# Electronic Engineering Portfolio

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Key Accomplishments

- Completion of various biomedical engineering courses including those related to biomaterials, introduction to mechanics, statistics, circuits, and microcomputer applications.
- Previous experience analyzing extensive data, creating various data models, and presenting to a variety of individuals.
- Ability to apply project management skills related to developing and implementing various processes including maintaining accurate documentation of the modelling process.
- Effective use and development of communication skills and ability to prioritize tasks to maximize team efficiencies.
- Successful application of engineering skills to create a pressure sensor feedback mechanism for potential implementation into prosthetics.

Professional Experience

Student Research Worker | Arizona State University | January 2018-Present
- Research and organize scientific publications related to complex adaptive systems.
- Ensure accuracy by confirming identified publications and uploading them into appropriate databases.
- Demonstrated time management and organization by completing high volume tasks in timely manner.
- Led and completed several projects related to office optimization through collaboration with peers.

Consumer Lending Intern | Wells Fargo | June 2018-August 2018
- Reduce operational risk by identifying and remediating discrepancies with department procedures and Government Regulations.
- Increase efficiency by analyzing, compiling and automating reporting distributed to Senior Leadership.
- Manage various projects requiring effective communication and collaboration with business partners.
- Promote innovation through successfully identifying and proposing process improvements to business partners for increased efficiency.

Research & Laboratory Aide | University of Arizona | Fall 2017-Spring 2018
- Research collaboration with Banner Sun Health Research Institute to study the use of body worn sensors for the diagnosis of cognitive impairment.
- Facilitated the project by explaining research procedures and tasks to obtain data.
- Evaluated study participants with varying degrees of cognitive impairment while following ethical guidelines.
- Correctly verify the collection of data to analyze and upload to the appropriate academic databases.

Education

B.S. Biomedical Engineering | May 2019 | Arizona State University
A.S. Science | May 2015 | Estrella Mountain Community College

Technical Skills

- FDA Regulations
- Engineering Process
- Data Analysis
- Solidworks
- MATLAB
- C++
- Mathcad
- Office
- LabVIEW
- Effective Communication
Dear Gore Hiring Manager:

As a senior studying biomedical engineering at Arizona State University, I am excited to learn more about the endless opportunities related to engineering. As such, I would like to be part of a challenging and rewarding career opportunity. After conducting a job search in the medical device sector, I came across a position for upcoming graduates with Gore and immediately became interested.

Biomedical engineering is a discipline of science that provides skills in all the major science and math courses to solve problems. In addition, biomedical engineering has allowed me to gain skills related to the engineering design process, circuits, MATLAB, Solidworks, FDA regulations, and even data analysis. All of which are proven skills to benefit an engineering department.

Besides academic skills, I have gained many skills from previous employment opportunities. My previous experience includes serving as an intern at the Banner Sun Health Research Institute as a research aide. My duties entailed obtaining and analyzing data through patient interaction. This position allowed me to obtain experience with body worn sensors, post-processing, attention to details, and the REDCap database.

In addition, my previous employment as a Wells Fargo Intern and a research Aide at Arizona State University has given me many skills related to record keeping, effective communication, teamwork, management, and customer service. These experiences in return has provided me with effective problem-solving skills.

Engineering is a subject that takes the above-mentioned skills and combines them together to form an innovative idea that can change the lives of many individuals. My skills and experiences would be beneficial in potentially changing the world of tomorrow.

Thank you for your time in reviewing my skills and experience. I hope my qualifications meet the desired needs and I hope to be part of this opportunity.

Please feel free to contact me at (602) 489-4026 or email me at antonio.lopez30@outlook.com.

Sincerely,

Antonio Lopez
Career Fair Plea

Hello, my name is [REDACTED] I am a senior majoring in biomedical engineering and currently have a G.P.A. of 3.56.

After coming across the quality engineer position with your company I decided to apply. I chose to do so because Gore is a reputable company and I strongly believe I will be able to provide a positive skill set to the team while learning many valuable new skills. Here is a copy of my resume with a cover letter and reference to the job posting.

Since I was in high school I wanted to focus my mind in an area that tied together engineering with the human body that would help improve the future of healthcare and decided to study biomedical engineering. This desire has allowed me to become a hardworking and fast learning individual.

My current coursework has involved the foundations to all engineering curriculum, the product design process, biomaterials, bioethics, and FDA regulations. These courses have allowed me to firsthand see the engineering process and design projects related to medical devices such as glucometers from the first stage in needs assessment to the prototyping step. These courses have allowed me to gain valuable software skills related to Solidworks, MATLAB, and Microsoft Office.

My previous employment experiences have allowed to gain valuable skills in teamwork, effective communication, and pay close attention to details. I completed an internship project with Banner Sun Health Research Institute and the University of Arizona related to the study of upper extremity function. This project involved interacting with individuals with a certain level of cognitive impairment. My duties involved asking these individuals questions related to their health status and obtaining data through the use sensors. The data was then organized, analyzed, and entered into various databases. In addition, I also had the experience to work as an Intern at Wells Fargo. These experiences allowed to gain skills related to effective communication, attention to details, and constant researching. Other experiences have allowed me to gain effective teamwork skills and learn about the various needs different individuals need related to projects.

I would really love an engineering position with your company. I think that this would be a great fit because my skills and experiences are those desired for the position that was posted.

Do you have any questions for me? Is it okay if I ask you a few questions? Does Gore offer programs for employees to continue their education, I am very interested in pursuing a master’s degree in biomedical engineering. I understand that many positions are throughout the United States, is there relocation reimbursement can you explain a little regarding how that works?

I would greatly appreciate an opportunity to interview for the position. Do you happen know when I could have the opportunity to be interviewed? If there is anything else you’d like to know about my skills and qualifications to assist you in making your decision, please feel free to ask. Thank you for your time and this opportunity.
Comprehensive Career Plan

1. Summary of Goals and Objectives

My career plan has thus been shaped in a form that will enable me to one day practice law. The reason I have chosen to study law is due to my own previous experiences related to law. During this process, I began to research various laws and began to analyze them in multiple ways. Through this, I also began to look at various case studies and understand the implication and the interpretation of various laws. Because of this, I decided that I wanted to pursue a career in law and hope to one my own private law practice within the next 10 years that focusing on a variety of legal aspects. In order to accomplish this goal, I have the intention of applying and attending the University of San Francisco. Ideally, I plan to complete my law degree in the next 4 years after completing my undergraduate degree in biomedical engineering. At the same time, I plan to work immediately after graduating in May of 2019 in a business that offers tuition reimbursement benefits.

Although law is sometimes seen as a subject irrelevant to engineering, in reality it is very important. Law becomes an important aspect related to engineering in regard to patent law. There are many engineering discoveries made on a constant base. These can occur at the same time by many researchers and issues can arise when patents are filed at the same time. An example of this in recent news has been the CRISPR debate among who really deserves the patent. Because this legal case ties back to engineering, my goal is to study the current advancement made in CRISPR, their meaning in future of healthcare and the future implications of using this technology.

2. Current Status

To prepare for my short term and long-term goals I have taken many classes, 67 credits, that have provided effective skills and experience that will be beneficial in the biomedical engineering industry. I have so far completed all the foundational classes to be successful. These classes include all the engineering calculus classes, chemistry classes, biology and physics classes that provide the foundations to understanding the technical related engineering skills related to biomedical engineering. Learning about physics, calculus, and chemistry have provided a solid knowledgebase of mathematical modeling, chemical reactivity, forces, the essentials of life, and knowledge of the human body. Other courses that I have taken this far that have prepared me for my career include biomaterials, signals, C++, Ethics, FDA Regulations, Statistics, and many biomedical product design classes. These classes have been helpful in providing a deep understanding of the issues and ethics related to biomedical engineering. Computer programming provided an understanding of the potential skills needed to setup computer programming for a medical device. FDA regulations provided an insight of the different types of medical devices that are approved by the FDA. The knowledge of statistics provided an understanding of using computer programs to analyze data and determine if something is effective or not. The product design classes have taught me the engineering process form beginning to end. These classes have provided realistic skills to designing devices or improving devices while identifying client needs. Classes that I’m looking forward to are capstone and business courses designated toward my business minor. I believe these classes will provide more information related to use of the engineering process, effective business decision, and proper project management for the actual creation of our own device as a senior. This will provide the essential skills to efficiently design a medical device or improve an existing device. In addition, these courses will provide important skills for a successful career.

On the other hand, I could improve my personal life. My social life is lacking, and I need to appropriate less school and work time to be more social. The difficulty I face is living so far from school. I face a long drive to get to school and another long drive to get back home. At the end of day, all I have time to do is do coursework and go to bed. I also feel like I need to devote more time to my faith, I need
to start attending mass more often. At the beginning of the semester I was doing great and was a good practicing Catholic. However, as the semester started getting busier I started focus more on school. Another aspect of my personal life that needs improvement is spending more time with my family. Although I live at home, I rarely see them and have no time to actually be with them. I know I need to be more helpful around the house. Since my dad passed away my mom has to do a lot more things at work and at home to keep the home going. I hope I am able to change this once I graduate and start providing an income. Along those lines, financially I am a bit worried. In the process of obtaining an education I have burdened myself with about $20,000 in loans. I know I shouldn’t worry, but the financial future is never certain and at my age with little saving this is something of concern. Nevertheless, I hope that in the next 5 years my car and my student loans will be completely paid off and that in the next 10 years I am a proud homeowner. My goal is to work hard and pay off all my debt in the next 20 years. I am strong believer that with a reduced amount of debt, I will be able to live a life with less stress.

3. Education

   Education is important because knowledge is power. Education exposes people to items that otherwise don’t occur in people’s lives. In addition, the educational process provides opportunities to meet with other individuals aspiring to be working professionals. During this process many learning techniques are learned that allows people to become critical thinking. This along with all the resources available at school provides aspiring engineers a way to be competitive with other individuals. Because of this, it is important to continue our education to be stay up to date on emerging technologies. This enables engineers to factor new discoveries into their daily work and deliver performing results. Continuing to learn also provides away for the brain to continue thinking critically. Along those lines, my short term educational goals include graduating with my bachelor’s degree. degree in biomedical engineering and a minor in business in 2019. My long term educational goal is to obtain my law degree, which I hope to obtain by 2023. Although it is not certain at the moment, I am even considering obtaining a PhD. The idea of being a lecturer and supporting aspiring students to reach their goals seems like an interesting and neat work experience. As such, my goals are to continue taking courses related to engineering and business. In addition, I plan to gain skills related to becoming a business owner. Over the summer, my plan is to prepare for law school as I hope to start a law program in fall of 2019. Although my first degree will be in biomedical engineering, the skills provided throughout the program have allowed me to think critically. This is a skill that will be very important in law school.

4. Research Experience

   My goals for research experience currently lie among my Capstone senior design class. This 2-semester class involves the use of developing a medical device from the beginning to the end. This process involves the entire engineering design process which includes establishing a group, obtaining customer needs, setting specifications, generating concepts, and developing a prototype. The research involved during this project will allow me to gain a great understanding related to migraine therapy treatment. The timespan of this goal is finish by May of 2019, which is when the entire project is due, and the biomedical engineering project symposium occurs. Besides, the development of a medical device I have previous research experience from working as clinical aid research at the University of Arizona. This was a neat opportunity in collaboration with Banner Sun Health Research Institute. For this project, I had the opportunity to interact with patients with varied cognitive impairment levels. These individuals either were normal, moderate, or severely diagnosed with a cognitive impairment. During the project, a sensor was used to determine the angle between the upper extremities. The research
participants were then asked a series of questions to determine if their cognitive impairment had an influence on being able to multitask in a variety of activities ranging from counting backwards while moving their arm in a consistent manner.

5. Industrial/Work Experience

As far as work experience I have worked a variety of places. Most recently I was able to take part in an internship at Wells Fargo. This internship occurred over the summer and I had the opportunity to interact with a variety of departments at Wells Fargo. This allowed me to be assigned a variety of projects that provided both business and technical skills. For example, I was building relationships with many managers in regard to building various reports. From the technical perspective, I was able to take lead on many projects that provided an insight on data analysis, models, and even developing macros in Office. My previous work experience has included being part of a clinical internship with the University of Arizona and Banner Sun Health Research Institute. There I gained experience interacting with study participants in a clinical setting and using sensors to collect data. The data was then organized, analyzed, and submitted into appropriate databases. Before that, I worked as a legal assistant an immigration and criminal law defense office. My tasks there involved answering the phone, filing government forms, writing legal motions, and researching plenty of immigration and criminal law. Before working there, I worked at Lowe’s Home Improvement as a customer service associate in the paint department. My tasks there involved providing a high level of customer service, ensuring store shelves were stocked, and creating custom paint orders in a timely manner. My very first job was at McDonald’s where I moved my way up to be a department manager. My tasks involved making sure the restaurant was generating profit, using store business tools to analyze business trends, provide training, and ensure the restaurant was operating at maximum efficiency during my shifts. These positions have taught me many skills related to the workforce especially working as a team and having responsibility. My current role is working as a student research aide at Arizona State University. This position has provided me with effective team leadership, being efficient, and paying attention to details. My goal within the next semester is to find a job that allows me to study at the same time that gives me the opportunity to gain industry skills.

6. Community Service

Over the past year, my community service has been to help the ASAP-METS program at Arizona State University. In the next school year, it is my goal to contribute around 20 hours to the program. I also want to expand my community service to include the local community once I graduate from college. I plan to volunteer at the local children’s hospital within the next year. If I have time I hope to also help the local food banks. I want to these things because I think it is important to provide back to the community.

