dEDU / dUs

Grand Challenges Scholar Program Portfolio: Advancing Personalized Learning

Eric Kolker

April 21, 2013

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

*d*EDU/dUs

Foreword

My time at Olin has reinforced my belief in the power and importance of being an active participant in one's education. Over the course of my tenure here, my participation has grown and evolved from a simple desire to learn how the world works to encompass entrepreneurial efforts and investigations that advance the existing curriculum. All the while, I have made a conscious effort to empower others to do the same.

Reflection

I came to Olin to learn the process of engineering. I wanted to know how the world works, why it works the way it does, and learn what I needed to know in order to effect change in it.

When I got here, I realized that being an engineer isn't about remembering equations, memorizing values, or even delivering a product to spec. Engineering, I discovered, is an approach to solving problems that pulls on a larger collection of knowledge and considers the needs of the people whose problem it is that you're solving.

It should come as no surprise, then, that a place like Olin, whose founding mission encompasses advancing engineering education, encourages efforts to engineer the process of education. As time went on and I absorbed more of the Olin curriculum, I became more interested in the process of education and more excited with the opportunity to be an active participant in my own education.

I had known when I was applying to college that I wanted to go somewhere where I would be allowed to build things right out of the gate. What I hadn't realized was the extent to which this implied that I wanted to take control of my education, to actively drive it in directions which excited me.

As I got to know Olin better, I realized that, even as a first year, I had a tremendous amount of power to help shape my experience and that of my peers. I began informally by helping my classmates with a course called Modeling and Control, or ModCon for short, which dealt with first order systems in the context of analog electrical circuits and differential equations.

Although I was fortunate to have seen much of the course content in electives during high school, I realized early on that the way in which the material was being presented in ModCon was vastly different from how I had originally learned it. Unsurprisingly, my instruction in high school was less rigorous and relied on a different set of abstractions, but still allowed me to build an intuition as to the way circuits behave. Consequently, while conducting and documenting labs during ModCon, I was forced to think about the systems' underlying behaviors in ways which were new to me. Doing so helped strengthen my grasp on the material, to be

sure, but also allowed me to help my peers by explaining things from angles not used by the professors. Unsurprisingly, I found that doing so helped to further crystallize my understanding of the phenomena we were exploring.

From that point on, I became increasingly aware of the power of education as a process, both in terms of the steps involved and the output they produce. I strove, and continue to strive, to help make my peers' experiences better and to take full advantage myself of the opportunities which were or could, with a little proactiveness, become available to everyone.

Now, as I stand at the threshold of the "real world" and look back on my time at Olin, I see a common thread of curiosity, analysis, and self-reflection. At the same time, I have tried to balance my desire to absorb as much information as possible with my assessment of what is and is not useful, available, or interesting to me, and done my best to force the scales to tip towards making the Olin education, *my* Olin education as well as that of my peers, as good as it can be.

In doing so, I believe I have worked towards the Grand Challenge of advancing personalized learning. My efforts, which span teaching, research, and curriculum development, have helped address the need for changes in education that tailor instruction to the student in ways which promote engagement, foster collaboration, and maximize learning for everyone involved. I have chosen not to call out on the specific requirements of the GCSP because I believe many of my experiences fall into and between these categories. For example, my involvement with ModCon, an inherently interdisciplinary course, has included elements of entrepreneurial service learning. The sections which follow further explain the details of my experiences and work and how they apply to the challenges facing the world in the coming years.

An international stage

My interest in education, although piqued most during my time at Olin, can be traced back to my elementary and middle school years, when I went to schools with Spanish immersion programs where the student body was majority minority. During these formative years, I learned math, science, and social studies in Spanish, had an armada Latina teachers who served as strong female role models, and was exposed to cultures and environments which were quite different from those in my home. I even spent a week and a half as an exchange student in San Salvador as a fifth grader.

In high school, I was fortunate enough to attend a science and technology magnet school where my peers were smart, motivated, and, again, had backgrounds, world views, and heritages that were vastly different from my own. I traded out intensive language training for courses which allowed me to build and leverage technology and broadened my extracurricular horizons to include robots and homecoming floats.

In making the transition from high school to college, I knew that my educational path was different from most of my peers'. What it took me slightly longer to realize was the fact that it had shaped me into who I am today and that this was both incredibly important to me and a

source of great pride. I firmly believe that my trajectory has given me uncommon perspectives and a bilingual foundation, both of which are universally useful yet often underestimated, and see these as being some of my most distinguishing assets, if not my most readily apparent ones.

