



Metabolizing Challenges

Grand Challenge Scholars Program Portfolio
Manage the Nitrogen Cycle

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This portfolio is submitted in partial fulfillment of
the Olin Grand Challenge Scholars Program
requirements



REFLECTION

Listening to our class speaker, I stared blankly at the white rows in front.

Have you ever looked at a gravestone?

What a morbid thought. I fiddled with my white gown.

Year of your birth. Dash. Year of your death.

Still surprisingly morbid for a graduation speech.

*But that dash separating those two years –
That dash represents your life...*

...

What will your dash be?

I have no clue. I stare up at the sky.

Something that involves the oft-said ‘leaving the world a better place?’

...

I’ll figure it out by my next graduation.

High school senior year was a rush of applications, final exams, and decisions. The questions everyone universally hated were the ones about identity. *Who are you? Describe yourself in three words.* What did that even mean? In addition to the sudden recurring bouts of identity crises, we were also faced with decisions that would define and shape us for the next four years of our lives.

I noticed Olin because, as a tour guide put it, Olin’s curriculum is not about , “what to think, but rather how to think.” Aside from the rave reviews about the enthusiasm and passion of the professors and the “palace-like” dorms, the full tuition scholarship pushed me to finalize my decision for Olin. Although I was nervous about turning down offers from more well-established colleges and universities, I looked forward to an education I could not easily learn from books and the internet.

For the next year, I found myself getting reoriented after jumping into the deep end from what was familiar.

Year One | realizations at the deep end

I spent the summer of 2009 traveling with other American Born Chinese (ABC) students and teaching English to elementary students in rural Taiwan. We traveled to our assigned schools in teams, where we would then develop and implement lesson plans with the aid of local teachers. Staying at this new location and teaching with strangers was an eye-opener in terms of culture and teamwork. Despite our own Asian backgrounds, as ABCs, we were embarrassingly ignorant about many practices and superstitions.



As a small island with limited resources, Taiwan is a very environmentally-aware country. When we first arrived, we were used to throwing all of our waste in one bag – especially since we saw no labeled receptacles that indicated us for us to do otherwise. Several days later, we were asked to sort our trash. Apparently, a local teacher had been sorting through our trash for us. The picture above shows us the night that we learned about our mistake and decided to grab chopsticks to sort through our trash.

GLOBAL EXPERIENCE & SERVICE LEARNING

We were all deeply embarrassed that we had forced a local stranger to go through our trash. Sorting our trash and helping the students clean up after lunches soon became habit. The teachers had never heard of janitors before, since the children were expected to clean up the classrooms and lunch tables. It was not a difficult situation to adjust to and made me question why America did not have many of the same practices.

We learned much more about local customs and expectations thanks to the local teachers. They would sometimes take us to the local night market, shown to the right. There we would learn that it was considered somewhat scandalous for girls to bare their shoulders at night and that food vendors would actually chase you down to return the money you had “forgotten”. There was no concept of “tipping”. At the same time they would not hesitate to ask if we had boyfriends, what it was like with a black president “OH – BAH – MAH?”, and the freedoms in our education system. They were just as curious as we had been about different cultures.



All of us had stuffed various teaching resources in our luggage from the United States. None of us had expected the students to be enamored with our cameras. They would often run around taking photos of one another and us. We would sometimes use their excitement for our cameras as bribes. *If you learn these words, you can play with the cameras during break. If you don't tell us why you were late, you can't use the camera.* We shared and compared stories of the children after class. Sometimes, we would feel guilty and out of sorts eating the meals provided by the school when we heard that a



student had skipped breakfast because her family could not afford it. We felt more fortunate when we had the chance to use the internet and exchange stories with other students we met during orientation, who were stationed at other schools around the country. Some students had been assigned to even more rural locations in the mountains with limited electricity and plumbing. They faced the unexpected task of attempting to teach without printers for worksheets. Teaching in Taiwan taught us a lot about what we had taken for granted.

Although most of us were inexperienced teachers, we were given a lot of freedom in the curriculum we developed. Occasionally, we were asked to incorporate certain topics, such as the eclipse (shown to the right), but otherwise we were free to develop and try out as many different teaching games as we wanted. Playing with, teaching, and conversing with the children on and off school hours, gave me a better appreciation of the opportunities I have had and increased my drive to help create similar opportunities for others. During this experience, I also learned about how some communication methods remain universal and the beginnings of how to coordinate with my peers to lead a class.



