Personal Statement: I grew up in Plattsburgh, NY – a town smaller than most universities – and the public high school I attended had correspondingly few resources. The only real opportunity to research and engineer was my school's Science Olympiad club, so I immersed myself fully. When I joined the team, which competed in event-based science and engineering contests, it had never performed better than 48th of the 54 teams in the annual state competition, and no individual had ever won a state medal. But by the time I graduated, after serving as co-President and co-Captain, our team consistently placed well in the state, won the small school award despite being half of the qualifying size, and won dozens of state medals. I led the charge, as the most decorated Science Olympiad competitor ever to hail from our region of the state.

From my experience in Science Olympiad, I learned three things. Firstly, I learned that my future is in robotics: in one Science Olympiad event, I created a robotic arm to sort objects into different bins, and fell in love with the process of creating a system that could think and act for itself. Secondly, I learned the importance of programs such as Science Olympiad that enrich education with practical experiences and introduce students to new fields and pursuits; without Science Olympiad, I may never have known the passion I held for robotics. Thirdly, I discovered that leading a team of ambitious people fulfills me: the joy I took in the long hours working with my fellow students toward a common goal, and in the successes and even failures along the way, showed me that I must aspire to lead in my future field.

These three lessons have driven the direction of my education. To pursue robotics, I sought out a tier 1 research university, University at Buffalo (UB), where I was awarded a full Presidential Scholarship to attend. I majored in Mechanical Engineering, and minored in Computer Science and Mathematics – the fields necessary to build the brains and bodies of robots – and I got involved in research as quickly as possible. By my second month at UB, I was involved with research in smart actuators for unmanned aerial vehicles, and by my second year, I was directly involved in researching robotics, with the Napp research group.

To pursue my inspiration to foster programs that promote immersion in STEM fields, I volunteered in the Buffalo Public Schools, helping to run a Science Olympiad program in an underperforming school, coordinating several volunteer outreach and tutoring efforts to other schools, and working with organizations that promote college access.

To expand my leadership experience, I worked at the helm of diverse groups: I founded and served as president of UB's Pi Tau Sigma chapter, a mechanical engineering honors society. I served as the music director of UB's co-ed a cappella group, The Enchords, leading rehearsals and putting together performances, and I led the viola section of the UB Symphony Orchestra. And finally, I headed a group of honors scholars at UB in creating a partnership with a Buffalo Public School.

My work has led me to perform in concert halls, present in conferences at my own university and at top robotics research universities, and to coordinate networks of volunteers in urban public schools. It has enabled me to independently write award-winning papers, and to work with graduate students in my labs to submit conference articles, two of which are currently under review. It has helped me to earn the **Barry Goldwater Scholarship**. But most importantly, my work has led me to the career that will allow me to contribute to the world as best I can for the rest of my life. As the leader of an academic research group in robotics, and in leading efforts in research and educational outreach, I can combine the three passions I have fostered throughout my undergraduate education. Earning a Ph.D. in robotics is the only way to equip myself for this future.

Relevant Background/Intellectual Merit: The path to this career formed at UB, with the Napp research group, and during the summers in research groups from coast to coast – in these labs, I probed different areas within the field of robotics, and learned how to be a researcher. With each new project, I delved deeper into the literature and neared the boundary of the field, and became more enthralled by the work. In a research setting, where I was not only developing physical robot systems, but also the control systems that drove them towards solving real problems that affect people's lives, I felt a deep sense of satisfaction and connection to the work.

In the Napp research group, I first immersed myself in the world of robotics, joining a robotic construction research project right at its inception. The eventual goal was to build structures with complete autonomy for applications in disaster areas and other environments unsuitable for humans. I developed a mobile robotic arm using inexpensive, off-the-shelf components, which we used to create an end-to-end system to autonomously construct an access ramp. Given only an inaccessible goal location, the robot builds a navigable ramp using amorphous bags scavenged from its environment. The two-year work culminated this fall in a paper, which I helped author, that is currently under review for publication in the International Conference on Robotics and Automation. Additionally, I will be presenting the work at the Northeast Robotics Colloquium and the Naval Academy Science and Engineering Conference this fall.

