**.Why APL**

I look for companies that can benefit our society the most because that is my professional goal. From my previous internship, I had a chance to lead a project to help HVAC technicians, and the magnitude of impact that I realized that I could have as an engineer as well as the appreciation that I received for helping them was so rewarding that I wanted to seek greater work that can benefit greater society. And I believe I could do so at APL. APL aims to provide solutions to the most difficult problems for our nation and to benefit our society and improve the lives of people, and it has been doing that with its innovation in the first Satellite Navigation System, recent DART mission, and more. I hope to be part of those innovative projects by contributing to APL and also achieve my professional goal with APL. Besides that I really appreciate the fact that you guys have this discovery program because I really want to explore more about what more areas I could work on within the Dynamcis and control area. And from the talks I had with Patric and Miriam I really felt that APL distinguishes it self from other companies with the aspect that not only that you guys are looking for someone just skillful, but also someone who wants to actively learn and absorb things. Have that mindset and attitude.

Discovery program is a plus. Patrick Cox/ Miriam Grap.

Group supervisor. ME graduate. Working for us navy oversea design of submarines. Masster in systems engienering. Air and missile defense aegis combat system. Protect from incoming cruise imissiles protect sailors and ships.

His job is plot stragetegic evoltioioon of aegies Model future threats and sim and run it couple times and give recommendation and system A B and C. Multiple criteria and make a decision.

Global helath mission optimize researsach pr+orofolio for medicien.

Force projection. Integrate all three systems

Work for a sponsor. Contribution to critical challenges. APL is collaborative. With team and within groups. Teamwork and communication. VT fuse after the war. 4 sectors work on immediate works. 2 research departments. < discovery program falls on it. 2 year commitment. Three different areas over the course of 2 yrs.

4Sectors: force projection sector- GNC.

Meet with Patrick.

Core values: critical contriubtoions to critical challenges. World class experticse, trusted service to our nation. A Collaborative fulfilling environment. Game changing impact. Unquestionable integrity.

**Tell Me About Yourself**

I am an integrated masters and bachelor’s student at the University of Texas at Austin. I am graduating this December, and my studies and experiences have been geared towards Dynamics Systems and Control, which I see as one of the technical areas this position is hiring for.

Specifically, this position is looking for a candidate with impactful experience through an internship. I am currently a Navigation Guidance and Controls Engineering intern at Sandia National Laboratory since May of this year. I have been developing an unclassified simulation for one of its flight vehicles in MATLAB and Simulink. I debugged existing models to make a functional simulation and automate simulation runs and git operations that save time in the Software-in-the-loop process.

I was also a Guidance Navigation and Controls Engineering Intern at Blue Origin. I did similar work there where I worked on MATLAB and Simulink Simulation for one of its rockets. Here I got a chance to collaborate a lot with other engineers through meetings and especially GIT for sharing works. It was a great opportunity for me to demonstrate one of the qualification for this job, which is to thrive in a collaborative team environment that requires communication and interpersonal skills.

In Academics, I have taken courses to consolidate my knowledge in classical control concepts and ~~Kalman filters~~. I could specifically talk about aerial robotics course later, in which I implemented 6-DOF simulations and path finding algorithms in C++. I really loved that course.

Lastly, I could talk later about my internship at Samsung Austin Semiconductor, again as one of the qualification for this position, I demonstrated my ability to quickly contribute to projects that are new to me. wait

I have leadership experience in Gudaloop, which is a student Hyperloop team and I took initiatives as a leader, and also my senior design project.

So, I matched my experiences with the qualifications of a candidate that you guys are looking for, and I think I could be great fit for this Discovery program, I would love to explore multiple technical areas and be a contribution to APL and to our nation with my passion to be a benefit to our nation.

**Discovery Program**

Technical Area they are hiring:

Dynamics and Controls

Qualification:

* demonstrated impact in at least one internship or project outside of classroom (Sandia and Trane)
* Demonstrated initiative that has enabled excellence in projects (Gudaloop)
* Thrive in collaborative team-strong comm and interpersonal skills ( Blue and Trane and Military)
* Engaged in multiple internships
* Have leadership experience (Gudadaloop and Senior Design Project)
* Ability to quickly contribute to projects in tech areas that are new to you (Samsung)

