

Grand Challenge Scholars Portfolio
“Bridging World and Engineering”
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Grand Challenge: “Manage the Nitrogen Cycle”

Submitted in partial fulfillment of the requirements of the
Franklin W. Olin College Grand Challenge Scholars Program

This portfolio describes my work in the five areas required of Scholars by the Grand Challenge Scholars Program. I review my activities in those areas, their outcomes, and my growth as a result. I also reflect on the themes that unite my experiences.

I am definitely part of the early wave of Grand Challenge Scholars—we are still figuring out what this program means and what a student’s experience as part of it should be like. As a result, my portfolio is more discursive and less cohesive than might be ideal.

1. Grand Challenge Project

The Grand Challenge I have worked to address during my time at Olin College is to “manage the nitrogen cycle” by developing technologies for sustainable agriculture (including decreased fertilizer use). I have done this through my year-long Senior Capstone Program in Engineering (SCOPE) project, as a member and program manager (for one semester) of a team doing consulting work for the research division of AGCO.

The specifics of my SCOPE experience are protected by a non-disclosure agreement, but I can sketch the broad outlines here: A common solution to pests, diseases, or nutrient deficiencies in crops is blanket spraying—covering the entire field with chemicals (fertilizers or pesticides) indiscriminately. This causes many problems, including increased resistance to such chemicals and contamination of run-off water. My SCOPE team is investigating the possibility of using unmanned aerial vehicles (UAVs) to efficiently survey fields from above. Software or trained agrobiologists could then identify problem areas and the necessary treatment, which could be administered to only the areas that need it.

In just one year, my team is not going from problem to finished product, but we are researching existing solutions and building a prototype architecture to demonstrate UAV capabilities to AGCO and to serve as a basis for future research. We are identifying areas that need further research for a complete system to be developed and sold. We are also analyzing the potential financial benefits to farmers of UAV-based surveying and targeted spraying. In this way, we are working towards a solution that will both benefit the environment and be readily adopted because of its financial value.

My SCOPE experience was the longest-duration project I have been involved in, and also the project most specifically targeted to address a real problem. Especially when I served as the team’s program manager, I learned (through trial and error) about the type of planning required for a project of this scale—the weeks spent just discussing, researching, and scoping the project, and coming up with a plan for tackling it. It was also gratifying to work on a project I knew might become a commercial product that would have a positive environmental impact.

2. Interdisciplinary Experience

My entire time at Olin has been full of interdisciplinary experiences. A few examples:

- a. Like every Oliner, I took Design Nature, which uses biology as a source of inspiration for engineering and draws on the artistic skills of sketching and sculpture during the design process.
- b. Over the summer of 2010, I was a psychology research assistant for Jonathan Adler. My coding experience and facility with technology enabled me to expedite some of the research processes. Thus, I was able to combine my engineering skills with my critical reading (used in coding narratives) and psychology.
- c. For a little over a year, I was a technology consultant for the social networking start-up The Opera Insider, a site with forums, reviews, and events by and for aficionados and performers of opera. I provided feedback on their desired and existing user experiences (bringing to bear my own perspective as an opera performer and viewer) and suggested which technological solutions (site design elements, hosting choices, first-pass development strategies, etc.) would best help them achieve their vision for the website.
- d. For my final project in my Computer Architecture class, I compiled a monologue from various parts of plays by Bertolt Brecht, and I explored the conceptual similarities between computer architecture concepts and Brecht's theory of theater. My reading of the monologue can be found online (<http://www.youtube.com/watch?v=pC6RdoHoKNQ>) along with notes that more explicitly outline the theoretical connections between the two fields.

In my experience, interdisciplinarity is not an end in itself but a necessary means for accomplishing a goal. With the exception of my Computer Architecture project, the question going in was never "how can we make this interdisciplinary," but rather "how can we make an enjoyable, accurate shark-inspired toy" or "how can we most efficiently and effectively write this psychology paper" or "how can we most economically create the desired user experience and remain flexible and scalable." That interdisciplinary perspectives were needed to answer those questions was incidental. Sometimes answering those questions required acquiring new skills within or outside of engineering (Excel ability, knowledge of Web hosting options, accurate sketching, an understanding of Brecht's philosophy). In the usual Olin spirit, I recognized those needs as they arose and used available resources (professors, friends, internet, books) to address them.

