

# CLEAN WATER FOR THE WORLD

Grand Challenge Scholars Program Portfolio

Heidi Nafis

Olin 2013

I came to college with a vague understanding of engineering and what it would mean for my future. At the end of high school I knew that I wanted to change the world or at least have some kind of measurable impact. I knew that I felt strongly about the environment and I knew that I liked math and science. Ultimately, this combination of inclinations led me to study engineering at Olin College – without entirely knowing what that meant.

My coursework at Olin framed the big questions of engineering and helped me begin to answer them. My first semester at Olin, I took my first engineering classes, which told me what engineering could be. I simultaneously took my first college math and science classes, which set a framework for *how* engineering could be. My humanities classes told me *why* engineering could be. My design courses helped me to tie engineering to humanity more closely. In true Olin “spiral learning” form, I reinforced and relearned these frameworks several times over.

Through all the projects and problem sets and by being around passionate people – my Olin classmates – helped me to find my passions and stick to my guns. At times when I was stressed or feeling insignificant, they helped me get excited again. Summer jobs where I could put all my focus on learning about what I actually care about helped me to balance out the tough times and occasionally uninteresting requirements of Olin’s curriculum.

Exposure to the outside world, whether as close as Boston or as far as the Arctic Circle, has also helped me stay balanced. Exploring the world has been immensely gratifying, although it has also only whetted my appetite for further exploration. There’s so much to see and to do!

Throughout Olin, I have slowly defined what engineering means to me and what I want to do with it. The broad impact of engineering that I started with has narrowed down to a desire to provide clean and sustainable water for the world.

All in all, by virtue of Olin’s curriculum, I’ve been almost inadvertently on track to embracing and embodying Grand Challenges Scholarship from day one. Fueled by passion and a desire to improve lives, my classmates and I have pushed each other to understand the context of the world we live in, so that we may impact it to the utmost efficacy.

### **Research Experience – Water Treatment Technology, and Beyond**

My first summer’s research at the University of South Florida was a completely life-changing experience. There were no a-ha moments, no epiphanies or sweeping realizations, but I went to Florida without knowing what my project would be – and without a good idea of what I even wanted it to be – and I came back to Boston with my hopes and dreams set on the problem of clean water.

Although I had decided to continue pursuing a mechanical engineering degree, I furthered my passion for environmental engineering by devoting all of my summers and most of my independent projects to relevant experiences. I spent a second summer researching water quality in California, for instance.

That first summer, I was part of the Tampa Interdisciplinary Environmental Research program. My project involved working to optimize ion exchange removal of certain contaminants by looking at

different available resins. With the help of some graduate students, I ran a series of experiments using different materials and analyzed the level of contaminants in each batch (Fig 1).

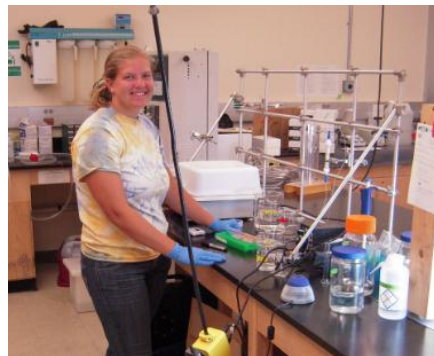


Figure 1: my experimental set-up at USF

The process truly exposed me to the difficulties of research; the machine used to analyze my samples was down for much of the summer, and so the project couldn't get that far while I was there to help with it. Regardless, because everything was so new to me I was able to learn a lot about environmental engineering and how I wanted to define it. To combat the frustration of ineffective tools I focused on the big picture of my project. The troubleshooting that I did to get all of my samples analyzed ended up being incredibly useful when I had to use the same type of machine (an ion chromatograph) the following summer. Coming into my second research experience with relevant background from the first experience helped me to feel that I was finally on my way to pursuing my dreams of being an environmental engineer, even with a mechanical engineering degree.

The results of my scientific experiments were inconclusive – I think we eventually determined that we had planned out the timing on our sampling wrong to begin with. The results of my program as a whole, however, were definitely deterministic in that I found my passion for water.

My second summer I studied water again, but this time from a more ecological, hydrogeological perspective. I worked in a hydrogeology lab looking at the effects of increased carbon dioxide on water quality.

