Chassis Plans Leadership in Engineering Scholarship
Grace Bushnell
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Prompt: In addition to a solid education, what is the most important trait for tomorrow's engineers to have?

Being communicative is the most important trait for the engineers of tomorrow to possess. Whether engineers are employed as corporate professionals, patent law experts or research investigators in academia, their careers and project outcomes hinge on how well they communicate. This includes communication to coworkers, colleagues and peers, those in other disciplines, management, and the general public. In my tenure as a biomedical engineering undergraduate and graduate student, I have already witnessed the effect that communication, or the lack of communication, has on careers, including my own.

Communicating with coworkers is perhaps the most obvious of these key interactions for engineers. Team-based engineering is the gold standard for both industry and research because a high-functioning and communicating team can work together to produce results far beyond the scope of an individual working alone. Team brainstorming fosters creative environments that produce new ideas. New ideas provide the spark that can change the direction of a project, allow for invention, and make a company or research program successful. Alternatively, the lack of a creative environment results in stagnation. Teamwork and team-based projects that foster creativity ultimately result in discovery, progress, and success for both the institution and individuals involved.

I have experienced firsthand the successes and failures of engineering teams brought about through communication. As a freshman I worked on an engineering team to create a product to help stroke patients with aphasia. Our team did not communicate well enough to coordinate tasks and as a result, we barely finished our project on time and the results were sub-par. Conversely, as a senior I led a very high-functioning capstone design team. As a result of our successful communication as a team, we were able to set and accomplish goals far beyond the scope of the class. These included collaboration with a neurosurgeon, publication of our results in *Neurosurgery* and award of first place for the Mickelson Prize for Innovation and Creativity – an award open to all seniors in the entire College of Engineering. As a graduate student in biomedical engineering, I am also part of a high-functioning collaborative team within my research group dubbed “Team Tumor,” consisting of post-doctoral fellows, graduate students, and undergraduates. Similar to my senior project experience, close collaboration and effective communication allows us to successfully execute a very ambitious research program. The product of this successful research has been the development of a polymer implant that attracts metastatic cancer, with the major goal of translation to the clinic to serve as a diagnostic device and therapeutic tool. This tool will ultimately result in increased survival in patients with metastatic cancer. With such lofty goals, effective team communication will continue to be vital to our success.

Communicating with colleagues who are not a part of an engineer’s immediate team is also extremely important. The ability to share knowledge with those of a similar level of technical expertise, but little or no knowledge of the project details, enables suggestions and feedback from an outside perspective. Communication between discrete engineering teams is vital for integration of different parts of a product in industry, a painful lesson GM has learned through the loss of lives and lawsuits surrounding their faulty ignition. In this case an engineer did not properly report to colleagues the part change and subsequent failures were difficult to diagnose. Similarly, in research, communication across different groups and fields is paramount to fruitful research programs. This is especially relevant in biomedical research that exists at the intersection of biology, chemistry, physics, engineering, and medicine.

In my career I have already faced the challenge of collaboration with scientists, engineers, and clinicians who work outside my field of expertise. These interactions have been demanding, but have also proved to be rewarding. As an undergrad, I first experienced this through collaboration with a neurosurgeon for my capstone design project. Our “well-oiled machine” of a team was, at first, stymied by the challenge

of communicating engineering concepts with clinicians and understanding the medical terminology being directed at us. Following our first meeting, with significant confusion on both sides, we sat down as a team and assessed how we could make future interaction more successful. We decided to minimize our use of engineering terminology and focus on the project elements that were directly relevant to the doctors and their patients. Combining this approach with our heightened awareness of the inherent mismatch between how doctors and engineers communicate was enough to ensure that the rest of our conversations were clear and productive. As a graduate student, I have taken these lessons and applied them to my current collaborations with a surgical oncologist and a post-doctoral fellow in biopharmaceutical sciences. The lessons learned have served me well and each time we meet, I learn more about communicating with people outside my field.

Finally, the most important level of communication for engineers and scientists is a dialogue with the general public. Possessing technical knowledge puts engineers in a position of power, one that comes with the responsibility of communicating that knowledge effectively. This includes the ability to communicate technical details to a non-technical audience while serving as an expert witness, applying for venture capital funding, writing a grant to a funding agency, or simply mentoring an aspiring engineer.

I am still early in my career and as a result have not been an expert witness or applied for venture capital funding. However, I have applied for and been awarded funding in the form of the National Science Foundation Graduate Research Fellowship Program. Additionally, I have presented my work to the public and served as a mentor. My first experience with biomedical research culminated in a public presentation about my summer project. As someone new to the science and the research it was relatively easy to explain what I had learned to people with no science or engineering background. All I had to do was think back to the short time earlier when my experience was on par with the general public. However, as my education-level and research have become more advanced, it has become much more difficult to put myself into my 18-year-old frame of reference. As I've moved forward in my career it has become more challenging to explain to family and friends exactly what I do in the lab. But just because it is difficult, doesn't mean it's not worth trying to do well. The experience that challenged me to do this was mentoring a high school student who was interested in science and engineering. A large portion of our interaction was talking about my research and explaining it in a way that made sense to a 16-year-old. It was incredibly difficult to do and I found myself choosing my words infinitely more carefully than if I was speaking to a colleague. However, each question the student asked was an affirmation that I was on the right track and was succeeding in nurturing his interest in the details while still providing information at a level that he could understand. After one particular two-hour, exhausting discussion, my brain felt as though its wheels were still spinning, but I was energized. I had successfully communicated my work and saw it spark an interest in and resonate with my mentee, achieving the best reward I could imagine. I resolved to continue to mentor young students to benefit both of us and as a way to "pay-it-forward" in my career. I know I will have many future opportunities to communicate my work to the general public and plan to augment my story-telling nature with additional expertise gained through experience.

The stereotypical traits engineers and scientists possess include being socially awkward, single-minded, and poor communicators. In contrast, the most successful engineers that I know are outgoing, social people, comfortable with communicating their work on all levels. I also feel strongly that successful communication has been vital to my career success so far. As a result, I would argue that the most important trait that tomorrow's engineers should cultivate is the ability to communicate well and to people with all levels of technical knowledge.