In college I wanted to continue to diversify not only my educational path, but also my cultural experiences. I quickly became an active member of Olin's mealtime Spanish conversation table and made a point of habitually befriending exchange students. Unsurprisingly, one of my favorite conversation topics was how school worked back home, how Olin was different, and what they saw as the pros and cons of both systems. Making such inquiries helped me get a better sense of what makes people tick and what's important to everyone, regardless of their background.

NINJAing

My involvement in ModCon didn't stop at the end of the year. The fall of my sophomore year, I applied to be a course assistant (at Olin we call them NINJAs, an acronym for "Need information now? Just ask!"). To my great pleasure, the professor chose me as one of the NINJAs, a title which I have now proudly held for a perfect six of six semesters since, through changes to the course and teaching team alike.

Officially, my duties as a ModCon NINJA include grading lab reports, holding office hours, and teaching weekly tutorials, but the job is so much more to me than a list of tasks and a paycheck. I see NINJAing as a means of giving back to the Olin community and a way to share my excitement about the fundamental concepts that underpin modern engineering. I have, by no accident, worked to become the unofficial and so-called "head NINJA" for the course and a respected campus expert for all things related to circuits, signal processing, and the murky transition from an idea to a working electrical system.

Doing so has had me in the lounges of the residence halls well past the end of my scheduled office hours, answering emails at unholy hours of the night, and debugging circuits and code remotely, all in the name of making sure that my flock of NINJees truly grok the systems they build, test, and deploy. It has had me answering and asking questions until I'm confident that the student really, truly gets it. It has me always hold my standards just out of reach so that, one day, when my students exceed even my lofty expectations, they will have accomplished something truly incredible.

By the end of the course, each of my NINJees will have been pushed beyond what the professor demanded and learned more than what was officially asked of them. Only then I can rest contentedly assured that I have helped them reach their full potential and given them a sense of pride in knowing that they got themselves there. Only then can I be sure that I will have inspired the next batch of NINJAs who will follow the precedent I have set and continue to inspire the coming generations.

But my commitment hasn't stopped there. Last summer, I helped redesign the course and its labs for a new professor. Through conference calls and video chats, I worked with the instructor and a handful of other NINJAS-to-be for a month and a half to tune the course for a new set of learning goals and materials. Doing so gave me perspectives into the difficulties of actually planning and running a course, which would prove useful during the spring semester of my senior year.

For my efforts I was rewarded with the opportunity to give one of the lessons to an auditorium of 90 students when the course's primary instructor was out of town. Delivering that lecture filled me with adrenaline in a way that only the combination of excitement and terror could. I had a blast describing first order filters, was reminded of how hard delivering a clear talk is even when working from good notes, and, again, gained further appreciation for just how difficult it is to take questions on the fly. At the end of the block, I was relieved and humbled when the two professors in attendance congratulated me on completing my first undergraduate lecture and told me that it had gone better than either of theirs.

EEProto

Sometimes, what's available in the course catalog or through independent studies and research is not enough. Sometimes, no matter how hard you try to pull together the resources on your own, it just doesn't add up, or can't be sufficiently organized to suit your needs. Times like these call for active entrepreneurial efforts with the purpose of enacting real, tangible change for the better.

Case in point, the new course called Electrical Engineering Prototyping. Last spring, it was no more than an idea a friend and I had. Olin has a course called Mechanical Prototyping, where students learn their way around the machine shop then spend a semester building firefighting robots, grasping mechanisms, gearboxes, or mechanical systems of similar complexity. However, there was no equivalent course on the EE side, and this was unacceptable to us. We saw a hole in the electrical engineering curriculum here and made a conscious decision to try our hardest plug it.

As last spring drew to a close, my friend and I worked to get the relevant faculty onboard and took surveys to gauge student interest. The following fall, we, along with a handful of our friends, did an independent study in which we planned the course. In collaboration with the professor, we chose assignments, lecture topics, laid out the calendar, and alpha tested the readings. We gave copious feedback, submitted a budget, and prayed that the administration would accept the proposed course in the spring.

Luckily, with sufficient buy-in from the right stakeholders, EEProto made it into the course catalog. Needless to say, I enrolled immediately. Luckier still, the professor approached my friend and me and asked us to NINJA the course. I accepted gladly.