About APL

* Vacuum and thermal Chamber for Equipment testing
* Meteorite lab
* APL values:
  + Unquestionable integrity
  + Trusted service to the nation
  + World-class expertise
  + Game-changing impact
  + Collaborative and fulfilling environment
* Core purpose
  + Critical contributions to ciritical challenges
  + Goal: create ddefinin g innovations that ensure our nation’s preeminence in the 21st century
* Vision
  + Become a Treasured national resource
  + Be recognized for technical leadership
  + Provide decisive advanctage to the nation
  + Sharing knolwedge and technology that benefit our society and improve the lives of people throughout the world
* 4 sectors
  + Air and Missile defense
  + Force projection
  + Asymmetric operations
  + Space exploration
* Discovery Program
  + Ability to reach back to different teams sh worked on for their expertise
  + Put you into network of people
  + Patrick Cox (Discovery Program Group supervisor)
    - Allowed members “to permeate and cotnribute to diverse scientific and engineering domains”
  + APL puts emphasis on this program and how important it is to find new talents and have thosetalents develop wellrounded understanding of different disciplines. Allows them to communicate with different people technical disciplines
  + Three rotations 8 month each

**Sandia**

One of the issues that GNC engineers in my team had was the inconvenient work process in the classified network. There were extra steps and time that needed to be on the classified network compared to working in a regular network. My mentor and I saw an opportunity to improve this process.

I began developing a simulation in the unclassified network because not all the GNC work had to be done in the classified network, and working in the unclassified side removes lots of inconveniences!

Fortunately, there was already a simulation in MATLAB and Simulink in the unclassified network, but it was broken and completely out of date. I studied the conops of the flight vehicle to understand what the simulation should be doing and debugged it to make it functional.

That process involved multiple meetings with my mentor to seek out for help to understand the model and the vehicle itself. My previous experiences in MATLAB and Simulink helped me to understand the exact issues with the simulation and come up with solutions for them. By the end of the summer, I was able to make the sim functional and produce a result. I am currently still working on the sim to make it more reliable and produce more accurate results

In addition, I also worked automating the simulations, Developers often took 10 mins~ 30mins a day or a week just waiting for a simulation to run. Since they had to run the sim very often, say if a sim takes 10 mins to run, but if he or she had to do it daily, that time adds up to almost an hour every week. This time could be saved.

So I used Powershell Script to schedule the sim to run at a designated time everyday by itself. Initially, my mentor and I were both unfamiliar with automating simulations, so we reached out to a software engineer to discuss different ways we could achieve that. We discussed two options to achieve this. Considering compatibility with the current development setup Powershell was most suitable.

I had never used PowerShell script before, but I was glad I got a chance to learn it and actually apply to a real work. So during the summer internship, I learned to use the script and wrote scripts that scheduled simulations to run at a designated time during the day daily, weekly or monthly, and also make the script to do GIT updates and produce the simulation results in a form of graphs( say a trajectory of the vehicle).

Currently, I have automated my unclassified simulation that I developed to run every morning at 1AM, do the git updates and save the results from the simulation in a designated folder, so that whenever I start working everyday I could just check the result folder without me actually running the simulation. This saves 30 mins a day for me which is how long my simulation takes to run

All in all, at the end of the summer, I was able to present my work on the unclassified sim and automated sim to my team. Engineers were looking to use the unclassified simulation in the future and showed a huge interest to use the automating script for their own development process that can save time! Through this experience I have made and am making an impact in my team at Sandia by providing an option to improve the GNC software development process.

**Blue Origin**

At Blue Origin, as a GNC engineering intern I worked on simulations in Simulink and MATLAB for the New Shepard rocket, specifically the ones that are used for verification and validation of flight software.

I was tasked with adding a new feature to the navigation model, which produced an incorrect satellite sky plot during a certain phase of the flight. This required me to work within an Object-Oriented MATLAB framework, which was completely new to me, and, to learn about flight systems and navigation concepts.

To tackle the problem, I started by studying the object-oriented programming (OOP) approach in MATLAB. I actively engaged with my mentor and other engineers. I asked for lot of 1on1s with them to teach me about the navigation system and best practices for improving the simulation. What is the purpose of this specific sim or variable. Why is this sim needed for navigation system. Initially, I didn’t even know what pseudoranges, L1, L2, Carrier phase ,etc. were. I was introduced to SIL, HIL, and process-in-the-loop (PIL) for flight software development. With all these understandings, I realized in the sim that during a specific phase of the flight, a rocket parameter wasn’t appropriately assigned that it caused incorrect representation of the navigation variables. So, I introduce new variables to trigger the appropriate assignment, modified variables to accommodate the allocated data sizes, and fixed all the bugs to be compatible with any other simulations that were relevant.

Besides that Communication was critical, and I didn’t hesitate to ask for help when needed. I would come up with a few ideas on why the simulation is acting certain way, say the sequence definition is defined incorrectly, or a certain trigger switches rocket states, Then other engineers gave me a feedback or suggested alternative solutions to my problem. Having many technical discussions like this, helped me progress through my project, and also learn new things very efficient way compare to doing everything all by myself.