7. Personal Mentoring Plan

Having a mentor is important for a variety of reasons. For instance, they may provide guidance for accomplishing long term goals. Along those lines, mentors also can pique at one’s personal interests and find interesting ways to challenge one’s mind to be more critical thinkers. Mentors are also useful to ask questions. These questions can range to their own research experiences, career goals, and even personal life. These kinds of questions can vary and depend on the kind of relationship that exists with the mentor. This can be helpful to obtain advice to ensure one is making the right decisions whether that is academically, financially, or regarding one’s personal life. Important questions to ask could be
how to get into research, why continue studying, ways to pay for school, career paths, and even identify mistakes they would have avoided if they were aware of them.

At my previous employment I had the opportunity to have the office attorney serve as a mentor. This was a unique and rewarding experience because the attorney would answer questions related to entering law school and great advice on being an effective lawyer upon graduating from law school. She provided best practices that would allow for success while attending law school and ways to look for scholarships to help pay for law school. She also was able to take me to court at one point to see an actual hearing in person for one of the office clients. I no longer work at the law office and in the process of completing my degree in biomedical engineering. As such, I have decided to have my mentor be a faculty mentor that can serve as an effective guide towards my senior Capstone project. The Capstone project entails working on a medical device among a group of seniors. Because the project is geared towards providing neuromodulation to treat migraines the team has decided to work with Dr. Helms-Tillery. He has provided us with great support, thus far, for the successful development of our project. The items discussed with him thus far have included

In the future, my plan is to find a mentor in the law field once I start attending law school. I hope to continue observing from a great attorney and learning from them. Because my plan is to work in the immigration law field, my hope is to work with an attorney who works in an immigration law office. Ideally, I would like to expand my knowledge on business immigration law. The office I previously worked at did all immigration law except business immigration. As such, it would be beneficial to have a mentor with experience in that field. This would be great in the long term to have comprehensive guidance in that field that enable me to have a successful career.

8. Economic and Financial Goals

My short term economic goals are to pay off all my debts that I have accumulated along the way of my undergraduate and graduate degree. So far, I have accumulated $20,000 in student debt to complete my undergraduate degree. Since I live at home, I needed to buy a car to commute back and to from school and still owe a balance of $6,000 on the car loan. Throughout my undergraduate degree I have worked to pay off my car and to have some money for other school essentials. My goal is to work my way through law school so that I can take advantage of tuition reimbursement and finish my law degree without getting further into debt. Because I plan to work immediately after completing my undergraduate education I plan to start repaying my student loans at the same time. Within a year after graduating my car loan will be completely paid off and the money I used towards paying the car will be used towards paying the student loans instead. This means that I will be on track to pay off my student loans in about 4 years, which makes my plans reasonable.

In the long term, my goal is to own my own law firm. It has been a long-term vision of mine to own my own law practice where I am helping other people in need and where I am able to provide back to the community. This would also allow me to hire works and even mentor those who have long term goals to also be lawyers. In addition, I plan to own a few rental properties. While I pay off my student loans and finish my law degree my goal is to save a down payment to buy a home at the right price that can be used as a rental property. The goal is to save up more money and do the same to have two rental properties owned. Thereafter my goal is to custom build my home in an area that is close to public transportation and makes financial sense. These plans are viable and if planned correctly will come true.
9. Graduate School

Although I don’t consider going to graduate school in area related to biomedical engineering as useful to me, I have decided to further my education by attending law school. Attending graduate school is important to me because it opens a variety of career paths that are not available with only having a bachelor’s degree in engineering. Completing a graduate school also provides more qualifications that makes an applicant a lot more prepared and competitive in the job field. With a degree in law, the opportunities are endless. For example, with an engineering background there are opportunities to practice patent law, become a corporate lawyer, or even open a private law firm. Therefore, my higher education goals include attending law school to become a lawyer.

As such my goal is to pursue a degree in law degree in graduate school. Doing this would allow me to get exposed to a variety of topics to be a successful lawyer. In addition, I would be able to network with a lot of people who are also working towards being a lawyer. Because law school is not directly related to engineering, there is no 4+1 accelerated MS program to take advantage of. In addition, my plan is to attend law school part time which would push me to complete my degree in four years versus the usual three.

To prepare for a law school I have some experience interpreting law from previously working as a legal assistant in a law firm. The opportunity allowed me to analyze case studies and get a sense of working with law. In addition, I have started taking business courses to obtain a minor in business that will give the skills to be a successful business owner. To facilitate my entrance in to law school, I have also completed my LSAT examination to be a competitive applicant. My education probably will end with a Juris Doctor degree in law. I don’t plan on furthering my education with a Ph.D. in Engineering. Along those lines, my goals are not having an academic career as a professor.

10. Long Term Professional Goals

My long term professional goals are to be a practicing immigration attorney. As such a detailed job description as a legal attorney would be to think critically while studying a broad and diverse legal case. In addition, I should be flexible to adapt to changing court hearing or changes in law. At the same time, it’s important to show compassion, empathy, and from important relationships with clients. It would also be my responsibility to stay up to date on all law changes and proposals for that matter. Along those lines, it would be extremely important to devote significant time and attention in continuing my law education to maintain my state bar.

My other goal is one day own my own legal practice. Ideally, it would be great to find another attorney to share ownership of the office with. This could be to alleviate responsibilities to one another in case one has to be out of the office for some reason. Along those lines, it would be important to get accustomed to good business practices to be successful.

11. Life Long Learning

The world is constantly changing which influences all aspects of our life. This is no exception to aspiring attorneys. Congress is always debating legislation that can have a great impact on the nation’s laws. The Supreme Court is always making interpretations of laws that can change the constitutionality of these laws. Because of this, attorneys must constantly keep up to date on law changes, and big case precedents. Therefore, my goals are to devote myself to lifelong learning related to a career in law. Specifically, as a practicing lawyer I will attend Continuing Law Education (CLE) courses to stay up to date.
Overall, my professional development plan is to complete my undergraduate degree. Upon completion, my goal is to obtain employment in San Francisco with an employer that offers tuition reimbursement. At the same time, my plan consists of starting Law School at the University of San Francisco. In the long term, my goal is to return to the Phoenix area and open my immigration law practice.

Besides my professional and educational goals, I also have personal goals I would like to accomplish. In the process of obtaining my career goals I want to continue incorporating a healthy lifestyle. This will allow me to ensure my personal wellbeing and be able to live life to the fullest. In addition, I would like to travel the world and experience different cultures and see a different perspective to life.

Other skills and hobbies I hope to one day accomplish are to learn more about sports. For so long in my life I have focused on my education that I know little about sports. My plan is to learn more about outdoor sports like skiing, snowboarding, camping, and even rowing. These are experiences that my curiosity keeps point out at and I want to learn how to do these things. My goals are to visit Colorado often and learn about these great activities. At the same time, I want to travel the world and explore various cultures and cuisines.

In summary, my plan is to finish my bachelor’s degree in the Spring of 2019. Over the summer, I would move to San Francisco and start law school in Fall of 2019. At the same time, I would also start my employment. If all goes well, I would graduate with a law degree in the Spring of 2023. Because my plan is to own my law office, shortly after, I would move back to the Phoenix area. I would work for a few years as an attorney before opening my own legal practice.

12. Family Planning

Because school has been my main priority while completing my undergraduate education I have put off getting in to a relationship. My goal is to meet someone who has similar interests as me and likes me for the person that I am. It would be great if this person also has similar goals for the future as me which allow us to get along even better. I hope that the person I find to develop a relationship with also wants to start a family. It would be nice to have two kids and teach them how to use what life gives them to be successful. At the same time, it would be important to decide many things together like number of kids, where to live, how invest, and prepare for retirement.

13. Travel Plans

Traveling is on my list for the future. This provides a way to disconnect from the daily life and gives an opportunity to experience different cultures. I like sightseeing, potentially getting lost, and discovering new places while traveling. Any stress I feel goes away and I feel rejuvenated to start any projects I left pending before travelling. Some places I would like to visit are Italy, China, Washington D.C., and Chicago. I would want to visit Italy because I am fond of the cuisine they offer. I would also like to visit China because of its unique culture. Visiting Washington D.C. is likewise on my to do list because of our nation’s history and my fondness for the lawmakers process. Lastly, I would also want to visit Chicago because that is where my dad grew up. While growing up he would always talk about all the places he would visit as a kid. Unfortunately, I never got a chance to travel with him to Chicago. I hope that I can visit these places soon and would like to visit the places in the United States during my school breaks. Once I graduate maybe I’ll take a trip to China and cross it off my to do list. I would like to visit these places either with my family or friends. If I’m married I would obviously go with spouse. I have even though about living abroad for some time. My parents own a home in Mexico and I have been
considering living there for some time. I’m even considering going to medical school in Mexico then moving back to the United States. Although it’s a great idea I have never thought of contributing or lending my talents to a third world nation. As such I don’t think I would serve in the Peace Corps either.

14. Investment Plans

Although I don’t have any investment per say I have started preparing for retirement. I currently have an IRA account. Once I have an established job I plan to increase my contributions and take advantage of a 401k if my employer offers it. In addition, I hope to save money to buy a house that I can rent out and one day bring extra income to my household. If the money is there and I gain knowledge I also hope to have some money invested in the stock market. Something minimal where I wouldn’t miss it if it’s lost forever. I also have plans to own my own business, which would be a private law practice.

15. Contingency Plans

A back up plan is important, and I feel like I have setup back up plans across my entire career plan. For example, my main goal is to obtain my undergraduate degree in biomedical engineering and go to law school. However, if that doesn’t occur I am also planning to obtain a minor in business. This makes me more competitive and I could even work with a finance company in case engineering or doesn’t work. In back up of that idea I also have taken almost all the prerequisites required for medical school. Although I currently work as on campus, my plan is to obtain an internship that would allow me to gain industry experience related to engineering before graduating. These backs up plans are not permanent, and I feel that they are constantly changing depending on how the current semester is going.

16. Philosophy of Life

My family is extremely important to me. Wherever I am I always think about my parents and siblings. I think this is because of my culture and the upbringing I had to be close with my family. Of likewise importance is my faith. I am happy Catholic individual, I think this is also because of my culture and upbringing to be a devout Catholic. Because of this I like to live my life with honesty, respect, and integrity. I also live by the golden rule. Whenever uncertainty hits I pray to God to give me strength to be able to move through difficult times and create opportunities that will be beneficial to me. I also like to take long drives to think things out and avoid making crazy decision I may regret later. To help cope with stress I keep myself active and like to work out. This keeps me in better shape than I once was. As someone who was overweight I attempt to take care of myself and watch what I eat to make sure I am a healthy individual. Although not as important, I like to have fun and may even be a thrill seeker. I really like to ride roller coasters and hope that I can go to an amusement park soon. Making money is also important, if we are alive we need it to survive. There are people not as fortunate who struggle, and I feel like it’s important to give back to them.

17. Other Issues

At the moment, my only issues are taking care of the doubts in regards of this plan. Sometimes, I question if I have truly thought out my life goals and whether this places me in a position I truly want to be. Only time will tell how my interests have evolved and whether the correct choices were made.
18. References

“Biomedical Engineering, MS.” *Arizona State University*, webapp4.asu.edu/programs/t5/majorinfo/ASU00/ESBIOENMS/graduate/false.

“Engineering.” Fulton Undergraduate Research Initiative (FURI), furi.engineering.asu.edu/.

“School of Law.” *University of San Francisco*, www.usfca.edu/law

The Technology of CRISPR & It’s Increasing Implications

1. Technical Area Chosen

The possibility of editing DNA in order to ensure the wellbeing of an organism provides a window of opportunity that revolutionizes the future of medicine. Scientists at the University of California Berkley, MTI and Harvard have successfully developed technology that allows for the precise editing of genome systems (Netburn 2017). This recent breakthrough is possible through the means of Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) which involves RNA and Cas9 proteins. The RNA is programmed to match a specific gene sequence which is the target subject and inserted into a cell along with Cas9. The RNA binds to a specific of the DNA and the Cas9 then breaks the DNA strand at the identified target. The cell then initiates the DNA repair process which can then use pieces of DNA preinserted to rewrite the genetic code.

![Figure 1. Image demonstrating the DNA Repair Process (CRISPR 2018)](image-url)

2. Importance of Chosen Area
As Netburn explains this technology has already been used to rewrite genetic mutations that causes sickle cell. In addition, this disease has been used. This technology can be applied to any organisms and has allowed for the corrections of mutations that leads to other diseases such as sickle cell. This also allows the gene makeup of other organisms to be altered such as mosquitos that fight malaria and make plants grow with an increased resistance to disease and drought. This technology is already used for the application for modifying yeasts to make biofuels and to improve crop strains. (CRISPR 2008)

**CRISP-Cas9 AND GENOME EDITING**

![Diagram of CRISPR process](image1)

**Figure 2.** Image demonstrating CRISPR Process (CRISPR 2018)

3. **Problem to be Pursued**

CRISPR is definitely a newer technology that is revolutionizing the medical field. As with any technological advancement there is a potential for negative effects that are unknown and need to be studied. The FDA recently cleared the CRISPR process for testing on human use, some patients such as cancer patients will now be able to have the DNA corrected on mutated cells. An interesting article by Sharon Begley at Stat News raises potential issues that could arise from using CRISPR/Cas9 genome editing technology. Among the potential issues that could arise by using this technology are:
1. Incorrect DNA Sequence Editing
2. Errors with DNA editing Process
3. Out of Control Virus Use and Virus Lifespan
4. Money May Overcome Data Integrity

The potential issues that are mentioned by the article are interesting nevertheless and important questions that must be answered to ensure the efficacy and the safety of using CRISPR technology. (Begley 2016)

In another research article it was reported that E. coli cells treated with Cas9 experienced abnormal cell morphology. (Cho, S, et al) This raises additional questions of whether Cas9 is a safe tool on human use if it’s safety is questionable on E. coli cells. As such is it’s important to research the potential issues that could arise from using CRISPR as a genome editing technique.