The inaugural run has had its fair share of setbacks and speed bumps, but that doesn't make me any less proud to have pushed it through. The fact that an effort I led and maintained will

result in the continued delivery of official, accredited degree credit to my friends and me because we have spent time learning about, designing, and assembling practical and useful circuits is incredible. Proud does not begin to describe how I feel. I had the opportunity to take and teach a course of my own design: a trifecta. How awesome is that?!

A significant milestone in the story of EEProto v1.0 was when the class ordered its first printed circuit board (PCB) as part of one of the labs. Figure 1 shows one copy of the class' combined PCB panel for lab four. Individual boards, four inches to a side, were cut out and distributed to the teams from three identical panels. With the approval of the teaching team, I pinned the panel shown to the wall of the classroom and have since initiated an effort to have more of the class' work formally put on display.

Although the saga is far from over, participating in the course has taught me about more than just capacitors. It has taught me how to convey technical information, which is at times both very important and highly abstract, in ways which are easy to digest. It has forced me to reevaluate the direction of an endeavor at the instructional level as the needs of students, requirements of the teaching team, and realities of the schedule change. Perhaps more importantly, it has given me hope that other such efforts can succeed and been a constant reminder of the gaps in my own knowledge and of the growth which will be required to fill them.

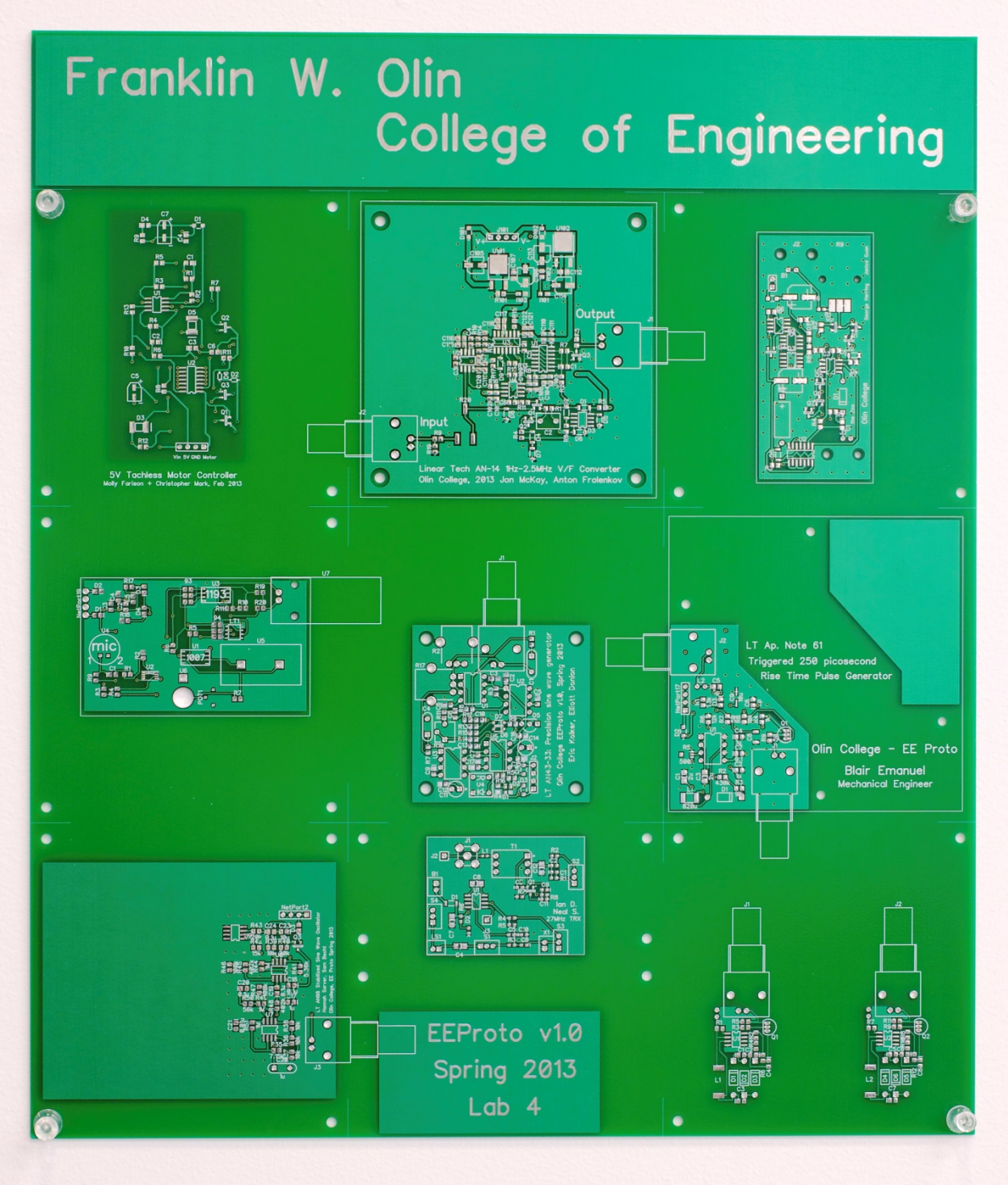

