Personal Statement

I first became fascinated with cars in high school, while attending the COSMOS summer science program at UC Davis. Although the four-week program covered several topics within mechanical engineering, I found myself most interested in the automotive applications. I was amazed at the level of engineering that went into making such a complicated mechanical system run smoothly and reliably, with relatively little maintenance. Inspired by this, I joined the Formula SAE team when I came to UC Berkeley as a freshman, helping to design and build a small formula-style race car. For four years, I thrived under the FSAE experience of working closely with a team of students, starting from the design/analysis stage all the way through to manufacturing and testing of the final product.

During my time on the team, I learned much more about all the systems that allow the car to run as a whole. The engine system was perhaps the most peculiar, because many issues were often difficult to diagnose. One recurring problem was that we would always use more fuel than we expected. Our solution was to use a larger fuel tank, but this was not ideal since the extra weight robbed us of precious acceleration performance. This reflected similar concerns about fuel consumption in the automotive industry. When I began graduate school, I was eager to make an impact by addressing the question of how to reduce fuel consumption without sacrificing power and acceleration. I already understood the basics of how internal combustion engines worked, but I was curious to learn more.

At the same time, my interest in controls was sparked while taking a course on dynamic systems and feedback. I remember being surprised when I first realized how often controls are taken for granted and sometimes even forgotten, even though they are crucial for maintaining the stability and good performance of so many systems. For example, I had spent a lot of time tuning the engine control maps on the FSAE team, but I realized that most people probably did not fully understand how critical this process was to ensure smooth operation of a car engine.

I decided to learn more about the intriguing subject of controls by joining Prof. Tomizuka's research lab. This gave me the opportunity to use controls in a robotics application, by working on a biologically-inspired robotic tail. The purpose of the tail was to provide orientation control for a small mobile robot while it was traveling over uncertain terrain. The tail had to be light yet still provide enough rotational inertia to counteract disturbances affecting the orientation of the robot. After designing and fabricating a prototype, I conducted system identification experiments to match the system to a model. I used the identified model to design a controller that would achieve my desired closed-loop response. When I implemented the controller on the actual system, I found that I did not need to modify the gains to achieve good performance.

I couldn't help but contrast this process with the engine tuning experience I had had in FSAE – where we tuned the control gains experimentally on a map of operating conditions, with almost no knowledge of a system model, then continued to adjust them months after the initial tuning stage was complete. While this was adequate for FSAE, I learned that this experimental tuning method is still the norm even in the automotive industry. This process is time-consuming and any changes to the mechanical design of the engine require a complete re-tune. Furthermore, most of the control loops in an engine system (e.g. torque, emissions) are run independently. I felt that utilizing an engine model could help to reduce the effort needed for experimental tuning and shed light on a method to integrate the control loops.

My FSAE experience has also helped me to develop strong leadership skills. As the team leader, I facilitated discussions among the subteam leaders to ensure smooth operation of the entire project and to avoid miscommunications which would lead to conflicts. I also maintained the team's connections with corporate sponsors, securing donations of funds and materials necessary to build a race car. Moreover, as a female engineer leading the team, I wanted to inspire other women pursuing careers in science and engineering. I promoted the team at events hosted by the Society of Women Engineers and was able to convince several women to join the team. Additionally, I was a volunteer for the Mechanical Engineering department each year at Cal Day – when hundreds of prospective students would visit the UC Berkeley campus – and encouraged many young women to consider a major in engineering, using FSAE as an example of the kind of project they could work on.

As the FSAE team leader, I also gained plenty of teaching experience, although not in the conventional sense of tutoring course material. One of the major challenges that we faced was how to retain knowledge within the team. During my first two years on the team, the design of each system was led by an experienced member, while the newer members worked mostly on manufacturing. This created issues when the senior members graduated and left the team, and the new subteam leaders were at a loss at how to proceed. When I became the team leader in my junior year, I instituted a new teacher/apprentice system, in which the experienced subteam leaders (myself included) would guide newer members through the entire design process, so that the newer members would be prepared to become subteam leaders the following year.

Through this experience of training students, I came to truly appreciate the importance of effective teaching. Not only did we have to train the newer members, but we had to do it in a way that kept them engaged and committed to the project. Admittedly, this was not an easy task, especially when some of the experienced members would get frustrated when the new members "just didn't get it." In these situations, I reminded them that the time we spent teaching the new members was an important investment in the team's future, and that we had to be patient if the new members did not pick up knowledge right away. Even with these occasional difficulties, I personally enjoyed the process of training the new members, because I could see that they were excited when they finally mastered a new skill. Today, as an alumna of the team, I still continue to mentor the current team as they face their own challenges.

This principle of passing on knowledge was crucial for ensuring continuity of our team, but it applies in a much broader context as well. Particularly within the academic community, I believe that instructors can teach students most effectively when they make the material engaging and relevant to real-world scenarios, and when they are patient in guiding students who may not grasp difficult concepts immediately. Over the course of my graduate studies, I intend to follow this methodology to teach what I know to undergraduates who will be helping me with the experimental setup for my research. Since controls is an essential aspect of engineering that few engineering students are even aware of until halfway through college, I hope to expose the undergraduate researchers to material that they will not have seen in their classes, and moreover show them why controls is so important.

My experience in Formula SAE, as well as in my other past projects and research, has allowed me to develop the skill set needed to conduct my research on turbocharged engine control. I have also developed strong leadership and effective teaching skills, and I hope to continue to do so during my graduate studies. After obtaining my Ph.D., I plan to be a professor so that I may continue to work at the leading edge of automotive research to benefit society, and also so that I may pass on my knowledge to a generation of future engineers. The NSF Graduate Research Fellowship will provide me with the financial resources to complete my graduate research and make an impact in the automotive industry and the academic community.