4. Importance of Problem to be Pursued

Mutations that are occur in the DNA of a cell can have detrimental effects. When a mutation occurs, and the cell starts replicating the cell will start to copy the defects and make multiple cells with the same issues. Since DNA is the genetic blueprint for the body to code for specific proteins and function, any mutations in the DNA code as a result can cause for the incorrect coding of proteins and essentially cause problems with proper cell function and result in issues with the body. (DNA and Mutations)

The introduction of the CRISPR gene editing technique changes issues related to DNA mutations. This technique creates and endless amount of opportunities that can reprogram DNA to remove any abnormalities that can cause medical problems. This is revolutionary as it would change the way medical treatment occurs at the moment. For example, cancer cells can be reprogrammed to stop the uncontrolled replication of cells. In another application there is a possibility of removing the HIV virus from cells and essentially create a cure for HIV/Aids. There are many more applications to repair of cells through DNA editing and more that are being researched.

Although current research methods show promising data in regard to CRISPR and even applications currently in used for mosquitos and crops there are little known effects on long lasting impacts. One component of the gene editing technique involves the use of a special enzyme referred to as Cas9. However, there is no indication how long the enzyme will continue working cells one introduced into the target cells. As such questions arise whether how long the enzyme is active and whether or not this would target cells that intended to have DNA edited. On the other hand, there are questions related to the actual editing procedure. One possibility for DNA to be edited at areas not targeted for repair or whether there is failure for DNA to bind together incorrectly during the repair process. Answers to these questions are crucial for the viability of the future for CRISPR technology.

These topics are important to research because such issues could end up causing more harm to the human body. For example, incorrect DNA editing can cause unintended DNA mutations that can lead to other issues. As such it’s important to conduct experiments that allows the data capture of unintended DNA sequence changes. The observation of these
differences could then be used to obtain statistical information and determine if this would indeed be safe for use on actual organisms.

5. Relevant Career Prospects

The CRISPR technology was discovered at institutions around the country such as the University of California, Berkeley and the Broad Institute in the east coast. This creates future careers prospects related to research. Gaining knowledge related to the CRISPR technology enables the possibilities to perform research in an academic institution. In addition, there are many private sector companies that are interested in learning more about the prospects of CRISPR technology. As such many companies are researching potential applications in the medical field. This is another source of potential employment and the opportunity for a career path.

This technology has the potential of receiving clearance from the Food and Drug Administration to treat a variety of medical conditions. Once that occurs there will be a huge demand in the health care industry for engineers with CRISPR knowledge to develop effective treatment options for a variety of patients for a broad spectrum of medical disorders.

Due to the origination of such techniques and the patents requests behind the initiation of the CRISPR technology. The individual research findings could also be studied along with research legal cases related to patent law to learn about the legal issues that could be faced with such technology. This provides an alternative career path that nurtures a career in the legal field.

6. Approaches: State of the Art

Current approaches only focus on the success of the gene editing technique. As shown in Images 1 and 2, included above, they demonstrate the technique involved for CRISPR technology. So far promising results have been found to correct these issues. This is advantageous in many aspects as the technology has already been developed to change some of the issues around the world. For example, crops resistant to bacteria and drought have made the growth of plants available where it was previously not possible. On the other hand, mosquitoes are being developed that are resistant to malaria. This is revolutionary because this eliminates a line of transmission for the malaria disease into human beings.

However, current techniques have not been able to determine the potential side effects of using this technology. There is very little known to understand whether the use of CRISPR affects other gene sequences and its potential side effects on the human body. It’s also interesting to note how using CRISPR would interact with evolution for the diversity of future human beings.

One similar study that was conducted by nature Biotechnology found that the use of CRISPR-Cas9 would cause “off-target DNA damage” (The Safety of CRISPR). The study as reported by Nature Biotechnology provided the use of Mice whose genome was edited using CRISPR-Cas9 procedures. This was done by extracting cells form the mouse and growing cultures of the cells and analyzing the DNA using a PCR machine (Kosicki). The use of the PCR machine allowed the sequence of the DNA to be mapped out before the edits were made and
after the edits. This allowed for a comparison of the actual base pairs among the DNA before the edits and after to determine if any changes were made. The data from this study helped demonstrate that the use of CRISPR-Cas9 may not be safe to use at its current standing. This was done by observing different base pairs of DNA where changes should not have occurred. As reported in Nature Biotechnology, although the cells were being repaired the DNA segments experienced “large deletions and complex rearrangements.” This shows that the studies previously conducted show that CRISPR may be unsafe to use.

The pros of the experiment conducted by Kosicki include the identification of errors in DNA using CRISPR-Cas9 (Kosicki). Other pros identified among the previous studies include the identification of the error in mitotically active cells that can have “pathogenic consequences.” At the same time, I think the study could have gone further to develop more information. The cells were only studied after placing them in a dish and growing cell cultures. The study could have expanded by inserting the edited cells into the cell and determine if the edited genome was effective in correcting previously identified health issues. In addition to the cons listed thus far, it would be great to see what other havoc the introduction of these cells would have caused in the mice’s immune response. It’s understood that it’s better to understand these effects outside of an organism before inserting them into an animal due to ethical concerns. However, other reports show that this technology has already been in use among patients in China (The Safety of CRISPR). Nevertheless, the previous approach identified by Nature Biotechnology has both pros and cons that make the results of the study useful.

7. Your Approach to the Problem

During my research project I plan to study the potential issues related to CRISPR and Cas9. Specifically, I would like to learn the specific statistics that demonstrate the actual possibility of having problems related to genome editing. This can be done by conducting a DNA sequencing technique before conducting DNA editing. This sequence can then be used to determine if there are differences to the edited DNA strands after undergoing CRISPR. Thereafter statistical analyses can be run to quantify the potential of error occurrence.

In order to gain a deeper understanding of CRISPR-Cas9 technology works. It is my goal to conduct an actual genome editing experiment. This experiment would be completely safe as it does not employ any living organisms, besides the use of E. coli bacteria cells. After conducting an internet search there was an economical genome editing kit that allows users to edit the DNA of bacteria cells. In particular this kit allows users to see how the mutation of a DNA sequence can allow these bacteria cells to grow in a manner that allows them to grow in media that they normally would not be able to grow in. In addition, the study would allow gene sequencing to be completed using a PCR device. Using these techniques would allow for an analysis of the DNA sequence before and after the application of CRISPR-Cas9 to change the bacteria’s DNA. This would also provide a way to determine if unwanted DNA changes occurred during the experiment.

8. Rationale for your Approach
Obtaining a DNA sequence before and after conducting DNA editing provides useful information. The sequence before the strand provides knowledge of the original DNA sequence and allows for the identification of the targeted sequence. Obtaining a sequence after the DNA sequence allows for the comparisons to the strand before the editing was conducted. This allows for the verification that only the intended DNA sequence that was mean to be altered actually changed. This would also state if areas not intended to be changed did change or if there were any other alterations during the technique. Due to the potential of differences statistics can then be used to quantify the actual values of the possibility of seeing such changes in DNA sequences.

This study is important to determine if more damage than good arises when changing human genome. As reported by Genetic Homes Reference, CRISPR-Cas9 provides hope to many individuals who are suffering from “single-gene disorders such as cystic fibrosis, hemophilia, and sickle cell disease” (What are Genome Editing). The report also mentions that this technology can one day be useful to prevent complex diseases that include cancer, heart disease, mental illness, and human immunodeficiency virus (HIV) infections. Because the world population is constantly growing, the number of individuals with these diseases is also always growing. Knowing the efficacy of this treatment method is important. It would be no good to use this technology if during the editing of DNA and incorrect sequence is changed that causes other diseases like cancer (The Safety). Knowing these effects is important to determine whether or not it is safe to use on humans.

9. Risk Reward Assessment

The chances of success for this project are pretty high. This is because the project employs the use of a kit that provides specific instructions on how to apply the CRISPR-Cas9. This means that as long as the instructions are followed, the equipment is functional, and due diligence is placed beneficial data will be obtained. There is room for failure because the bacteria kit requested could be defective, equipment may not be functioning correctly, or the specimen could be contaminated causing error in the data obtained.

This project provides a greater understanding of how the Cas9 enzyme works to snip out issue DNA and then use CRISPR to edit the DNA to repaired sequence. This research project would provide expanded knowledge to areas related to DNA, RNA, cell damage, cell repair, and statistical analysis. Some potential issues in the research is having difficulty obtaining a concise DNA sequence before and after the genome editing technique.

Nevertheless, as issues arise I suspect ways to overcome them. For example, if it’s not possible to run sequencing or editing techniques, I plan on reaching out to institutions to obtain DNA sequencing for their research and conduct statistical analysis based on those strands. Additionally, as I take more courses to biomedical engineering and conduct further research regarding to CRISPR new connections can be made that can help improve my research proposals. There is always the potential of not being able to obtain successful results which in itself proves to be successful by providing an effective learning experience.
It is expected that the completion of this experiment will provide a wide range of skills and knowledge. Just based on the fact that the experiment provides a way to change DNA means that a comprehensive skill related to DNA in general will be gained. Because there are many processes involved through DNA replication, the involvement of the Cas9 bacteria to use CRISPR will also provide a deeper understanding of how bacteria would be used to hang on to sections of DNA to change them. At the same time various DNA sequencing skills would be gained. This would be gained through the use of a PCR machine. This machine would also provide for a sequence to be obtained before and after altering the DNA. The before and after sequences could then be analyzed which would provide further analyzation skills. Because the cells would need to be cultured on petri dishes, additional skills would be gained that effectively teach proper lab handling techniques.

In addition, future research from this opportunity would allow me to hopefully learn how to program the actual DNA targets to edit the DNA for. This would allow me to analyze different DNA sequences that potentially cause various diseases. This has the potential of even coming up with a special CRISPR-Cas9 technique to solve a medical issue.

10. Preparation to Date

A majority of the biomedical engineering courses provide a fundamental foundation that is helpful for the success to the understanding of the CRISPR technology background and applications. Among those courses are:

- BIO181 – General Biology I
- BIO201 – Human Anatomy/Physiology I
- BIO202 – Human Anatomy/Physiology II
- BME322 – Statistics for BME

These courses have provided the necessary knowledge to be able to perform the experiment successfully and gain valuable knowledge and experience a learning experience.

Among other course I have completed are mathematic courses ranging from Calculus I to Differential Equations. This provides the ability to create models that represent the data from the experiment and use different techniques to interpret or analyze the data.

11. Special Relevant Skills

To be successful in this project a variety of relevant skills are required. For example, it is crucial to be able to work independently to be able to stay on task. It is likewise important to have effective communication skills. This will be beneficial in being able to write research findings and provide an effective presentation. Previous experience with academic research is also important to be able to learn about previous research techniques and learn to apply gained knowledge as needed to new project.

In addition, normal lab skills are beneficial along with computer usage and data analysis. This will be helpful in conducting the experiment, collecting valid data, analyzing data, and compiling research findings in a final report. Another skill that may be helpful is fluent knowledge in the Spanish language. Upon potentially publishing, the research findings can be
published and presented in both the English and Spanish language. This may provide useful
 critique from scientists around the world who are conducting similar research.

12. Required Resources and Budget

The essential resources needed to conduct this research project involves the basic lab
equipment that can be found in the basic biomedical engineering labs at Arizona State
University. In order to gain essential knowledge related to CRISPR technology, sequence DNA,
and analyze the data extra materials will be needed to conduct the experiment successfully. As
such, CRISPR kits were found to successfully run the experiment. This research would only
require one kit to perform the DNA editing technique. This kit is available as a DIY kit from a
company called Odin has a price of $159.00 and includes sufficient material to perform the
CRISPR part of the research. (“DIY...”) To perform the appropriate sequencing of the DNA
before and after a sequencing kit will also be purchased. As such a sequencing kit from
ThermoFisher Scientific and has a cost of $330.00 The kit has the potential to run 100 reactions
which should be more than enough material to conduct the sufficient amount of sequencing
needed. (“BigDye...”) As such it’s estimated that a budget of $600.00 would provide the
necessary materials to conduct the research and also have some back up funds in the case
additional materials are needed. Other computer resources such as Microsoft Office, MATLAB,
and SPSS for data analysis are readily available at the Arizona State University campus.

13. Timeline

My research for the CRISPR comparisons are spaced out over a semester of 16 weeks.
The specific components during the study are research, experiment planning, conduct
experiment, compare data, and create a final report. As shown in the Gantt chart below 3
weeks have been devoted to researching CRISPR technology. There after 5 weeks are assigned
to planning an effective experiment which is then proceeded with performing the experiment
over a span of 8 weeks. Following the experiment 6 weeks will be used to compare the data.
Upon analyzing the data 4 weeks will be used to create a final report. As seen in the chart, the
tasks overlap one another so that adjustment can be made to the project as needed.

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14. Future Plans

The revolutionary CRISPR technology brings an interesting case related to the legal aspects of patent rights. The research behind CRISPR was conducted at the University of California, Berkeley while The Broad Institute was conducting their research related to CRISPR. Each institute respectively submitted patent requests on different claims. Professor Doudna from the University of California submitted patent rights based on CRISPR technology could be used on all cell applications. On the other hand, the Broad Institute submitted patent rights after the University of California on the claims that the applications were only for human use. This makes the case interesting because the Broad Institute asked for a speedy review of their patents. An ongoing legal battle has now ensued to determine who deserves the rights to the technology behind the actual CRISPR techniques. (Buhr 2017).