Interdisciplinarity in engineering can come from two directions. Sometimes a problem begins as a non-engineering problem, and engineering helps to solve that problem. This was the case with my psychology research and is the case with emerging fields like computational literary analysis. At other times, a problem is very obviously an engineering problem (creating a website, building a robot, etc.), and fields beyond engineering can help to solve it. Non-engineering fields can here provide inspiration (e.g., biology in the case of my Design Nature project) or context (e.g., a user perspective in the case of The Opera Insider). Context is one of the lessons of the Grand Challenge Scholars Program, and it's one that is essential to modern engineers. Not every part of life needs to be optimized; not every inefficiency is a problem. Even if a problem truly exists, engineering is not always the answer. The GCSP is about identifying which problems are real and important and can be best addressed by engineering (perhaps in combination with other disciplines).

3. Entrepreneurial Experience

Like most Oliners, I have had many experiences with mini-entrepreneurship. I started a two-week business in the Foundations of Business and Entrepreneurship class, and I am currently in the process of trying to license a Systems class project to a larger company to be further developed and sold. However, my most sustained entrepreneurial experience at Olin has definitely been founding the Olin Opera Organization (OOO).

I entered Olin knowing that I was passionate about opera and also knowing that Olin had no organization of campus with the goal of developing and sustaining interest in opera as an art form. Near the end of my first year at Olin, I completed the necessary paperwork and founded OOO. Many new clubs at Olin fizzle out as their founders lose interest or become busy, but I determined not to let that happen in this case, and it did not. As the president of OOO, I have so far arranged group outings to nineteen operas, three musicals, and three ballets. I have identified and publicized operas that would be especially engaging for newcomers to the genre: In 2010, I brought seventeen students, most of whom had never seen an opera before, to a performance of *The Barber of Seville*. In addition, I have started an opera DVD library within the Olin library (with a collection of ten DVDs that will hopefully continue to grow) and served as a point person for questions about voice lessons and other opera-related opportunities in the area surrounding Olin.

It is my hope that OOO will continue after I leave Olin. (Good entrepreneurial ventures that have had time to grow should be able to survive the founder's departure.) To that end, I am currently searching for a new president of OOO and creating transition documentation to help guide him or her through my processes. This will include lists of opera companies in the area and their student ticket policies, advice on coordinating outings, an inventory of club DVDs and suggestion for future acquisitions, and opera-related contacts at Wellesley and Babson. OOO currently manages with a very low budget and relatively high engagement, and I hope my current planning will enable it to continue to exist and thrive in future years.

Starting OOO reinforced for me that many ventures can be started with no resources other than time and dedication. Although I did seek funding from Olin for some events, OOO could have operated financially independently (with students paying the full cost of their own tickets); the real necessary spark was a determined organizer to make things happen. This is true of profit-oriented entrepreneurial initiatives as well: With some exceptions, very little money is required to begin. Instead, passionate people who are willing to spend time are the foundation of success.

4. Global Awareness

When I entered Olin, I was trilingual (Japanese, Spanish, and English) and had already had an international experience, during which I spent a total of three months in Central America. I leave Olin even more globally aware: proficient in five languages (German

and Italian, in addition to the above ones) and in the process of learning a sixth language (French) and more extensively travelled.

I attended Japanese immersion elementary school and briefly visited Japan (acting as a translator for my grandmother) when I was seven years old. My adopted siblings (adopted when I was seven and they were five and eight) are from Guatemala; I learned Spanish by speaking to them. In high school, I spent two summers—for six weeks each—teaching at an elementary school in rural Honduras.

Upon reaching Olin, I began to seriously study opera singing. Around the same time, my interest in European literature and philosophy was growing. I realized that I needed to increase my language repertoire in order to fully explore my interests. Over the summer of 2010, I taught myself Italian. The following summer, I taught myself German. In both cases, I achieved advanced proficiency and was able to succeed in upper-level literature classes at Wellesley College following my period of self-study.

My language skills enabled me to have culturally immersive travel experiences. In the summer of 2011, I spent two-and-a-half weeks in Munich, living with a local family, wandering the city streets during the day and eating dinner with the family or attending theater in the evenings. I visited both tourist spots and local attractions and communicated almost exclusively in German. I learned through questions and experience about living in Bavaria—the school system, employment, the pace of life, etc.—and I picked up the accent, speech patterns, and mannerisms common to the region. My classmates in my German class the next semester asked me whether I was Bavarian!

In the winter of 2012–2013, I spent a month in Italy (Sorrento, Firenze, Roma, and Milano). In Sorrento, Roma, and Milano, I felt like a tourist—the sites and activities were clearly tourist-oriented, and our hosts tried to speak to us in English (and in Sorrento they spoke to each other in Neapolitan, so I could not even understand their conversations). However, for nearly two weeks in Firenze, we stayed with an artist and his wife in a small apartment near the center of town. Our hosts spoke almost no English, and our dinners with them consisted of long political and philosophical conversations (with me serving as the translator between them and my English-speaking father). During the days, we wandered the streets of Firenze, sometimes stopping to see museums or churches, but often simply window shopping and people watching. I felt very at home.