The research project was just starting and wasn't necessarily ground-breaking, but I learned even more about water. In addition, I learned how to take water samples and do field work (Fig. 2). I mastered sampling techniques before my grad student did, and I had a few particularly empowering moments where I, the mechanical engineering research assistant, taught my geology grad student how to follow certain procedures. If I could be a leader in my lab, I can certainly be a leader in the greater water community someday.

I had another amazing summer experience, this time cementing the idea that I wanted to help people in person, rather than through lifelong research. I discovered that I could make an impact without a PhD, and that appealed to me. Because of these experiences, I have opened the doors to the field of environmental engineering. Although I haven't completed the corresponding coursework, I have pushed

into the field in a small way and gotten experience that I'm passionate about. After studying different aspects of water treatment and quality, I have a well-rounded background in the area of water.

Since I knew I wasn't bound for a PhD, I spent my last summer experiencing what working as an environmental engineer was like in industry by working in the waste treatment group at a chemical plant in Houston. I worked with water and waste treatment machinery, which presented me with another, different side of clean water. Water treatment technology bridged an easy gap for me between my mechanical engineering background and my environmental engineering dreams, and I could easily see how I could do similar work beyond Olin.

Unfortunately, I haven't been able to snag my dream job yet, but thanks to my research experience, I at least know what it is. It's incredible to think about how one project can change your life goals.



Figure 2: summer research moments. L to R, analyzing water samples at CSU-LA and collecting water samples near Mammoth Mountain, CA

## The Interdisciplinary Olin – an Inherently Multifaceted Experience

It can be tough to pin down specific interdisciplinary experiences I've had while at Olin, since everything feels so inherently intertwined at this point. A friend of mine once told me that he has a hard time seeing non-technical people as useful components of society because they don't make progress in the same way. To me, that idea is ludicrous; even clearly demarcating the line between technical and non-technical would be the subject of much debate.

To me, even engineering is more than engineering. That sounds cryptic, but it's easily exemplified in Olin's multidisciplinary curriculum. When I was deciding where to attend college, I had concerns that Olin's small size and focus on engineering would constrain my education – I have broader interests than strictly engineering. I liked the way that Olin left required space for arts, humanities, and social science (AHS) classes. I had studied French all the way through high school, and I was able to continue French and take classes in three more languages in my four years.

Because of it, I feel more prepared to enter the global workforce on a more equal front. It's important to be able to communicate and interact with all types of people. Internationally, language exchange is one way of crossing bridges between people. Closer to home and referring back to my friend's comment, it's also important to interact and communicate with non-engineers. Global progress comes with exchange of ideas.

Overall, I'm not meant to be an in-the-box engineer. As I mentioned earlier, one of my research projects was within a hydrogeology lab. At the beginning of the summer, when I first met with my mentor, he read my background and said "mechanical engineering? Are you in the right place?" I enthusiastically responded that yes, of course, I'm passionate about water and I wanted to work in that space.

Interdisciplinary courses and opportunities have allowed me to hang on to several passions at once: environmental engineering and sustainability, the problem of clean water, people, and language. One of my favorite interdisciplinary courses that focused on both sustainability and people/communication was Sustainable Design. In addition to the engineering components of deconstruction and design, the class touched on both the scientific and humanistic impacts of poor design and pollution. I learned about ocean acidification and the people in the developing world who recycle dangerous electronic components. Environmental impact stories can be really intense, but it's necessary to see the big picture to understand sustainability and good design. The class was really powerful for me, and the multitude of cross-overs reinforced the importance of global context in today's world. It's not only butterfly wings that can cause tsunamis around the world any more.



Figure 3: a display of my Sustainable Design project, which involved redesigning a bread machine to make it more sustainable

### **Entrepreneurship – Understanding Market Context through User Interaction**

Before college, I saw entrepreneurship and business as things that other people did. I've never felt any particular attraction to joining the business world or starting my own company. To be honest, I think I might have come to Olin in spite of the entrepreneurial focus rather than because of it.

At the end of my four years, however, I have come to terms with entrepreneurship. Although I still have no particular inclination to organize my own start-up, my experiences with market research and user interaction have helped me understand that entrepreneurial thinking goes way beyond business. Entrepreneurship is about people, not just buying and selling. Entrepreneurship is about understanding people's needs, and then fulfilling them.

