**epicLab.html**

**Introduction**

I joined the lab under the Human Robotic Augmentation Team through the Vertically Integrated Projects program at Georgia Tech. My team led by Ben Shafer, a GT grad student, is centered around testing a variety of controllers (including proportional myoelectric, impedance, neuromuscular model based, hybrids, etc.) and utilizing Human in the Loop Optimization (HiLo) to decrease the metabolic cost of using a hip exoskeleton. The role of my partner and I in the project was to develop a controller with a user interface using MatLab and to link this controller to a Simulink model. The goal of the controller we worked on was to adjust control parameters live while also allowing the user to visualize the current state of the exoskeleton better than what was previously provided with Simulink Real Time Explorer. The ultimate goal was to reduce the total time spent testing with a person in the hip exoskeleton.

**The Project**

My partner and I decided to split the project into two main components. Component one was the ability to access the Simulink model from our controller and change the control parameters live without having to rebuild the model. The second component was the ability to pull data off the currently running Simulink model and into our GUI. My partner focused on the first component while I worked on the second. I struggled a lot initially in the project attempting to figure out the best way to pull a constantly changing value from the Simulink model. I considered C-Mex functions, creating a user block and then setting the user data field to the needed value but in the end with a little bit of external help I decided that host scopes would be the most effective method to implement for this project. After making this decision, I implemented a timer object on the MATLAB side of the project so that it would constantly pull the data values from the running Simulink model at a fast-enough rate to keep the graphs up to date. I found that I could not surpass 14 Hz with the timer object in the GUI if I wanted it to not show any lag. I ended up deciding to use an animated line to graph the data we pulled from the model because it was the easiest one that met all our requirements.

**The Final Product**

By the end of the semester, we had finished working on our MATLAB GUI and it was ready to be packaged into an app. We were now able to control parameters from the GUI and also provided a lot of customizable features in terms of graphing the data live. In addition, the user is also able to save the data recorded during the testing session. Our final step was to modularize the GUI so that we would be able to use the GUI with various different Simulink models. Once we finished making it, we presented the app to the rest of the members in the lab.

**Longterm Outcome**

This experience overall was very useful as I got a lot of exposure to a lab environment. I learned a lot in terms of actually getting hands on with a project. However, I would say that the most important lesson I learned was the importance of not going down rabbit holes when presented with a broad problem. To elaborate a little bit, early on in the project the first thing I had to figure out was how to pull data from the Simulink model and into the MATLAB app at a very fast rate. I evaluated a couple different possibilities and looked into the different options. I spent a lot of time trying to do this by using user defined MATLAB function blocks and changing their user data parameter. However, this was extremely complex, so I was stuck on this part of the project for a while. It was during this roadblock where I got help from my mentor, Ben. He suggested I check out host scopes. Host scopes were the answer to my problems, but I had not realized this because I had not come across it during my initial research. This roadblock could have been easily avoided if I had looked into how I could use Simulink a little bit more from a higher-level perspective to achieve my goal rather than immediately diving into user defined functions. Through this, I learned the importance of when presented with a problem, attempting to find the easiest and most efficient way to solve a problem rather than exhausting all my resources into one sole idea that could potentially work.

Scno.html

## Introduction

This is a national organization of which there is a branch in Georgia Tech. Our purpose is to help local non-profits in any manner we can and by doing so also gain experience in the field of consulting through the organization as well as by meeting with like-minded individuals. During my time in this organization, I have been able to serve on two teams tasked with helping two different local non-profits.

## The Project

### Client #1: City of Refuge: Atlanta

City of Refuge is a local homeless shelter in Atlanta that is well known for being well organized and well managed. On the team serving this client, my role was a Business Analyst. Our goal was to create a donor analysis report and provide suggestions for them to increase donor retention as a whole. They provided us with a history of donations they received including the amount and the donor’s name. This data was in the form of around 15,000 different data points. I was the primary data analyst for this project and tasked with essentially identifying useful trends with this unsorted data set. <br>

I found several useful factors through these data points such as the time ranges in which different entities would frequent higher amounts of donations. In addition, one other trend we identified was the stock price of the company in relation to if they donated during that time period. There were also a couple other factors that we were able to realize through the data. Another aspect in which we wanted to service the client was by looking at their current website, donations options and other factors, etc. We realized that their website was rather outdated and did not have an option for a reoccurring subscription plan. This is something that we recommended and was implemented soon after. Once we finished our analysis, we prepared a final report with all our recommendations to present to both the members of this organization as well as our contact within City of Refuge.

