

Thinking Like an Engineer

Grand Challenge Scholars Program Reflection: Theme of Security

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B.S. Engineering: Electromechanical Systems

This Portfolio is submitted in partial fulfillment of the Olin Grand Challenge Scholars Program.

Abstract:

When I define the words “engineer” and “entrepreneur,” and then compare myself against those definitions, often find in myself almost all of their attributes. Yet I don’t consider myself either of these. Why not?

I wrote this portfolio to try to answer that question. In writing it, I found an organic feedback loop between my goals shaping my actions and my actions shaping my goals. While reflecting, I also found that the GCSP pillars of Service, Interdisciplinary Learning, Global Dimension, Entrepreneurship, and Research had woven themselves throughout.

As of graduation, this progression has led to a strong identification with an engineering mindset and an international, security-based focus. Someday I may feel like an engineer, but for now I’m content to think like one, and to one day use the engineering toolset to make positive change in the world.

I've always been lucky, even when it didn't always look like it. I was born seven weeks early, but I happened to be only a short helicopter ride from Dartmouth's brand new NICU ward. As my mom described it, "the paint was still drying on the walls when we got there." And yet, almost five days after I was born, they were able to take enough tubes out of me that I could be held. If I had been born a few months earlier, or a little further away, I wouldn't have been able to get the top-notch care I got. Already, luck was on my side.

Over the next 16 years, I moved seven times, to a half-dozen states. If you had tried to tell eight-year old, or twelve-year old, or even sixteen-year old me that I would one day look back and say that yes, even this, was lucky, I would have laughed at you every time. Or at least criticized your clear misunderstanding of the word "lucky." There was no way moving this often was even fair, let alone lucky.

But it was lucky – for a few reasons. Even at the time I could see that I made friends quicker than my peers, and I learned at a young age how to have a discussion with almost anyone. It wasn't until 2008, though, that I learned a much deeper lesson about fortune. Every time we had moved, it had been because of my dad's job. I'd often hated moving, but it never occurred to me that every time we did so meant that he *had* a job. The 2008 Recession hit halfway through High School, and with it came another move. One that we were lucky to "have" to make.

During my junior year, I started thinking about college. Even having lived in so much of the country, I had no idea where I wanted to go. On top of that, I had no ideas about what I might want to study, either. With nothing to go on, my parents helped me create a list that might expose me to as much variety as we could think of, in hopes that this would unearth preferences. We plotted out a route from our house in Minnesota, around the Great Lakes to Vermont, south to Maryland, and back. Then, between my Junior and Senior year, my mother and I went on a three-week, whirlwind tour. While this failed to point in a direction of study, it did lead to a short list of schools to apply to. Seven, to be precise. Among these were two state schools, two liberal arts schools, two private universities, and Olin College of Engineering – my favorite of the bunch.

After applying, a conversation with a friend caused me to doubt my odds of acceptance. He told me there was no way I'd ever get in; after all, he'd gotten a perfect score on the ACT and he hadn't even made the wait list. I had done well, but definitely hadn't gotten a perfect score. I didn't stand a chance. And yet, as time went on, I convinced myself that this was the best school for me. I mentally built it up in my mind that getting a rejection from Olin would be the *worst thing ever*.

Eventually, the letter came. And it wasn't a yes. But it wasn't a no, either. I had been waitlisted, and given the option for guaranteed admission the following year. This was the biggest stroke of misfortune I'd befallen in a long time. It took some convincing, but my parents eventually agreed that if I could come up with a plan for the intervening year, I could accept the deferral.

Over the next week or two I crafted a plan where I would attend one of the liberal arts schools I had applied to. After all, while I'd built up Olin as the perfect school for me, it only offered engineering degrees – and I wasn't sure that's what I wanted to do. I was good at math and science, but I also really loved reading and writing and current affairs. Someone who liked all that probably wouldn't be happy as an engineer. I would probably be happier finding a way to combine my talents. And, if I decided that I wanted to pursue engineering after all, I could hardly go wrong – I could go to Olin after a year and spend a total of five years in school, or I could apply to a 3-2 program at the liberal arts school and still spend five years in school. Like moving, perhaps this wasn't so misfortunate after all.