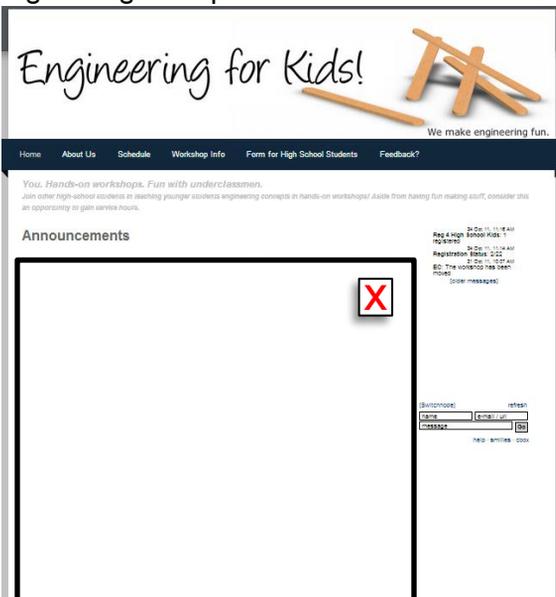
ENTREPRENEURSHIP

My experience teaching in Taiwan would be the first of many experiences where “teamwork” could not simply be individual work cobbled together. Most of my first year at Olin was spent adjusting to the realization that most of my approaches and strategies to solve problems from high school were not practical or feasible. “Open-ended projects”, where the topic and much of the presentation format was left to the student, just left me at a complete loss. It was like running in a marathon where no one knew where the finish line was. At first, I had been determined to trudge on independently by myself – an attitude that had been initially shared by much of my class. After several weeks, a professor, frustrated, showed us survey results, where only one student in my whole class had went to ask the professor a question. This confusion and struggle over just the requirements of various assignments made me realize how much I had used my success in high school to define me.

Year Two | Exploration

Disturbed by how lost I felt, I decided to apply for and accept a research position in psychology for the summer to study the topic of narrative identity. I ended up spending much of that summer reading and listening to the life stories of adults in their 60s and 70s through recorded interviews. Learning about other people’s lives, their uncertainties, and their reflections about their lives helped to settle my own anxieties. This gave me the chance to let the lessons of the past year sink in and the confidence to take on new projects in completely new topics.

My second year at Olin was full of projects in various topics with students from different technical backgrounds. These projects included the failure analysis of Volkswagen tires, construction of biomimetic robots, and designing products for women concerned about self-defense. One project was memorable because it was the whole team’s first foray into entrepreneurship as part of a business class. The focus of the project was driven by myself and another student. Both of us were interested in education and had past experience teaching others in high school. We cajoled friends to join our nonprofit concept, which was to create a system that would encourage high school students to teach engineering concepts to middle school students.

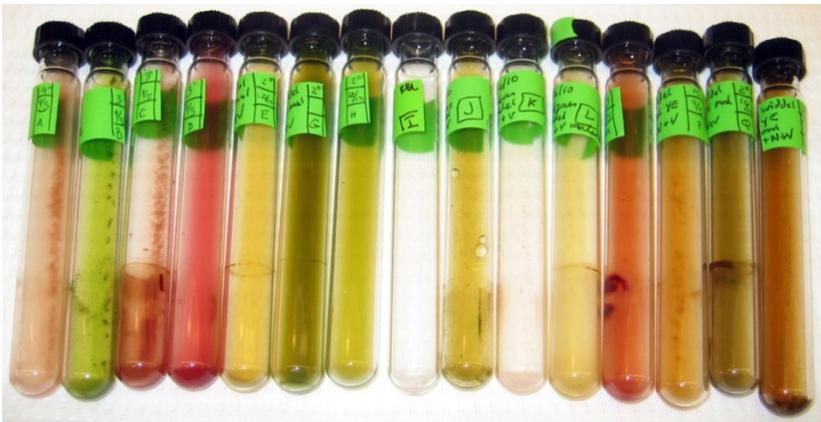


We floundered a lot at first before we began to truly understand the concept of “fail early, fail often”. Since a lot of our initial concepts had not been fully fleshed out, we hesitated to make many phone calls. Consequently, we lost several opportunities to other entrepreneurial groups who were also looking for similar venues. Once we understood the press of time, we tried to avoid unnecessary hesitation. We ordered and handed out business cards and pamphlets and local soccer games and grocery stores. We held experimental workshops – and discovered the disadvantage of having a team with mostly similar technical backgrounds. Eventually, we established a website, shown to the left, and found high school students interested in continuing our endeavor. The whole experience taught me the importance of asking around for help or advice. *You might get denied if you asked, but you will always get denied if you don’t ask.*

PROJECT & INTERDISCIPLINARY EXPERIENCE

I also began to develop skills for scoping out long term project schedules that year. Two of my projects had extended past a semester and developed into conference publications. The first project was my first independent study project at Olin. As a purely student-driven project on bipedal motion, our timeline and deadlines were often flexible. Consequently, our first semester, was not very productive; the importance of external and internal hard and soft deadlines began to become glaringly apparent. Eventually, through trial and error, we managed to hit our deadlines and also learned about the process of conferences submissions. My other work was a microbial research project, where I began to accept the interdisciplinary nature of engineering.

