The Wright Path

Sustainability Grand Challenge Theme

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For as long as I can remember, I've found pleasure in making things. Things that moved, things that flashed, things that buzzed, things that whirred all have excited me to no end. I remember one of my first "inventions" was a handheld fan powered by an old electric toothbrush motor and a 9v battery. At the time, I did not understand the interworkings of the motor I was using, nor the chemistry of the battery, nor even how the shape of the propeller allowed it to move air. I did, however, understand what each piece did, and I found great pleasure in putting the pieces together to make something new.

As I moved from grade school to junior high to high school, my knowledge of how things work grew, and with it grew my desire to make more things. When learning about kinematics in physics, my friend and I decided to build small coilguns using the circuits of discarded disposable cameras to see if the equations of motion worked out. Along the way, I unintentionally learned a lot about electricity and magnetism, RC circuits, and what a high voltage discharge across skin can feel like. Projects like this led me to be one of the founding members and vice president of my high school's engineering club. I recognized that I not only did enjoyed making devices and contraptions, but I absorbed knowledge much more readily when I could use it to make something physical. For this reason, my choice to attend Olin College was a no-brainer. Olin's focus on project-based learning and application driven education resonated with what I enjoyed, how I knew I absorbed information, and how I liked to apply myself. Through the whirlwind that has been my time at Olin, I have had the pleasure of taking part in many experiences that speak to the five curricular components of the Grand Challenge Scholars Program: a Grand Challenge Project, an Interdisciplinary Experience, an Entrepreneurial Experience, Global Awareness, and Service Learning. In this portfolio, I will be focusing a handful of projects and experiences that highlight these components of the program.

Building an Electric Bicycle

For the past many years, I have worked to design and build simple, functional, and cheap electric vehicles. In all of my attempts, I have focused on using discarded or used materials, building with common tools, and sharing my designs so that others can build off of my work. I've also focused on only using electric motors as a means of propulsion due to their inherent simplicity, unobtrusiveness, and cleanliness. My first electric bicycle was built using a friend's old BMX bicycle, two small lead-acid batteries, and a motor controller like those found in golf carts. The build was fun and simple, but it did not prove to be a practical vehicle. Over the years, I found larger batteries, more powerful motors, and stronger frames. I continued to iterate on my design until I had made bicycle capable of traveling tens of miles at road speeds. The bicycles were improving, but they were on the whole still not practical vehicles. While at Olin, I built my most functional vehicle yet: an electric bicycle capable of traveling a hundred miles on a charge and at speeds of 45mph. After many iterations and years of experimentation, I built for myself a functional vehicle with zero emissions, essentially zero required maintenance, and for a fraction of the cost of a comparable commercial vehicle. If the reward of having a functional vehicle was not enough, building an electric bicycle also allowed me to meet variety of wonderfully interesting people. Through my electric bicycle project, I was able to meet comedian and car enthusiast Jay Leno. I had the opportunity to speak with him about my motorized bicycle, and our conversation was shared on his website, Jay Leno's Garage. This exposure allowed me to share my interest for electric vehicles with tens of thousands of viewers, many of whom contacted me personally for specific information on the project.

My electric bicycle project, and every path it has lend me down, has helped me grow both as engineer and as an individual. A particular example from this project that stands out in my memory involves learning how to weld to for the first time. Before I had learned to weld metal, it was my belief that fasteners (nuts and bolts) were always stronger than welded joints. In part, I held this belief because I understood how fasteners worked, and I did not fully understand what happens to metal when it is welded. The closest thing to welding I had experience with was soldering, and it seemed obvious to me that bolts were stronger than solder. Due to my negative perception of welding, the first two versions of my electric bicycle were assembled using only mechanical fasteners. However, I was later able to learn how to use a MIG welder due to the generosity of a neighbor, and subsequently I came to better understand the mechanical characteristics of proper welding. I learned that in many of my applications, welding could make my frames significantly stronger and allow me to construct even more intricate structures. Learning how to weld not only changed my perspective on mechanical design, but it forced me to reconcile with the fact that a small amount of new knowledge could dramatically alter beliefs I had previous held as truths. The experience made me realize that my perspective on any situation is defined by the knowledge I have at the time, and as I gain new experiences and new knowledge, my perspective will undoubtedly change. Appreciating the influence my history has on my perspective has helped me better understand the perspectives and actions of others.