Thus, my goal upon entering college was to pursue creative writing and physics degrees, so I could write textbooks that weren't so terribly boring. Then maybe more students would see physics as a fun subject, not a chore. And over the next two semesters, I had a lot of fun pursuing that goal; I took creative writing courses and journalism and documentary filmmaking, but also took physics and

computer science and discrete mathematics. I joined a fraternity and learned the value of a tight-knit community, and how much positive impact a small group could have on the lives of others. At the end of that first year, though, I had to assess all this against the opportunity to accept the deferred admission to Olin.

I initially tried to make the decision based on the academic opportunities at the two schools. This, unfortunately, got me almost nowhere. The content foci of the schools and their pedagogical methods were so different the comparison was almost meaningless. I ran into similar trouble trying to compare across social opportunities. Of course I was going to adapt and thrive at either school – I'd already learned that through years of moving around. The only meaningful comparison I could construct was around post-college job opportunities.

Regardless of the undergraduate experience at Olin, I still wasn't convinced that engineering was going to be interesting. My mental model of an engineer involved desk-bound work in a cubicle. It just seemed extremely constraining to limit my focus to something as 'narrow' as engineering. But the value of having a steady, family-supporting job was still fresh on my mind, even as the economy was showing signs of recovery. Olin graduates were going to Google, Microsoft, and Boeing in droves, and you couldn't go a week without reading an article promoting a STEM degree over one from the liberal arts. Although transferring wasn't going to get me closer to my goal of writing better textbooks, I couldn't justify not pursuing the engineering degree.

For that first year at Olin, I had much less of a long-term goal. Yes, I was going to become an engineer, but I didn't have that broader purpose I had when I was going to help students get better textbooks. Over the course of the first semester though, I connected strongly with Olin's core value of Service. This manifested first in my participation with SERV (Support, Encourage, and Recognize Volunteerism) our on-campus student-led group dedicated to coordinating community service opportunities for other students. As an elected member of this eight-person board, I was immediately able to help others, helping others. On top of that, while I wasn't the official communications director, I began sending almost all of the group's campus-wide emails. Though I was no longer moving towards my previous goal, I had naturally reframed my goal into one of using my writing talent to help others.

In that semester I also began to try to address what I saw as a key problem on campus – organization and security of communal equipment. Olin has an amazing culture of open access; tools, equipment, and even labs and machining facilities, are freely accessible to students almost 24/7. This freedom to work openly whenever inspiration strikes, I believe, has led to dozens of really neat student projects.

However, as with all community goods, there comes the inevitable entropy as tools don't make it home. During my first semester, I got very involved in one particular equipment repository known as the ME Stockroom. A heavily used but unpoliced space, the stockroom had nearly reached the point of unusability. Working with a faculty member, we began with the mindset that simply providing organization might cause students to see the stockroom as a place that was worth the effort of maintaining.

In my second semester I took a class called Principles of Engineering, where we were instructed to work in teams of four to "make something cool, with a non-trivial electrical, mechanical, and software component." This project had a lot of firsts for me: it was the first time I had such an open-ended prompt, the first time I worked with a team for almost two months straight on a single task, and my first taste of the challenges of systems integration. To select a project, most students picked things that looked neat or were fun to build. This led to many projects, like an automatic LEGO stacker or a cake decorator, which were really fun, but didn't have much of a purpose once the class was over. As my

team tried to pick a project, however, we wanted something that addressed a larger purpose, and the stockroom was firmly on my mind. We decided to try to create an automatic tool checkout system.

We quickly realized that the items that we stored in the ME stockroom were too varied to create an easy storage system, but that idea of creating something that could give back to the Olin community stuck with us. We pivoted to working with chemical storage, since the bottles were a more standardized shape and size. In this area, though, we found that the faculty in charge of chemicals on campus had avoided the problem of entropy – at the cost of locking down all of the chemicals. Their storage room was one of the most difficult to access on the entire campus.

