Electronic Engineering Portfolio

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Summary: Sophomore in biomedical engineering with experience in MATLAB, Mathcad, and Solid works. Passionate about developing new medical devices and devices that allow the early detection of diseases.

**Education:**

Bachelor of Science in Engineering — Biomedical Engineering
Barrett, The Honors College
Grand Challenge Scholars Program
NSF Engineering ASAP scholar
Arizona State University, Tempe, Arizona

May 2021
GPA: 3.77

**Software Skills:**
Solid Works, MATLAB, Mathcad, MS Office, and MS Project

**Research:**

Volunteer Research Assistant
Dr. Karen Anderson’s Lab

- Optimizing the kinetics of an LED display biomarker platform to create a low-cost point-of-care test for detecting HPV16 oncogenic biomarkers in patient sera.
- Preparing this device to be tested on 13,000 women for cervical cancer biomarkers in New Delhi, India, in collaboration with the All India Institute for Medicine.

**Work/Internship Experience:**

Intern
Arizona Kidney Disease and Hypertension Center

- Meet with patients to review eligibility criteria, process blood samples, enter patient data, and keep FDA regulatory binders current.

Math and Physics Tutor
Chandler-Gilbert Community College, Gilbert, Arizona

- Tutored basic math through calculus 3 and differential equations as well as physics from mechanics through thermodynamics, optics, and wave phenomena. Proven communication skills teaching technical concepts to students.

**Volunteering:**

Fulton Ambassadors

- Give tours of Ira A. Fulton Schools of Engineering at Arizona State University to perspective engineering students and speak at outreach and special events.

**Awards:**
Member, VEX U PYRO Robotics

- Placed 10th in the world and won Amaze Award at the World Championship (4/28/2018)
- Team won Excellence Award, Tournament Champions, and Robot Skills at the Southwest Regional VEX U Competition (11/04/2017)

**Academic Career Steering Project:**

Founder, Engineering World Health

- I will start an Engineering World Health chapter at ASU where our goal will be to build a medical device to be used in third world countries where electricity is not readily available. This project will help steer my career by allowing me to gain the necessary skills needed to design and build medical devices.
Dear Sir/Madame,
I am very interested in the Gore 2019 summer internship program within the implantable medical devices division. The idea of implanting a device into a patient’s body is a delicate art that truly fascinates me. Therefore, I am submitting my resume for your review.

As a biomedical engineering student, I am passionate about designing medical devices that will improve the lives of others. I am in the process of starting a club called Engineering World Health in which we will design medical devices for third world countries. In this club, I am bringing together students from different disciplines of engineering to design this device. Through this multi-disciplinary engineering project, we will learn a broad range of skills from material choice to learning customer needs. In addition, we will be able to apply the technical skills we are learning in our classes such as programming, circuitry, and thermodynamics.

I am passionate about designing and developing biomedical devices to better the lives of others and I believe I would be an asset to W. L. Gore & Associates Inc.

I look forward to speaking to you at your earliest convenience.

Sincerely,

Rachel Fisher
Comprehensive Career Plan

1. Summary of Goals and Objectives

TECHNICAL AREA
I would like to work as a physician in a private practice as well as working on regenerative medicine or cell-targeting medicine. I would like to become a physician as I love the doctor patient interaction and would love to be able to make such a tangible difference in people’s lives. I also would like to work on research within regenerative medicine or cell-targeting medicine because I find both of them to be extremely interesting topics and they both possess so much potential to radically change the lives of countless people.

I would like to work in a private practice as it gives you more freedom to make decisions based off of what you believe will be best for your patient, instead of sometimes being restricted by policy. I’m not entirely sure who I would be working for in terms of regenerative medicine or cell-targeting medicine research, but I personally know of several doctors who are doing research in a topic that interests them, as well as practicing as a physician, so I know it’s definitely a possibility.

GENERAL LIFE GOALS AND OBJECTIVE
I want to graduate from ASU with an undergraduate degree in biomedical engineering, get a masters in biomedical engineering, and receive an MD. I want to have a career that I feel fulfilled in, which I believe will be a career in which I get to apply technical knowledge to help people and make their lives better. I hope that as I go through life, I learn how to live in the present instead of constantly being concerned about the future or looking back with regrets. I want to be able to make enough money to be able to support both myself and my parents as due to different circumstances in our life, they had to make several monetary sacrifices to do what they believed was best for my brother and I. I want to one day get married and have kids and have the chance to watch them grow. I want to be able to work part time while they’re still at home and after they go to college, I would like to start working full time again.

