Personal, Relevant Background and Future Goals Statement **Morgan Blevins**

Great use of a personal anecdote to grab the reader's attention

On a spring day in my junior year of high school, I found myself on a ferry to Seattle, on my way to a National Geographic talk. My friend had offered me his ticket on the off chance I could attend in his place, and as I watched Mt. Rainier tower over the Puget Sound, I was unknowingly on my way to an experience that would permanently set me on a course to become an engineer. The talk was given by the JPL Astrobiologist [redacted]. He spoke about his research in designing a vehicle that could someday venture through our solar system to discover what lies below Europa's ice crust. I was enraptured. I could not stop thinking about the engineering challenges that his scientific questions prompted and their translation to our own oceans and poles. How can we make a system resilient to the harsh environments of an icy world, or Antarctica? How could we monitor climate in the Arctic or detect possible signs of life in deep sea conditions? I became fascinated with research focusing on our oceans; alien worlds in their own right. Growing up on an island, I spent much of my childhood on stony beaches, reveling in winter's cold salty winds and jumping into the bioluminescent filled bays in the summer. There are countless questions to answer about our oceans, many with implications in climate change, carbon and methane cycling, and the origins of life. Developing instruments for exploring and facilitating discovery and climate research in the ocean, Arctic, and space environments became my passion.

Clear explanation of how this experience influenced the author's research interests

Transition into specific research area that the author wants to pursue

As an undergraduate at Harvey Mudd College, I pursued a degree in engineering, graduating with high honors in the spring of 2019. In June 2019, I became a doctoral student in the Massachusetts Institute of Technology (MIT) - Woods Hole Oceanographic Institution (WHOI) Joint Program where I am part of the Aeronautical and Astronautical Engineering department at MIT and the Applied Ocean Physics and Engineering department at WHOI. The Joint Program combines my interests in oceans and space and enables me to draw on inspiration from both disciplines in my research. At WHOI, I am advised by [redacted] in the Chemical Sensing Lab, where I specialize in developing the next generation of low cost dissolved gas sensors, with a focus on the greenhouse gas methane. At MIT, I am additionally advised by [redacted]. By researching jointly with these two institutions, I am able to collaborate with ocean engineers, climate scientists, marine chemists as well as colleagues in autonomy and controls.

Demonstrates ability to collaborate across a variety of disciplines

Though I have been driven by my interest in ocean science for a long time, it was my research as an undergraduate and as an intern with NASA that developed my specific technical interests in chemical sensing and spectroscopy, and provided the foundation for pursuing my PhD.

Clearly labeled required section

Intellectual Merit: At Harvey Mudd, I became well versed in engineering practices and developed an interdisciplinary approach to problems through diverse technical challenges. I established a strong foundation in chemistry, physics, and math through my core classes, a background which lends itself to the close tie between science and engineering in chemical sensing. In my senior year, **I led my capstone research team in a year-long project for City of Hope Cancer Research Center**. My team investigated the use of Raman spectroscopy for detecting breast cancer cells during tumor removal surgery, a capability that could eventually enable surgeons to ensure they leave no cancer cells behind and prevent the need for patients to require second surgeries. One of my main technical focuses in this project was in the fiber optic design of the handheld surgical probe. I designed, prototyped and tested components for attaching optical fibers to existing spectroscopy probe heads. I also led a team in designing optic fiber tips to produce a specifically desired scattering pattern. My contributions yielded successful results and were implemented in

Clear mention of leadership role

Quick description of overall project

Concrete description of author's own technical contributions

the final prototype, which my team presented to the surgeons and stakeholders at City of Hope. **I delivered a functional prototype of a handheld Raman spectrometer with capabilities for distinguishing breast cancer tissue**. **This project has now been passed on to City of Hope engineers who are working to patent this technology.** My team's research contributed to the scientific community as we presented an affordable and manufacturable optical sensing approach to the biomedical industry. My research demonstrated that the financial barrier set by the high cost of optical equipment can be circumvented via our techniques. Our approach in making an affordable method for detecting cancer in breast tissue can be explored for use in other parts of the body and for other disease applications. My research provided City of Hope with the intellectual property to start a business for commercializing this system, with aims to eventually sell it as a global and affordable solution to breast cancer cell detection. This experience directly translates to my current research in methane sensing, as it also relies on applied spectroscopic techniques and creating portable, affordable systems.