### Client #2: Community Assistance Center

Once the previous project had been finished, I got the chance to work alongside fellow organization members to help the Community Assistance Center. On this team my role was a Senior Business Analyst. The Community Assistance Center or CAC in short is essentially a food pantry that picks 300 local individuals every year and helps them recover from some form of accident or incident that renders them unable to provide for their family. They help by giving the family a certain amount of allotted food throughout the year at regular time intervals. Our main objective was to decrease the food waste and increase the efficiency of the center as a whole. Unlike the previous project, we got the chance to visit the Center while they were in operation. During this visit, we got to see in person the food intake process (food that was donated), the methods of storage and how the food is transferred from storage and into the actual pantry where the person visiting the center can pick it up. <br> We identified 2 main avenues in which we could improve the efficiency of the center and decrease food waste. Currently, they manually log the total pounds of food received into several binders and then manually transfer this information to an online database at a later time. The staff mentioned that this was a rather tedious process so we decided to migrate this process of logging information to an online spreadsheet so they can just export it to the databases that they are required to fill out for tax purposes. The second area of opportunity was rearranging the layout of the center. It was in the form of a grocery store with different sections but the placements of the items could have been optimized. We communicated our suggestions with our contact at the Community Assistance Center and we are currently in the process of implementing them.

## Longterm Outcome

From the first project, I got the chance to use my newly learned MATLAB skills and saw the project from a new perspective through exposure to more experienced members on my team. While I was working on this project, I was taking a MATLAB class so I was able to use my newly learned skills for data analysis. This was just a great feeling overall because never before had a class immediately been of practical use in the real world. Going into this project, I was very focused on solely the data points and how best we could utilize them to help our client. However, through the guidance of more experienced members from my team, I realized that other aspects like the client’s websites and how they interact with companies would be of equal importance. From the second project, I got the chance to improve my abilities in analyzing a currently operating process and figuring out the best ways in making it more efficient with minimal energy at minimal costs.

Robojackets.html

## Introduction

This project was based around Motorama, a competition which is held annually. We planned to participate in the 3lb BattleBot division. The competition essentially entailed an elimination style tournament in which each team would control their 3lb BattleBot, essentially it was just a remote-controlled car that had a weapon and shielding, in hopes of disabling their enemy bot first for the win. After this competition, we were also able to compete in RoboGames, a similar competition held by Georgia Tech. Figure one shows Entropi, our 3lb beater bar that we designed and machined.

## The Project

### Designing

This competition had really only 1 main rule, keep whatever you build under 3lbs. My team and I initially began with a design phase of our bot. We then advanced to model the bot in SolidWorks. We were able to use some standard parts such as the DYS 20A Micro Opto Multi-Rotor ESCs, screws and wheels. In terms of electronics, we used a 1000mAH lithium polymer battery. Refer to our wiki for further specific information regarding parts as well as the motors used. But most of the other parts were items we created from scratch based on our initial design. We chose to use a beater bar for our weapon made out of Steel that connected to Aluminum hubs and Stainless-Steel roller ball bearings. We had an axle going through the weapon on each side of the bot on the inside of the beater bar to increase the structural integrity of the weapon. Rather than using a conventional surface for the back of the bot we decided to use a High-Density Polyethylene sheet which we could bend around the top and bottom plate. We found that this would decrease the rigidity of the bot as well as provide more space for the electronics. <br> Next, we participated in our first Design Review in which several mentors of the project gave us useful comments. They mentioned that the axle in its current state would a be a risk to the bot since it would be difficult to have it both be connected to the sidewalls as well as the weapon. In addition, they let us know that we needed to add skids to the bottom of our side plates to prevent the weapon from ever hitting the ground as this would lead to the bot sustaining serious damage due to the high speeds of rotation the weapon would be operating at. They also highly recommended that we increase the width of the weapon to increase the amount of damage it could deal. Once we made these recommended modifications, we found that our total weight will be exceeded 3 lbs so we made a parabolic cut on both the top and bottom plate so the side closest to the weapon was in the shape of a parabola. This reduction was enough for us to meet our requirement. After these changes, we participated in a final design review in which all our changes were approved, and our bot was deemed ready for production.