Figure 1: For one of the labs in EEProto, pairs of students designed printed circuit boards based off circuits found in application notes from Linear Technology. This is the full panel which contains all of the class' work. The precision sine wave generator my partner and I laid out is in the center of the panel.

RepO

During the fall of my senior year, while I was busy designing EEProto, I also had the good fortune to take a course called Representing Olin Outcomes and Experiences. The course, taught as a highly student-driven, open seminar by Olin's Dean for Faculty Affairs, aimed to address the issue of how to present and talk about Olin to the outside world. We were tasked with finding something worth exploring and doing so: an introspective researcher's dream.

My partner and I were curious about the effects of Olin's academic flexibility on enrollment, major declarations, retention rate, study abroad rate, and whatever else we could uncover. We experimented with a dataset from Olin's registrar with the intent of building a graph which told the story of when Oliners changed their majors. Through a combination of programmatic data parsing, review of relevant literature, and graphic design, we ended up generating the graphic shown in Figure 2, which shows data for a single class split between women (top) and men (bottom).

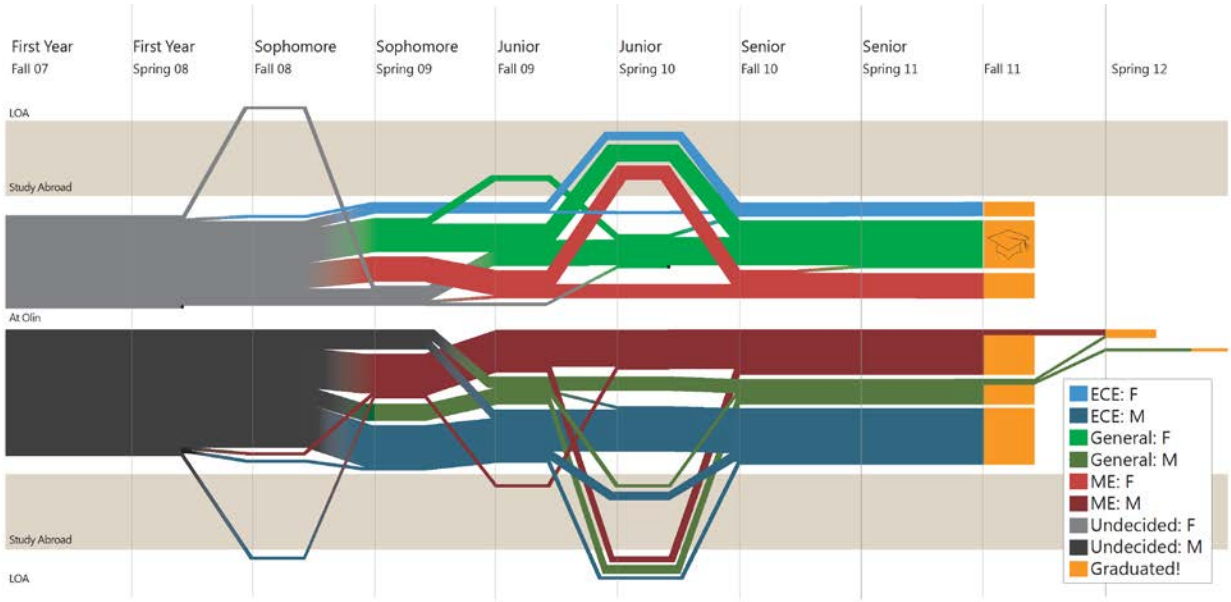

Figure 2: The "Butterfly Sankey" chart my partner and I created to show when students of the Olin class of 2011 changed majors. Declared majors vs. time are tracked by color, and the graph is split between women and men, drawn in light and dark shades, respectively. The vertical axis tracks the students' location of study between Olin, another institution abroad, and Leave of Absence (LOA).

