

# A Holistic View of Engineering

Nikhil R. Gupta '13

Franklin W. Olin College of Engineering

## I. Grand Challenge Project – Sustainability

Throughout my academic career at Olin College of Engineering, I have worked towards solving the Grand Challenge area of sustainability. My interest in renewable energy, specifically biofuels, culminated in a final project during my Senior year at Olin.

In my final semester, I worked on studying renewable energy on a systems level in the hopes of advancing the Grand Challenge area of sustainability. The goal was to help people in developing countries with their energy needs. I wanted to focus on developing energy technologies and processes for income-constrained individuals, which would allow them to become more self-reliant with respect to their energy needs. I aimed for my processes to be low cost, sustainable, relatively easy to implement, and scalable.

I strongly believe in the power of chemistry. I believe one of the greatest hurdles to alternative energy sources is one of energy density. Fuels, storing their energy in chemical bonds, are much more energy dense than any other energy storage technology discovered, save nuclear. Wind and solar are interesting technologies but I do not believe they are scalable and economical in the way that fossil fuels have been for mankind. Thus, I wanted to focus this sustainability project on biofuels.

Biofuels, as chemical fuels, have the potential to be as energy dense and scalable as coal, oil, & natural gas. They also have the advantage of being generally compatible with existing infrastructure and existing technologies. For my sustainable energy project, I decided to focus on three biofuel technologies, which I could envision as possibly empowering those in developing countries in the future.

For my project, I focused on two processes to make biodiesel and one process to make biogas. I saw biodiesel as a useful fuel to focus on since most of the developing world uses diesel fuel for their transportation needs compared to petrol fuel (gasoline) in the United States. Additionally, diesel generators for the production of electricity are widespread throughout developing nations such as Ghana & Uganda. I saw biogas as a useful fuel source to replace natural gas for cooking and possibly even for use in engines for transportation and generators for electricity.

For my biodiesel processes, I decided to focus on a relatively mature process and a novel process. I worked on a transesterification process to convert waste vegetable oil into biodiesel and a process to grow algae, isolate algal lipids, and process these lipids into biodiesel. For my biogas process, I worked on producing biogas through the anaerobic digestion of the organic fraction of municipal solid waste (food scraps).

My goal throughout was to design a scalable, continuous system which would also be cheap and economical. I was also mindful that for these processes to have a large impact in a developing country context, they had to be relatively easy to implement, operate, and maintain. As such, I designed my systems utilizing common materials and pieces of equipment which could be found in any metal scrap yard in a developing country and which had a critical mass of technicians who knew how to utilize said materials and equipment.

Overall, my biofuels project was a great experience. I learned a lot about the challenges of designing sustainable solutions for capital-constrained members of developing countries. I also learned much about different types of biofuels technologies and the potential of biofuels to help displace fossil fuels. In this way, I believe I made progress in helping to solve the challenges associated with the Grand Challenge area of Sustainability.

## II. Interdisciplinary Experience

I have been fortunate to have had significant interdisciplinary experience throughout my college career. Over the past 4 years, I have studied at 4 different institutions of higher education: Olin College, Wellesley College, Babson College, & The University of Illinois at Urbana-Champaign (UIUC). I utilized Olin's cross-registration agreements to take courses at Wellesley and Babson in the liberal arts and business/entrepreneurship respectively. I developed a study away exchange partnership with UIUC so that I could take higher level chemical engineering courses not offered at Olin. By studying at different institutions and interacting with students from different background and different college majors, I was able to learn much and have a highly enriching, interdisciplinary college experience.

In addition to my coursework and interactions with various institutions, I would like to highlight three specific experiences which helped me to think from an interdisciplinary perspective. The first of these experiences is my work in a capstone engineering course at Olin entitled "Affordable Design & Entrepreneurship" (ADE).

In ADE, I had the pleasure to work in an interdisciplinary team of students from Olin, Babson, & Wellesley towards the goal of helping to empower and improve the lives of rural Ghanaian women. Through my ADE project, I worked on mechanical engineering, chemical engineering, design, business, and entrepreneurial aspects. Our goal was to help village-residing women in Ghana process a staple food crop of Ghana, cassava, in a faster, more efficient, and less burdensome manner. We aimed to do this through the creation of a Ghanaian-run business which would distribute novel technologies in this area throughout Ghana. Such a task, by necessity, required work and analysis from a variety of different disciplines. I enjoyed trying to think of our challenge and goals from a systems level perspective and an entrepreneurial perspective. Real life is more than just one discipline. In order to create something scalable in the real world, you must draw from different backgrounds, different experiences, and different areas of knowledge. This exercise was quite a rewarding one.