### Production for Motorama 2019

We essentially created the bot from scratch materials such as sheet metals for the walls of the bot, a sheet HDPE for the back, a steel block for the weapon and steel cylinders. We ordered the wheels, bearings and electronics mostly from McMaster. With the help of our mentors, we got access to CNC Milling Equipment through the program at Georgia Tech. In addition, they trained us in using Bandsaws, Lathes and Mills. The only aspect which we were not able to directly do by ourselves was the water jetting that was required for the weapon and sidewalls. This was done by a mentor due to certain regulations on campus. One of the first things we worked on in terms of production was milling the required screw holes in the side walls as well as the holes required for the hubs holding our weapon to be attached to. We had the chance to use programmable and also manual mills. Once these screws holes were made, depending on if they were clearance or through holes, we tapped them so that we could have threads on them. Next, we worked on lathing the hubs to the right sizes. While working on this, we had two members working on the electronics of the bot. There were certain modifications we had to do on the items we had bought from the supplier to meet the required specifications for our product. Once this was all done, we realized that we were still slightly overweight, so we cut out triangles in our side and top walls to meet the weight requirement. Our record at competition was 1 – 2 overall.

### Production: Competition 2

Before our next competition, we had the chance to make some changes and redo certain parts that were badly damaged. We decided to make the depth of the hubs longer since that was one the weakest parts on our robot. Rather than doing it later, we had the triangles cut out initially so that we would not have to worry about doing this manually before competition. The final issue was our belt for the weapon motor. We had destroyed our previous one during the last competition and we didn’t have a spare of the same size so we needed to figure out a way to make a larger belt work. We did this by using a hub without a grove for it to set on. We had to add a screw to the hub to ensure that the belt wouldn’t just walk off while being used.

## Results

For the first competition, out of three games we won one and lost two games. The main issues with our bot had to do with our drive motors and the hubs to maintain the weapon. For the second competition, we advanced to semifinals from pool play with a similar record. However, our bot broke apart when the enemy bot hooked the side plate and ripped the weapon out of the hubs. Refer to the linked wiki for further details into how we performed at competition as well as our analysis on the strengths and weaknesses of our bot.

## Longterm Outcome

Until this project, I had previous hands on experience with parts such as solar panels and batteries from the CubeSats I worked on earlier. However, this experience was in a very limited area. I did not have the chance to really start from scratch and build a product such as this one. I got exposure to CAD in the form of SolidWorks and this was very useful as I will need this for industry as well as for my future class. Another useful set of skills I learned that most engineers should know is CNC Milling. This project served as a very cool introduction into the equipment available at Tech for us to use. Finally, this was a great project for me to do coming from having done CubeSat because it took the skills, I learned in that project to a whole another level. For example, I had previously attended formal design reviews for the CubeSat we planned on launching with experts from NASA and JPL in attendance but my role on that project was solely regarding power related components. However, I gained a lot more exposure to that aspect of industry through this project.

Cubesat.html

## Introduction

This was a program that was introduced to my high school during my sophomore year. After getting through an interview process, a team of 10 others and I were selected from my school. We got the opportunity to work on the power related components of a CubeSat, a nanosatellite that was 10 cm long on each face. The plan was to put this CubeSat together and launch it as a payload on a larger rocket. There were a few schools involved in this project from my school district and each school had a different role. We had three main mentors throughout the production of these three CubeSats. Ibeth Jaime, the Computer Science teacher at our high school, served as our team lead alongside Commander Ronnie Nader from the Ecuadorian Space Agency who provided the technical expertise that we lacked in the early stages of our project. Finally, Brent Freeze served as the lead for the whole project and was the liaison between the various different teams (schools) working on this project.

