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# Engineering Across Disciplines: Advance Personalized Learning Grand Challenge

Chelsea Nayback

[chelsea.nayback@alumni.olin.edu](mailto:chelsea.nayback@alumni.olin.edu)

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# Engineering Across Disciplines

*Advance Personalized Learning Grand Challenge*

Chelsea Nayback | Class of 2014  
Engineering with Concentration in Biology

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

## **Abstract**

My grand challenge at Olin was shaped in three main areas. Long-term research in the biology lab, interdisciplinary learning through many classes, but in particular User Oriented Collaborative Design, and participation in the campus organization Engineering Discovery. Doing research and participating in clubs in addition to classes helped me get to know others in different disciplines and learn more about their solutions to problems. Another large component of my learning involved giving and receiving feedback, both from people outside of the Olin community and within. This double dose of feedback allowed me and my teammates to better understand the problems we were trying to solve. To get this feedback, many presentations were done, which gave me the confidence to stand up and present my methods and results with conviction and certainty. Many class projects were team oriented, which allowed me to learn how to work well with others. I also did work on my own with guidance in research. Doing both of these things taught me to work independently but always take others advice and criticism into account. Overall, I believe Olin provided me with an engineering education that will allow me to understand and effectively communicate with people in many disciplines with a variety of educational backgrounds.

## Long term project-Research

I have been doing research for three years in the biology lab with Professor Joanne Pratt. I had taken biology with her the semester before, and asked her if there was anything I could work on so I could get experience, being a bioengineering major. She had openings in her lab, so started in the Fall of 2011. Joanne's research focuses on a leukemia cell line call Jurkat. We've been working on characterizing the Fas Ligand pathway in the cells to determine potential drug targets. I started by learning basic lab techniques and how to run specific experiments. By my junior year, I was working mostly alone, able to do all the things necessary for an experiment and teach them to the others working in the lab. I also started to decide which of the experiments that would be most beneficial to support our hypothesis. We now have a draft of a paper that will eventually go on to be published, so that other groups can use our findings to help their research as well.



At Wood's Hole for NEIC  
left to right: Becca, Alison, Me, Brandon, Emily, Jaehee

With the others (pictured above) in the lab, I have attended two conferences, AAAS (American Association for the Advancement of Science) and NEIC (New England Immunology Conference). At these two conferences, there was a poster presentation session, during which Alison, Becca, and I discussed our poster with others and received feedback about things that we could work with in the future. People suggested different types of DNA that could be used to activate Fas Ligand, as well as drugs that they had used that could affect the expression of our genes as well. We also had the opportunity to visit other posters, asking questions and learning about the kinds of things that other people were working on. While most of it was not relevant to our research, due to being in different cell lines or animal models, it was still a good way to learn about how other people do immunology research. There is a very limited view at Olin of

research, with only a few professors doing biology research. Getting outsiders to look at our work helped to give a new perspective. There could be others that had been looking into a similar pathway that know of a specific protein that could be tested. One person brought up the activation of CN $\delta$ , which is one of the proteins that we had used. As we don't know what activates it, this is a useful thing to look into, as it could affect how we look at the results. While our lab hasn't looked into this yet, it is on our list of things to do. At AAAS, there were people from colleges and universities around the world, which led to some discussions on things that people do differently because of their location and culture. While AAAS was a very general conference, located in all types of sciences, NEIC focused just on research in immunology, which meant that we received more targeted feedback and the posters and talks were very focused in one area. This gave us the opportunity to really dive into immunology and learn about things that we didn't even know existed. There were talks about allergies, and natural killer cells and even vaccines. I found the talks about allergies really fascinating, since I have allergies myself. Not much is actually known about allergies and what causes them, and I'm interested in looking into this more in the future, perhaps going to grad school and becoming an immunologist. There are also people looking into vaccines that are "non-vaccines" and bypass the usual route of immunization. Watching all of these talks taught me about how to prepare a good presentation as well as how to deliver an effective talk. Especially since some of these talks were at a higher level than I understood, I could look at it and determine how best to structure my presentation so that people without as extensive of a background could understand it.

### **Interdisciplinary Learning**

There are a few classes that I feel really shaped my Olin career. One of these was User Oriented Collaborative Design (UOCD), in which my team worked with wheelchair users to design a product to improve an aspect of their life. In the beginning of the semester, each team chose a people group and got to know them. We tried to put ourselves into their lives and understand the problems and challenges that they had. For example, we talked with a wheelchair basketball team, and learned just how hard it is to shoot the ball towards a regulation height basket without using your legs. We went back to the design studio and outlined their values and needs and from these insights, and came up with areas of opportunity, or areas in which products would be incredibly useful. Some of the areas that we came up with included clothing, customizing wheelchairs, protecting hands, and advocacy. Once we had come up with product ideas in these spaces, we designed preliminary prototypes and took these back to our users. Our users then gave us honest feedback about the ideas, and we took this feedback in and narrowed down our ideas to one. We then made a final prototype of this idea.

In the end, our product tackled the area of checking one's weight. The final product was a scale that our users could use without having to move from their chair. One of my teammates has actually partnered up with another Olin student and is making it into a product. UOCD was the class where I really started to learn about teamwork. I was on a team with 4 others, and while two of them were fairly outspoken, the rest of us didn't speak up as much. The professors made sure that all of us got a chance to speak, so that everyone's ideas were heard. This helped with my public speaking skills, but also made it so that I was more willing to speak up in group meetings. As a team, we tried to make sure that everyone was able to object to an idea,

and to make themselves heard. It was a great team experience and helped me in other classes, especially Real Products Real Markets, since I was working with only one other person. I learned how to speak up, make myself heard, and to do my share of the work. If I couldn't finish an assignment, I learned how to lean on others for help.