My personal experiences and my interest in puzzles brings a vast amount of attention to this case. As such my future career goals are to pursue a career in law and potentially practice patent law. Doing so would allow to gain a deeper understanding behind the respective patent filing, research notes, and potentially be able to determine who truly deserves the patent rights. To prepare for my future endeavors in a law related career I have taken steps to ensure my candidacy is competitive to enter the field.

My short-term goals are to complete my degree in Biomedical engineering, while at the same time pursuing a minor in business. So far, I have taken many technical classes that demonstrate different techniques and approaches to biomedical engineering that relate to biomaterials, signal processing, product design, and FDA regulations. At first glance, this may seem like it’s irrelevant to a degree in the law field. However, these classes have engaged and instilled the engineering process with provides a logical way of thinking that prepares the mind for a field of logic such as law. The classes have provided the skills and importance of understanding the multiple steps and documentation that is required to all aspects of engineering in general. As such understanding the documentation and scientific background of technological advancements is important to be able to make the right interpretation when it comes to law in general and especially cases related to patents.

To grasp a better understanding of how business, make decisions and the reasons behind them I am pursuing a minor in business. The classes involved to obtain a minor involve accounting, marketing, advertising, and financing basics. These classes will provide a different
perspective of other issues relevant to law and engineering. Broadening my knowledge to include both engineering and business increases my ability of being accepted into law school.

From the engineering perspective, I have planned to take courses related to biomedical instrumentation and capstone product design. Biomedical instrumentation provides knowledge related to the various tools biomedical engineers use. In this course the opportunity will provided to take the skills learned and build an actual device that functions. In addition, the capstone product design incorporated all the skills learned thus far to create a medical device. This will be a challenging and rewarding course as the entire engineering process will be covered for our medical device. This will bring the skills related to business needs, problem solving, and documentation to great use and growth.

Upon graduation from Arizona State with my bachelor’s degree my plans are to attend law school in the evening. Ideally, my goal is to have a normal day time job that supports my personal development. This could have the benefit of having tuition reimbursement that would help cover law school expenses. It would be neat to work in a biotech company as an engineer while pursuing a law degree. Once I receive my law degree I could potentially shift my position from the engineering area to the legal area of the company. This would allow me to gain industry experience while gaining legal knowledge to be a successful lawyer within a company. However, if aid is not available the income I make as an engineer should be sufficient to work and pay my law degree as I go to school and complete my degree.

A personal goal of mine has always been to live in San Francisco. As such I have applied to the University of San Francisco to pursue a law degree. The school has a class profile with a 75th Percentile GPA of 3.58 and an LSAT score of 158. (Johnson 2018) As such I plan on placing a great effort into my courses to be able to obtain a GPA close to that and thus have high prospects in being admitted into their law program. In addition, I have begun studying for the LSAT through online prep course, textbooks and practice exams. I am certain that with effort I will be able to accomplish my dreams.

In the meantime, I also plan on joining a law club at Arizona State University. This will allow me to meet new people and expand my network to include other prospective law students. This will also allow me to gain a different perspective of why other students want to obtain a career in law. Here, I also hope to take part in various community service projects and learn more about important legal cases that are shaping the legal system. In my spare time I hope to read about precedent law cases that revolutionized the intemperance of various laws and the effects it has in various categories.

Lastly, I also have completed a summer internship at Wells Fargo Des Moines, Iowa. This internship strangely enough is not directly related to engineering but does involve some level of data analysis and problem solving. The position is for a Consumer Lending Intern which involves financing. This position provided me with many important skills for a career and potentially obtain a job with Wells Fargo in San Francisco upon graduation. This could be the beginning of a lifelong career with Wells Fargo.
15. References


DNA and Mutations, evolution.berkeley.edu/evolibrary/article/mutations_01.


Organ Regeneration

As a student studying biomedical engineering it’s interesting to note that there are a variety of technical areas that are available to specialize in. For example, one area of biomedical engineering may focus on creating insulin pumps that helps diabetic patients manage their insulin level while other areas may help improve the design of prosthetics. One area that is quickly growing within biomedical engineering is the stem cells to solve a variety of problems related to the human body. One area of stem cell research that is extremely interesting is the use of stem cells to regenerate organs.

The potential of using stem cells to regenerate organs is a revolutionizing idea that would change the current treatment methods for failing organs. Although current methods exist to treat issues related to organ failure, they may not be easy to access in a timely manner. For example, many times patients who need an organ transplant may have to wait many years before they are able to take advantage of an organ transplant. This makes the possibility of patients dying while they make their way up the waitlist. Statistics from ten years ago demonstrate that 31% of those waiting on the kidney transplant list had passed away while waiting for a kidney transplant. (Casingal, V, et al.). Another treatment that is currently available to treat kidney damage is the use of dialyses. Dialysis usually occurs multiple times week to ensure that blood is properly filtered.

Finding a way to effectively repair or replace a human organ through the use of pluripotent stem would help solve the problems related to damaged body organs. The main problem that needs to be studied is whether or not stem cells can be used to repair or grow damaged organs. In researching this task, it would be important to also learn which pluripotent stem cells are best for the task and ways that successfully encourage the development of a fully functional organ, if at all possible.

The idea of using stem cells to regenerate organ growth revolutionizes current treatment methods. Current research to the use of stem cells demonstrates the potential to regenerate organs to replace failing organs. Such innovations would mean that there would be less need for organ transplant and other treatment options. There is an opportunity to reduce and even eliminate the organ waitlist for
individuals who lives currently depend on being able to receive an organ transplant in a timely manner. Other individuals would also benefit from having to receive other types of treatments such as obtaining dialysis multiple times a week. This would provide a great access of comprehensive and reliable healthcare to a variety of individuals. Overall, people lives would improve in relation to health care and they would also have another chance at life. This ultimately means that people would not die while waiting for an organ transplant.

Stem cell research is an interesting topic that is currently being studied by a variety of companies and universities that bring many opportunities. Some example of companies that are currently studying stem cell for various biological purposes include Cynata, Regeneus, and Johnson & Johnson. The use of stem cells among each of the companies differentiates through their specific research methods. Cynata is an Australian based company whose research focuses on the use of stem cells and regenerative medicine. Cynata focus on creating therapeutic products that depend on the use of mesenchymoangioblasts for the treatment of osteoarthritis, Crohn’s disease, and other heart diseases. Regeneus is another Australian based company that focuses on creating therapies that treat health issues related to osteoarthritis, cancer, and skin wounds. On the other hand, Johnson & Johnson is a United States company that focuses their stem cell research for the purpose of treating Type 1 diabetes. Although these are just a few companies there many more companies located around the world that also conduct stem cell research. Besides various companies many professors are studying stem cells in their own laboratories throughout various universities around the world. This means that there is an opportunity to study the wide range of uses of stem cells in a variety of settings. Their opportunity to have a career path at a company. The opportunity also exists to conduct research at a local university while working with other professors while also continuing an education at the graduate student level.
One example of successful stem research for the use of growing an organ is from the research conducted by Tung-Ling Lu and colleagues at the University of Pittsburgh School of Medicine. Their current research techniques allow for the creation of a personalized human heart. The heart is essentially grown by taking a mouse heart, decellularizing it and placing stem cells that proliferate into cardiomyocytes that eventually contract. The hearts were prepared for decellularization by first freezing them, and then thawing the hearts. The hearts native cells were removed, decellularized, by connecting the heart to a perfusion pump perfusing a solution of deionized water, phosphate-buffered saline solution, and ethylenediaminetetraacetic acid. (Lu, Tung-Ying, et al). After this stage the heart was decellularized leaving behind the extra cellular matrix. Cells were then inserted into the heart matrix by creating embryoid bodies. The emboid bodies to be inserted into the decellularized heart matrix were prepared by taking induced pluripotent stem cells and adding bone protein, and growth factors. The specific mixture of proteins and growth factors induced a high rate of proliferation of the cells to have human cardiovascular lineage. The harvested cells were then introduced into the mouse heart extra cellular matrix through a perfusion method with nutrients specifically meant to encourage the re-endothelization of the heart.

The image on the left demonstrates the various phases of the heart decellularization process of the mouse heart from the initial cellularized heart mouse and the final decellularized extra cellular matrix. It was observed that the heart grown developed spontaneous contraction after 20 days of perfusion characterized with a mechanical force and also responsive to drugs. It is important to note
that contraction in this study was achieved by leaving intact decellularized mouse hearts. On the other hand, there are studies were a contraction was not achieved due to a lack of vascular structures. The issue of vascular structures raises an interesting question of whether a specific proteins or growth mediums can be inserted into the heart to promote proper vascularization. Other questions that have come to mind related to study of this experiment relate to the actual function of the spontaneous contractions of the heart. The question now is whether or not the newly grown heart is capable to be programmed to have constant contraction that could have a greater use for human implantation. It is however worthy to note that since human stem cells are used in the mouse extra cellular matrix the newly grown heart actually expresses a majority of heart characteristics related to a human heart.

This technique is very interesting and raises a new research question that expands on the current studies from the same research experiment. The previous discussed study states that after a specific amount of time the cells were then transferred to another stage of the cell preparation prior to insertion of the new heart cells into the decellularized heart cells. (Lu, Tung-Ying, et al). A new possible approach is whether increasing the amount of time in the specific growth factors and protein mixtures would further encourage the proliferation of the stem cells into actual human cardiomyocytes.

My rationale for such approach is because the current study shows that after cells were in the specific solutions after a specified time frame the final results demonstrated a higher characterization of human heart tissue with actual contraction like forces. This is probably because in each of the stages that the cells were in the mixtures they were influenced by the presence of the proteins to actually differentiate into heart cells. Therefore, increasing the amount of time of the stem cells in the mixture of growth media and proteins will further influence the differentiation of the stem cells into heart cells. Whether or not doing this increase the characterization of the mouse heart to a human heart may help further the studies of these applications for actual use in implantation of the human bodies. These
studies can be incorporated into species heart studies such as pigs which would have a more realistic heart size compared to those in humans.

Based on previous studies there is a high probability that the proposed research would be successful. By performing such research, I would gain endless amount of knowledge. To begin with knowledge would be gained related to the proliferation of stem cells. This knowledge would not only be helpful for the use of the growing organs but also for other bodily repair applications. On the same note, techniques would be learned that specifically deal with the mechanisms that ensure cell survival. Other techniques through this research would provide interesting ways to create cell growth scaffolds or foundations by taking an existing organ and turning it into an extra cellular matrix after decellularization. The applications would have many life changing implications for use in the world of medicine.

Learning these skills would solidify any previous education coursework and help increase employment opportunities with companies that are currently focusing on stem cell research. Previous coursework that will play important role in the success of this experiment include biology, anatomy & physiology, biomaterials, chemistry and conservation principles. These courses have provided a framework related to the successful function of cells, effective use of biomaterials to ensure cell survival, chemical properties, and various flow rate properties. Future coursework that will be beneficial in the preparation of such research is transport phenomena.

Other skills previously obtained that would be essential for the success of the research include being a reliable individual, being responsible, and having a strong work ethic. These skills along with the ability to research and communicate effectively would provide an effective combination for successful research. This along with the future skills gained would prepare me for a future related to stem cell research. Those opportunities may be present either with various companies all over the world or with various universities. Nevertheless, this field is something where continuing an education is a must and has to be considered for the further learning of an individual.
References


Senior Design Report

Project: Migraine Treatment Device

Team Member Description of current design work done

Cynthia Crockett

Outside of the design task, my effort for the completion of the project included research on migraines and in-house discussions about potential directions for the device.

In this Design Task, I did several of the parts of subtask 1, including individual explanations of my skills and resume creation. I also worked on Action Item #2, completed Action Item #4, and part of both Action Item #6 and Action Item #7. On top of this I did editing of the document and final document compilation and formatting.

Kasun Daundasekara

To produce our product, we must choose a product development plan. Its product development type is “New product platforms”. Our product development project involves a major development effort to create a new family of product based on new platform.

For this Design task I worked on Task #3, which is focused on selecting a product development plan. To do this we used chapter 4 in U&E, searched for technologies about and the background of migraines, and did the research of current treatment of migraine.

Joseline Valenzuela

This DT cycle, I researched various preventive and treatment methods for migraines. In the process, I discovered technologies which involved stimulation of the cranial nerves. The current devices seem to be effective alternatives for those who do not want to use medication. I also researched ethical concerns associated with our proposed non-invasive device. I also found data that supports the idea that migraine treatments are important to a large section of the population, and that alternative treatments are necessary.

I completed the justification behind the selection of our capstone project, research ethical concerns that might arise, and facilitated the initial contact with a potential mentor. I also did research on worst practices done by [redacted] and reflected on what we should avoid doing as a IPDT Team. I also helped in editing of teammate’s technical writing, as well as citing sources in IEEE format.

Antonio Lopez

There are currently various emerging technologies being used to treat migraines. One of those technologies is the use of transcranial direct stimulation. To better prepare for our future prototype, the technology method was read to gain a better understanding. In addition, I also read the designated chapters from the class textbook.

For this Design Task I worked on the rationale for team formation, creating succinct summary of the product proposal. Along those lines I helped develop our team expectations and consequences. I also assisted in creating the innovation charter, product vision, and mission statement. In addition, I also identified what is trending in the market segment and assisted other team members complete their tasks. Lastly, I helped put the individual Action Items together on a Word Document and help with the formatting.