2. Current Goals

EDUCATION
Some of the coursework I have completed thus far are Calculus 3, Differential Equations, Organic Chemistry, Physics 3, Conservation Principles, Fluid Mechanics, Numerical Methods, and Anatomy and Physiology 2. I don’t feel like I currently have enough coursework to work on technical projects that interest me on my own, however, I am currently working in a lab where I’m learning skills that I believe will be important for me. However, I think that Conservation Principles does provide me with some basis as to how products such as medicine can be produced on a mass scale. I also believe that anatomy and physiology has given me at least a surface level understanding of the human body and how interconnected it all is, which I believe is important to understand for all the topics I’m interested in pursuing research in. I think I’m currently missing a lot of cellular classes such as biochemistry, cellular biology, and immunology, which I am planning on taking several of this coming semester. I’m really looking forward
to all of the classes mentioned above, particularly immunology as we did a module on immunology in anatomy and physiology, and I found it absolutely fascinating. I’m also very excited to take biomaterials because I’m very interested in learning more about the properties of different materials and how those materials can interact with the human body. Taking these classes will allow me to gain a basis of the technical skills necessary to begin researching topics I’m interested in such as regenerative medicine or cell-targeting medicine.

PROFESSIONAL PREPARATION
I currently have an updated resume and cover letter, as a result of this class. I think I tend to be a good writer and am okay at giving presentations, although sometimes I get very nervous. To improve at this, I plan to be more prepared for presentations, so I can feel more confident and less nervous going into it. My critical thinking skills I would say are average for an engineering student, but I have found that the amount of sleep I get greatly affects how well I am able to critically think. As a result, I will make sure that I am getting enough sleep every night in order to critically think well. I think I tend to be pretty good at listening to others, career planning, and general planning. In order to improve my career planning skills though, I will continue to research potential careers and continue to talk to others further down that career path than myself. I don’t currently really have any professional mentors, but I do have some great mentors in my personal life. I tend to do well both with working independently and working in teams. How well I can read and understand technical material tends to depend on how strong of a background I have in that subject. To improve upon this, I will continue to read journal articles on topics I don’t understand but we talk about in lab meetings. I like to make sure that I truly am learning whatever content we’re covering in my classes and have typically been able to do this just by paying attention in lectures and doing homework. However, I have been finding myself getting easily distracted in classes recently. In order to prevent this from happening, I’m going to start putting my phone into my backpack during class time and take notes in a notebook instead of my computer if possible. I tend to be able to communicate and explain ideas to others relatively well, as I used to be a math and science tutor at the community college. I tend to be able to apply what I’ve learned in my math, science, and engineering classes relatively well to real-world problems. I am not very good at decision making as I’m an indecisive person and never want to feel like I’m closing a door on an opportunity. In order to become a more decisive person, I’m going to practice making decisions on my own, instead of asking everyone else for their opinion, especially on smaller matters. I’m also not the best with dealing with uncertainty as I like to plan everything out and know exactly what’s going to happen. However, I do think this is something that I have been improving on, and will continue to work on, as I’ve slowly become more accepting of the unknown. How well I lead a group I have found is directly correlated to how confident I feel in the subject matter or in that situation. In order to improve myself as a leader, I will continue to work on building confidence in myself and my leadership.

PERSONAL LIFE
I would say I currently have a pretty good social life. I tend to spend most of my free time with my boyfriend, and we like to study together or eat lunch together when we can. I don’t tend to see my other friends too much outside of classes though, which is something I want to improve upon. I intend to make
more time for my other friends and be intention about making plans with them throughout the school. However, I find this hard to do sometimes as I don’t have much free time, and when I do I like to spend it with my boyfriend.

**ECONOMIC STATUS**
I’m currently financially stable. Due to my academic scholarship, this scholarship, and financial aid, I have not incurred any debts thus far and should be able to graduate with my undergraduate degree debt free. Additionally, I’m hoping to become a paid research assistant in a lab or participating in FURI.

3. **Education**

**IMPORTANCE OF EDUCATION**
Education is important to me because I genuinely really enjoy learning about absolutely everything that I can and because I know that it’s vital to the careers I’m interested in. Although tests and homework can be stressful at times, I overall really enjoy school. I love learning about new technologies, learning technical skills, and creating friendships with peers.

**EDUCATIONAL GOALS**
I want to get a master’s in biomedical engineering as well as a medical degree.

**PLANNED COURSEWORK**
I’m not entirely sure what classes I’m planning to take yet as the biomedical engineering major map was restructured and I have the option to stay on the old major map or change to the new one, which would give me an emphasis in either biomedical devices or biological devices. I’m also in Barrett, so I may take additional honors classes or do honors contracts in order to fulfill the honors requirements. I’m also a part of the Grand Challenge Scholars program which requires me to take two classes or participate in two experiences for each competency. These competencies are interdisciplinary, research, service learning, entrepreneurship, and multicultural awareness. I believe that taking these additional classes, beyond the ones required for my major, will help me to be a better engineer and doctor.