We soon found that the data we had could be used for so much more than showing what students could have, at one time, had on their diplomas. By turning the data on its side, were able to visually show which courses were the most popular or diverse, what majors were underserved, and when a course tended to show up in a student's career. We plan to present all of this at a faculty meeting for the purpose of spurring a review and revision of the existing curriculum.

By pivoting again we were able to create charts we called “fingerprints” for every single student. These festivals of color and data show what courses the student has taken, when they took them, and with whom. They are, in essence, maps which show each course a student has touched and the links between that student and the rest of the college. Mine is shown in Figure 3 below.

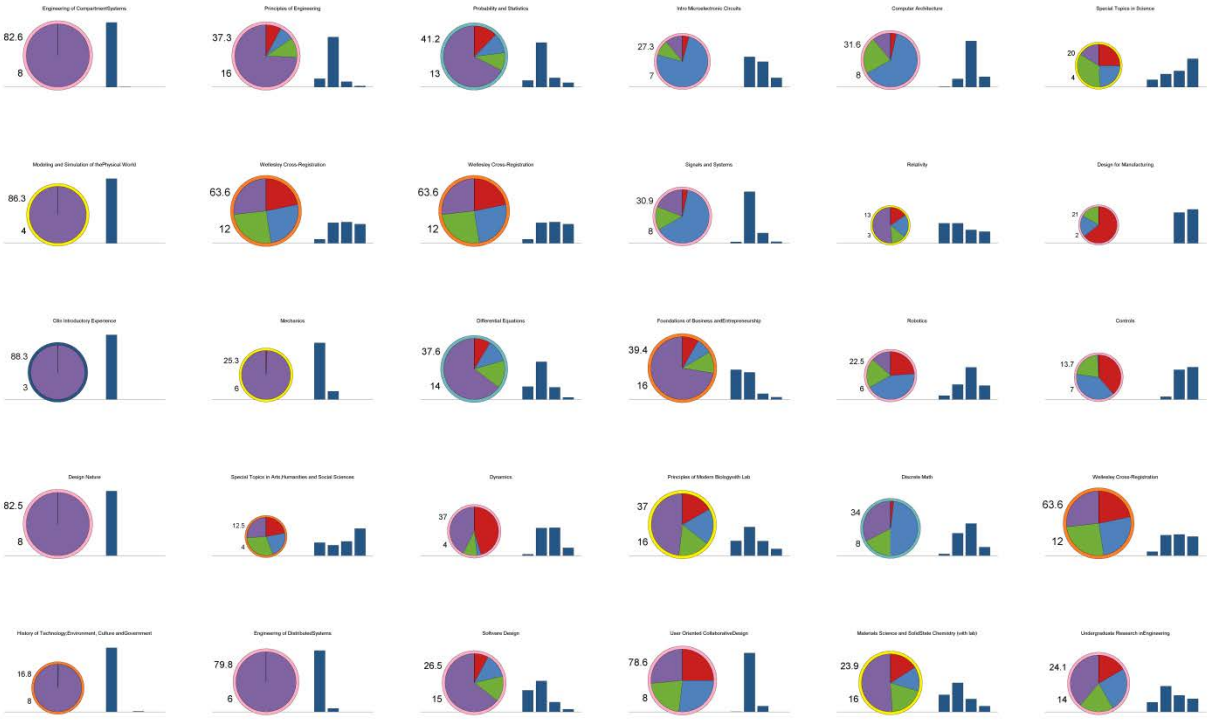

Figure 3: My fingerprint at Olin. The meta-chart shows the enrollment profile of each class I took. Each column represents one semester and each bar/pie chart pair shows data from one course which I took that semester. The slices of the pie charts show the distribution of students’ majors (red = mechanical engineering, blue = electrical and computer engineering, green = general engineering, purple = undeclared) at the time of enrollment, while the color of the border denotes which credit type the course awards (pink = engineering, yellow = science, orange = art/humanities, cyan = math, royal = other). The upper left numbers are the average number of students who enroll in the course each semester and the lower numbers are the number of semesters in which the course has been offered. The bar graphs show the distribution of the students’ class year at the time of enrollment: first year to senior, left to right.

Although RepO has come to a close, my interest in using computation and visualization to help uncover and address challenges in the educational space has not. My efforts continued the following semester, this time using the results of Purdue’s MIDFIELD study (https://engineering.purdue.edu/MIDFIELD). This much larger dataset allows me to make comparisons between different institutions across much wider spans of time. The results, which are currently protected by a nondisclosure agreement, shed light on factors which influence a student’s decision to complete a degree in engineering.