The second experience I would like to highlight is my capstone chemical engineering course at the University of Illinois, "Process Design". In my Process Design course at UIUC, my team designed a methanol production process capable of producing 2 million tons of methanol per year at a purity of 99.95% by weight. When designing and performing the economic/financial analysis of this full chemical plant, we had to consider all aspects of the facility and of the associated logistics and operations. We had to draw from many areas of knowledge including chemical engineering, design, economics, finance, chemical plant operations, health & safety, and environmental impact assessment. Ultimately, we performed a thorough analysis and

developed a final design we were all very proud of. If we were to ignore non-technical aspects of our design, we would have produced something of little value, an incomplete design which could not be implemented in the real world. It is because of the interdisciplinary nature of this course that we produced something useful and learned much in the process.

Finally, I would like to highlight my interdisciplinary experiences with an independent study I conducted during my Senior year at Olin College. During my final year at Olin, I engaged in an independent study on energy. The goal of the independent study was to study energy in the modern world from a holistic perspective with the intent to identify trends and areas of opportunity in the future. I studied not only the technologies of energy, such as biofuels and nuclear power, but also the financial and economic aspects of energy, as well as the legal, social, and political aspects. This independent study gave me more insights as to what key aspects are currently lacking in various alternative energy systems and what the key “push” and “pull” forces are that are affecting the global energy industry. Ultimately, I hope to use these key insights to help me make a large impact in this challenge of energy and sustainability.

### III. Entrepreneurial Experience

During my tenure at Olin College, I have had significant experience with entrepreneurship. My long term goal prior to coming to college and throughout my 4 years in college has been to start an alternative energy company. As such, I have focused much on business and entrepreneurship in addition to my major of chemical engineering and my passion of energy & sustainability. I have had significant coursework in business and entrepreneurship, but I have gained the most entrepreneurial experience by attending entrepreneurship conferences in the Boston area and by learning from friends I have made at Babson college.

Additionally, as mentioned, I worked during my senior year in Affordable Design & Entrepreneurship to develop a business venture in Ghana aimed at helping rural cassava processing women. As mentioned, this was a very interdisciplinary experience where I focused heavily on business and entrepreneurship. This was a great experience for me; it helped me immensely in building up my Entrepreneurial IQ. I really had to think about entrepreneurship practically, not in the theoretical manner in which entrepreneurship is sometimes treated. If we were to help cassava processing women in a significant way at scale, we had to think through the many challenges and risks associated with starting a new business venture. This was real life and this realization helped us to think critically and practically about the business we were attempting to create.

The culmination of my entrepreneurial studies and endeavors at Olin was manifested through my Entrepreneurship Capstone course. In this course, I followed the entrepreneurial advice of Tim Ferriss in "The 4-Hour Workweek". I worked to create a business with low fixed and operational costs, which could be designed in a way such that it would require low maintenance and time commitment, thus freeing up the owner's financial and time constraints to pursue their main passions. I ended up starting a business focusing on providing targeted college admissions advice to Indian-Americans and to international Indian students. I received funding from Olin, created a website, and advertised in "Khabar Magazine", a major Indian-American magazine, for the purposes of testing demand for my product.

I really enjoyed working on my business, "Stealing Ivy" during the fall semester of my Senior Year. A good friend of mine once told me that when you have a business of your own, it's all you ever think about. I found that as I was creating and shaping my business that semester, I was always thinking about it. My "Muse", as Tim Ferriss calls it, was always at the back of my mind. But it didn't take over my mind in a bad way. My startup didn't consume me and stress me out. Rather, I loved working on it and thinking about it. I loved talking about it with other people and reflecting on milestones I had achieved.

Ultimately, I realized that entrepreneurship and business in general are really just social activities. Businesses are composed of people and function as a way to link people together, to aid them in working together and helping one another. As I was trying to start this business, most of the time, I had no idea what I was doing. From determining the idea for the business (what it would do), to figuring out how I would reach my customers, to creating a website for the company, I never really had any real experience in these areas. I realized though, that I could bounce ideas off of others and that I could get family and friends to walk me through the creation and design of a website.