**INCLUDE SUMMER PLANS**
My main goal for this summer is to study for and take the MCAT. However, during this time I plan to continue volunteering in the research lab I’m currently in, or potentially being a part of FURI. Another potential opportunity I’m looking into for this summer is getting a biomedical engineering internship that is about half of summer. Additionally, I’m planning on shadowing and volunteering at a hospital.
EDUCATIONAL OPPORTUNITIES

I am planning on applying for the Mayo Clinic-Barrett, the Honors College Premedical Scholars Program, GCSP research stipend, and potentially scholarships for a travel abroad. In a larger sense, I am also planning on applying to the 4+1 program at ASU as well as medical school at several institutions. I don’t know too much about additional scholarships or fellowships I can apply for however, it is something that I will be sure to look into.

4. Research Experience

RESEARCH GOALS

I’m currently volunteering at a research lab here at ASU where I am working on protein purification, which is being used for testing lateral flow assays to detect cervical cancer. The protein purification process is relatively long as it takes about a week to make and purify a set of that particular protein. By purifying different kinds of protein, they can be used in the lateral flow assay to see if one protein binds to the antibodies better or not. I’m also interested in working on a more biomedical engineering related project, but I’m not entirely sure what area I’m most interested in yet. By the time I graduate from ASU I hope to have at least one paper with my name on it published as well as presented at at least two conferences.

RESEARCH/PROJECT OPPORTUNITIES TO BE PURSUED

I’m interested in participating in FURI, EPICS, and potentially an REU. I’m not entirely sure what I would be interested in researching but potentially something with STEM cell research, neurodegenerative disease, or prosthetics that are controlled by the brain. I’m interested in researching any of these topics as they are all topics I think are super interesting and would make a huge impact on the lives of countless people.

IMPORTANT DEADLINES

The deadline for Spring 2019 FURI Applications is October 11th at noon. The application for FURI includes a two page research proposal, a bibliography, a timeline of your project, the budget for your project, a personal statement, your resume, unofficial transcript, and a FURI faculty member proposal support letter. Although this does not require a letter of recommendation, you will need to have a faculty member who is willing to approve your FURI proposal. As EPICS is a class that you enroll in, there is not application for it and you must be enrolled by the day classes start, which is January 7th, 2019. Applications for an REU over the summer is due by March 6th. To apply, you must submit an application, your unofficial transcript, and a letter of recommendation from a faculty member. I do have at least one recommender in mind to use and I have started building a relationship with her. However, I think it’s important for me to continue building a relationship with her by going to office hours and talking with her in class.
**INCLUDE SUMMER PLANS**

My main goal for this summer is to study for and take the MCAT. However, during this time I plan to continue volunteering in the research lab I’m currently in, or potentially being a part of FURI or another research experience, either at ASU or an external lab such as Mayo Clinic or The University of Arizona College of Medicine.

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**5. Industrial/Work Experience**

**IMPORTANCE OF INDUSTRIAL/WORK EXPERIENCE**

I honestly haven’t thought extensively about the importance of industrial experience as I’ve been more focused on what I need to be accepted to medical school. However, I think it is very important to gain industrial or work experience as it allows you to gain the skills that companies are looking for within your area of interest. Additionally, it gives you a glimpse into what working in that field would be like which is crucial to determining how interested you are in working in that field.

**PRIOR INDUSTRIAL/WORK EXPERIENCE**

I have not had any industrial work experience within engineering thus far.

**DESIRED INDUSTRIAL/WORK EXPERIENCE**

I would like to gain industrial work experience within a biomedical or genetically based company such as Medtronic, TGen, Gore, or Stryker.

**INTERNSHIPS TO BE PURSUED**

I would love to get an internship at Medtronic, TGen, Gore, or Stryker. I find each of their companies to be extremely interesting and would love to gain the real-life experience of what working for any of them would be like as I think it might help me decide what I’m interested in pursuing within biomedical engineering.

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**INCLUDE SUMMER PLANS**
My main goal for this summer is to study for and take the MCAT. However, I would love if I could get a biomedical engineering internship that is about half of summer as it would allow me to gain the real-life experience of what working as a biomedical engineer is like, while also giving me adequate time to study and do well on the MCAT.

6. Community Service

IMPORTANCE OF COMMUNITY SERVICE

Community service is important to me as it gives me the opportunity to give back to others, as I know I am extremely blessed to have the life that I do. I think it can help in your career as potential employers like to see that you care about others and in some cases community service can lead to a leadership opportunity. Additionally, working within the community allows you to change your perspective and perhaps help you better understand what products people really need and what could drastically improve their lives.

PRIOR COMMUNITY SERVICE

When I was in high school my friends and I started a MATHCOUNTS club for homeschools in which we taught them various math concepts and at the end of the year they got to compete at the MATHCOUNTS competition. I am also currently a Fulton Ambassador in which I give perspective engineering students a tour of ASU and share my experience at ASU. This allows me to impact perspective engineering students at ASU and give them a student’s perspective of what being an engineering student at ASU is like. Being a part of this has helped me improve my public speaking skills. I am also currently a part of Project Sunshine in which I go to Phoenix Children’s Hospital to play games and do crafts with the children there. In Project Sunshine I get to impact the kids at the hospital by brightening their day and hopefully helping them forget about why they’re there and instead just focusing on having fun. Being a part of this has allowed me to interact with patients, which influenced my decision to become a doctor, as well as serve as a reminder that doctors’ and engineers’ jobs truly have such a large impact on countless lives. I like to participate in these activities as I really enjoy each of them and it changes my perspective from being so focused on myself to how I can help others.