In the end, I successfully implemented the new feature that corrected the satellite detection issue, producing accurate skyplots. Additionally, I incorporated a navigation block that improved the simulation's fidelity, ensuring that it reflected real-world conditions more closely. Lastly, I want to put emphasis on how much of the GIT I learned here. It was my first time using it and my first exposure to git at Blue. This experience really ramped me up to be proficient in using Git.

So, at blue, I was able to gain an experience with simulations in MATLAB and Simulink. I became proficient in Gitlab. Lastly, I demonstrated communication and interpersonal skills that are required by this position, and this experience makes me a fit for this discovery program.

**Guadaloop**

I was the lead suspension engineer for the team in Spring 2023. The suspension design when I became the lead did not have any sufficient engineering justification. Meaning, We did not run a thorough stress, cost analysis, or reviews from any professionals. so we could not answer any questions when someone asked why our suspension was designed this way. So, I took the initiative to scrap the entire design and begin from scratch. Of course, this required discussions with my teammates. I explained that we should not sacrifice long-term value for short-term results. Although we already had some sort of design that could make the process faster and maybe even start manufacturing an actual system, it’s meaningless if we don’t have sufficient engineering background to this design. We won’t be able to convince the judges in the competitions, and even people within Gudaloop why our design was the best choice. Also, if the system failed, it will hard to identify the cause for the failure. I tried to communicate my opinion as much as I can to my teammates, and I was able to convince everyone to agree with me. So we started everything over.

I led the team to take a methodical approach. Because this was a self-led project, we had to seek out the requirements for this design ourselves. I gave instructions to clarify performance specifications, brainstorm, picking a design and analyzing our selection. We used Pugh charts, gantt charts, multiple sessions of 6-3-5 method, and ran stress analysis through FEA for different design options. While leading these processes, I felt the that it was important to earn the trust of members to have your teammates follow you and lead them. I had to genuinely listen to them and create an environment where people can talk freely and show that your open to any novel ideas. I think keeping this in mind helped me propagate discussions for new ideas and consensus

All these activities provided a solid justification for our team’s design, and if anyone had asked why certain things were designed in such a way, we were able to give them a sufficient engineering reason. So at the end of the summer of 2023, the team created a final CAD of suspension system along with documentation of the entire engineering process and its justification. The team just had to manufacture it at the time! With this experience I was able to lead the team by earning the trust of the teammates and also to self-identify the requirements for the design.

**Aerial Robotics**

This course was basically a competition where student teams competed to see whose algorithm could go pop ballons with a drone the fastest. our team developed an algorithm that would enable a drone navigate through an obstacle field. In the process, I created a 6DOF drone simulation in MATLAB, developed a path-finding algorithm in C++ .

I started the work by modeling the drone's dynamics in MATLAB. So we would see in a visualization tool in matlab how the drone flies based on a trajectory that we give. The dynamics was accurately modeld that the drone moved as we intended at least in the simulation first. We also implemented a PD controller to control its attitude and trajectory, and emulated GNSS and IMU measurements. With this course in addition to Sandia and Blue experience, I got a chance to be proficient at MATLAB.

After I built a complete 6DOF simulation, I then moved on to making a path finding algorithm in C++. I compared different methods, A\* Dijkstra’s and DFS and determined that A\* is the best. All this C++ developm,emnt utilized a game engine that was used to check the performance of our path finding algorithm. This a\* implementation helped me become more familiar with C++.

All this development was of course time limited in less than 3 month period. So teamwork was key to this competition and facilitating it was proficiency in git and communication. I did lots of work independently to accomplish my responsibilites for the team and studying the materials for this course. However, of course, teamwork still needed.

I led the team in using Git for collaboration, ensuring everyone understood version control, since no one in the team had the experience before Also my team communicated alot. I thought communciation will be key in solving technical issues i ndeveloping software and also for time managing, since all of us were busy with other works and job seeking and extracurrricular acitivities too, and again this devleopment had to be done in 3 months. so I suggessted we have designated times every week that we focus on working on this togetther. Being physically togehter helped us communicate much better than working remotely through zoom or email. WE would ask questions to each other right away or debug things together or discuss confusiong topics togther on the spot. I think this was essential in helping us develop a successful algorithm.

Our team successfully developed the algorithm and placed 2nd in the competition. Through this course, I gained an experience in developing and validating models and simulations through the complete 6DOF simulation for the drone. Gained an experience in C++ , MATLAB, Simulink ,.and Git. Communication is a quality you guys are looking for and I couldn’t have succeeed without communication in this team project.

