and Tom Joynt introduced me to Arturo Lopez, an engineer who actually lived in Alexandria, VA. Not only had Arturo biked the route from Alexandria to Carderock in the past, Arturo offered to give me car rides to and from work a couple of days per week!

For the next couple of days, before my bike arrived, Arturo took me to and from work and pointed out pieces of the bike route as we drove by them. He gave me a cycling map of the Arlington Virginia area and pointed out the route I should take.

The first weekend my bike arrived, I decided to do a test ride to see if I could make it to the C&O Canal tow path (which would be about half the commute). After many wrong turns and an extra forty five minutes of biking, I made it to the tow path. I attempted to take a short cut on the streets from the Pentagon to Alexandria on the way home, but got lost and ended up in Old Town Alexandria from where I had to call my roommate and ask her to look up directions online to help me get home. My test ride which I had hoped would take under 2 hours round trip took about four hours, but better get lost on a test ride than when trying to get to work.

On Monday, Arturo gave me a ride again and I told him how I had gotten lost on my test ride, especially when trying to find the short cut. That evening, Arturo sacrificed getting home as quickly as possible on the freeways to show me how to take the short cut biker route on the streets from the Pentagon to my apartment. I now felt confident I could bicycle to work and told Arturo I would give it a try the following day.

I successfully made it to the tow path in 50 minutes and biked for another 40 minutes until I came across the Mile 10 marker. I guess I had expected a very obvious exit at Mile 10, but what I found at mile 10 was the canal on my right and the Potomic River on my left and no where to exit the path at all. I continued on the tow path until Mile 11 where I found an exit path into the woods on my left hand side. I followed the path and ended up in a random parking lot. I tried making a phone call from the parking lot, but I did not get any reception. I got back on the tow path and continued toward Mile 12. I ran into two joggers and asked them where I could exit the path to get to a road. They told me there was an exit about a half mile down.

When I got to the road, I had no idea what road I was on. There were tens of cars backed up behind a stop sign, so I decided to ask the driver of a convertible what road I was on. When I found out I was on MacArthur Blvd I was ecstatic! I remembered that Carderock was at 9500 MacArthur. I picked the wrong direction to bike on to MacArthur Blvd, but did the required about face and made it to work in a total of 2 hours and 10 minutes. Ok – so no improvement over the 2 hour public transportation commute, but definitely more entertaining.

Because I was going to meet my friend in Georgetown for dinner that evening, I did not have to get back on the tow path that evening to head home because I took a more direct route to Georgetown along the streets. But because I would be biking again the next morning and knew there had to be a better way to exit the path, I asked my co-workers for the exact location of the exit near Mile 10. They said there was a little path on the left hand side near Mile 10 just after I cross under the 495 overpass.

The next morning, I exited the tow path on this tiny dirt path that I found right after I crossed under the 495 overpass. The path got narrower and more overgrown as I kept walking. Eventually, the path was so overgrown, that I started making my own trail and somehow ended up on the 495 freeway with oncoming cars flying at me at 65 mph!! Not wanting to walk back through the thicket to get more scrapes and spider bites, I walked on the shoulder of the 495 until I could pull over on a grassy area and figure out where in the world I was. Luckily I found Clara Barton Parkway and made it to work in a total of 2 hours – still no improvement over the 2 hour public transportation and now more scary than entertaining.

Tom Joynt had seen me walking on the shoulder of Clara Barton Parkway so as soon as I got to work he drew a map for me to show me where the actual tow path exit was. Sue Miller, my ice cubicle neighbor (I call it an ice cubicle because the air temperature was kept at a constant 66 degrees Fahrenheit and I was given a little space heater to compensate for the cool temperature), gave me a red ribbon to tie to a tree at the exit of the tow path so I would know where to exit the path the following morning to avoid another near death experience walking on the 495 freeway.

The next day, I found the red ribbon and made it to work in an hour and 40 minutes! Now that is an improvement!