FUTURE COMMUNITY SERVICE

A community service opportunity I’m interested in is being a clinical volunteer at SHOW, a student run clinic that is open over the weekend to treat vulnerable populations, such as the homeless. I would like to do this as it will give me clinical volunteering experience as well as help them run their clinic more smoothly to ensure that the homeless can receive optimal treatment for free.

PROFESSIONAL ORGANIZATIONS
I’m a part of the Biomedical Engineering Society (BMES) as well as the Society of Women Engineers (SWE). I’m not currently planning on joining any other organizations as it’s already sometimes difficult for me to make it to their meetings.

**LEADERSHIP SKILLS**

I’m planning on starting a chapter of Engineering World Health at ASU this year, which will allow me to build leadership skills by leading and organizing the club. Additionally, I have been regularly attending some club meetings this year that I believe could lead to potential leadership opportunities next year. By the time I graduate college I hope to have held at least two leadership positions for at least a year because I believe being a leader is a critical skill that companies are looking for.

**IMPORTANCE OF MENTORING**

Being mentored is important to me as I believe that mentors have so much valuable wisdom that they have to share with others and can help guide you to not make the same mistakes they did or have seen others make. I would like to have a mentor to help guide me in creating my career path and what I’m involved in or to mentor me in projects such as FURI. I think this would be most helpful to me as I now know what I want career wise but I’m not sure how to get there. I would like to hear about why they chose the path they did and what skills they think are most helpful to various engineering jobs. My plan to gain suitable mentoring is through professors in classes and the professors I work under in the research lab I’m in. One of my professors this semester I’ve been taking to as she originally wanted to go to medical school but ended up getting her PhD in biomedical engineering instead. I found it really interesting to hear about her work, what she researched, and the pros and cons of working within research. I also know there are mentors that are available to us through this program and have identified a few that I will reach out to.

**Economic and Financial Goals**

In 5 years I hope to be in medical school, at which point I will be incurring debt to pay for tuition and living expenses. In 10-15 years I hope to have graduated from medical school, be completely debt free and earn enough money to support myself and my family. I also hope to be making enough money that I would be able to regularly donate to nonprofit organizations as well as invest in real estate. I believe that becoming a doctor would support these financial goals.

**IMPORTANCE OF GRADUATE SCHOOL**

I hope to be accepted into medical school but if that doesn’t work out then I plan to get a Masters or possibly a PhD. Graduate school is important to me as I know there are many more opportunities for jobs if you have a higher degree, in addition to getting paid more. If I’m not accepted into medical school
straight out of undergrad, I plan to finish the 4+1 program and apply again the following year. My current GPA is just below what is required for the 4+1 program but after this semester it should be high enough to meet the GPA requirement.

PREPARATION PLANS

I would plan to go to graduate school full-time. I would more than likely have to use student loans to pay for graduate school, but I am also planning on applying for as many scholarships as I can. I am planning to study this summer for the MCAT and make that my number one priority in order to make sure I do well on it as it is one of the most critical components of a medical school application. I plan to study for it by using self-study books as well as by using resources provided for free through the partnership ASU has with Princeton. I am working on developing relationships with my professors in order to have strong letters of recommendation, and am already working on my personal statement.

MS THESIS AND COMMITTEE

If I ended up getting a Masters, I would want to do a MS thesis because I’m currently in a research lab and I really enjoy it! I’m really not sure what my thesis topic would be yet but possibly something relating to stem cell research because I think this has so much potential and find the topic really interesting. I have not thought about who would serve as my MS thesis supervisor or thesis committee. I have not thought about how to start planning for this as right now my goal is really to go to medical school, so that’s what I’ve been focused on.

PhD IN ENGINEERING, TOPIC, THESIS, COMMITTEE

I have thought about pursuing a PhD in engineering if I don’t go to medical school because from everything I’ve seen that’s who’s conducting all of the truly groundbreaking research and it would open the opportunity of becoming a professor at a university. Once again, I think my research topic would be something within stem cell research due to the potential it has. I have not thought about who would serve as my PhD thesis supervisor or PhD thesis committee. I have not thought about how to start planning for this as right now my goal is really to go to medical school, so that’s what I’ve been focused on. I have considered a direct PhD but I don’t think this is something I will more than likely do unless I decide I don’t want to go to medical school as completing a masters within the 4+1 program would be an extra year, which would allow me to reapply to medical school the following year instead of something more long term like a PhD.