I took a Foundations of Business and Entrepreneurship class (FBE) in my first year at Olin. The course as a whole impacted me relatively little, perhaps because of my preconceived prejudices, but it at least made entrepreneurship more accessible as an idea. We talked a lot about what it meant to be an entrepreneur. The discussion still lay mainly in the business domain, but I believe that subsequent FBE classes have branched out more into the realm of idea entrepreneurship, which I discovered for myself largely through Olin's design curriculum.

User-Oriented Collaborative Design (UOCD) is arguably the true foundation course of all Olin's design curriculum. The course involves a semester long project in which teams of students get to know people within a specific user group and design a product to fit the needs that the users may or may not even know they have. While working directly with liveaboards (people who live on boats – my team's user group), we came up with the idea for a new mail system that catered to their nomadic lifestyle. At some point in the process of iterating our final idea, I made the first connection between engineering, people, and entrepreneurship.

In a class entitled Affordable Design and Entrepreneurship (ADE), I tied it all together. My team partnered with an inventor in India to improve the design and business model for an automatic water chlorinator that he had developed. Called "Zimba", the chlorinator was meant to attach directly a hand pump water source and remove the necessary user initiative to chlorinate contaminated water. We were expected to perfect this product with little to no understanding of its greater context, and it was *hard*. My team's struggles to fit the Zimba product into the big picture of the water crisis were the ultimate proof for the importance of market context, which can be only loosely appreciated without user input and interaction.

Fortunately, at the end of ADE our team traveled to India at the end of the semester and had a chance to visit the site where there are Zimba units currently deployed (Fig. 4). A few short days spent observing the usage patterns and interviewing the users answered almost all of the questions we'd been generating throughout the project (Fig. 5). If we had acquired the user input earlier, in some way, the project could have been structured and designed quite differently. With the power of 20/20 hindsight, my entrepreneurial experiences have reminded me, time and again, of the importance of the big picture and the user.



Figure 4: a Zimba unit in its natural habitat



Figure 5: talking with the community in India about the Zimba

## Engineering Global Context – a Semester Sojourn in Sweden

I spent the spring semester of my junior year at Uppsala University in Uppsala, Sweden. It was an absolutely incredible experience. I chose to go to Sweden for a number of reasons, including but not limited to: the Scandinavian commitment to sustainability, my Swedish heritage, the chance to learn a new language, and the fact that I'd never been there before. I was looking for a new experience, but I wanted to keep it in within my personal context, and I appreciated the chance to explore both my family history and my areas of interest.

Uppsala was a great choice because I was able to interact with actual Swedish students as well as other international students. I was very involved in a student nation, which strengthened my relationships and granted me access to deeper windows of Swedish culture and Swedish perspectives. Some of the most interesting discussions I had with Swedes were actually about American politics and the American education system. We agreed on many things, but we tended to come from different angles because of our varied backgrounds. Beyond cultural perspectives, we also shared food (Fig. 6), music, language, and a lot of laughter.

Being a native English-speaker abroad is both humbling and empowering. It's empowering in the sense that English is the most wide-spread, international language, and I could communicate with everyone in my native tongue. At the same time, it's humbling to converse so freely with others who are *not* speaking in their native tongue. Although I am reasonably proficient in French and now Swedish, my vocabulary doesn't even come close to my international friends' English.

While abroad, I didn't take a single class that I would color as engineering. As far as sustainability and my continued fascination with water systems, I did take a master's level course on sustainable water management, which provided yet another angle on the water crisis. Overall, however, I studied abroad for the "abroad" rather than the "studying". I did my best to be open to everything and try as much as I could. This led me to ice skating on open water (well, ice), eating pickled herring, dogsledding, serving beer, participating in a *kroppkake*-eating competition, celebrating new holidays, and even witnessing the northern lights (Fig. 7).

I also had the opportunity to travel around a lot throughout the semester. My most eye-opening adventure was to St. Petersburg, Russia (Fig. 6). Having traveled mainly in Western Europe, it was mind-boggling to actually visit a country with such a low number of English-speakers. The cashiers at the grocery store would simply point to the numbers on the screen and hold their hands out for money.