SO I wanted to point out these qualities to show that I am a fit for this position. Despite our time constraints we were still able to work out the time and finished with a good result. so please let me know what you think, if there is anything else I need to talk about or need work on too.

Control specific experience

This was a three-person team competition. The goal was to create a path finding algorithm for the drone to find the fastest way to predetermined targets in a field of obstacles. One of the task I was involved with was designing a controller for the drone attitude and trajectory controller within a 6-DOF simulation that I was developing too in MATLAB.

First stpe to it was knowing what the dynamics euqtions that define Drone behavior.I ended up using 4 ODE that describe its position, velocity, attitude and angular accelartion. Then I had think about what control inputs do I have, in this case, it was a Thrust force from the propellers directed towards the z-axis or just up in reference to drone’s body frame, and there is also the torque created from that same force too.

Of course we can develop a control equation from the desired trajectory. Basically multiply the errors by adequate gains. For attitude, we were hinted to use the direction of the x-axis of the body frame and the z axis because one axis of the body frame can defifne a direction the drone is pointing to and another can define its tilt. So with that a PD control law was implemented. The most difficult part was finding gains.

P and D gains were in a matrix form for the attiude controller. I tuned it until the drone followed a desired circular and a designated height as closely as possible in a MATLAB simulation. Also I wanted the quad’s front to face the center of the circle throughout the flight. Also at a certain height .

This was a simple tuning, but I think was most diffiuclt part for me because I almostly blindly tuned this until I got the behavior of the drone I wanted. I could not have been getting the correct trajectory because of other parts of the sim not the controller gains itself. For example, my dynamics model could have been incorrect. Or my gnss model could have been incorrect.

And this is where separating the simulation into different subsystems or modularizing the sim came in handy. I was able check the validity of each subsystem separately

I would first test the dynamics model on its own without any controller to see if it produces the trajectory I want. And then I can confirm that dynamics model is correct. So I was able to confirm all the other subsystem was correct, and knew that it was my controller gain that was the issue.

At one point, I got stuck at this state where I see a steady state error in the altitude. One could ask Why didn’t I use an Integral controller to fix the error from here.

Well, since I used PD controller, these are the equations I used to calculate the force and the torque input to the dynamics model.

Besides that PD reduces computational work by having one less term relative to PID controller and making it easier for me to tune the gains since there are 8 terms to tune already, I knew the integral term shouldn’t be necessary, since I already have the mg and the feedforward term here. So, the controller will always no matter what produce the force command enough to make the drone hover with the mg term, the errors it observe should produce the extra force command to the drone motor. So I knew PD should work. I later found out the correct gain and got it to look like the previous slide (previous slid).

**Trane**

This was my first professional engineering experience. Among couple of things I was responsible for, most memorable was a component qualification project. I led the project, and the product had potential to save installation time for technicians, and I had to test its performance, check its standard compliance, and price to help the company decide whether to use this product or not. This type of product was not a typical component in HVAC, so I had many discussions with other professional engineers on how to test the performance and interpret the standard. I also met with manyh technicians to receive their feedbackand reflect them on the methods for testing the component.I have also come up with a safety measure incase the component fails during tests. Experimented it and showed other engineers that it does perform properly as a safety mesure. I loved this project, it was really fun coming up with my own tests, interacting with actual users of the product,and learned alot from other engineers. It was great chance to show my written and verbal communication skills and was great leadership experience that I believe you guys are looking for this position.

**Senior Design Project**

This project was heavily customer focused and time driven project. The team I led was tasked with designing an impact test machine for equipments on naval ships. It was important that we met our customer’s need and deliver a product in a timely fashion, since we were designing such a big system from the ground up in three months.

To understand our customer’s needs and also deliver the results on time, communication was key. Projects like these, I think it is important to have every member and our customer be on the same page without much confusion. Do each members know exactly what tasks to do. Do we understand why they are build this product, where are they going to place this? What are other specifications? Does the customer understand what we are going to do? If the team is confused, it delays the time for it to do actual work on the project, and rather have to do the work again, or be stagnant in confusion. In order to reduce such misunderstandings and miscommunications, we held meetings regualraly with the customer and amongst our team to give each other chances to communicate as often as possible, and at the end of every meeting, I clarified action items and each members due dates for everyone, so everyone knew what to do and made progress on the project until the next meeting. Also, I stayed open minded as a team leader. This was very helpful when we were brainstorming ideas on how to raise the hammer for the system and bolt down the system and etc. Having multiple ideas, allowed us to consider different options we were able to compare each of them and be confident on our choices of our design. We can say this was a better idea because of this reason. Another way I stayed open minded or tried to be communicative was when a member thought that he could not finish his work in time, I discussed about it before the due date with the team and tried to see if we can distribute the work or reach out to our sponsor and the faculty to see if such extensive study was necessary given the time. At the end, we successfully met every single deadlines and produced a CAD model of the machine. Presented them to an audience.