JOB DESCRIPTION

If I become a physician, my specific job description would depend upon which specialty I would peruse. However, as of right now I think I would like to have a specifically within primary care, possibly pediatrics or family medicine. Regardless of the specialty, my job would consist of diagnosing and treating illnesses as well as routine wellness checks. From my understanding, the flexibility of this would
depend upon the specialty as well as if I was within private practice or a hospital. However, overall I think I could have relatively flexible hours. The resources available to me once again would more than likely depend upon if I was in private practice or within a hospital as there would be more resources available within a hospital setting. Being a physician would not provide me with the opportunity to work from home but would come with great benefits. The most obvious of these benefits would perhaps be a high salary, but I believe this would also provide me with a stronger understanding of what devices could be most useful to patient care.

**STARTING YOUR OWN COMPANY**

Staring my own company is something that has somewhat interested me as both my parents have owned their own company and my dad is currently still self-employed. However, as a result I’ve also seen the struggles of starting and running your own company so I’m not sure if it’s something I would want to pursue or not. I really don’t know much about the more business end of starting a company such as forming a LLC, creating a business plan, or securing intellectual property.

**PROFESSIONAL DEVELOPMENT PLAN**

In undergrad I’m planning on graduating with a degree in biomedical engineering, completing my Barrett thesis and graduating with Honors, participating in FURI for two semesters, being a published research author, presenting at conferences, and completing at least two engineering internships with companies such as Medtronic, Gore, or Stryker. In the long term, I plan to graduate from medical school, and work as a doctor while possibly doing some biomedical research or working with biomedical engineers to help them better understand what medical inventions could be groundbreaking to medicine.

**PERSONAL DEVELOPMENT PLAN**

I want to continue working on my communication and interpersonal skills. I also want to continue to learn and improve upon work life balance. In addition, I want to become more involved in volunteering for organizations that I truly believe in the work of, such as my church.

**NUTURING SPECIFIC SKILLS AND/OR HOBBIES**

I would like to become more competent in coding in C++ and Arduino, as I think these will both be imperative skills in the future within any field. I would love to continue dance, specifically ballet, and it’s my dream to one day be on pointe. I also would love to learn how to play guitar and piano better as well as various crafting skills such as soap making, knitting, or crocheting.

**FUTURE EDUCATION PLANS**
My dream is to attend medical school at Mayo Clinic in Arizona, and specialize within pediatrics or family medicine.

**Family Planning**

Thus far, I have met most of my friends through classes or clubs and met my current boyfriend in a robotics team we were both on in high school. In a partner, I look for someone who is Christian, honest, and giving of their time. It’s also important to me that they see the value in education and have goals that they are pursuing and passionate about. I would like to get married later on, more than likely during or after medical school. I would like to have kids, and possibly adopt a child. In order to make important decisions I hope that we would both be able to explain to one another our opinions as well as truly listen to what the other has to say. I think that at some points we may have to make decisions that will benefit one of our careers more than the other’s, but I hope that these types of decisions would be based off of what we believe will be best for our family in the long run.

**IMPORTANCE OF TRAVELING**

I’ve never really had the opportunity to travel much this far due to financial reasons, but it is something that I have always wanted to do! I would love to travel in order to experience other cultures and I think it would change and shape my perspective on the world. The country I want to travel the most to would be Taiwan, as that’s where my mom is from but I’ve never had the opportunity to visit it. In high school, I took Mandarin and absolutely fell in love with what I learned about the culture and architecture there. I would love to do this potentially over summer and winter break with my family. I would also love to travel to Europe, Japan, and Australia with either friends or my significant other perhaps over breaks or after we graduate college/medical school. At this point in my life I don’t really see myself living overseas as all my family is here and although I would love to travel and see the world, I would miss my family and friends here so much. However, perhaps at some point in my life, I’ll become a part of an organization such as Doctors Without Borders to help third world nations.

**Investment Plans**

I plan on taking a portion of my money each month to invest in rental real estate. I also plan to save 10% of the money I earn each year in a 401k for retirement. In order to become more informed about investing and retirement, I plan on hiring a financial advisor and conducting research on my own in order to understand what options may work best for me at that time in my life.

**Contingency Plans**

If I’m not accepted into medical school than I intend to get a masters in engineering and work as a biomedical engineer, hopefully within research and development.
**Philosophy of Life**

To me the most important thing in life is God and people and this is what I base my life around. I want to live a life that is pleasing to God and help others in any way that I can in order to contribute to society in a positive way. In my career I want to be able to improve or brighten someone else’s life. My family and friendships are also extremely important to me as I am a very extroverted person and I can’t imagine myself being happy without them. During bad or uncertain times, I trust that God has a plan for my life, that He knows what he’s doing, and I try to surround myself with my family and friends.

**Other Issues**

I think the above career plan is very thorough.