There was one amazing week where everything seemed to come together. One week where my idea transformed from a project to a startup company. At the beginning of this week, I had only really come up with the idea of the business and a preliminary website. By the end of the week, I had an advertisement to submit for printing in the December issue of “Khabar” magazine. Things just seemed to fall into place. Aspects of the creation of the magazine which I had thought would take much time and effort seemed to come together effortlessly. It was due to the unwavering help of friends whom I had gotten interested in the business that everything seemed to go swimmingly.

Ultimately, I realized that most tasks and goals in life are best solved by seeking the guidance and assistance of experts in the relevant areas. Ultimately, an entrepreneur’s main job is finding skilled and knowledgeable people and getting them interested enough to help him out. Thankfully, this aspect of pulling knowledge and expertise from a variety of different areas is something I enjoy very much. Truly, this aspect of my work with “Stealing Ivy” was the one I found most rewarding.

#### IV. Global Awareness

Through “Affordable Design & Entrepreneurship”, I have gained global awareness. Our work is directly aimed at helping marginalized individuals in developing countries. In addition to the previously mentioned experiences I had over the semester, I had the good fortune to be able to travel to Ghana during winter break of my Senior year. My ADE team traveled to Ghana, where we met and worked with rural villagers, shop owners, members of agricultural co-ops, and machinists. We stayed overnight in rural villages and we learned about the needs and values of the women we were trying to help, as well as the society in which they live. We received first-hand exposure to the harsh realities many throughout the world face every day and we learned how to communicate and work with people who come from starkly different worlds than our own, in an attempt to try to help improve the lives of those in rural Ghanaian communities. My trip to Ghana and my work with ADE was an amazing experience that I will never forget.

## V. Service Learning

My ADE project helped me immensely in empathizing with others who come from a different background than I do. By hearing about the struggles of people in Ghana, specifically rural village women, I was able to gain a better sense of the hardships they face every day. I came to understand how they spend a great portion of their time and energy working very hard to merely feed themselves, their families, and their communities. I gained a better appreciation of the fragility of life in non-developed nations and the hope people have to rise up out of poverty.

Through my trip, I was able to directly help these Ghanaians I was attempting to understand, and to learn from them as they shared with us some of their wisdom and collective societal knowledge. Through ADE, we focused not on designing *for* Ghanaians, but rather *with* Ghanaians, in an attempt to empower their communities. Overall, ADE was an excellent medium for learning about those living in poverty around the world and for attempting to help better their lives.

## VI. Reflection

College has been a great experience for me. Through college, I have had a crash course in how the real world works. Many of my naiveties about how societies function have been destroyed over the past 4 years and I have gained a greater holistic perspective on life and modern society. By being able to interact with various people from different backgrounds, with different interests, studying different subjects, I have been able to gain significant knowledge and insights in a wide variety of areas. These insights have allowed me to better understand others and to empathize with them.

By studying at 4 different institutions, I have been exposed to different cultures and environments and have become more adaptable. Through my “Affordable Design & Entrepreneurship” class, I have seen how differently people in other countries live and have gained insights as to what improvements would make the biggest impact to the lives and communities of rural Ghanaians.

I have cut my teeth in the area of entrepreneurship by starting and running my own business while in college. This experience helped me to cement, with experience, the learnings I had gained through coursework, entrepreneurship conferences, and conversations with entrepreneurially-inclined friends. This experience showed me how different the classroom is from the real world and how good technology is only one small component of a successful widespread solution.

Finally, throughout my college career, I have gained a strong foundation in energy and sustainability. My Grand Challenge Project in biofuels allowed me to attempt to develop sustainable energy solutions for poverty-stricken members of developing nations and to gain more technical knowledge and experience in chemical processing and biotechnology. My energy independent study allowed me to study the field of energy in a rigorous, in-depth, holistic manner. This independent study provided me with technical, economic, legal, and political insights into the energy industry and helped me to develop insights as to challenges and opportunities in the energy and sustainability arenas for the future.

With the experiences, knowledge, and insights I have gained over the last 4 years, I am confident that I have built a strong foundation which will serve me well in tackling the Grand Challenge area of Sustainability.