Neither in Germany nor in Italy did I “study abroad”—that comes next year, when I will earn my Master’s degree from the University of Cambridge in the United Kingdom. However, in both cases I felt I had more opportunity to observe life and interact with locals than I might have had if I were based at a university. In both Munich and Firenze, I lived and interacted extensively with local families. I was in Munich in August—the vacation month—so I was able to play with the neighbors’ children, go on excursions to castles and beaches with local families, and enjoy long, communal dinners in beer gardens or the backyard. I was in Italy in winter rather than the tourist season, so most of the people on the streets were Italian-speaking locals, and the atmosphere in restaurants and museums was more quotidian and less frantic than it might have otherwise been.

What struck me most about both of my experiences abroad was the pace of life. People seemed much less plugged into e-mail and social networks (yes, this was true even of people in their teens and twenties), and much more devoted to preparing and eating good meals, holding long conversations, and interacting with their neighbors. My host family in Munich rebuked me for “working too hard”—reading too much and learning vocabulary and grammar when I was not otherwise occupied—rather than taking my vacation time to simply enjoy myself and experience life. Stereotypes about Germany notwithstanding, that seemed to be a theme in Munich in August: relax. Fresh fruit stands and musicians dotted the streets downtown; it was not unusual to buy a box of berries and sit down on the pavement to eat them while admiring a string quartet. The streets were more bustling in Italy, but restaurants and houses had a similarly relaxed feel: a meal usually involved at least three courses and service was slow, so it could easily last three hours. No one seemed bothered by this or concerned about efficiency; it was merely an opportunity for conversation.

As a person who usually follows my Outlook calendar down to the minute, I took several lessons from my foreign experience. One was the realization (or at least the reminder) that relaxing—truly freeing myself from all meetings and obligations—for several weeks at a time greatly improves my productivity and creativity upon my return. Another was that conversation can be more valuable if I don’t approach it as a transaction. As an engineer, I sometimes try to optimize my human interactions for efficient information transfer. But the gains of my foreign experiences (improved language skills, a better understanding of politics and culture in other countries, amusing insights into foreign perspectives on the U.S., and a global network of friends) were not acquired through carefully worded questions and pithy answers, but rather through conversations that my new acquaintances and I shared purely for the joy of each other’s company.

5. Service Learning

My service learning experiences during my time in college have been Olin-centric. I believe the Olin model of project-based, interdisciplinary engineering education is a very good one, and that I can best help engineering education by helping Olin to thrive and by sharing Olin with others.

My two major service learning commitments—the Olin Volunteer Ambassadors League (OVAL) and the Olin Honor Board (HB)—fit this model.

As an OVAL member, I lead tours for prospective students, parents, employers, guidance counselors, and representatives from other colleges. I also host prospective students for overnight visit and speak on open house panels. I have been actively involved in all of these activities for the entirety of my four years at Olin. This is an activity that involves interacting with the outside world to share the positive aspects of the Olin model and to help students and parents understand whether it is a good model for them.

As an elected member of the HB this year, I work to increase awareness of the Honor Code—an essential part of Olin’s culture—and to ensure that it is functioning effectively. I also sit on the panel for cases of alleged Honor Code violations. The Honor Code is currently under review (being revised to improve the wording and to reflect the current student body’s principles), and the HB is also overseeing (though not directly running) that process.

I have also taken on smaller service projects throughout my time at Olin—mentoring a younger student for each of the past three years through the SIBBs program, participating in some Friday service time activities, consulting with a local FIRST LEGO League team, and donating many items to the annual SERV charity auction.

My dabbling in various SERV events taught me that altruism is not sufficient motivation for me. In order for service to be gratifying, I need to be excited about the work I am doing. Because of my enthusiasm for Olin, OVAL and the Honor Board are invigorating commitments. Spending two hours on a Friday afternoon to complete an isolated project is not. If I want to serve others effectively and enjoy doing so, I am better off taking on long-term projects with visible outcomes than attending small, organized events.

6. Active Participation in GCSP

Admittedly, I am late to commit to the GCSP. I wasn’t certain about compiling a portfolio and being a Grand Challenge Scholar until a few weeks ago. However, despite my uncertainty, I have been an active participant in GCSP activities ever since my first year at Olin.