Design Subtask #1: Selection of BME Capstone Project, IPDT Team, Mentor(s) via U & E Chapter 1-4 Methodologies
Approximately 10% of the worldwide population suffers from migraines and about one-third can predict a migraine because it is often preceded by visual disturbances [1]. The International Headache Society diagnoses a migraine if it occurs at least five times and lasts 4-72 hours without treatment [1]. People who suffer from migraines have similar symptoms, such as throbbing pain on one side or both sides of the head, sensitivity to light, sounds, and sometimes smells and touch, blurred vision and lightheadedness [2]. People with migraine tend to have recurring attacks triggered by several different factors, including stress, anxiety, hormonal changes, bright or flashing lights, lack of food or sleep, and dietary substances.

Current treatments include prevention of an attack and the relief of the symptoms. Some preventative measures are lifestyle changes, such as sufficient sleep, timely meals, exercise and stress reduction. Usually the relief treatment options include the use of sumatriptan, ergotamine drugs, and analgesics such as ibuprofen and aspirin [1]. The sooner these treatments are administered, the more effective they are. Another technology in the market is by a company called CEFALY Technologies. “Cefaly is an External Trigeminal Nerve Stimulation device (e-TNS) for migraine treatment. A self-adhesive electrode is placed on the forehead and the Cefaly device is magnetically connected to this electrode. Precise micro-impulses are then sent through the electrode to the upper branch of the trigeminal nerve to either relieve the headache pain during a migraine attack (Acute setting) or to prevent future migraine attacks (Prevent setting)” [3]. This device ranges from $349 - $499, is approved by the FDA and is only available with prescription. The third treatment option used to treat migraines is gammaCore. This technology treats migraines and cluster headaches by stimulating the vagus nerve [4].

After learning about the most common methods, which are pharmaceuticals, we noticed that there is a problem of medication overuse, which happens when migraineurs take pain medication in high dosages and high frequency that they began to overuse it. Since it is the most readily available solution, people often do not have another choice. This brought us to think of an alternative preventative and relief treatment that would help those who do not want to overuse medication. Our product idea is a non-invasive migraine prevention and relief device that uses transcranial direct current stimulation (tCDS). Based on research done on tDCS, it seems to be a safe and effective tool for neuroplasticity in migraine. A clinical trial reported that in migraineurs, tDCS was moderately to highly effective in reducing pain intensity (SMD 20.91, P=0.04), decreasing attack frequency (SMD 20.75; P=0.004), and reducing the need for pain medication (SMD 20.64, P=0.03) [5]. Recent research shows that transcranial magnetic stimulation and direct currents are safe and effective to be used as therapeutic approaches for both symptomatic and therapeutic treatments [6]. This would solve the problem of medication overuse by people who suffer from migraines and are searching for a less invasive alternative.

Subtask #1b: Rationale for Formation of Capstone IPDT Team; Behaviors: Project Organization

Ulrich and Eppinger’s Product Design and Development textbook, explains the essential six phases that are part of the development process which include: planning, concept development, system-level testing, detail design, testing and refinement, and production ramp-up. Each of which require a broad range of skills to be successful. As stated in Chapter 2, it is important that members of the team be classified as having a specific function and project they work on an. Working on a function must also
overlap with the project they are working on. Furthermore, the book also states that is important that the members of the group have a several different functions, each working on the development of a specific product [7].

Taking the above information into consideration it was determined that a team of four individuals would bring a broad skillset that allows for specialized functions on a specific product development. The team was formed by identifying potential needs based on the Indigo Assessment. The first individual, [Redacted] was identified with having skills related to analytical problem-solving empathy, diplomacy/tact, mentoring/coaching, and leadership. In addition, her strengths were tuning into the environment, accommodating team balance, leader, firm stance, bring enthusiasm, and helping others win. [Redacted] identified [Redacted]'s behaviors from high to low as steadiness, influencing, compliance, and dominance. The second individual identified was [Redacted] whose top skills were conflict management, teamwork, presenting, continuous learning and flexibility. His strengths were obtaining information, supporting a leader, and having clear expectations. Kasun's behaviors in order from high to low are steadiness, compliance, dominance, and influencing. The third individual identified for the team was [Redacted] whose top skills were presenting, written communication, leadership, empathy, and mentoring/coaching. As such her strengths were praising peers, promoting causes, bringing high energy to research process, being a good listener, and being a methodical and reliable researcher. Her behaviors from high to low were influencing, steadiness, compliance, and dominance. Lastly, [Redacted] was identified as a team member for having top skills in planning/organization, goal orientation, people advocacy, time and priority management, and written communication. His strengths were helping others, asking questions, being a strong supporter, and a good listener. His behaviors from high to low were compliance, steadiness, dominance, and influencing. As such these skills, strengths, and behaviors were a good mix that complement one another. Altogether, these skills create a strong team that ensures the successful development of a medical device. In addition, each team member possesses extensive work experience that brings in additional skills that will be helpful throughout the project.

The identified roles needed for a successful Capstone project were Project Manager, Mechanical Drafting, Electronics Engineer, and Software Engineer. These major roles were assigned based on everyone’s strengths and experiences along with a secondary role. Team member [Redacted] was designated as Project Manager based on her leadership skills and extensive experience as a leader with extra-curricular activities on campus. Her secondary role was identified as Mechanical Drafter due to her previous experience and heavy involvement in using various design software packages. As such her role as Project Manager is to ensure that the proper development is taking place accordingly to designated planning. With a secondary role as a Mechanical Drafter, [Redacted] will help the main drafter as needed to accomplish the team tasks. [Redacted] was assigned with the role of Electronics Engineer based on her prior experience with circuits and a secondary roles in Technical Writing and Quality Assurance. As such, [Redacted] will be responsible for ensuring the circuits components of the planned device are designed accordingly and her expertise will prove to be useful in troubleshooting as needed. In addition, her secondary role will be helpful in ensuring that reports are done professionally and that the product will be safe, effective and high quality. [Redacted] was identified as the Principal Mechanical Drafter with a secondary role in Circuit Design. As such he will be the main person to conduct engineering design on various software packages and aid with Circuit Design. Lastly, [Redacted] as the Software Engineer with a secondary role in Statistical Analysis. As such, he will be
responsible for ensuring that any computer programming or software troubleshooting takes place. The secondary role will help with any data organization or analysis that arises. It must also be noted that these roles can be cross functional and they members of the team have the obligation to help each other as needed.

Nevertheless, it is equally important to mention the various ways to keep team members of the IPDT team accountable. An interesting article from the Harvard Business Review provides many ways to hold people accountable and includes: clear expectations, clear capability, clear measurement, clear feedback, and clear consequences [8]. As such, the three ways the IPDT team plans to hold the team accountable is through clear expectations, clear feedback, and clear consequences. For each task assigned, there should be a minimum amount of effort placed on such task to ensure a high-quality product is delivered that meets a high level of due diligence. Secondly, the team must ensure that clear feedback is provided throughout the entire design process. As such, the team will be honest and clear in providing effective criticism to ensure project objectives are met. Lastly, failure to agree to these terms will result in consequences. The first consequence will entail meeting the capstone team and discuss the lack of engagement and potentially identify ways to correct the issue. At the same time, the lack of quality deliverables will be reflected on the individual’s performance review through specialized reporting. Lastly, if the behavior is not corrected then the individual will face the dismissal from the Capstone group.

Subtask #1c: Recruitment and Selection of Qualified Capstone Mentor(s)

Recruitment of a possible mentor begin at the start of this semester. We have Dr. Stephen Helms Tillery as a possible mentor because of his background in Neuroscience, specifically his knowledge in neural plasticity. We thought this would be a good match based on the links between headaches and neural plasticity [9]. We hope that he can help us figure out if our idea is viable. He also has a background in ethics, which will become helpful when thinking about user needs and how our device can improve migraine symptoms, as well as analyzing possible risks to the user. We have sent an email to set up the first appointment with Dr. Helms Tillery.

Subtask #1d: Completion & Submission of Proposed Medical Device Product Proposal Form

Subtask #1d-a: Capstone Project Proposal Description

Our team is JACKmed Innovations. Our goal is to create non-medicine-based treatments for various medical conditions. The members of our team are

Contact information is listed below:

Cindy Crockett: 801-696-4001, ccrocke3@asu.edu
Joseline Valenzuela: 602-703-6012, jvalen16@asu.edu
The mentor we have chosen is Dr. Stephen Helms Tillery. We are planning on meeting with him this week to discuss the project further. Dr. Helms Tillery is a professor of neural engineering, research and ethics. This will help us as our goal is to create a device that affects the brain. Dr. Helms Tillery’s contact information is listed below.

Email: stephen.helmstillery@asu.edu Phone Number: (480) 965-0753 Office Location: ISTB1 181H

Subtask #1d-c: Descriptive, Stand Alone BME Capstone Project Title

Migraine Treatment using Transcranial Direct Current Stimulation (tDCS)

Subtask #1d-d: Succinct Summary Description of Proposed Medical Device Product Design Activity

The proposed medical product seeks to provide a treatment for migraine sufferers who are debilitated by their condition. The specific need of the device is that current treatment options are primarily oral medications which have many side effects. The proposed product’s goal is to provide effective treatment for migraines that also serves as an alternative to medication. As such, the proposed product has a market segment of all patients who suffer from migraines and are seeking an alternative to pain medications for treatment. The use of transcranial direct current stimulation (tDCS) is proposed to provide a migraine treatment option.

Subtask #1d-e: List of Team Members and Contact Information

Subtask #d-f: Specific Technical & Primary Roles:
Cynthia Crockett:
(i): Technical Role/Primary Role: Electrical Engineer
(ii): Secondary Roles: Technical Writing and Quality Assurance
(iii): Team Size Justification: A team of 4 members was selected to best complete the project. Each team member has a primary role and two secondary roles. These complement each other and help the team achieve high performance standards. Roles were assigned based on team members skills, experience, and personality. The goal was to create an evenly distributed load for team members, so no one must take on too much.

(iv): Team members are expected to put in a minimum of 16 hours a week for the duration of the project. Some weeks will require more effort than this and it is expected that if this is the case, team members will put in all the hours needed.

Kasun Daundasekara:
(i): Primary Role: Mechanical Drafter
(ii): Secondary Roles: Circuit Designer, Software Writing and Troubleshooting
(iii): Team Size Justification: The team size was selected to be 4 members. This was determined to be the best size because of the various roles that were necessary for our project development plan. To maintain high productivity, each team member was given specific roles and I selected this role because my skill set is more in Design and Drawings.
(iv): Expected Weekly Time Output: Each member of the team must work at least 16 hours per week. It is expected to increase once practical part begins

Antonio Lopez:
(i): Technical Roles/Primary Roles: Software Engineer
(iii): Team Size Justification: The team size was selected to be 4 members. This number of individuals allows for a comprehensive skill set in a variety of areas related to mechanical drafting, circuit design, technical writing, project management, and many other areas. In addition, everyone’s strengths and behaviors were analyzed to ensure they were a good fit for the team. Doing so created a good complement of skills that benefit the team while also providing an equal distribution of work that would not have been possible with a team composed of less or greater individuals.
(iv): Expected Weekly Time Output: The current expectation from the team members is to commit at least 16 hours a week towards the capstone project. This number is expected to grow as the Capstone projects evolves throughout the various phases of product design.

(i): Technical Roles/Primary Roles: Project Manager

(ii): Secondary Roles: Mechanical Drafting, Business Marketing Associate

(iii): Team Size Justification: The team size was selected to be 4 members because the project chosen requires software, hardware (design), specific neural research and electrical components. It would be rather difficult to assign all these roles to less than 4 people. The IPDT members chosen have strengths that complement the team. The areas of expertise vary by each member, and their technical roles reflect their strengths.

(iv): Expected Weekly Time Output: My expected weekly time output is a minimum of 16 hours a week. This time will be used to organize the tasks for the upcoming DTs, schedule meetings, research any information needed, and any additional assignments. It will also be used to research customer needs.

Subtask #d-g: Justification of Roles

The role of electrical engineer was assigned to Cindy Crockett. The electrical engineer needs to be able to design circuits, utilize electrical components, and build the electrical system of the device. This includes the utilization of LT Spice and an understanding of basic circuitry. Other requirements include the ability to work in a team and communicate well. As is seen in Cindy’s resume, it is clear that she has the basics of these skills. Cindy has designed circuitry systems for devices, such as the Microcomputers Design Project where she created the electrical system for a device that relayed an EMG signal over Bluetooth. Cindy also has experience with LT Spice, a basic circuit diagramming software useful for this position. It is also clear that Cindy has experience working on teams, both in professional and academic capacities. These include the Biomedical Product Design and Development projects I and III where she worked as a team member to design products to meet user needs. It also includes her internships both at Popetech and at Barrow Neurological Institute, where she worked with other people to complete the required tasks. One of Cindy’s greatest traits is her desire to learn new things. If something is out of her scope, she will do what she needs to do to master the skill as is necessary. This was clear at Popetech. She started the internship with no web design experience and ended with a completed website built from scratch and reformatted several others to meet modern specifications.
The main technical role as Mechanical Drafter was assigned to Kasun Daundasekara. As Mechanical Drafter, I will turn a concept into set of plans for a medical device. The plans should guide others, such as the manufacturing professional, to continue the building process. As a primary role of mechanical drafting and design, I can create and modify concept layouts, 3D models, assemblies and detail drawing using software such as SolidWorks and other Computer Aided Design (CAD). I will oversee determining appropriate design for device in all size aspects and design shapes. In addition, I can work with my other team members with software development and circuit design because of my physics background and knowledge in software such as LTspice.