My ongoing work in the Napp research lab is another autonomous end-to-end system, this one for creating a robotic gripper that is mechanically optimized for a given task. Presently, there exist several models of fully 3D-printable grippers, but they do not take advantage of the full capabilities of 3D printing: when creating a one-off device on a printer, the device can be fully customized at no extra cost. My system would take care of the design aspect, automatically generating an optimized gripper design in printable format given a set of user requirements. The system has the potential to improve research and industrial projects in many applications where robots are used, because in these applications, where oftentimes a robot repeats one task ad infinitum, an optimized gripper could greatly increase effectiveness. I wrote a paper on this work, for which I was honored with **second prize in the Silent Hoist and Crane Materials Handling Paper Competition**.

Additionally, I further explored the world of robotics at two REUs. At Oregon State University, I learned of the rapidly growing field of soft robotics, and created an additive manufacturing system for automatically integrating electronic circuits into these malleable machines. I was able to present my specific contributions to the project at a robotics conference at Cornell University.

At UMD, I applied dynamics analysis to the world's smallest walking robot. I created data-informed mathematical models of milligram-scale robot walking and running, and helped move towards an understanding of locomotion at this scale – an understanding that could lead to great strides in robot locomotion. For this work, my graduate mentor and I recently submitted a paper to the Micro Electro Mechanical Systems Conference (MEMS).

Broader Impact: Although my research inspired me intellectually, it did not offer an opportunity to promote STEM education as directly as I hoped. To gain experience working with and administering such programs, I became involved with educational outreach in the Buffalo community. Initially, I took part in the many unique connections UB has with the Buffalo Public Schools (BPS), but I soon began working with community leaders to grow these connections and build new ones.

My first experience in the BPS was with the Interdisciplinary Science and Engineering Partnership (ISEP), an NSF-funded program that focuses on improving the STEM education of

young students in the BPS. As part of the program, I volunteered biweekly in School #31, an underperforming middle school where many students were never given an opportunity to succeed: some were stuck perpetually behind, with no resources to catch them up, while others struggled with drugs, sex, and incarceration of friends and peers – issues that should not be on a middle schooler's mind. These kids were never given a chance, and the repercussions are far-reaching in their lives and in our society.

In that time spent volunteering, I realized two things: I am deeply compelled to work towards bettering educational opportunities for all students, not only those who were fortunate enough to attend a good high school. But secondly, I learned that I wanted to foster programs that dug deeper than only tutoring in schools: as a tutor, I was doing great work, but I was only applying a patch. In my second year at UB, I tried to make a more lasting impact: I coordinated and secured funding for a partnership between Hutchinson Technical Public High school and the UB Honors College. Through this partnership, we have brought a large group of high school students to UB, to learn about the college experience and application process. Additionally, we spent a year working individually with refugee and high-needs students towards success on the Regents exams that decide graduation in New York.

Through this partnership, I learned the difficulty of allocating resources best to those who need them. We were effective when working with students with greater need, but our time was poorly spent with many students who needed no help at all. However, our program in bringing students to UB was successful in showing students a day in the life of a college student, and making college seem more accessible and less intimidating.

Going forward, I plan to pursue these two approaches: targeted one-on-one work with high-needs students, and programs to make college more accessible and tangible. This year, I am working with the FAFSA Completion Project, which has increased FAFSA completion by more than 60% in the BPS, teaching students that they can afford to attend college. But in my future career as the leader of a research lab, the real work lies: I will establish a program that increases college attendance in STEM fields through experiences in research labs and through one-on-one academic help.

For my work in the BPS, I earned the **Mechanical and Aerospace Engineering Humanitarian Award** from my university.

I believe that bringing better education to students with few opportunities is one of the most important services our society must provide, and I am grateful to learn from these students, and help to give them the chance they deserve.

Future Goals: By combining my experience with additive manufacturing, distributed system control, walking robot dynamics, and alternative robotics fields, I hope to lead a team of researchers to create systems of rapidly and autonomously manufactured robots that can reliably and inexpensively explore unknown and dangerous environments, and work together to accomplish goals in these environments. This could range from a team of nano-robots exploring the human body, to small magnetic walking robots inspecting a bridge for faults, to groups of robots exploring and building infrastructure for humans in undiscovered extraterrestrial areas.

In addition to leading this research effort in a university setting, I hope to continue my work in education. From the position of a university professor, I will lead and coordinate programs to engage underprivileged students in STEM topics, expose high school students to research and engineering opportunities, and introduce robotics to kids.

The NSF-GRFP will give me the opportunity to devote all of my energy to these pursuits while earning my Ph.D., so that I can enter my career equipped to lead in research and in education.