My interest in engineering is relatively recent. Like many of my peers, I had only vague ideas about majors and careers after high school. On the recommendation of my guidance counselor, I listed "engineering - undecided" on my college applications. I did well in, and enjoyed, math and science, but the same could be said for most of my classes. After choosing to enroll at the University of Delaware, I declared chemical engineering mostly for the strong reputation of Delaware's program. By the time my freshman year was over, however, my interest in engineering began to wane. To my knowledge, none of my engineering peers had the spontaneous dorm-room conversations that, according to university marketing departments, are endemic amongst budding political science, anthropology, and even quantum physics students. My failure to appreciate the necessity of the fundamentals left me disappointed in engineering as an exciting profession.

As college progressed, however, I slowly began to see my chosen discipline in a new light. Through undergraduate research, in particular, I came to relish the excitement of turning ideas to reality. My research revolved around a novel application of thermoelectric materials, which have long held promise as a critical piece of the sustainable-energy puzzle. The benefits of thermoelectric power are numerous: they capture energy from waste heat (such as that of industrial processes and automobile exhaust) and naturally-occurring thermal gradients (such as geothermal energy), have a small size, degrade slowly, generally consist of nontoxic materials, and operate silently. However, their widespread adaptation has been limited by their low power outputs and efficiencies. Although a large number of thermoelectric applications have been considered, investigated, and commercialized, the thermal driving force remains the same in each: a steady-state, spatial temperature gradient, such as that between automobile exhaust and ambient air. My project, advised primarily by Dr. Joshua Zide as well as by Dr. Ajay Prasad, aimed to model and build devices that convert periodic variations in temperature into spatial temperature gradients for thermoelectric power generation. This type of power is ideal for sensors and other low-power electronics.

Over the past three years, my problem-solving capabilities and personal and professional development dramatically accelerated as a direct result of research. For example, we were interested in adding a simple solar simulator to our experimental apparatus to quantify the effect of solar radiation on our devices, but commercial options ran for sums well outside our research budget. The simulator had to match the frequency, intensity, and spectrum profiles of the sun; simply sinusoidally adjusting the power to the bulb would skew the radiation spectrum. I designed a pulse-width modulation program with a sinusoidally-varying duty cycle in LabVIEW and connected it to a LabJack and a halogen lightbulb; the result was a suitable solar simulator at a fraction of the cost. Experiences like these spurred my passion for hands-on engineering and problem solving. Additionally, through both numerical and experimental simulations, I have developed a sense of the process of engineering design – tweaking rod configurations, fine-tuning truncation distances, and toying with degrees of oxidation to wring every last milliwatt of power from each device. Rather than being tedious or daunting, however, the process of iterating to convergence was a game scored by cost and elegance. Some of the components of the experimental devices include fortune-telling crystal balls and fabric from the local arts-and-crafts store. I also learned to communicate my results to both technical and nontechnical audiences. My research has contributed to three publications in technical journals, and I have presented at conferences from Indiana to Islamabad.

Additional experience contributed to this reversal. Coursework, particularly design projects, demonstrated the power and subtlety of making assumptions with limited information. Can we assume the demand for propylene glycol in 2020 increases proportionally with projected natural gas demand, and what are the consequences if we overdesign the manufacturing facility? Can we assume our oil pipeline will not be targeted by drunken caribou hunters, as the Trans-Alaska Pipeline was in 2001, and what are the implications if we are wrong? Additionally, interning with DuPont has illustrated the challenges of good design when squeezed by both shareholder demands for quarterly profits and a public commitment to safety, health, and the environment, especially in an industry traditionally viewed as callously indifferent to these concerns. Is swapping a carcinogenic coolant with a known global warming agent a good tradeoff? At what capital cost does implementing a nontoxic, environmental coolant become unreasonable? For me, these questions represent philosophy with numbers, as quantifying safety, environmental, and geopolitical attributes reflects our judgment of their value.

I plan to be an engineer developing technologies that dramatically improve peoples' lives, such as increasing access to fresh water and clean energy. I refer to "developing" in the traditional R&D sense of bringing proven research to market; my work will likely be performed in either an industrial laboratory or a start-up setting. To this end, graduate studies in materials science and engineering will immerse me in a fascinating interdisciplinary field primarily focused on applied research. I am convinced that many of this century's greatest innovations in energy and water access will come from the field of materials science, including distributed energy, localized structural materials, and passive water treatment. I believe electrochemistry is the key to enabling advances in renewable energy, as intermittent power sources such as solar and wind cannot be integrated into the grid without dynamic and cost-effective storage systems to distribute supply. I plan on developing deep expertise in the fundamentals of battery science in graduate school and then apply this experience towards scale-up and commercialization of promising battery technologies and other materials science innovations.

Accordingly, Stanford Materials Science & Engineering is the ideal fit for my career objectives. Stanford MSE's top-ranked graduate program is known by my Delaware professors to be successful, challenging, and interdisciplinary. Many Stanford MSE faculty are actively engaged in electrochemical research; Dr. William Chueh's battery imaging research and Dr. Yi Cui's research in nanomaterials for battery applications are particularly attractive topics. I also hope to collaborate with Dr. Tom Jaramillo (Stanford Chemical Engineering) on photoelectrochemistry. Additionally, Stanford's storied history and culture of applied innovation are well-suited for my interest in technology development. Finally, I would be remiss if I failed to mention Stanford's sunny, vibrant Bay Area location and its proximity to both San Francisco and expansive biking trails as personally appealing attributes of the school.