The main technical role as a Software Engineer was assigned to Antonio Lopez. As a Software Engineer the individual is expected to navigate through various programming languages, such as MATLAB, C++, and LabView. In addition to the navigation skills required, the individual is required to have experience working as part of a team and effective communication skills. Lastly, the individual holding such position should have knowledge related to the FDA. Referencing Antonio’s resume, it is shown that he holds technical skills related to the programming languages requested in the primary technical position and include MATLAB, C++, and LabView that he has gained through various biomedical engineering courses at Arizona State University. Such courses also provided a fundamental introduction to FDA regulation. In addition, Antonio’s prior experience demonstrates that he has worked effectively as part of a team at his student research worker position. Lastly, his experience as a consumer lending intern has allowed him to gain effective communication skills. Referencing his resume, it is shown how his qualifications make him a good candidate for the Software Engineer technical position.

The role of Project Manager was assigned to Joseline Valenzuela. She has had 3.5 years of experience with team management and leadership, as she has been in the executive board of a professional engineering organization on campus. She has demonstrated excellent time management skills, as she manages a job, physical and mental health, research internship, role as president for the organization and capstone. She knows what it takes to keep the team on track by making sure they understand the tasks and feel comfortable asking questions. She learned to be patient and understanding from working with k-12 students for 3 years. She also has experience with mechanical design, as well as the use of laser cutters, machine shops and 3D printers. She has a passion for design and enjoys using her artistic abilities to improve user experience. She plans on using programs such as CorelDraw and Solidworks to bring the ideas to life. Joseline also has knowledge in website design and effective marketing practices, which she has learned from the student organization and on campus job. This is beneficial in the
business aspect, since persuasive skills are necessary when contacting potential investors and customers. Her resume reflects the necessary skills to successfully manage her roles as project manager, mechanical drafter and business marketing associate.

Subtask #1e: Individual Accountability and Demonstrable IPDT Contributions

Electrical Engineer, Technical Writing Specialist, and Quality Assurance Job Description

JACKmed Innovations is a medical device company designed to help people find non-medicine-based solutions to their health problems. Currently, JACKmed Innovations is starting a new project and is searching for team members to support this product development goal. JACKmed Innovations is searching for a team member to handle the electrical engineering aspects of product development, the technical writing skills of report creation, as well as the quality assurance component of device design.

The primary role of Electrical Engineer includes the design and implementation of circuits, an understanding of how different electrical components fit together, and the ability to apply this knowledge in the design of a complete physical device. As the electrical engineer, the candidate should be able to use LT Spice and/or other circuit design software.

As well as being the primary Electrical Engineer on the team, the candidate will need to fill the role of Technical Writing Specialist. This includes editing and formatting team documents in a manner that is conducive to clear understanding and professionalism. The primary software used for this purpose is Microsoft Word. The candidate will also need to understand and use Zotero for citation and bibliography formatting.

The last role the candidate will need to fill is that of Quality Assurance. This role focuses on making sure the device being produced fits all the safety standards that are required legally as well as ethically. The candidate will need to know what the standards are, how to determine if a device is meeting those standards, and what to do when the device is lacking in an area.

JACKmed Innovations is interested in candidates with experience from previous coursework, internships, individual and group projects, and other professional experience.

An ideal candidate would be able to innovate and think outside the box. This project and future projects will have challenges and the applicant will need to be able to come up with unique solutions to problems that arise. JACKmed Innovations specializes in innovating solutions. Doing the same thing as other people are doing will not be an acceptable practice.

This role is not an individual effort. The person hired as Electrical Engineer and Technical Writing Specialist will need to be able to work on a team in a productive and helpful manner. They need to be able to communicate clearly and effectively and listen to input and criticism without letting their ego get in the way.
Some tasks will require very specific responses, so the candidate needs to be able to follow directions precisely. Other times, the candidate will need to work on their own with little to no guidance. Both skills are necessary to be a successful team member.

JACKmed Innovations is willing to train the right individual to the role. While a basic set of skills are required, a candidate who shows willingness to learn and grow in the field and their specific roles will be chosen over a more qualified candidate who is unwilling to improve their skills.

Mechanical Drafter, Circuit Design and assistant software engineering job Description.

Without mechanical drafting and design there is no way to turn a concept into set of plans for a medical device. These plans guide others, such as manufacturing professionals, to continue the building process. As a primary role of mechanical drafting and design, the designer should be able to create or modify concept layouts, 3D models, assemblies and detail drawing using software such as SolidWorks or other Computer Aided Design (CAD). Designers are responsible for converting concepts into reality with basic specifications, and data sheets. Also, the candidate must work well with other engineers and make sure the drawings meet or exceed the other engineering requirements. They must be able to communicate with other members on team and be flexible to change and alter their designs as needed. They must be able to analyze problems and implement timely solutions, have a flexible approach with the ability to both adapt to and facilitate change, and be a self-starter with the ability to work independently and manage priorities/deadlines on multiple tasks. An artistic mind would be a plus point to bring ideas into a creative and attractive design. Designs must follow the rules of physics and the candidate needs to work with problem solving skills.

In addition to the primary role as a mechanical Drafting and design, the candidate should have experience with circuit design. As a medical design company most devices comes with electronic components, so the candidate may need knowledge about electronics parts and how to efficiently use that in space. Required skills as a circuit designer may include to comprehensive understand of circuit design software such as LTspice, knowledge about AC to DC converters, signal processing. They should also have a knowledge about low pass, high pass or bandpass filters, and be able to keep and manage record books. Last, they should be able to develop and maintain circuits through testing and troubleshooting.

For the second secondary role, the candidate should have some experience with software engineering knowledge in order to work with software engineer. The position involves day to day operation of writing and troubleshooting various program languages such as C++, MATLAB, and
Mathcad. The candidate should have a knowledge of numerical methods and know how to work with algorithm base problems.

The candidate must be able to work productively and communicate effectively during the product design period. As part of a team, the candidate needs to adapt to team culture and behavior and be willing to learn new technologies and theories as well.

Referencing Kasun Daundasekara’s resume, it shows that he has experienced on most of the requested skills, and he is interested to learn new skills, such as software development. As a Mechanical Drafter, he will ensure to turn a concept into set of plans for a medical device. The plans should guide others, such as manufacturing professionals, to continue the building process. As a primary role of mechanical drafting and design, Kasun will be able to create and modify concept layouts, 3D models, assemblies and detail drawing using software such as SolidWorks and other Computer Aided Design (CAD). Also, he will oversee determining appropriate design for device in all size aspects and design shapes. In addition, he is able to work with his other team members with software development and circuit design as well. Interested skill sets can be achieved by supplemental reading, researching and working with other members and learning from them.

Software Engineer, Process/FDA Engineer & Statistical Analysis Job Description

At JACKmed Innovations, there is an increased interest in providing solutions to patients. In an industry where every detail counts, our team is made up of individuals with a renewed interest in medical devices. JACKmed Innovations has defined the following job description for its Software Engineer team member. This position has the title of Software Engineer but is a comprehensive role that also supports other tasks including statistical analysis.

The primary role of Software Engineer involves the standard day to day operations of writing or troubleshooting a variety of programming languages. The expected languages for the day to day operations include reasonable knowledge related to C++, MATLAB, Mathcad, and LABVIEW. The essential skills of a software engineer are the ability to interchange engineering principles and mathematics. In addition, the applicant must be able to work collaboratively with other engineers and have troubleshooting knowledge. In addition, the applicant should feel comfortable paying attention to details and ensuring accuracy throughout various processes. The applicant must have a good sense of time management and ability to stay focused. As such the Software Engineer is also responsible for ensuring they can communicate effectively and concisely with other members at JACKmed Innovations.

In addition to the primary role as a Software Engineer, the candidate should have experience analyzing data. Under the secondary role of statistical analysis, the individual will have the responsibility to organize any data in a meaningful format for reporting purpose. As such the applicant will be expected to communicate to a variety of leaders in multiple work settings. Most of the statistical analysis will
occur on Microsoft Office and there must be sufficient experience and knowledge related to the software suite.

Because JACKmed Innovations focuses on medical devices the applicant should have previous knowledge related to the engineering process and FDA regulations as another secondary role. The experience for such position can come from a variety of sources including, but not limited to: previous coursework, individual projects, and professional experience.

Referencing resume, it shows that he has gained the requested skills which have been acquired through a variety of biomedical engineering courses. These same courses have provided a broad overview of the engineering process and FDA regulations. In addition, previous work experience shows that he has gained experience working as a team and processing data. This is demonstrated in the various work projects as a student researcher while working at Arizona State University. These skills are further demonstrated in Wells Fargo experience. In addition, previous work experiences have taught him to effectively take criticism and improve his deliverable work products. For example, while working at Wells Fargo he was a part of various projects where he had to reach out to a variety of leaders through various lines of business. During these situations various opportunities for improvement were identified and considered. At the same various communications methods were learned.

Lack of required competencies will be gained through supplemental reading, mentor feedback, and self-learning tutorials to ensure the success of the project.

Project Manager, Mechanical Drafter and Business Marketing Associate Job Description

The Project Manager at JACKmed Innovations must plan, budget, document and oversee all aspects of the project. Project managers must have strong leadership, good time-management, analytical and budgeting skills the role is to manage the logistics of team meetings, such as making sure they run efficiently. Some of the responsibilities include setting up the location, times, and room reservations of the meetings, as well as making sure the team members are clear on their own tasks. Project managers must have experience with leadership and problem solving in a timely manner. This requires keeping a very detailed work log and calendar that properly outlines important deadlines and task items. has had leadership roles in a student organization, where she learned to time-manage and lead members to complete tasks in a timely manner. She has also been working in a research lab, where she must pay close attention to detail. She plans on keeping an organized calendar throughout the year to keep everyone in the team accountable.
The Mechanical Drafter must be able to confidently use design software, such as solid works and AutoCAD. They must also be able to use hardware tools to transfer the ideas from paper to reality. Some of these tools include power tools, 3D printers and laser cutters. They must research the type of materials that are optimal for the given project, especially if the project involves human users. Joseline has the qualifications to have mechanical drafter as her secondary role because of her experience with Solidworks, CorelDRAW, laser cutting and 3D printing. She will be expanding on those skills by watching tutorial videos on other design programs, like AutoCAD and Ansys. She will also research biomaterials that can be safely used near the face. Besides learning about biomaterials, she will also consult with electrical engineering professionals to discuss the safety of the proposed device even before it is manufactured.

The Business Marketing Associate’s role is to effectively advertise the product to potential investors and customers. They must research the market statistics to determine customer needs and demographics, so the design can be the most effective. They must keep in mind that customers vary from the user, to medical professional and investors, and must be comfortable interacting with all of them. Joseline has years of experience with networking, event planning and influencing companies to donate to the student organization she is part of. She also knows how to create business plans that effectively describe the team’s ideas and goals. She knows how to budget and plan for possible problems that may arise. Her strong interpersonal skills make her a strong candidate to speak to the potential customers to access their needs. To maximize her business marketing skills, she plans on attending professional development workshops to learn more about professional writing and how to interact with people.

DESIGN SUBTASK # 2: CREATION OF INNOVATION CHARTER/PRODUCT VISION/MISSION STATEMENT

The Innovation charter for the Migraine Treatment Using Transcranial Direct Current Stimulation (tDCS) device is as follows: “Create a non-medicine-based treatment method for migraines through the senior capstone experience”.

The team’s preliminary ‘Product Vision’ is “Redefining migraine treatment methods”.

The Mission Statement for the device is broken into several categories. The product description is a device that runs tDCS into the nerve, decreasing migraine symptoms. The benefit proposition for the device include: no medicine involved, easy at-home treatment, portability of treatment, and migraine symptoms successfully treated. The key business goals include setting the standard for future migraine care, as well as capturing 15% of the primary market and 5% of the secondary market. The primary market is migraine sufferers that have tried medication and dislike side effects. The secondary market is
migraine sufferers who do not want to take medication at all. Assumptions and Constraints as follows: new technology, tDCS technology, and energy efficient. The stakeholders for this venture are end users, investors, manufacturing operations, service operations, and distributors and resellers.

REGARDING ITS DEVELOPMENT

Our product idea is non-invasive migraine prevention and relief device. Its product development type is “New product platforms”. This project involves the creation of a new family of product based on new platform [7]. This has both advantages, and disadvantages.

The first advantage is 10% of the world’s population suffer with migraines, which opens our product to a large consumer market. A second advantage of our product is that it is non-invasive, which means it does not go directly in the patient like pharmaceutical drugs. The main technology being used to make this product is tDCS (transcranial direct current stimulation).

Another advantage of our product is that it is 100% free of pharmaceutical drugs. This is an advantage because the current treatments, such as triptans, have many side effects which can be difficult to live with. These side effects include nausea, dizziness, drowsiness and muscle weakness, and triptans can’t use for people at risk of strokes and heart attacks [10]. According to current research tDCS is safe and highly effective for pain reduction and affects neuroplasticity [7], making our product much safer. It will also be able to be used for people at risk of strokes and heart attack. Our product idea solves the problem of medication overuse that many people experience with migraines.

There is some disadvantage of our products as well. The first disadvantage is the cost of manufacturing. As a device, our product could be more expensive than the current drug treatments are. Clearly, this could be a problem once we start to sell the product, so we must plan to minimize unwanted costs. We must also make sure to give it a good lifetime warranty to encourage user trust in the product. Another disadvantage is the product can be uncomfortable to use. Our product is device that can worn at the front of the head or side of the head and that can make users uncomfortable in several ways, such as being too tight, too loose to where it falls frequently. It is very important to us to plan to make product that is comfortable and user friendly.

A third and major disadvantage of our product is the price of testing the product. Finding clinical research patients can be costly. To make matters worse, migraines are generally not everyday problems, rather they happen only a few times a month with no regular schedule. This adds time to the product testing phase, which will cost the company more money.