But this one-size-fits-all lockdown didn't always make sense. Even non-hazardous chemicals like table salt were locked away. We designed our system to accommodate a tiered access approach, allowing distinctions to be drawn between non-hazardous, hazardous, and very hazardous materials. Also, the entire thing was designed to add no burden to the user above a normal chemical closet. When users swiped their ID card, the system would know which levels they had access to, open the appropriate doors, and detect when the doors were closed. It would then run a self-inventory. The user didn't need to remember to check anything out or back in; the system would automatically detect which chemical was missing or returned, and mark that against the ID that was used to open the doors.

In the end, our project was hamstrung by the low budget (elegant solutions were difficult to find for less than \$200) and the extreme inexperience of the team. We had, on average, three semesters of engineering experience a piece, and none of us were mechanical or software engineers. Nevertheless, I learned a great deal about properly scoping projects to the allotted time and budget, inter-team conflict resolution, and the importance of integrating systems early and often. Also, the ability to take a class project designed with the goal of increasing my personal knowledge, and gear it towards my larger desire to help others was a groundbreaking idea for me.

In the same semester, I got my first introduction to entrepreneurship. It came through a class called The Entrepreneurial Initiative (TEI), which was a rebranding of an earlier class, the Fundamentals of Business and Entrepreneurship (FBE). The rebranding came about due to a desire to teach students that entrepreneurship is about more than just building a business – something that was consistently lost amongst a culture where “entrepreneurship” and “tech startup” were basically synonymous.

The professor stressed that an entrepreneur wasn't just someone who started a business, but “a person who organizes and manages any enterprise, especially a business, usually with considerable initiative and risk.” This meant a person who organized a non-profit organization, or started a college, or any number of risky enterprises was still an entrepreneur. As long as a person was seeking out and responding to some kind of demand, and able to organize a solution to that demand, they might be considered an entrepreneur. And, in order to achieve this solution, an entrepreneur would almost certainly have to adapt, refine, or completely abandon their goals as they tried to best match their resources to their situation.

This was completely lost on me at the time. While the lessons were important, there were a few barriers keeping me from understanding them. The biggest was that this was not at all what I wanted to hear from the class. I was coming into the class with the mindset that it was going to teach me the fundamentals of how to successfully identify, start, and run a small business. It was neat that the definition of entrepreneur could be expanded to cover other kinds of initiatives, but I was just looking for a business class. Once I decided that the class wasn't going to cover the topics I wanted from it, I found it difficult to engage in the content it *was* trying to deliver.

Unfortunately, my response was neither unique, nor in the minority, and the professor interpreted the disengagement as a sign that he needed to do more to show that people doing social good through non-profits could be entrepreneurs as well. So, he pushed the class' focus to an extreme non-business orientation, barring any traditional businesses from the final projects. By the time he tried to introduce the concept of having highly flexible goals, I had already disengaged entirely. Thus, it wasn't

until several semesters later that I realized I had gotten any value, or retained any content, from the class whatsoever. Despite the disconnect between the professor and myself, I had subconsciously internalized the lesson of refining your goals as your circumstances shifted.

Over the summer between my first and second years at Olin, I had the opportunity to work on a joint education research project with an Olin faculty and a student and professor from Wellesley College. We had recorded several math professors' classes, and spent the summer quantifying trends in the students' and professors' speech. From this, we were able to create a series of frameworks to help the professors learn about how their teaching influenced, and was influenced by, their classroom culture.

While I had participated in, and even helped organize, events throughout my first year that focused on engineering education outreach, this was the first project for me that really formalized around an education theme. Continuing beyond this project, for each of my sophomore, junior, and senior years, I went on to work with a handful of high school groups to try and teach engineering and design concepts. Since I had almost no experience in the education field, every new project I took on in the space had a dual purpose, both helping pass my knowledge on to others, and building new skills at the same time.

The research project didn't just kick start my interest in education, but was also my first experience with Wellesley College, one of our partner schools. The following fall I began taking language classes there. Wellesley offers dozens of languages, so choosing which one to study was an in-depth process. At the time, I was just starting to think of what I might want to do upon leaving Olin, and what I should do while in school to set myself up for those outcomes.