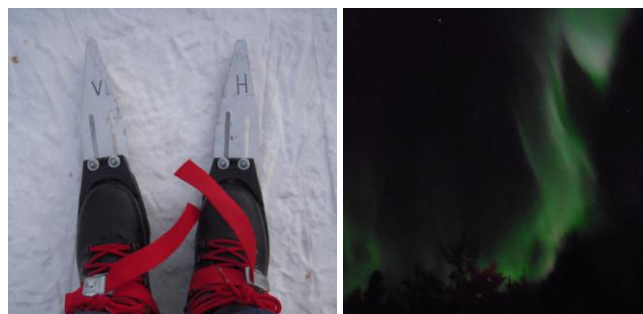
There was also more poverty than I had most recently witnessed, and it was a good reminder of how fortunate and semi-isolated the U.S. and I are. Although I traveled to some dozen countries, it's only the tip of the iceberg. I know now more than ever before how much is really out there.

When I returned to the U.S., I struggled more with culture shock than I ever did when I first arrived in Sweden. I think it has to do with a mix of expectations and changed perspectives. When I went to Sweden, I had very few expectations for how it would be. I tried to keep an open mind, and I was receptive to new experiences and lifestyles. Back home, however, I have set expectations for the way things have always been. Living abroad for five months broadened my horizons and altered my habits enough that home felt strange at first. Now that it's been almost a year since my return to America, I like to think that I've kept the best of both worlds. It's impossible to embrace new experiences for extended periods of time without allowing some things to become natural.

I don't have any idea where I want to end up in the long run, but I do know that I'm not ready to settle anywhere yet. I want to explore! I can't wait to travel more, to live abroad, and to meet new people. I identify with the Grand Challenges mission of global citizenship – we aren't so different really, and it's so limiting to stick to just one place when there are so many worth experiencing.



**Figure 6: new cultural experiences!**  
On the left, me at the Church of the Spilled Blood in St. Petersburg. On the right, Swedish classmates at a Swedish gasque



**Figure 7: more firsts - Left, Swedish ice skates. Right, northern lights seen from northern Sweden.**



## Service Learning – Engineering Discovery and Opportunity

Volunteering is something I've always enjoyed, but it only recently asserted itself as an active part of my everyday life. Olin's volunteer organizations are full of service-minded people that successfully incited me to do what I wanted to do anyway. I've thought a lot in college about how fortunate I really am. With so much to share with the world, there's really no reason for me to hold back. In my first year, Olin also inspired me to get involved by hosting a training session for Boston Cares, a local organization that coordinates a near-constant stream of volunteering events for young professionals and anyone else who wants to join. Because Boston Cares updates and reminds me frequently about service opportunities, I can sign up to help out whenever I have time.

The best part of service and volunteering is the return on investment. In the grand scheme of things, most service activities are such a small investment from us, and yet they can have such a huge return in the opportunities they provide for other people.

At Olin, I've spent a lot of time working with kids as a part of Engineering Discovery. I've helped with workshops and after school programs for preschool to middle school aged students. The most fun I had was when I helped organize a math program for a group of about twenty third graders. We focused on scaling, as a math concept, but we practiced scaling with the context of designing a sustainable city on Mars. We told them to design for Mars because we wanted them to abandon preconceived notions as much as possible. We spent a few weeks on basic math, a few weeks talking about what it means for a city to be sustainable, and then we set them loose. Small groups focused on different components of the city: food, power, transportation, etc., and they had to communicate with each other to figure out how much space they would have and what would need to interface with what.

We had an unsurprising crop of hot dog cannons and similarly exciting additions to the standard buses, schools, and restaurants, but the kids also had great insights. It's worth the tangents to see kids get excited about math and science activities. I think they might even have *learned* something. For a few hours of my week, I got to enrich STEM curriculum and give kids new friends and new ideas. For me, this exchange is easily worth it. The potential impact and the fun I have inspire me to keep volunteering.

When I was in first grade, my class was learning how to read. To combat the boredom in those of us who had already mastered this skill, my mom volunteered to come in and help us work on more advanced reading. Her small commitment helped at least half a dozen children stay excited about school. Through my work with Engineering Discovery, I've had a chance to be that difference.

Through service, I can actually make a difference. Considering that effecting change is one of the reasons I decided to become an engineer, it's fitting that I can also do my part to impact the world in small, direct ways as well as grand, global ways. When those small ways also incite others to change the world in their own ways, at whatever scale, well, then, perfect. If I do it right, we can all be Grand Challenge Scholars someday.



Figure 8: students present a scaled map of their "Sustainable City on Mars" as part of the third grade math program at Mitchell Elementary School in Needham, MA