**References**

FURI Application:
https://furi.engineering.asu.edu/apply-to-furi/

4+1 Program:
https://sdbhse.engineering.asu.edu/msinfo/

Pre Health Resources:
https://barretthonors.asu.edu/academics/enhance-your-academic-experience/pre-health-resources
(1) TECHNICAL AREA CHOSEN

Personalized medicine

(2) IMPORTANCE OF THE CHOSEN AREA

This area is important as it has the potential to drastically change health care as we know it. Currently when one goes to the doctor for treatment they note your symptoms, sometimes will run some scans, and will give you the best diagnosis and course of treatment that they can based off of these factors. Personalized medicine shifts the treatment of an individual from what treatment has been found to be most successful for the majority of people to what treatment would be most beneficial for that individual. This is critical for risk assessment, prevention, detection, diagnosis, and treatment (Personalized Medicine Coalition, 2018). Personalized medicine has already impacted patient care across the world for many diseases such as breast cancer or cardiovascular disease. Before the gene expression profiling test existed, in order to determine the probability of a heart transplant recipient accepting the heart, a heart biopsy would have to be done (Personalized Medicine Coalition, 2018). However, now a genetic test can be performed on a non-invasive blood sample to predict the probability of the recipient’s body accepting the heart. I’m passionate about personalized medicine because I believe that it can very realistically completely change how patients are currently treated, can greatly increase the efficiency of patient’s treatments, and diagnose patients earlier.
(3) PROBLEM TO BE PURSUED

Although personalized medicine is an extremely broad topic, one of the most prevalent uses of it is currently is to match a common treatment response to patients’ genomes. This information can then be used by doctors to prescribe the best medicine for patients based off their genetics. As a result, one of the largest challenges within personalized medicine currently is creating a device that can be used to decode the human genome more quickly and accurately (Vogenberg, Isaacson Barash, & Pursel, 2010).

(4) IMPORTANCE OF THE PROBLEM TO BE PURSUED

The concern that genome sequencing would greatly increase the cost of healthcare, and therefore is currently infeasible to integrate is one of the current major barriers to implementing personalized medicine (McKinnon, Ward, & Sorich, 2007). This problem is important as without being able to decode patients’ genomic pathways in a fast and cost-effective way, personalized medicine will be ineffective as it will only be used on a select few. However, without a large data set as to how different genes react to different medications, a field known as pharmacogenomics, having a patient’s genome sequenced will be essentially useless. If this problem was solved, it would allow personalized medicine to become a much more prevalent way to treat patients. Furthermore, decoding patients’ genes can be used to test for predispositions to certain diseases, allowing doctors to carefully monitor the patient for that disease, which would allow the disease to be caught early on (Mayo Clinic Staff, 2018).
(5) RELEVANT CAREER PROSPECTS

deCODE genetics, Inc currently is currently the world leader in genetic testing and is headquartered in Reykjavík, Iceland. deCODE genetics is a biopharmaceutical company that was founded to find common genes that are associated with common diseases and to use this information in the development of new drugs. Their headquarters in Reykjavík, Iceland is their only location. Illumina is a biotechnology company within the United States that develops and manufactures devices for the analysis of genetic variation. They are headquartered in San Diego, CA with their locations within the United States in San Diego, CA, Foster City, CA, and Madison, WI. The locations in California would be of greatest interest to me. I have not applied for an internship there as their summer internship programs are 12 weeks long, which would not allow me to study for the MCAT. However, I may apply for an internship there the following summer.

(6) APPROACHES: STATE-OF-THE-ART

The first attempt to decode the human genome was a project that took over a decade and approximately $120 million to complete (Human Genome Project Budget, 2013). The primary way currently used to sequence genomes is known as the clone-by-clone method in which human DNA is fragmented into smaller pieces, somewhere between 150,000 and 200,000 base pairs, and then cloned in bacteria (Human Genome Project Completion, 2010). This bacteria then replicates so the quantities of DNA are large enough to be sequenced and then use genome mapping techniques to place the clones in the right order. They then can reconstruct the entire sequence by using overlaps between the different clones. Another popular method called “whole-
“genome shotgun”, breaks down the genome into smaller pieces and once again sequencing and reassembling the pieces into the full sequence (Genome Sequencing, 2003).

The largest advantage to the clone-by-clone method is that it’s extremely reliable but it is slow as the mapping step is very time-consuming (Genome Sequencing, 2003). The whole-genome shotgun method has the potential to be faster, but it can be very difficult to sequence as each piece has such a small fragment of the genome. As seen in Figure 1, the cost to sequence genomes has significantly dropped in recent years.

![Figure 1. Cost per Genome over Time](The Cost of Sequencing a Human Genome, 2016)

However, the devices that have been used to decode genomes have been very large and take a significant amount of time to sequence.

A promising technology comes from a company called Illumina, who claim that they are currently working on a machine that is one day expected to be able to decode the entire human genome for under $100 and in under an hour (Buhr, 2017). However, their device is not yet at this point and it still take time to interpret the data.

More recently, a study was published in January of this year in which the entire human genome was decoded in a device about the size of a cellphone (Jain et al., 2018). The researchers
were able to do this by passing strands of DNA and electrically charged atoms through nanotube structures and then able to map the base pairs based off the changes in electrical current. This study was also able to close some of the gaps in assembling the human genome.