In the summer of 2018, I interned with NASA's Johnson Space Center through the Aerospace Corporation. In my primary project, **I designed and prototyped a carbon dioxide sensor system for the Neutral Buoyancy Laboratory spacesuit helmet**. I worked independently under the NASA spacesuit engineering team. Informed by my experience in electronics and sensor system design learned in my Harvey Mudd course work, I calibrated candidate sensors and tested them under normal operating conditions in a suit, ultimately creating a demonstrative prototype. At the end of my summer, **I presented my prototype and recommendations to my NASA and Aerospace Corporation advising departments**. My research helped to reveal the limitations of commercial sensors under the humid and high-pressure environmental conditions of a spacesuit and I presented different avenues to approach this issue. From this research, I came to appreciate both the importance of chemical sensing for environmental monitoring, and the need to expand the capabilities of small and affordable sensors. Through this experience, I developed skills in self led research techniques and project management methods that will have application to my PhD research.

While at NASA, I also assisted in research with their Human Interface Branch. In my role, I designed a testing regime to evaluate proposed LED options to replace the existing spacesuit helmet lighting for NASA's advanced spacesuit (xEMU). I independently wrote a test plan and conducted the testing. After the testing, I compiled the results in a report detailing the methods and findings to share with NASA engineers. **The testing, iteration, and data analysis I performed directly influenced NASA's official decision to use a new light design for the xEMU**. This project taught me the power of documenting and representing your work and research. This project hinged on the communication of results and I gained insight into how to most effectively achieve that. This experience will inform my PhD research process, especially in crafting well written and communicative research papers.

My research experiences with NASA and City of Hope awakened in me a passion and excitement for the intersection of science and engineering required for chemical sensing. My favorite aspect of my previous research was seeing how optics and spectroscopy can take chemical phenomena that are invisible to our eye, like molecular bonds in the case of Raman spectroscopy, and reveal them. I feel like an explorer trying to navigate by the stars, but when clouds and urban light obscure my view of the night sky, I have to fashion my own special telescope to reveal the path. In the pursuit of my passions, I find myself a perfect fit in [redacted]'s Chemical Sensing Lab. The applications of my research prior to graduate school have been outside of ocean

Use of bold to highlight clear description of research outcome

Explicitly stated broader impact of research project

Connection between past experience and current research goals

Clear description of research project and author's contributions

Excellent example of practical and impactful research; focuses on ability to work independently

Explicitly stated broader impact of research project

What the author learned from this project

What the author learned from this project - communication skills backed up by a concrete example.

Use of bold to highlight clear description of research outcome

Connecting this experience to future work

Circles back to earlier themes of interdisciplinary research and passion for developing instruments

science; however, the engineering and scientific principles driving them directly translate to the ocean chemical sensing research I have begun.

Clearly labeled required section

Broader Impacts: Having female mentors and being a mentor myself was integral to my success and happiness as an undergraduate student. Being able to look up to someone like myself and learn about their journey, successes, and challenges has always been uplifting, and this is what drove me to be a mentor to younger students. While an undergraduate, I worked as a site coordinator for a program called STEAM:Coders, which provides free coding classes to children who are underrepresented in the STEM field. I orchestrated the program alongside the coding teachers and led the administration side, interfacing with both the students and their parents. For two years, I additionally volunteered for Science Bus, a program in which I visited the same local 5th grade classroom to teach science lessons weekly. It was rewarding to find ways to engage young students with science topics that they would not have otherwise been exposed to in their curriculum. I prepared live demonstrations and hands-on experiments, exploring projects from balloon powered hovercrafts to petri-dish bacteria colonies. At WHOI, I plan to participate as a mentor for the Girls in Ocean Engineering and Science (GOES) summer program for middle school girls as well as aid in the advisement of summer undergraduate researchers.

Concrete examples of past outreach work with details about personal contributions

Statement of personal takeaway from this experience

Future plans to continue this work

Through my participation with the Harvey Mudd chapter of the Society of Women Engineers (SWE), I was a mentor to a junior member. Currently I participate in MIT's Mentor Advocate Partnership (MAP) program through the Office of Minority Education where I have the opportunity to mentor a first year undergraduate as she navigates her first year at MIT. As a woman in engineering, I hope to help younger women see themselves in similar roles in the future and to continue increasing the percentage of women of all backgrounds in STEM.

Succinct summary of author's broader impact goal

Summary paragraph reiterates previous content of the statement

Future Goals: In college, I developed as an engineer and as a person and now I am thrilled to be starting down my path of graduate research. In my PhD program, I strive to continue finding a sense of purpose and passion in my work and to constantly revisit my goals and motivations. My big-picture goal in life is to make a meaningful impact on the preservation of our planet and the life on it. I see myself achieving this goal first through a PhD thesis that advances the capabilities of ocean chemical sensing with specific application to better understanding the global methane cycle and changing Arctic and ocean climates. After completing my graduate work, I aspire to become a professor at a research institution where I can lead my own research while also contributing to the education of students and future engineers. The NSF Graduate Research Fellowship will empower me to conduct my research to my full potential and take full advantage of opportunities like deployments and field testing.

High-level mission

Specific research expertise

long-term career ambition

Closes with statement of the value of this fellowship for achieving the author's goals