I biked to work 2-3 times per week, drove with Arturo 1-3 times per week, and rode public transportation 1-2 times per week. By the end of the summer, I could make it to and from work in an hour and 20 minutes for a round trip time of 2 hours and 40 minutes (quite an improvement from the original 4 hour commute). I also got an MP3 player for my birthday and I found that listening to music on the bus and metro actually allowed me to read without getting motion sick making the 4 hour commute on public transportation somewhat enjoyable. When I left Carderock, I told Sue that her red ribbon was still marking the Carderock exit of the tow path so she could inform the next adventurous biker to just look for the red ribbon past Mile 10.

3.2 The Fire Alarm

The day the power went out at Carderock, I was working on the shaft telemetry system down in the electronics lab. After reading how to adjust the filter settings on the receiver boxes in the system manual, I decided to open the receiver boxes to verify that all receivers had the correct filter settings. I carefully unscrewed 4 Philips head screws to remove the top cover of one box. At the exact moment I lifted the lid, the lights in the lab went out, the fire alarm went off, and the emergency lights started flashing. I looked at the receiver and nearly froze in my tracks as I read: "CAUTION! HIGH VOLTAGE!" I couldn't help but think, could I have somehow blown the power to the entire building?

I walked outside the lab and noticed that others had evacuated their buildings and realized that the power to the entire site had gone down! AHHH! The power remained off and the fire alarms kept ringing for the next four hours. Could opening one receiver box really have wasted a half a day's work of thousands of Carderock employees?

I was so shook up by the experience that the next day I went down to the lab to continue work on the shaft telemetry system, it took me 10 minutes to work up enough courage to open the next receiver box to check its filter settings. I closed my eyes and winced as I pulled the lid off of the second receiver as I waited for the sirens to go off again. To my relief, nothing happened. I had known all along that taking off the receiver lid could not have caused the power to the entire base to go down, but I still had to wonder because of the untimely coincidence.

A week later the lab technicians, Jim Siron, Dave McFadden, Jack Pitchford, and Tom Whitting, asked me to help them make 150 custom cables that had to be completed by the end of the week. I agreed to help out because I was interested in learning how to use some new materials and tools. I learned how to connect BNC connectors and spade lugs to wires, how to solder connections and how to heat some heat shrink and duwall over the soldered joints. After one full day of cutting, crimping, soldering, and heat shrinking I felt sufficiently proficient in the art of making cables that I proposed setting up an additional soldering and heat shrinking station for me to speed up the cable making process. For some reason, the additional heat from a second blower and the additional smoke from a second soldering iron caused the fire alarm to go off! The room really wasn't all that hot or smoky, but the fire department was there within 10 minutes responding to the alarm. They turned off the alarm, took down our names and told us to open some doors as we continued to work. The additional soldering and heat shrinking station did help us complete making cables quickly, but I was so embarrassed for seemingly setting of the fire alarm a second time.

We completed making the cables by the end of the following day so on Friday I went back to working on the shaft telemetry system. I needed to come up with a way to mount the brass stationary loop antenna around our mock up shaft so the stationary loop would fit uniformly around the shaft and would not rub up against the shaft as the shaft was spinning. I decided to build a wood frame to fit around the shaft to which I could mount the stationary loop antenna. I figured out the appropriate dimensions for the wood frame, made a drawing and then asked for assistance to locate the supplies I would need to build my frame. Jim Ferraro located some two-by-fours in an old trailer and Jim Siron located an old power saw, drill sets, safety goggles, and wood screws. After a quick demo by Siron on how to use the old power saw, I practiced using the saw by cutting small pieces off the two-by-fours. My first couple of cuts were pretty jagged and sloppy and made quite a bit of saw dust. Just when I thought I had figured out how to make a smooth cut…the fire alarm goes off! I guess the dust particles in the air caused the alarm to go off this time.

The fire department arrived within 10 minutes. When they saw me cutting wood they said, "Oh – it's you again." I told the firemen that I had a few more cuts to do and when they saw the old saw, they decided to show me where the alarm shut off switch was so I wouldn't have to bother the fire department again in case I caused some more sawdust.

3.3 A Unique Diving Experience

At about a half mile long, the David Taylor Model Basin is the largest tow tank facility in the world – so long that in order to keep the tracks above the water level constant throughout the whole basin, the tracks are slightly bent to match the curvature of the earth. The Model Basin has been used for decades to test new designs of model ships and submarines but perhaps is now better known for the international human powered submarine races it hosts every other year.