My first year, I was a participant in the conversations that shaped the GCSP at Olin. I helped develop the standards and guidelines for the program when it was just beginning. I fell out of the loop at some point, but my interest in the GCSP was re-ignited by the Interesting Conversations series. I attended and participated in all of the talks I could—at least two thirds of them.

Because this is Olin, one of the most common Grand Challenge-related topics was personalized education: What in the Olin model works or doesn’t? How can we expand the Olin model? How can we make engineering education more effective for different types of students? How can we improve feedback channels in education? I can’t claim we found any brilliant answers (and there are all sorts of groups within and beyond Olin working on similar questions), but I spent quite a bit of time thinking about Olin’s education and shared my thinking with others. It was through these experiences that I also learned about myself as a learner, as well as about existing frameworks and efforts in the area of engineering education.

I learned some surprising things about myself during these conversations. Even compared to my Olin peers, I am unabashed about approaching professors with feedback. However, I am timid about starting technical projects with a lot of uncertainty and as a result often end up with non-technical roles on project teams—an outcome that both anecdotal and

empirical evidence suggests is correlated to my gender. (Olin has made efforts to decrease this correlation between gender and team role in some freshman classes, but Olin could do more in other contexts and many schools don't explicitly address the issue at all.) I enjoy a project-based approach to engineering education but have more confidence in structured, problem-sets-based environments, where I can more precisely assess the quality of my work and compare myself to others. These were all things I had probably noticed on some level before, but that I first consciously realized and articulated during Interesting Conversations.

7. Overall reflection

I cannot summarize my entire educational experience into a single, pretty story, but there are a few clear, common threads throughout my college years:

- **Engineering education:** Given that I come from a background of seven years in FIRST robotics, a program that engages students with STEM through intense, hands-on robotics competitions rather than traditional coursework, it is perhaps unsurprising that I care a lot about engineering education. I don't view myself as an innovator within engineering education: I have not taught, and I don't know what new techniques will work. (Can anyone know without trying them out?) Instead, my mission in the realm of engineering education is to find existing solutions and models, make them thrive, and spread them. This has been a theme in my participation in OVAL and even the Olin College Honor Board. I believe in many parts of Olin's model: hands-on learning, interdisciplinary education, the honor code, and the close community of students, to name a few examples. I want to make these aspects of the Olin experience even better and also to give more students the chance to learn about and experience them.
- **Bridging disciplines:** Engineering is not my only love and perhaps not even my most salient one. I am passionate about languages, theater, literature, philosophy, and opera as well. Much of my time at Olin has been spent trying to pursue these varied passions and combine them in some way. My reflection on "interdisciplinarity" mentioned several of my approaches to this, and the "global awareness" section could be considered more of the same—an attempt to improve in the areas of languages (especially those related to opera) and literature. I don't think it's possible to use all of these passions simultaneously in pursuit of a single goal, but my efforts to do so have pointed out areas in which I might make a difference by bridging several of them: technology-related ethics guidelines and policy; philosophy of mind of language as it is influenced by computing; appearances and influence of technology on literature, especially in the 1800s; critical analysis of the literary and theatrical purposes of stage machinery; even directing high-tech *Regie* (i.e., directorial concept-driven) theater or opera.
- **Projects:** This is most definitely a theme for every Olin student, and is certainly no more mine than anyone else's. Still, it has been a defining part of my Olin experience. My projects have been in many disciplines—engineering (my SCOPE project, a cake-decorating machine, a computer game, Design Nature toys, mathematical models of physical phenomena, a whale-surveying system, and many more); entrepreneurship (a wine tags company, starting new clubs at Olin, a

dorm plants company, an ill-starred attempt to physically archive Facebook pages, an in-progress plan to license an invention to a consumer toy company); psychology (summer research with pending papers); philosophy and literature (a published paper at the intersection of 19th-century philosophy and 18th-century literature, a pending paper in feminist philosophy of language, an exploration of the philosophy behind various versions of *Antigone*); theater (more productions than I could possibly list or recall); and cross-disciplinary areas that defy categorization (my Brecht-computer architecture mash-up monologue, a phenomenological analysis of a Decker's version of *La Traviata*).

The next step in my education is a master's degree in European Literature and Culture, which will likely be followed by studies of law, philosophy, and/or policy. I can't promise I will be solving any of the currently listed Grand Challenges ten years from now, but I will most definitely be drawing on multiple disciplines, including engineering, to complete projects that are essential to the United States and the world. During my four years at Olin, I have specialized in engineering, explored other disciplines, grown, and decided on a direction for my next few years. I am excited to use my Olin and GCSP experiences as a springboard to move forward.