My design skills and marketing skills were put to the test in a course known as Real Products, Real Markets. With a partner, I went through a design process starting from a very simple idea, and we made design decisions based on feedback from other people on campus. Our final product was wooden, laser-cut earrings. We started the design process with wanting to make something that had layers, and made different types of layered animal paperweights, before deciding to make earrings. The class built off of ideas from UOCD, in finding something that people would actually buy. I learned how hard it really is to sell a product to people. We sold both through the internet, on Storenvy, as well as in person to test our marketing skills. We spread the link to our site throughout the Olin email listserve, as well as on Facebook. This afforded us a very limited reach of people. We tried to find forums and other places where we might get orders, but unfortunately were unable to find a good place to post our link without annoying people on the forum. While we did do some selling in person, with a busy class schedule, it was hard to find time to go places outside of Olin to sell. It helped that the Olin community is very supportive of classes that sell things, but my partner and I found that it was very hard to sell to those outside of the community. It really hit me through this class how hard it can be to start up a business and to actually be successful. A successful entrepreneur must believe in the product and work hard to get people to buy it. It also was very challenging to do things with only two people. I learned a lot about working in a team in this class, more so than others, because it was only me and one other person. I had to do a lot on my own, and it was too much for two people with other classes to deal with as well. Communication was very important, and I learned how to keep those lines of communication open at all times, and make sure my partner knew what was going on. Through this class I learned how I need to pace myself and work on projects. I learned to work on the small, easy things first, the work that I enjoyed doing, then move on to harder things. Real Products took up a lot of my time, and as a result, I needed to prioritize it over other classes.

Biomedical materials is another class that was important to me. Though it is classified as a Bioengineering class, it covers immunology, basic biology, and materials science. Material properties change once materials are placed into the body, and even if things are considered biologically inert, they can still be rejected. The body doesn't even always react the same way to the same material each time. This is a huge problem for the medical community, in that they cannot be sure that their devices will work for everyone. This is an area in which many grants are given, and it requires people of different disciplines to approach the problem in different ways. Instead of just coming up with a material that has the right strength and bending parameters, there are other factors at play, like cell adherence. This requires different types of materials, and affects the way that people design products. I think this is something that I would love to work on in the future, something that requires people to work together on something that doesn't just require their knowledge, but all the knowledge of others as well.



Teaching third grade math (from the Boston Globe

<http://www.bostonglobe.com/metro/regionals/west/2013/12/19/olin-students-offer-classes-math-science-physics-and-engineering-for-local-kids/AwBlmykucl7NSqz8sPwqM/story.html>)

### **Engineering Discovery**

One of my favorite things at Olin was participating in Engineering Discovery, a group of Olin student volunteers that works with local schools to help excite K-12 students about math, science, and engineering type problems. I joined the mailing list for the club at club fair, went to the first meeting, and was hooked. I had done some work in high school with my mother's first grade students, as well as being part of a group called Peer to Peer. Peer to Peer was a group that paired high school students with elementary students that needed a friend. This introduction to teaching pulled me into Engineering Discovery, and I am very glad for it. Engineering Discovery was a great way to do some community service and have some fun at the same time. The kids really enjoy learning about the topics that we give them, and they love to have someone that isn't a regular teacher help them out with things. One of the activities that I participated in for three semesters is referred to as third grade math. The third grade teachers have noticed that some of their kids don't enjoy math as much as they used to. These kids then come to the art room one morning every week to work with us, to make them more excited about learning again. In the first semester of my participation, we challenged the young students to build a sustainable city on Mars. This city had to have buildings that were certain sizes, with specific area and perimeter. The kids calculated the amount of space it would need to house a certain amount of people, how much food and water they would need to provide for those people, and how much space that would take up. They even got to make a physical map of the city at the end. It's really fun to watch something click in someone's head, after they've been struggling with it. Once the kids get the concept, they'll start asking all kinds of crazy questions, things that we never thought they would understand. We taught them the Fibonacci sequence, and one child started to ask all kinds of questions about the "golden ratio". She wanted to know why it was so special, and how it had been found in the first place. The second two semesters I did this activity, we taught various lessons on more advanced mathematical principles like area, perimeter, estimation, and graphing. It was always worth it to go in and see the energy that the third graders had for learning and the way that they loved to learn what we had for them that

day. They always want to know right away what we're doing that day, and ask all kinds of questions.

Teaching third grade math has been a great experience for me, as I get to learn how to work with children and how to make them understand concepts that seem so simple to me. It requires a lot of thinking in different ways, trying to figure out the best way to make something exciting, but also teachable. I've learned a lot about myself through Engineering Discovery. I've learned how to describe things in different ways for the kids that don't understand the first time, how patient I have to be, and how fulfilling it is to teach. I don't think I could have gotten that anywhere else. Olin really provided me with the opportunity to learn these things by setting aside service time and allowing me to search for things that I like to do. This is something that I got throughout my Olin experience. I may be a Engineering: Bioengineering major, but I was able to take classes in design, materials science, and biology, as well as introductory classes in circuits, mechanical design, and software. I look forward to the day when I can be with someone in another field and can talk with them on a basic level about their work, because of the number of different classes I was able to take at Olin. I got to choose what I wanted to take, and I think this will really help me in the future.