Essay Component

At the beginning of my research, I was very confused. I was jumping into a world (the world of gravitational wave researchers at the Laser Interferometer Gravitational Wave Observatory, LIGO) that had thousands of member's worldwide, had just recently received the Nobel Prize in Physics, and contained some of the most complex physics in the world. My mentor, before assigning a research topic, tasked me with understanding as much of the science that I could and to learning how to use Unix (the basic programming language used by LIGO researchers to control analysis programs). This bombardment of information and lack of direction made it difficult to sort through which parts were going to be important and which parts were too in-depth. For example, I quickly learned that knowing the basics of Unix would be integral to my research so I began to focus my time on understanding the language. After countless YouTube instructional videos, specifically from Naresh I Technologies, I was able to effectively use this language. This was in contrast to my feeble attempts to understand how the interferometers worked at a fundamental level. Because the resources that I received from Professor Shawhan (a brief information packet detailing the basics of the LIGO website and how to join the listserv) did not comprehensively cover how LIGO worked, I had to rely on Internet searches to gather information. However, I found that most websites offered a brief, watered-down explanation of the science behind LIGO that proved insufficient to me. After a few days of unsuccessful research, I decided I needed to move on.

After creating a foundation, my mentor, Professor Peter Shawhan, declared it was time to get started with the real research. Professor Shawhan decided that my focus would be on something that he had started a few years earlier but had not been able to complete: the search for scalar gravitational waves. The first time I learned of my topic, I was skeptical…what are these waves and how will I be contributing to the advancement of science? After talking with Professor Shawhan, however, I quickly learned why he had an interest in these waves and the incredible opportunity that provided…the first slight on Albert Einstein's famous general theory of relativity. Professor Shawhan explained that general relativity did not predict the existence of such waves but other competing theories did. As I realized the potential groundbreaking implications of my upcoming research, I couldn't wait to begin.

My task would be to determine if the search that LIGO was currently undertaking, the search for tensor gravitational waves (which are predicted by general relativity and have been confirmed to exist), was either sensitive enough to detect weak scalar gravitational waves or would a completely separate search be needed to look for such waves? To get started, Professor Shawhan contacted another LIGO scientist, Dr. Vedovato, who had written the program that I would be using for my research: Coherent WaveBurst. Dr. Vedovato began to teach me how to use his program, based in Unix, through multiple conference calls where he would walk me through a tutorial analysis while answering any of my questions. Once I completed the tutorial, I would send him the results and we would walk through how to analyze the graphs. With Dr. Vedovato's help, I was able to analyze thousands of potential gravitational wave signals and determine the efficiency of the search at detecting such signals. However, I knew that Dr. Vedovato had his own research to attend to and thus I tried to only ask questions if I couldn't answer it myself. For example, in addition to writing the code for the simulation, Dr. Vedovato also ran a website called Coherent WaveBurst that contained an archive of information on how to run an analysis, definitions of variables that he used, and explanations of the code. I spent many hours learning what his C++ code (I've only learned Java) meant and what every component of the analysis was actually doing. This knowledge eventually allowed me to begin running my own analyses and, inevitably, running into errors. At first, I would bring my errors to

Professor Shawhan and watch his problem solving skills in action as he discovered the root of the problem. Possessing this skill is something that I tried very hard to hone, often holding back on asking questions until I had exhausted every resource/option that I formulated could help me find a solution. By the conclusion of this project, I was able to solve most problems without the help of Professor Shawhan or Dr. Vedovato.

One of the main reasons I reached out to Professor Shawhan for this opportunity was to help me decide what type of career I want: a research-based career where I spend my time analyzing data, a hands on career where I help in design, or something completely different? After 3 months of analyzing data, I believe I have partially answered that question: sitting at a computer all day is not the type of career I want to have. My goal is for my next opportunity to be more team based/applicable to everyday life to determine if this is the path I want to take.

Reflecting back on this research experience, the one thing I would change was the acclimation process. I wish I knew beforehand what specifically I needed to know so I could best prepare for the bulk of the research and not lose time trying to learn extremely complex systems which had no application to my research.

While I did not use the library for this research experience because of the extremely specific nature of the project, I have run into several problems in schoolwork where I am attempting to view a scientific study only to realize that it is paid viewing only. If Maryland libraries could provide free access for students to view all scientific literature, this would be extremely beneficial in advancing both schoolwork and research.