## The Projects

### Irvine01

This was the first CubeSat that we worked on and as a result the objective was mainly to get an introduction into this industry. Our payload was an Omnivision OV3642 Camera with which we planned on transmitting information from. However, our primary objective with this educational CubeSat was to learn the process of putting one of these CubeSats together. My team was in charge of testing the solar panels, the battery, ensuring that the spacecraft’s power budget remained positive and several other tasks related to the power of the spacecraft. Since I was a relatively less experienced member on the team as a sophomore, my main role was to ensure that the power budget of the CubeSat was operational. This meant that I had to contact the various teams to check how much power their components would draw and for how much of the orbit cycle their component would actually be on and drawing power. This was rather tedious because I was often only given ranges or estimates since certain things were not set in stone yet. However, an important lesson I learned through this is to always consider the worst case possible in all scenarios just to be on the cautious side as emphasized by our mentor Cdr. Nader. The original plan was to launch this CubeSat into space in early 2018 and this would have made us the first high school team to have successfully launched a CubeSat into space. However due to significant delays, we were unable to launch it into space until November 11th, 2018 on the “It’s Business Time” Rocket by Rocket Lab in New Zealand. Post launch, we were able to locate and communicate with this CubeSat using the radio station at Cal Poly SLO. We received telemetry data which consisted of the CubeSat’s position as well as temperature and voltage data from different components. In addition, we also received pictures from the camera on the CubeSat which can be seen below.

Figure #1: Irvine 01 Deployable Solar Arrays

Rocket Lab's Video Clip Regarding Irvine01 Project

Media clip of Irvine01 Project

Irvine02

By the time we started this project, I had learned a lot more about this area of work and thus took on more responsibility. In addition, many of the seniors had left and this left a few veterans, but most of the members of the team were new members who did not have any previous experience with the work we were doing. A lot of the logistics for this second CubeSat was very similar to the first one we had worked on. Like before, we were carrying an Omnivision OV3642 Camera as our payload. This time we were also using an EXA FEROX Class 450/15 Pulsed Laser to hopefully speed up the communication. In addition, we planned on applying for an ELaNa (Educational Launch of Nanosatellites) Launch funded by NASA. In order to do this, we would need to attend a design review in which we got feedback from industry professional about our proposal. So, once we put together a proposal which basically explained the different aspects of our mission and the work all our teams would be doing, we attended this Design Review held by experts from JPL and NASA. For this design review, I served in a runner up capacity for the presenters of our team. Once we had received the RFAs (requests for action) on our proposal, we made the necessary changes, submitted our ELaNa application and proceeded to complete the required testing. Later on, in the year, we were notified that we were accepted into the ELaNa Launch program and given certain deadlines to meet. Unfortunately, due to a lack of proper documentation, we did not have the procedures and experiments we ran on the first CubeSat so we had to start basically from scratch with what we knew and with the help of our mentor Cdr. Nader. This time around, I was in charge of not only the power budget but also served as the DSA team lead. This meant that my sub-team and I would be responsible for all aspects of the DSAs such as ensuring that the solar cells successfully charged the battery, that the panels would release and deploy within the allotted time, etc. I did not want to repeat the mistakes of the past so this time around, I ensured that we wrote testing protocols and documented the experiments that we did run so that they could be referenced in the future. This was much more tedious because it meant that it would slow us down, but my team and I through our past mistakes recognized the importance of this and ensured to do so. Since we had previously done this testing, it was not difficult to carry out and Irvine02 was flight ready by the time my class graduated. It launched 2 months after Irvine01 on the Falcon X [CONFIRM] and we became the first high school team to launch two CubeSats in one year. Post launch, we were unsuccessful in communicating with Irvine02. We were unable to diagnose the most likely cause of this and the current team in still attempting to reach a conclusion.

Irvine03

For Irvine03, my team and I mostly worked on creating the plans and proposals for what we wished to do with this CubeSat. Due to a restrictive timeline, we were forced to do it alongside the testing we conducted for Irvine02. Irvine03’s payload was a laser with which we planned to use to communicate [CONFIRM]. My main focus during this stage for Irvine03 was perfecting the power budget and ensuring that using our payload intermittently would not render the power budget negative [CONFIRM]. Like Irvine02, we were planning to apply for the ELaNa Launch so we needed to complete our proposal before our scheduled design review that way we could receive the necessary feedback and then apply for the Launch within the deadline. This time, I was in charge of presenting the power budget and shields on the CubeSat during the design review to the judges from. Like we had done in the past, we received the RFAs and proceeded to improve our proposal before we submitted our application for the ELaNa launch. It was around this point in which my class graduated high school so we left the actual hardware testing for Irvine03 up to the veteran members of the CubeSat team who would not be graduating.