One disadvantage that can prove advantageous is that this is a technology-intensive business. This means it will take some time for people to adopt the new technology, which is a disadvantage. However, once the technology catches on and is adopted by the public, the focus on technology will increase product performance and open the doors for future projects.

CAPSTONE PROJECT
For this project, the team will need many resources. Some of these resources are known at this time, while others are not. Included here are the known resources that the project will require.

As this project includes electrical components, it will need to have circuits built in. While the final components may be purchased, the initial phases will require the team to build things to test. This means the team will need working breadboards, wires, op-amps, resistors, capacitors, etc.

The project also requires several software programs. For design, testing and programming, LabVIEW and MATLAB will be important. LTspice will be used to diagram the circuits. Solidworks and CorelDraw will be used for modeling and creating the prototype. The Gantt Chart will be created on Microsoft Project. All report formatting will be done on Microsoft Office. The project organization, file repository, and rough drafts are done on Google Drive.

Required facilities include PEBE rooms 290 and 340. Room 340 will primarily be used for team meetings and working on the digital components of the project. Until weekend access of room 340 is granted, the team will be utilizing meeting rooms in the Nobel Library. The equipment in room 290 will be incredibly beneficial as physical prototyping begins. This includes the machine shop and the tools inside, the oscilloscope, the 3D printer, the laser cutter, and the computers.

Other various equipment the team will need includes personal computers, notebooks, a functioning printer, and a binder to keep everything in. As the semester progresses and the team discovers more about their project and its specific requirements, this list will be expanded.

DESIGN SUBTASK # 5: IDENTIFICATION OF PERCEIVED/REAL ETHICAL ISSUES ASSOCIATED WITH CAPSTONE PROJECT

Some ethical issues that may arise from this project are due to technology utilized in the device. That is that the product will be using current to stimulate the user’s brain. There is a possibility that system and product failures may cause severe medical consequences. It is our duty to develop the product with the best possible materials and techniques.

According to the Biomedical Engineering Society Code of Ethics, it is the duty of biomedical engineers to do no harm and always have a benevolent intention when creating a new product that will affect people’s lives. To avoid any violation of these codes, we as engineers need to put great effort in understanding the topic, components and assembly of our device.

Since there is not sufficient research on the use of transcranial direct current stimulation (tDCS) with migraines, specifically neuroplasticity, there would have to be tests done on animals before testing on humans. This raises the ethical concern of using animals in research subject, and to do so, we would have to follow the IRB rules for working with animals.
Another ethical concern is the availability to the public. The type of device we are developing will most likely have a high price range. This means that there will be people who will not be able to afford it or have access to it. Our duty is to choose a target customer market and make sure we understand how we can maximize their availability.

Adherence to the clinical trial guidelines of the International Headache Society is important, on top of adhering to the other codes of ethics. This is because the device will be dealing specifically with the brain and migraines.

If our device is to be tested on human subjects, the procedures would have to abide by the Academic Responsible Conduct Research (RCR) as well as the Biomedical Engineering Society Code of Ethics. We will comply fully with legal, ethical, institutional, governmental, and other applicable research guidelines, respecting the rights of and exercising the responsibilities to colleagues, human and animal subjects, and the scientific and public [11].

Another ethical concern associated with the product idea is how long it is made to last. There must be sufficient testing of the device under different conditions to test if it will continue to be safe for the user, as well as if it is worth the market price.

One last ethical concern will be supporting the claims that are made regarding the ability of the device to alleviate migraine symptoms. This means that it is our duty to use proper language when marketing the device, so we avoid making false claims.

DESIGN SUBTASK # 6: WHAT’S HOT/WHAT’S NOT & WHAT’S EXEMPLARY/WHAT’S NOT IN YOUR MARKET SEGMENT

Tide of Lies

The article “Tide of Lies” was very interesting to me. The basis of the article is that a researcher in Japan, Dr. Sato, completely fabricated research data for 33 clinical studies. 21 of those studies have since been retracted [12]. I found this to be an incredibly important read for a biomedical engineer on the cusp of their career. Because of my personal ethics, I would never fabricate data for a study, however it was important for me to see the results of what happens when fabricated data is used in future studies. This for me means it’s important to pay attention to studies used in my research to make sure they seem solid and make sense and not just use them because they’re published.

For the team, this article has important implications. Capstone is a stressful time. It would be easy to fabricate information to make sure we complete tasks on time. However, the article shows the pitfalls of such fabrication. Something minor could change the entire results of something later that is major. Even
small lies have big consequences. Thus, it’s important for us to be careful to be completely honest in our reporting, regardless of whether we think it’s important.

Another aspect that is important is holding other teams to equal standards of honestly. The article discussed how Alison Avenell and her team were able to determine Dr. Sato was creating false data and how they felt responsible to act on that knowledge. They reported their findings to every journal they could think of until someone was willing to publish their findings [12]. In our team’s situation, should we discover another team is fabricating data or lying about their project, we should report it to either Dr. Pizziconi or Dr. Coursen for them to take further action. It is important for us to follow the Avenell’s lead and be forthcoming with such information, regardless of the personal consequences.

Why the Big Picture Matters:

Members on team focus on their area of expertise. This exposes the project to costly oversights as article mentioned [13]. So, members must pay attention to what the other members are doing too. Looking at others’ expertise, team members can learn other skills as well. Products come with all different features, so each team member must understand the cost associated with various features and the timeline for each implementation. So not only their individual part is important. Every part of design product is important. If one member takes more time for their part without thinking of others, it exposes the project to costs in both money and time. For example, if a designer takes more time than expected, others must wait till the design target is finished and it will slow down the whole project. It is important for each member to reach their design targets in a timely manner, and if they don’t, that means they don’t respect others on the team. Knowing this can help individuals be less selfish. Also working group with positivity and good vibes motivates every team member to drive toward the goal and everyone will learn how to respect each other’s culture. They will also be more capable of adapting to each situation. These things not only shape their career, they also help change their life views and that can make beautiful and peaceful world as well.

One of the most detrimental parts of product development is when teams don’t consider product efficiency and don’t test to find appropriate efficiency projections. This will cause great difficulties if the team tries to do this near production launch, so every team member should know that and make sure to establish production strategy at least midway through alpha phase. That will allow the team to make changes to their product. This limits the problem of teams being unable to test strategy until the end, which can result in huge losses in unrealized sales. If that happened, our team effort may not pay off and can result in wasted effort.

Another part of production development is Cross-Pollination. As the article mentioned, the electrical engineer engages with the software engineer [13]. As our IPDT has only four members, everyone should be Cross-Pollinating with each other. For example, once a designer finishes their design target, it is very important that everyone on the team reviews the design of production. So again, good test planning will require reviews at every design target and that can allow the team to analyze production test results and manufacturing risk. The team can come with arguments and ideas but need to make sure to keep
the “big picture” in mind, which is the end goal. Making decisions are more important than arguing. Arguing can slow down the process and can cost a lot at the end of the project. Each member of team needs to stick to their schedule, time and money management, as well as everyone putting in maximum effort in pursuing good results.

Why Do You Love Your Job in MedTech?

The article by Jamie Hartford places a great effort in analyzing why individuals like their jobs in MedTech. Such effort resonates greatly with the IPDT members as developing biomedical engineers. One important aspect covered by the article is the amount of hard work that is involved with obtaining a college education in a MedTech major compared to others. The article also discusses the long hours involved in industry, how federal regulations sometimes makes it difficult to advance ideas, and how it may be tempting to switch other high paying careers like law or medicine [14]. Nevertheless, as aspiring biomedical engineers the IPDT team members have made it this far into the program and understand that going forward a significant amount of time will be invested in designing a medical device. In addition, the team understands that regulations are in place to ensure that existing regulations are satisfied to ensure the wellbeing of the product users. Although these factors may seem negative, they have created a positive view of the future in developing a medical device.

As far as the practice of biomedical engineering, the article mentions many reasons why people like to stay in the field. One main point the article makes is job security. There are many factors that include the constant need to improve devices, processes due to an increase in aging populations and need to decrease health care costs [14]. The article also states that these jobs are “recession-resistant” due to the dependence of medical treatment. In addition, the Jamie mentions that the medical device industry has a strong base in the United States with a median salary of $119,000 a year. However, the most important reason explained by Hartford as to why people love their job in the MedTech industry is the actual type of work that is done. That is, people are working on devices that creates a positive difference in the lives of patients whose lives are either improved or saved through these devices.

The entire design team can relate to these practices and agrees that the passion and desire to help improve the lives of many is one of the reasons a degree in biomedical engineering was chosen. Developing or improving a device that changes lives, regardless of the amount of work, brings a level of satisfaction that can’t be experienced elsewhere. Nevertheless, the perks associated with a career in the MedTech industry is also appealing. Based on the metrics explained by Hartford, there is a sense of relief knowing their job security and a decent income in working in MedTech. In conclusion, the IPDT members takes these notes as motivating factors to succeed in the biomedical engineering.

Exclusive: How Elizabeth Holmes’s House of Cards Came Tumbling Down

The article by Nick Bilton described the downfall of the biotech startup Theranos caused by the founder’s secret unethical practices. Elizabeth Holmes made some mistakes when creating her company Theranos, which led to its downfall. Holmes kept an atmosphere of secrecy and did not allow people within her company to share information with each other. This form of extreme control allowed for years to pass before the questionable practices were discovered. Her threats to fire people if they did not follow her rules kept people in fear, with her lead scientists eventually committing suicide.
Not only did she keep information from her workers, but also from investors. Her unethical practices reached as far as giving dozens of people inaccurate results. This placed people at risk of not knowing which disorders they had, and trusted that Theranos would let them know.

These types of negative practices are making IPDT members become more careful in their ethical practices because scandals can ruin the reputation of the company and can remove investors’ support. The potential risks to the public health should be a main motivator for members to communicate with each other, and that way they can solve any errors before it gets to the public. Trust in each other is an important detail, as well as feeling comfortable to share ideas and concerns. Individuals should be motivated to speak their mind when they see a problem.

Team members in biomedical engineering should avoid Holmes’ negative practices if they want to have a good product, as well as the trust of customers and investors. Our team will work together to solve any problems that may arise, and that will create a sense of trust within the group. Everyone brings their strong attributes to the table and they should be able to contribute without fear of getting into trouble.

The main practice learned from the fall of Theranos is the importance of honesty within the company and with the consumers and investors. Our team must adopt a very strong sense of ethical responsibility to build trust in all areas needed. It is incredibly important to be honest with what our product will be able to provide. Even if it ends up not working the Wayne wanted, we need to make sure to advertise it honestly.

DESIGN SUBTASK # 7: REFLECTION ON RELEVANCE OF PRIOR FOUNDATIONAL MEDICAL DEVICE PRODUCT DEVELOPMENT CALLS

Design Task #1 was useful in completing Design Task # 3 in various ways. First, the knowledge of trade magazines gained in DT #1 helped us be able to find current research about medical devices that are hot. This helped us narrow down our direction for our product choice. It also introduced us to MDDI Online, which is a great resource for current medical device news and information. Some of the potential articles for Action Item #6 came from MDDI Online. We know that this is a reliable source of information because of the tasks we were assigned in DT #1.

Another useful feature of Design Task #1 was narrowing down our career interests. Before this design task some of us hadn’t thought much about the roles we wanted to play in the professional world. Design Task #1 gave us an opportunity to really think about what we wanted to do and why. This helped us when we were discussing potential roles within the group for Design Task #3. For example, I had never really considered what part of the engineering process I wanted to be involved in, but because of thinking of my desires and skills I already have in DT #1, I realized I liked the electrical components. This led me to choose the role as electrical engineer.

One of the most beneficial parts of DT #1 was the updating of our resumes. For Design Task #3, we had to specify our roles on the team and why we should be given that role. We had to justify that role by showing we had the skills in our resume. If we hadn’t already updated our resume in DT #1, this would have been a much more arduous process. Instead of completely rewriting resumes, we were able to make minor adjustments, thus saving time.
Design Task #2 was also useful for completing Design Task #3. The first part of DT #2 discussed the medical device industry at large. This helped us narrow down fields we might be interested in and positions we might like to hold. Again, this was useful in choosing the direction of our career path. It also taught us what exists in the current market, so we had a baseline to begin from.

The NAICS and SIC codes were not useful directly for Design Task #3, however they will play a part in future development of our product and were therefore worth learning about. Without this knowledge, we wouldn’t know how to classify our business in the legal field once we have a completed product.

The most useful part of DT #2 was the final subtask where we researched companies and their products. Each of us researched a different company and learned about things we thought we were interested in. We learned how the company functioned and what they produced. This knowledge helped us choose the direction we wanted to go with our project. Joseline’s research included a company called CEFALY Technologies. They have an alternative migraine treatment device on the market. This inspired us to do research on migraine treatments for DT #3. Based on personal experience and research, we determined that another alternative method would be incredibly beneficial. This inspired our project direction.

Design Task #1 was designed to familiarize us with some of the biggest medical device association and their publications. That is good starting point of the capstone and that helped us to know about what is new and what is hot in the current medical device industry. This also widened our knowledge base on different kinds of research going on medical device industry. The most important part of Design Task #1 was the required reading of articles. The goal was to help us understand what experts think the main causes of device success and failure are. These articles listed nine ways medical devices fail and ten rules for designing great medical devices. The causes of failures and the rules for success apply to Design Task #3 by showing us how important it is to be wise in our decisions, including in how we choose our team, our mentor, and what kind of product we should create.