When I spoke with Dan Dozier over the phone before I started my internship he said, "Because you applied to the Our Underwater-World Scholarship Society, I bet underwater time is important to you." After I whole-heartedly agreed with this statement, Dan regretfully informed me that my summer internship would not involve much underwater time, but if I brought my dive gear across country, he would take me for a dive in the Model Basin. I took Dan up on his offer and dragged my 40 pounds of dive gear to DC.

Diving in the David Taylor Model Basin was a dive experience unlike any other. The water was dark, cold, and eerie, but also crystal clear and quiet. Swimming along the basin bottom (22 feet deep) Dan and I found many 'treasures' especially in the area of the basin that was not used for the submarine race and therefore had not been cleaned in years. Our 'treasures' included Scott Gowing's old badge, a screwdriver with a Carderock phone number on it, a CAUTION – LASER AREA plastic sign, large pieces of the ceiling, two aluminum coke cans that crumpled at the slightest touch, a fishing weight, large steel drill bits, somewhat sizeable pieces of old model ships, hoards of zip ties, and red colored sediment rolled up in cylindrical tube shapes.

The next day I gave Scott his old badge which he seemed overly delighted to have. Dan called the Carderock number that was on the screwdriver only to find out the number was no longer in service. Dan later spoke to an engineer who worked in the basin about the screwdriver and found out the number on screwdriver was a serial number that just happened to have the same first three digits as all the Carderock phone numbers.

I kept the fishing weight and one large steel drill bit for souvenirs of my unique diving experience. Sadly, I forgot to place these items in my checked baggage when heading back to California. Luckily I realized I had the heavy dirty rusted drill bit in my carry on before I went through security because I had no idea how I would have explained to the TSA why I was carrying a big piece of rusted metal.

3.4 A Day at Sea

Tim Coats, my advisor for the porous hull project, worked at Carderock's Combatant Craft Division down in Norfolk, Virginia. He invited me to spend a few days in Norfolk to get a tour of some of the facilities located there and to ride on the USNS Guardian to observe some wave buoy data collection. Eager to get out on the water, I readily accepted his offer, booked a hotel in Virginia Beach and rented a car to make the 3.5 hour drive to Norfolk.

Day one consisted of touring some future sights of Carderock facilities at the Old Dominion University and at the Norfolk Naval Base. On day two, I woke up at 6 am to meet Tim and his co-worker Kelly Haupt at the Design and Test boat yard at Fort Monroe. The three of us boarded the Guardian along with Captain Rich, an engineer named Mel, and two engine room mechanics.

Right away Mel explained to me how the data collection system worked and showed me some sample data sets of past collected data. After about an hour's ride out to sea, Kelly and Mel placed the wave buoy in the water and for the next 6 hours we sat at sea following the drifting wave buoy. Every half hour Mel radioed the Mighty Servant III, a huge platform ship practicing launch and recovery operations, the live sea state data received from the wave buoy. Every 15 minutes or so, Captain Rich moved the ship to keep the drifting wave buoy in view and every 20 minutes or so the two engine room mechanics opened the engine room door. I was able to keep myself entertained watching Mel's, Rich's, and the mechanics' tasks for about two hours and then spent the rest of the day sitting on the back deck of the guardian enjoying the sunshine, the big blue ocean, and the music on my MP3 player or sitting in the front cabin reading the newspaper or Bowditch's book on navigation and listening to XM Comedy Radio.

Though the day passed by very slowly and the seas were a bit rocky, I was very happy to be out on the water and have had the opportunity to ride a real Naval vessel. The next day Kelly told me that because there was a small craft advisory in effect, if I were a government employee I could get hazardous duty pay for riding the Guardian the day before.

4.0 Conclusion

From my report hopefully you can tell that my internship at Carderock was filled with great learning and memorable experiences. I was able to make a decent contribution to four different projects, learn about the type of work engineers at Carderock do, and have fun in the process. I hope that OWUSS, Mercury Marine, and NSWCCD continue to work together to provide another student with the OWUSS US Navy Internship next year.