## Longterm Outcome

This program was one of the earliest things that exposed me to industry level work. We got to work with top of the line individuals in their respective fields while getting the chance to build these CubeSats with top notch equipment supplied by industry leaders. I learnt a lot in terms of how long-term projects such as this one are done at an industry level. This was further emphasized because of how large of an effort this was among so many different individuals across the different schools. In addition, I really improved my leadership skills while attempting to unite my team with this project especially during a time in which many of them were struggling with school work and other academic struggles high school students endure such as AP classes, SATs and college applications. Overall this opportunity was a great one because I got the chance to work on such a cool project with a great group of individuals with whom I have made great friendships with.

UCSD

Introduction

This was a summer research opportunity where a friend and I got the chance to conduct research using UCSD lab facilities. Under the guidance of Dr. Siegel, we attempted to analyze the base components of native and non-native plants of the La Jolla area. We then presented our findings to the rest of the members of the program as well other faculty members who wished to be present.

Our Research

We initially visited Scripts Costal Reserve to collect plants which we could use to run tests on. We collected two plants: a Lemonade Berry, a native plant used often as a beverage sweetener, and a Crystalline Ice Plant, a non-native plant with no recorded uses. The main test we ran on these different plants was Thin Layer Chromatography using a 70/30 Acetone/Hexane mix. We ran the tests with spinach and sunscreen first to gather test points but also as practice for when we actually ran TLC on the plants we collected. We were able to find similarities and differences between the different plants. [INSERT] After we had finished our research, we create a poster (shown below), with which we then presented to our fellow peers.

[Insert Picture of Poster]

Long Term Outcomes

This experience was one of the earliest memories I have of being introduced into a college level lab and being given the independence to run whatever test we thought would be best based on the given materials. In addition, it allowed me to visit UCSD very early on and get an introduction into the college atmosphere. Overall, it was an interesting experience and only because of my exposure to this field early on did I have time to achieve a Biotechnology Lab Assistant Certification while still enrolled in high school.

Thermal vs Distillation

Introduction

This was a science project that I worked on during my sophomore year in high school. It was during this time period that the drought in California was reaching new lengths and thus I wanted to dedicate some time into researching it and the underlying solutions.

My Research

My investigative question for this project was “How efficient is Reverse Osmosis compared to Thermal Distillation?”. I focused mostly on the researching aspect of this project rather than attempting to answer my question by conducting a hands-on experiment simply because this was the more feasible method. I used public data for the cost of the process of reverse osmosis and thermal distillation. I tried two experiments, one for each of the processes of water desalination. However, my experiments were not the best designed experiments since I did not have the necessary expensive equipment required to actually simulate these processes. My experiments essentially consisted of a model that mimicked how the process would run but due to a lack of the needed equipment, the models had several inconsistencies in that they were meant to represent. I did find that although my experiments may have been flawed, they agreed with the theoretical numbers I had arrived at with the research I had conducted. I found that in the short run, thermal distillation is more cost effective. However in the long run, reverse osmosis is one of the better alternatives to switch to especially since the technology and science behind the process is constantly being improved as research into these membranes and filters advances in industry. I presented my work at the Irvine Unified School District Science and advanced to the next level of competition. At the Orange County Science fair, I proceeded to get Honorable Mentions and also a Gold Award from the Orange County Water District (w/ a $500 award) for my research.

Longterm Outcome

This project was merely out of self interest in this topic as it was the center of a problem that I encountered on a day to day basis. I learned a lot about the state of water desalination through this project and was surprised when I learned a new reverse osmosis plant, Claude “Bud” Lewis Carlsbad Desalination Plant, was being set up in San but suffered from rather high operational costs and sporadic delays. Overall, this project sated my curiosity on this topic and I look forward to seeing how efficient we can truly make the reverse osmosis process as our technological advancements progress.