Another part of Design Task #1 was developing a professional BME resume and looks book. Subtask #4 also asked us to indicate our areas of career interests relevant to medical product specialty areas. These three subtasks were useful in helping potential designers choose a group in Design Task #3. Carefully reading the resumes and look book help us to know potential team members strengths and weaknesses. It also helped in guiding us in giving positions, duties, and responsibilities to each member of group in Design Task #3. These positions will apply to all future design tasks.

Design Task #2 helped us to increase our knowledge of the medical device and diagnostic industry. Using NAICS codes, we identified all the different sub-industries. Manufacture and Distribution USA helped us find out how big these sub-industries are and the main locations of each sub industries, as well as top companies in each category. This knowledge is useful in Design Task #3 because the NAICS codes from Design Task #2 lead us to conclude our device falls into NAICS code number 339112 and SIC code number 3841, or the sub-industry of Surgical and Medical Instrument Manufacturing.
Design Task #2 also lead us to determine important information on US market size as well as median salary information for each sub categories. Knowing market size and salary information is important part of decision making in Design Task #3. Design Task #2 also directed us to find information of one of the leading companies. It helps us to know about the company’s goal and inside culture, including reviews the company. That gave us a conclusive summary of that individual company as well as advantages and disadvantages of becoming a part of that specific company. This helped in Design Task #3 by guiding us in our design of our group, including knowledge on how to develop a positive culture. Another part of Design Task #2 was researching the company’s new technology and why that company is leading in the industry. Researching this, we learned how those top companies maintain their reputation, such as placing a large portion of their budget in research and development to invent new technologies. This will help us learn to build a reputable company as we progress through the capstone experience.

The preparation of Design Task 3 was simplified in one way or another due to various tasks requested in previous Design Tasks. Design Task 1 provided a way to gain exposure to the various Medical Device and Diagnostic Industry associations and their subsequent publications. In addition, such tasks provided a way to identify the focus or thrust of each of those associations and their respective publications. A very interested read from one of the associations provides an insight as to the characteristics of good product design and potential reasons for failure. Design Task 1 also requested the design of a professional resume that matched the skills and interests that have been gained as an emerging biomedical engineer. An interesting look book was then created that provides some general info about the emerging engineer.

These tasks proved to be useful for the preparation of Design Task 3. For example, by understanding the characteristics of successful product design that was then used to form a comprehensive team with a variety of skills. In addition, preparing a resume allowed for a successful analysis of the personal skills and experiences. These could then be matched to specific roles that were being sought while assembling teams. Furthermore, listing out the interests provided a way to find a team with similar interests. The creation of the resume provided a good template for the resume to be submitted for Design Task 3. In addition, the creation of the Letter of Transmittal was very useful to prepare the future iterations as a team. Design Task 1 also provided a general structure for formatting that should be followed as a template for future Design Tasks. Overall, Design Task 1 provided extensive information that was useful for the preparation of Design Task 3.

On the other hand, Design Task 2 was assigned to gain an insight to the actual Medical Device & Diagnostic industry in the United States and abroad. As such various MDDI metrics were researched that related to size, location, distribution, product types, product classifications, employment trends, market information, trade, and research information on an emerging company. These insights were discovered after researching a broad range of information through various resources. The information for the global
aspect of the MDDI profile was for the country of China. As such much information was discovered that differed greatly to the MDDI industry in the United States.

The tasks completed in Design Task 2 were not as helpful for the preparation of Design Task 3. It was interesting to learn the various geographical distribution of many companies and the employment trends as emerging biomedical engineers. However, that was not of much use when preparing Design Task 3. The parts of Design Task 2 that were useful were the specific tasks that discussed the major products that are of the MDDI industry. The global analysis of the MDDI profile wasn’t as useful either. Nevertheless, Design Task 2 also provided more experience in preparing the Letter of Transmittal and practicing the formatting for the Design Tasks. Overall, there was a lot of great information learned in both Design Tasks. Some information was useful for the preparation of Design Task 3, while some was not. However, there has been exposure to information that may be helpful to future Design Tasks. Nevertheless, the preparation of both Design Tasks provided an analysis of everyone’s experiences, skills, behaviors, and work ethics were analyzed to form a potentially successful IPDT team.

Joseline Valenzuela:

Design Task #1 was helpful to research the current trends in biomedical technology. It inspired me to learn more about the research that is happening right now, and promising devices that might hit the market. It was also an introduction to Due Diligence, as it taught me to not procrastinate on any design tasks. I was also able to update my resume. I ended up removing experience that does not have any relevance to the capstone design. The look book became very helpful when selecting team members because it highlighted my interests and the value that my diverse experiences can bring to the table.

Design Task #1 was helpful when completing Design Task #3 because we had to make sure that our idea was feasible and see if there was any research done about Direct Current Stimulation. We had to make sure it was safe to pursue and there was sufficient evidence that it could alleviate migraine symptoms.

Design Task #2 was helpful in the sense that it taught me a lot about the medical device and diagnostics industry. I did not know how large it is until I did all that research. I believe Design Task #2 was more helpful for Design Task #3. It allowed me to see the big picture of the industry

and the importance of innovation. The industry research will play a role later when we begin to look at our market size, customers and their needs. We will also be using it to assess how we compare to other similar devices in the market.

The main thing that came from Design Task #2 is the research of the entrepreneurial company CEFALY Technologies. I found this company when researching migraine treatments, since I suffer from chronic migraines myself. I had never thought of looking for this type of technology. My previous research was more focused on finding medication that did not make me drowsy during the day, as well as preventative practices, such as diet and exercise. I came across this company and was impressed by
their claims that they can prevent and treat migraines by using the device for one hour a day. It gave me the idea of designing something in the same realm, but that it could also be more affordable. Since I had that research done, once we got into groups, I was able to articulate my idea and that is the direction our project is taking.

APPENDIX A: GANTT CHART

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APPENDIX B: REFERENCES


October 26, 2018

Re: Antonio Lopez Serrano

Dear Law School Admissions Committee:

Purpose of Letter:

Deciding to further your education beyond obtaining an undergraduate degree is an important decision to make. At the same time, it is crucial that the aspiring student can make themselves competitive among other applying candidates. As such this letter is written not only as a recommendation letter but also to further demonstrate the need for Antonio Lopez to earn acceptance into a Juris Doctorate program within your law school.

Overview of Letter:

Antonio is an incredible individual with a unique story who has gained various skills and experiences to succeed as an undergraduate student studying biomedical engineering with a minor in business. These skills will transfer to make and ideal J.D. student. As such those skills and experiences will help ensure that Antonio becomes a successful lawyer.

My Relevant Background:

I have worked as an engineering professor at Arizona State University since 1990. Previously, I served as an instructor at Massachusetts Institute of Technology. In addition, I have gained experience from working at IBM, AT&T Bell Laboratories, Raytheon Missile Systems and even consulted for Elgin Air Force base, Boeing Defense and Space Systems, Honeywell and NASA. and Raytheon Missile Systems.

While teaching at Arizona State University, I have led and taught various school programs that ensure the success of engineering students who transfer from local community colleges.

How I Met Applicant:

I came to know Antonio in my Academic Success & Professional Development course as a selected scholar who transferred from a community college. During various occasions in class he expressed his interest to the class that he was interested in pursuing a law degree and becoming a lawyer.

Summary or Overview of Future, Goals, and Objectives:

One day during office hours, Antonio came to me and discussed why he wanted to pursue such career path. He explained to me that his parents brought him to the United States when he was only four months old. He also explained to me that he found out about his immigration status when he was very young. Instead of letting a legal status change his outlook on life, he used this as an excuse to do even better and work hard to ensure he obtained an education. This work paid off as he had the honor to be the class valedictorian in high school. Unfortunately, Antonio did not have legal status at the time to continue pursuing his education. However, that did not stop him he independently researched various immigration laws and case studies to determine if there was any aid to his situation. At the same time, Antonio worked and took whatever classes he could afford at community college to continue working towards his goals. Once Antonio received his green card, he transferred to Arizona State University and
began working towards a bachelor’s degree in biomedical engineering and a minor in business. His
determination to accomplish his goals demonstrates his willpower and dedication to reach his dreams.

Relevant Preparation:

has gained various skills to prepare himself for law school. Among those includes gaining
previous work experience as a legal assistant that handled immigration and criminal matters where
had the opportunity to interact with various clients, government agencies, and research case
studies. In addition, has recently completed a business internship at Wells Fargo which provided
a different work experience. These experiences along with his rigorous coursework have provided
with very powerful skills such as problem solving, logical thinking, effective communication,
among many others that will prove to be beneficial while he attends law school.

Additional Preparation Planned:

To continue preparing for admissions into law school, has diligently been preparing for the LSAT
examination. In addition, he continues to put a great effort into his studies at school and while working
as a student research aide at Arizona State University. As a senior in biomedical engineering, he is
currently working on a medical device project that requires a lot of research and analysis. These
experiences further provide essential skills for his future success as an attorney.

Examples Demonstrating Ability to Overcome Obstacles:

Regardless of his past experiences, has continued to work hard in all his endeavors while
overcoming obstacles. Although his family has suffered two deaths within the last year he continues to
put a great effort into his studies and career. This along with previous immigration are examples of
obstacles that has overcome and made him a stronger hard-working individual.

Special Accomplishments and Awards:

The work and dedication devotes to his busy life is being reflected in his awards and
accomplishments. Due to his academic success can continue being a Transfer Scholar at Arizona
State University. In addition, his ability to maintain a high-grade point average has allowed him to be
named on the school’s Dean’s list once again. These accomplishments and awards show a broad
spectrum of the goals has achieved and plans to achieve in the future.

Overall Potential for Success and Concluding Comments:

is an individual who contains the skills and mindset to be a successful lawyer. passion
to study law and help others is strongly expressed when he talks about his future careers goals and
hopes to provide legal aid to others. I truly hope to hear soon that this letter served its true purpose and
has demonstrated that merits to be accepted into law school.

If you have any questions please feel free to contact me at or you may also email me at

Best Regards,

Armando A. Rodriguez, Ph.D.
Wednesday October 17, 2019

To whom it may concern:

It is my pleasure to write a letter of recommendation for [Name]. I had [Name] as a Calculus I student at Estrella Mountain Community College and as a student in both my College Algebra and College Trigonometry classes at Buckeye Union High School. In both high school and college, [Name] always had the highest grade in the class. He is very hard worker and he grasps concepts very quickly. He is one of the top 4 brightest students that I have had in my 30 years of teaching, the other three also became doctors. He is also very humble, which is not always the case for students as gifted as [Name]. He was very patient when he tutored students. I have seen him on numerous occasions, go above and beyond to help fellow students understand the material. He takes the lead in organizing study groups. I can tell that he takes his academics very seriously.

I have also seen [Name] working in the community at a local business. I have seen him interact in a very professional manner with customers at our local Lowe’s store. [Name] gets my highest recommendation to medical school. I believe with all my being, that [Name] will be an exceptional doctor with phenomenal people skills. Feel free to contact me, if you have any further questions.

Marcus Eads
Adjunct Instructor at Estrella Mountain Community College
Math teacher and department chair at Buckeye Union High School
Statement of Purpose (Focus on Graduate School)

Goals:
As a current student studying at Arizona State University, I have many goals that I would like to accomplish both in the short term and in the long term. My short-term goals are to finish my undergraduate degree in Biomedical Engineering, while simultaneously obtaining a minor in business. In the process of finishing my undergraduate degree I have been working to obtain relevant work experience that will be useful for my future career path. In addition, I am learning to make the correct financial decisions to be financially stable once I graduate with my undergraduate degree. Upon completion of my undergraduate degree I look forward to obtaining an employment opportunity that will provide the flexibility needed to continue my education. My goal is to obtain a law degree and practice immigration law. I want to truly make a difference for the immigrant community by taking my personal experiences as an immigrant and helping facilitate the process. My plan is to one day open my own law office.

Why:
The development of these goals has occurred throughout my educational shaping in high school and the various life learning experiences I have gained in the process of obtaining my undergraduate degree. During high school I discovered a strong interest in calculus, physics, and anatomy and physiology. I was interested in seeing how life situations could be represented mathematically, but at the same time I found the bodies various structures and function interesting. The human body became fascinating to me, especially learning about various symptoms and trying to diagnose a specific medical condition or treatment in a classroom setting. As such I decided, to major in biomedical engineering with the purpose of one day attending medical school. During this time, I was also very heavily involved in business extra-curricular activities and thus decided to also major in business. My personal issues related to my immigration status and my personal interests to fix those issues allowed me to develop my mind in way that was intrigued by law and policy making. This allowed me to learn how to read and interpret law and gain a deeper understanding of politics.

Future Plans:
To accomplish my goals, I have developed a plan to reach my dreams. Currently I am working and completing my undergraduate degree. I look for a balance between work and school and this makes sure I obtain work experience and minimize my debt. Although I have gained a variety of work experience I have high hope in finding a job position that will allow me to gain experience that provides law analysis skills. This will better prepare me to be ready for job upon graduation. Ideally, my goal is to obtain a job that provides tuition reimbursement. After graduation I hope to work in the banking industry while at the same time attending an evening program to obtain my JD degree. My goals are to slowly work towards paying my undergraduate student loans and at the same time pay my way through law school. Upon graduating, I will work as a lawyer for a company. After gaining experience my plan is to open my own law office.

Summary:
As a student aspiring to one day be a successful lawyer who gives back to the community I have both short-term and long-term goals. In the short term I am actively working towards obtaining my undergraduate degree in biomedical engineering while obtaining experience through various internship opportunities. Using these goals in the long term I hope to gain experience that will support my preparation for law school and pay off my undergraduate loans in the process. Ensuring my undergraduate debt is paid will allow me to focus on my legal career and one day be a highly respected lawyer who can help those in need.