So, With this senior design project, I helped my team deliver the deliverable on time, stayed open minded to run the project efficiently, and focused on our customer to meet their needs.

**Military-** In Korean military, there is quarterly, squad team qualificaition test that measures the team and the individuals’ abiltiy to operate missions. So physical tactical, and other miltiary basics a solider should know. On the team missions, for the first two quarters I took, we could not get that above 90 points that we needed for our company’s goal. those two first times, it jsut seemed like coordinating the entire squad was hard, the directors for the tests seemed just harsh for no reason. I wanted do something for us change our squad’s performance. So When I rose to the rank when I can start commanding other fellow soliders, I started discussion sessions within the squad before we took a test. we came up with the plans together, rehearse them. talking about each other’s movements, strategeis, tips they have heard over the months. This really solidfied our operation during the test and we did recieve that high performance grade that we needed. IT was really an accomplishment for us. From that I learned that it’s just a discussion and the planning together is what makes a huge differenece and gave us the result we wanted. All we needed to do was communicate among us. and I think Engineering is not much different from that. Communication is the key and discussions are wehre we find solutions in any engineering roles and projects. I have been working since to communciate and at the same time lead my team members through verbal communication in any engineering projects

**Samsung**

This was my internship two summers ago. The work I did there was not something I expected, but it was a chance for me to learn an entire new thing from the start and apply to work right away. At the time, I had never coded before, I did not how to make websites. But during that internship I was tasked to learn Javascript, HTML, CSS SQL, VBA and all to create a website and excel tools that helps technicians report failures and record manufacturing data without error and quickly.So I learned all those and at the end I presented my work to engineers and especially the technicians. It was really rewarding again to see technicians appreciating my work and seeing my work at practice. I believe it is still functional in the semiconductor fab right now saving about 1 hour for each of the technicians every shift. I also gained confidence that I can learn new things and quickly adapt to it as well. I am sure there will be new knowledge that I need to learn within the discovery program, so I want to show here that I have an open mind set to learn and will learn and apply my learnings for this position.

**How do you resolve conflicts?f**

One time in the Korean miliatry in 2019, I heard about an opporutnity to volunteer as a translator for FINA international swimming event. I thought at the time it was a good opproutnity for me to experience new cultures through people around the world, get some sort of revelation or insights like I had when I first came to the United States from Korea, also I thought at the time it could be a good resume builder. So They were looking for people who could speak english amongst the soliders who can volunteer. So I volunteered and asked my captain if I could get a permission to go. My captain was okay with it, but I also had to get a permission from the higher up battalion commander. He initially said no. I couldn’t directly get a chance to directly ask him due to rank in order, I was able to infer it and ask my captain why he refused to let me go. The primary reasons were that me going to big events will have uncessary risks by going out in the public. Say I could get involved in accidents and if anyhting bad happens it’s battalion’s responsibility for my accidents. He didn’t want to complicate things.

Although it was battalion commander’s command which is almost like a law in the base, I didn’t want to lose my one and only opportunity t obe a translator. I thought I will never have this chance again. I didn’t give up and I thought I should be given this oppruntiy to do it. There weren’t any big trainings coming up too, so I thought since now I understand why he said no, I should persuade him with my reasoning. So I decied to write an essay for him, listing reasons why I should be sent out to volunteer. I expalined the benefits of this chance, such as an oporutnity to expeirnece the people around the world that can expand my insights and views for the world , which is what happened to me when I moved to US from Korea. I also said I wanted to make my draft service meaningful and this opportunity will be one of the reasons why I had a great time despite it being a draft. I also emphasize the importance of enhancing my ability to communciate with people. Like now I need to be able to talk to anyone about my stories and listen to other people and this event is the perfect opprutnity for it.

With this letter, I asked my captain if I could go into his office directly and hand in this essay myself. I was granted the access and handed it over to him. I was nervouse but I was glad that I tried my best and still belived that I was doing the right thing for the right reasons. The next day I was granted the permission to volunteer from him. Which was great! In the end unfortunately, the volunteering positions were already all filled and couldn’t do it. But I was glad I could solve this conflict through communicating my reaosning to him. I learned that some disagreements could sometimes be solved by simple communications.