(7) YOUR APPROACH TO THE PROBLEM

My approach to this problem will consist of me systematically comparing the differences between Illumina’s approach and by mapping the base pairs based off of the changes in electrical current.

(8) RATIONALE FOR YOUR APPROACH

I believe that combining these two technologies could lead to potentially creating a genome sequencer that is inexpensive, portable, and time efficient. This is extremely important as these are all critical components in order to make sequencing practical in a clinical setting, which will increase the prevalence of genetic sequencing to be as common as getting a blood test. Genetic sequencing being commonly performed is critical for physicians to know how patients with particular genes will react to one medication over another, in addition to being able to identify cancerous changes in DNA (Tumor DNA Sequencing, 2017).

(9) RISK-REWARD ASSESSMENT
I believe that this approach has the potential to be successful as each of technologies possess unique traits. However, I’m not sure how well these technologies will combine and as a result, it may be rather difficult. I will gain a stronger understanding of how genome sequencing works as well as how to combine multiple technologies. This project will also allow me to better understand what it is like to work as an engineer and will provide me with an experience that will be relevant to gaining an internship at companies such as TGen. It’s not possible for me to fail this project as even if it doesn’t work out how I’m hoping it will, I will still gain valuable knowledge and experience that will carry with me through life. An obstacle I foresee is that the technology that the Illumina device uses may not be shared or available on the internet as they were still working on developing this technology in 2017. I do believe that I possess the necessary skill set in order to understand these technologies as I believe I possess the skills required to read, understand, and summarize technical papers. Once again, I’m not sure if Illumina has shared what technologies are being employed in their device in order to make it so time and cost efficient so that may be a potential resource that I’m lacking. I also don’t currently have extensive knowledge as to what parts of the technology results in the different positive aspects of that technology. For instance, I’m not currently sure what makes the changes in electrical current less time efficient than other methods.

**(10) PREPARATION TO DATE**

Taking General Biology 1 and 2 has helped me learn about DNA, it’s structure, and its base pairs as well as enzymes and how they can be used to cut DNA. Taking Physics 2 has given me exposure to electric charges and currents as well as how electric fields interact in vacuums or
various materials. Additionally, extensive reading on these topics from various journals and publications has helped me gain a deeper understand of how these technologies work. The current research lab I’m in is mainly focused on biochemistry, and as a result I have learned about and read several research articles relating to nucleotide bases and DNA polymerase. Finally, all of my engineering classes has helped me develop stronger problem solving and reasoning skills.

(11) SPECIAL RELEVANT SKILLS

I am able to work well both independently and in a team. Through time I have found under what conditions and environments I work the best and most productively in. In teams, I typically take on the role of breaking down the project into parts and then discussing with the team which parts each of them would like to have and setting the meeting times to work on the project. I am typically able to communicate with fellow peers as well as convey our ideas through writing in a clear way. I also have a good amount of experience with creating slides for and presenting technical presentations. Through various classes I have taken, I have some experience coding in C++ and MATLAB as well as creating 3d models of products in Solidworks.

(12) REQUIRED RESOURCES AND BUDGET

Since for this project I will be comparing the strengths and weaknesses between Illumina’s approach and mapping the base pairs based off of changes in electrical current, I will
not actually be performing either of these in the lab and therefore will not require any physical resources. It is likely that I will require access to several conference papers and journal papers in order to gain a deeper understanding of how each of these technologies work. However, I will more than likely have access to most of these articles and journals through the ASU library and if there’s an article or journal that I would like access to, I know I can make a request through the ASU library for free access to it. Additionally, it is rather likely that I could use additional expertise in the various subject areas and therefore will more than likely reach out to various professors who specialize in those areas as additional resources.

(13) TIMELINE

1. Research what each method entails and identify which parts of each method allow for the positive attributes of that method

2. Research if anyone has tried to combine these technologies and if not how compatible each of them might be with one another

3. Create a method that would allow the best aspects of each of them to be combined

4. Create the final report and presentation
(14) FUTURE PLANS

To prepare for this project, I am planning on taking the following classes:

- BIO353- Cellular biology
- BME322- Statistics for BME
- BIO340- General Genetics
- BME301- Numerical Methods in BME
- BCH361- Principles of Biochemistry

I think that cellular biology, general genetics, and biochemistry will help me gain a better understanding of DNA how it interacts with various enzymes, and the size and charges of each base. Additionally, I think taking Numerical Methods and Statistics will help me when analyzing the data.
Additionally, as mentioned earlier I plan to continue to research these areas and talk with professors or fellow students, potentially within different disciplines, in order to gain a deeper understanding of these concepts. Finally, I hope that I will be able to conduct a FURI project or potentially my senior capstone, which would provide me with experience within the area. I hope that these experiences will make me a good candidate for companies that work within these areas and hope to be employed by one of them once I graduate.