Intelligent Vehicle Lab

During my first year at Olin, my established interest in electric vehicles and my growing curiosity in robotic systems led me to wander through the Intelligent Vehicle Laboratory. With the support of Professor Drew Bennett, I began a research project in collaboration with Ocean Alliance, a nonprofit organization dedicated to protecting and monitoring the marine environment. The project was titled APHROS (Autonomous Persistent Hovering Robotic Operating System) and my goal was to create a small unmanned aerial vehicle (sUAV) that could be launched from a sea vessel, fly above a surfacing whale, collect any expelled biological matter from the whale, and return to the vessel without contaminating the sample. In order to accomplish this, I needed to design and construct the aircraft's mechanical and electrical system, I needed to understand the biology of what I was collecting in order to ensure I would not be contaminating my samples, and I needed understand the user requirements of those who would be using the system so that using the vehicle would be straightforward and intuitive. In order to address the project holistically, I drew upon my experiences in studying mechanical design and transport phenomena when building the vehicle, user-orientated design when designing the interface, feedback control when developing autonomous behaviors, and biology when determining how the vehicle would affect the marine subject. The combination of these disciplines allowed the project to be developed into a real, practical, and useful system for Ocean Alliance.

Through my research with Ocean Alliance, I have had the privilege of being introduced to people working all around the world on a mission the affects the wellbeing of entire planet. Roger Payne, Founder and President of Ocean Alliance, and Iain Kerr, CEO of Ocean Alliance, have been studying whales for more than forty years, and my work will help them access a wealth of information they have not previously had available. The context of my research is not only exciting and motivating, but it has allowed me to have an impact on a global scale. Even after I graduate from Olin, I aim to continue working with Ocean Alliance to aid in the deployment of the devices I've help create.

Rapid Prototyping

Along with my APHROS research, working in Intelligent Vehicles Lab also gave me the opportunity to maintain and manage the lab's rapid prototyping equipment. The primary machines in the lab were two Dimension 3D Modeling Printers and a Roland Subtractive Rapid Prototyper, all of which saw heavy use on behalf of the student body. After being trained in the basic operation of the machines, I focused on maintaining the machines, managing the jobs submitted by students, and making sure jobs that would damage the machines were not processed. As my experience with the machines grew, I found I was able to help other students with their designs to aid in their manufacturing. As I continued to manage the rapid prototyping equipment over the years, my role became more focused on educating students on how to successfully design for our particular rapid prototyping equipment and for other manufacturing processes. In my junior year, I was asked to formally teach the Design for Manufacturing class about rapid prototyping equipment and how to design for the machines we have at Olin. I have since created and given more presentations on rapid prototyping technologies outside of Olin, in

an effort to inspire students to experiment with these devices. I believe that most forms of engineering and design can benefit from rapid prototyping technology, and it has become my goal to introduce these technologies to as many students as possible.

Working Outside Olin (entrepreneurial)

Through my work in the Intelligent Vehicle Lab with Professor Drew Bennett, I was introduced to Helen Greiner, co-founder of iRobot and CEO of CyPhy Works. The summer between my sophomore and junior year at Olin, I worked for Helen at her startup company CyPhy Works on mechanical design and fabrication of small unmanned aerial vehicles. The following summer, I joined Rest Devices, an even younger startup company focused on simple “human-centered” monitoring devices. There I worked on a bit of everything; from mechanical design and prototyping to sales and marketing. Working at Rest Devices was demanding, but I became addicted to the sheer diversity of my work hours. My time at both of these companies gave me a juxtaposing insights into how small companies form and how they are run.

It seems obvious now, but it surprised me how much the nature of interactions between employees defined nearly every aspect of each company. At CyPhy Works, every employee had their own office space, separate from every other employee. Interactions were planned and scheduled; unplanned interactions were simply distractions. This mentality made it difficult to feel connected to the company as whole, and consequentially, it did not inspire much motivation to excel. At Rest Devices, not only did everyone work in a single large room, but people working on related projects sat at the same table. Communication was constant and lively; there was never a quiet moment. Though there were there were less than a quarter of the employees at Rest Devices than there were at CyPhy Works, I felt like I was a part of something much larger while I worked at Rest Devices. Of all the aspects of running a small entrepreneurial venture I learned from these two companies, I found the nature of how employees interacted to be fundamental to how the company ran as whole.