Over millions of years, bacteria have developed a diverse range of metabolisms. We have been able to exploit this range of metabolisms for many types of solutions, such as bioremediation, alternative fuel sources, diagnostics (as tools for detection), and nitrogen fixation. Since spring 2013, I helped to develop methods to cultivate nitrogen-fixing, anaerobic, photosynthetic bacteria for characterization. Our first semester was dedicated primarily to understanding the growth curves of bacteria from marine and freshwater environmental samples under different media conditions and exposed to different wavelengths of light. The cultures were provided either malate or cellulose as a carbon source and ammonium or dinitrogen gas as a nitrogen source. We found that different bacteria were selected for under different wavelengths of light despite being given the same media conditions. All the tubes in the picture below started with the same media and sourced the same environmental sample. However, they were placed in different boxes that contained LEDs emitting a wavelength specific to the box. We presented our findings at the Northeast Microbiologists: Physiology, Ecology and Taxonomy (NEMPET) conference that same summer. We then began our characterization of the bacteria cultivated by different wavelengths, to determine the efficacy of wavelength solution. Through community 16srDNA analysis, we discovered that wavelength has a slight impact on bacterial communities, but nutrient conditions have a predominant impact. Currently, we are writing a paper for journal submission.



Although I had attempted to avoid any interaction with circuitry, I soon found myself calculating appropriate resistance values for resistors and soldering LEDs to breadboards to create light panels for the bacteria. Partially out of laziness and partially out of curiosity-driven impatience, I also developed MATLAB code to reduce the amount of time

necessary to graph and analyze our data measured using spectrometers. Through this project, I saw how bioengineering, material science, electrical engineering, and software could come together for one project. I also saw the futility in attempting to avoid one discipline during the course of my education and how knowledge in one discipline can help inspire solutions in another discipline.

THE OLIN EXPERIENCE

Year Three | Communication

I was extremely fortunate in that until my junior year, I never had to deal with any significant team drama. In fact, up to that point, there had never been a need for a project manager. Unluckily, or luckily, my team projects during junior year were all less than satisfactory due to miscommunication. For one class project, to avoid conflict, the team pursued two design instead of explaining the lack of interest in one of the ideas. Eventually we split into two teams and I ended up working on both teams due to my access to certain equipment and materials. While we hit our goals on one sub-team, I was called into a meeting

with a professor for the other sub-team. During that meeting, I was surprised to learn that one member had been feeling overwhelmed with her work for the team, especially since she felt that the third member of our sub-team had not been contributing to the project. While we managed to pull the project together, none of us had been particularly satisfied with the end result. Through that class, I learned the importance of explicitly stating concerns and the necessity of regular check-ins.

For my other project, as the only upperclassmen, I was elected the position of project manager. Since the rest of my team were second-semester sophomores and had taken Topics of Bioengineering with Professor Alisha Sarang-Sieminski, I made the assumption that everyone understood technical writing, knew how to search for literature, and had experience working on semester-long projects. As a result, a lot of the project time was spent discovering and fixing errors, generated by that assumption, in our preliminary work and determining what exactly everyone's baseline knowledge was. Through this project, I gained a greater appreciation of the importance of establishing this baseline at the very start. At the start of my senior year engineering capstone project, I took the lessons from junior year to heart and asked about what everyone felt were their technical strengths, weaknesses, learning goals, preferred methods of communication (visual or audio), and the expected amount of time they were willing to dedicate towards the project. We had regular anonymous feedback surveys and team reflection sessions. Thus far, our project has proceeded smoothly.

Year Four | Final Countdown

For me, senior year has been the year where all of the lessons I have learned have come together. Through conversations with businessmen on airplane rides, Olin alumni over emails, and other students at graduate school visits, I think I have only just begun to understand how unique Olin's education curriculum is, as well as the potential opportunities that I can create for others—especially if I work with other people with different backgrounds. Four years ago, I would not have understood the advantages of teamwork, how to scope and plan a project, or how to tackle an open-ended problem. For me, that dash on the gravestone had meant following some fixed path and stacking a brick on top of the work that other people have already created. Now, that dash represents helping others create a machine to lay the bricks and grabbing onto interesting projects as they come – regardless of the field.