(15) References:


Dear Selection Committee:

I am writing this letter in support of Ms. [redacted] and through this letter hope to illuminate what sets her apart from other medical school applicants. I had the pleasure of meeting Ms. [redacted] during the Fall 2018 academic session. She was a student in my BME200: Conservation Principles in BME course at Arizona State University (ASU). It was a pleasure to have had [redacted] in this course as she asked good questions, actively participated in all activities and projects, and explained ideas to her classmates. So often, students desire to find the path of least resistance through a particular course and hope to simply fulfill a course requirement. Not [redacted]. She is a student of the greatest integrity, work ethic, and intellectual curiosity.

[redacted] is certainly one of the most motivated, conscientious, and dedicated students I have encountered as an educator. Her ability is substantial, and her test scores and grades attest to her application. She is able to quickly understand the concepts and is able to apply it to many different situations encountered in the engineering curriculum. [redacted] enjoys the challenge that this curriculum offers and is an excellent problem solver. You can count on her to come up with a creative way to solve a problem, using past skills as well as concepts that she is currently studying. I do not see the same level of professionalism, competence, and overall excellence from many other students. The experiences [redacted] has gained with class projects has prepared her to continue her education and I have no doubt that the leadership skills as well as the problem solving and content knowledge she displayed will serve her well as a future doctor.

In addition to being a model student, [redacted] and I have personally had several conversations as to what career path she wants to pursue. We have spoken extensively as to my own research within stem cell engineering, as it is an area of interest for her, as well as the field of medicine. I believe that the critical thinking skills she has developed through the engineering curriculum will serve her well as a future doctor and scientist. Additionally, I believe she has and will continue to learn and develop the skills necessary to design and create innovative new medical devices and equipment. In addition to taking challenging engineering and science courses, [redacted] also consistently volunteers with and is aware of various populations such as the homeless, those who have been victims of human trafficking, and how to help patients who are addicted to opioids. Volunteering with these populations has given her a unique perspective with treating them as she sees them as more than just their medical issues, but instead as a fellow human being who is worthy of love and attention.

On a personal level, [redacted] is sincere, appreciative, and capable of functioning effectively under stress. She wants to succeed, has pride in herself, and keeps everything in perspective. Her competitive nature is controlled and well-directed. She works well in groups and independently, understanding the importance of working in either format. [redacted] is one of the most mature students I've encountered. She has opinions, demands quality instruction, is honest, dependable, engages in critical thought, and makes me a better teacher. Our school is a better place for her being here and I am a better person for knowing her.

[redacted] merits my highest recommendation. If further comment is needed on her behalf, please do not hesitate to contact me.

Sincerely,
Statement of Purpose:

I plan to get a MD and would like to work in a private practice as a primary care doctor. In addition, I would like to conduct research either within regenerative medicine or personalized medicine. This will allow me to combine my passions of getting to directly help and interact with patients with engineering devices to help others. These goals have been fueled by my collective experiences.

Through different experiences in my life, I’ve seen how drastically good health affects people’s lives. Within my own family, my brother struggled with health issues through high school and college. He has more recently gone through treatments that have been effective for him, and as a result has drastically improved health. Seeing the difference in his personality, confidence, and overall demeanor between then and now has been incredible to see and truly shows how deeply health affects the quality of one’s life. I would love to become a doctor in order to positively impact people’s lives in the same way I’ve seen doctors positively impact my brother’s life.

Throughout high school I loved math and science and have always wanted to design and create devices in order to improve others’ lives, both within the health arena and outside of it, which is why I chose to major in engineering. I’ve found my engineering classes to be extremely interesting and have really enjoyed developing my critical thinking and problem-solving skills in addition to collaborating with others on class projects in which I get to dive deeper into a particular problem in order to develop a potential solution. As a result, I would love to be able to not only directly impact the lives of patients that I treat but also indirectly help countless others that I will never meet, by creating a device or helping to develop a technology that will improve their lives. Additionally, I am currently in a research lab, which I have found to be very enjoyable as I love getting to design experiments to test different hypotheses I may have on a particular topic.

Within the field of personalized medicine, I would like to work on creating a device that can be used to decode the human genome more quickly, at a lower cost, and in a more compact form. This is paramount to making personalized medicine a reality as without being able to decode patients’ genomic pathways in a fast and cost-effective way, personalized medicine will be ineffective as it will only be used on a select few. Without having a large set of data to see how different combinations of genes may react differently to various medicines, knowing the genes of a select few will not be useful. My approach to this problem will consist of me systematically mapping the base pairs based off of the changes in electrical current. I believe that taking genetics as well as circuits will be particularly helpful to this research as it will allow me to gain a better understanding of how to measure and calculate electrical current as well as the properties of genes. I am hoping to present this research at a conference at some point, possibly at the BMES or IEEE Conference.

In summary, although I may not currently know everything necessary to solve this problem, I know I can learn these technical skills as I love continually learning and have great mentors who are knowledgeable within these areas in order to guide me. I believe that this, combined with my passion for helping people will lead me to be a good doctor and researcher.