STEP Reflection Essay

This summer, I worked as an undergraduate researcher with the Billinge Group in the Columbia University Applied Physics and Applied Math department. Although I had devoted one summer in high school as a research assistant in the physics department of a local university, my time with the Billinge Group constituted my first college internship, as well as my first summer spent in New York City. During the ten weeks of my “official” internship, I had a wonderful and educational experience learning about everything from the physics of materials to workplace culture to career possibilities after college.

Currently, I am a rising junior, majoring in Materials Science and Engineering—part of the Applied Physics and Applied Math department—so this position was the perfect opportunity, not only to gain valuable work experience, but also to acquire knowledge in my field of study. The main focus of the Billinge Group is “solving the nanostructure problem.” Nanotechnology currently exists at the forefront of scientific innovation, with applications ranging from pharmaceuticals to photovoltaics: our group’s mission is to contribute to a greater understanding of the complex structure of these extremely miniscule particles.

Before I embarked on my internship, I tried to prepare by brushing up on my programming skills: Python is the primary language used by the group, and although I had taken one introduction class at university, I anticipated my biggest challenge would be my lack of coding abilities. Consequently, I completed an online Python tutorial on Codecademy and perused the group website to learn a little bit about various projects other members were already working on.

During the initial week of my internship, my Principal Investigator was away in Europe for about a week, so the parameters of my project were to be decided upon his return. Because
the field of Materials is so broad, projects ranged from organic chemistry to diffraction physics, so it was a matter of which area I wanted to undertake. I spent this brief waiting period reading on crystallography, a subject shared by nearly all members of the group and essential to the understanding of nanostructures; in a mere week, this reading contributed immensely to my limited knowledge of lattice structures, which I will need for future classes.

The goal of my summer project was to create a computational tool to model fundamental diffraction patterns of scattering objects, and comparing patterns created in Python to analytical results derived in *Diffraction Physics* by John Cowley. My project was an extension of another group member’s: ultimately, we hoped to use the tool I would create to predict the scattering patterns of more complex structures. Although the project sounded incredibly intimating in its entirety, my P.I. suggested a series up steps to take—for example, starting out by modeling a slit in one-dimension, then two slits in one-dimension, and so on. However, even with a sequential break-down, beginning the project was difficult—the online Codecademy tutorial offered help with basic syntax, but my project required a higher level of programming, such as knowledge of certain functions. Still greater was the conceptual challenge: starting from scratch, how would I construct an object in one-dimension? Where would I even begin?

Although my P.I. cautioned me that the learning process would be exponential—starting slow then gaining in speed—in the beginning, I felt like I was progressing at zero miles per hour. Yes, after Day One, I had figured out how to create a Numpy array, but I was completely lost on the next steps to take. One day, however, my P.I. asked me how my project was going, and I admitted that I was stuck. Graciously, he spent the better part of an hour helping me understand some basic diffraction concept, until I felt confident enough to continue on my own. At another point during the summer, I was hindered for a few weeks by a certain function, and although I
was extremely scared, asking my P.I. for help allowed me to make progress once again—and contrary to my fears, he was extremely keen to offer his assistance. This was perhaps my biggest lesson this summer: learning to ask for help.

In addition to this major realization, as my first internship experience, I discovered the notion of workplace culture, from collaborating with group members to determining who made the coffee each morning. I felt like my summer with the Billinge Group was the exact opposite of stereotypical corporate culture: instead of adhering to strict schedules and deadlines, group members had few limitations, but were expected to make progress in an efficient and timely manner. Additionally, as Professor Billinge was more often than not out of the office, this summer also tested my ability to work independently. Although I think I improved my capacity for self-motivation, it also provided insight into my productivity level with different driving forces—however, I am still undecided whether I work better under self- or external-motivation.

Overall, this summer was an incredible learning experience in many ways: in addition to gaining technical knowledge in materials and programming, I also learned about work in the real world and how I respond to a more relaxed work atmosphere. With some research experience under my belt, I think I would like to pursue an internship in the industry next summer, to gain a different perspective on potential career paths. Although I believe I will probably work in the engineering industry after college instead of academia, my summer internship was definitely an enjoyable experience, as well as a positive capability to bring to future employers. Next semester, Professor Billinge has agreed to let me continue research with his group. So, in addition to learning more about coding and crystallography, I will hopefully make contributions to the understanding of nanostructures while simultaneously gaining valuable work experience.