During the year before Olin, I had become good friends with many journalism and history majors, and through these connections I became very interested in following the Arab Spring protests in North Africa and the Middle East. I also had studied French in high school. Because of these, I was highly interested in building up a skill set that would allow me to work in North Africa. Taking Arabic, then, seemed like the logical choice; I could use my language and engineering skills to help improve lives and strengthen these fledgling democracies whose social institutions had been repressed for so long. And, like with my decision to go to liberal arts school before Olin, there was little downside in choosing to study Arabic – at worst, I would gain an appreciation for a new language and culture. Thus, I started to loosely build up a new set of long-term goals; though they were closer to my previous goals than I initially realized. I wasn't abandoning the communication theme, but adding the ability to communicate across a new language.

After two semesters of studying Arabic, it became clear that with my other classes, I didn't have the time required to adequately study, let alone master, a language so different from English. However, I still wanted to know more of the history of the region, which I had the opportunity to take classes in at Wellesley. At the same time, my goals received a major push towards a security focus. At the spring career fair, I received information about the Navy Nuclear Propulsion Officer Candidate (NUPOC) program, and I was hooked. I found in this a way for someone with an engineering degree to avoid being chained to a cubicle desk. On top of that, I would be able to learn and develop leadership skills in a real-world, high-stakes position immediately upon graduation. How many 23 year-olds can be qualified to run a nuclear reactor? I immediately began the several-month-long application process, and in July of 2013 I enlisted in the Navy through this program.

It was also clear by the end of my sophomore year that the Arab Spring had fizzled out, and the Middle East had returned to its uneasy, pseudo-democratic regimes. The need for help in the region was still great, but it started looking less likely that I would be able to provide that help. However, service

members were still being sent to places like Iraq, Afghanistan, and Libya with considerable frequency – a trend that only seemed likely to accelerate as Syria descended into deeper conflict. Though I would never be deployed directly to the area, there was a real chance my future colleagues might be. It seemed less critical that I study Arabic – since the area speaks not only Arabic, but also Farsi, Pashto, and a dozen other local languages – but more critical than ever that I try to understand the historic, religious, and political drivers that continued to make this region unstable.

Initially, this led to a class on Islam’s role in shaping the history of the Middle East, and a seminar titled “Conflict and Peacemaking in the Middle East” which was an overview of the history of the Arab-Israeli conflict. These gave me a new understanding of the tensions and sources of conflict, and allowed me to place current events in their historical context. Over time, my classes transitioned beyond just the region into security more generally, with a focus on International Security. Collectively, the classes looked at the questions of why do we go to war, and how can we try to prevent it or, in the event that we can’t prevent it, minimize its harm.

Throughout this time, I didn’t halt my engineering growth either, though unlike most of my peers, I didn’t wind up focusing in on a specific discipline. Instead, I crafted my own concentration within Olin’s general engineering program: Electromechanical Systems. This path allowed me to take several courses in both mechanical and electrical engineering fundamentals, along with a couple systems-level design and analysis projects. In the same way that my humanities classes looked at the how and why, my engineering classes sought to address the fundamental trends in engineering; I was able to directly observe how a simple set of tools can be infinitely retooled to address an overwhelming array of seemingly diverse problems.

As I prepare to graduate, I find it more difficult than ever to answer the question “why did you decide to study engineering.” Whenever I try to define engineering, I invariably find that I “should” be an engineer. And yet, I find the label uncomfortable. While I’ve (happily) discovered my high school notions of engineers being chained to their desks were incorrect, I still find that the idea of being an engineer too limiting – the very statement “we will engineer a solution” implies, to me, a technical solution. I want to be able to solve problems in a much more holistic way, bringing together engineers and their technical expertise, but also writers and politicians and teachers with their many insights into what drives people.

And while trying to answer that question, I inadvertently stumbled into the question of what it means to be an entrepreneur. This is another label which I’ve never applied to myself, yet when I define an entrepreneur as “someone who constantly updates their goals in response to personal resources and perceived needs,” I find that I “should” be an entrepreneur, too. After all, I’ve been shifting and adapting my goals subconsciously for years.

I think, in the end, I chose to study engineering precisely because of this latent entrepreneurial thought process. The engineering skill set is primarily designed to solve problems and help humanity thrive. It happens to work in a very process-based, logic-oriented way, but is just one of many problem solving methods. What I ultimately want to do is help others, and the ability to think like an engineer gives me a powerful set of tools for doing that. Whether I label myself an engineer or not won’t take those tools away.