REFLECTIVE ESSAY

Prior to completing my research project on integrating sensory feedback into a bidirectional neural bypass device, I took human anatomy and physiology courses. While learning about the human nervous system, I began to realize how closely it resembles an electrical circuit. My foundation in biomedical and electrical engineering piqued my curiosity about how to record from and communicate with the human nervous system using biomedical devices. Accordingly, when invited by Dr. David Thompson to work as an undergraduate researcher in the Brain and Body Sensing Laboratory around the same time, I began exploring research on brain-computer interfaces (BCIs). The position introduced me to methods for recording brain activity non-invasively and how the recorded data can be used to control an external interface. The following summer, I sought to explore the research opportunities in neural engineering more broadly by applying for Research Experience for Undergraduates (REU) programs. Dr. Joshua Smith accepted me to work in the Sensor Systems Laboratory at the University of Washington as part of the Center for Neurotechnology. I researched the potential application of wireless power to enable battery-free sensing of neural activity in muscles. Both research experiences guided my decision to research neural interfaces for my project.

To better understand the recent advancements in neurotechnology, I began reading recent articles in high-impact journals such as *Nature* and the *Journal of Neural Engineering*. A device that caught my attention was Battelle's neural bypass device, which had been used to successfully restore motor function for an individual with a spinal cord injury. Upon further investigation of the literature on neural bypass prosthetics, I learned the technology still had several limitations. Thus, I had the opportunity to research methods for improving the functionality of the device for my project.

In preparation for conducting research, I established my research objectives to present to Battelle to aid its decision on my proposal for improving the functionality of its neural bypass device. Then I outlined a list of questions to guide my search for information to meet my research objectives. After completing preliminary research on the main objectives, I developed an outline of the structure of my paper that would purposefully organize the information I would be gathering. This way I was able to track the progress of my research. I also used Zotero to save the citation information I intended to include in my final report. Zotero allowed me to rearrange the sources based on my placement of each source in the body of the paper and export the list as a works cited in IEEE style to my references page.

To ensure that my research was thorough and reliable, I reviewed professional journal articles and conference papers I identified using the online databases provided by Kansas State University. Specifically, I decided to use Scopus, IEEE Xplore, and PubMed because of their extensive coverage of professional publications, and the availability of full-text documents relevant to my research. The publications in these databases have also been peer-reviewed, which increased my confidence in the correctness of the information contained in the articles. I also searched the internet for reputable websites based on date, domain, and presence of cited sources to obtain additional information on Battelle and statistics about spinal cord injuries.

One article that significantly influenced my research project was “New Perspectives on Neuroengineering and Neurotechnologies: NSF-DFG Workshop Report,” because it covered both the advantages and disadvantages of all three methods proposed for improving the neural bypass device. Although not frequently cited in the final report, I used the article as a guide for finding other sources with more information on the points made about each method. I also sent an inquiry letter to one of the authors to gain additional information on the concepts presented in the article. The article allowed me to compare in detail the three proposed methods and strengthen my final recommendations.

The search technique that proved to be the most successful was to use 1-4 keyword searches in the technical database most relevant to the topic and limit the results to the most recent 5-15 years of publication. For example, I used PubMed when researching tissue damage and ethical considerations and IEEE Xplore when researching methods for restoring sensory information and the future of neural bypass device design. The basis for this decision was that PubMed is typically more concerned with the interaction of devices with patients, while IEEE Xplore focuses primarily on the technical aspects of device design. A second technique I frequently used was to investigate the citations of notable articles for further information, specifically when I needed more detailed information to understand a topic more fully.

After initially spending significant amounts of time reading every article thoroughly to evaluate its value to my project, I learned to become more selective in my approach to finding information. I shifted to reading the abstract and looking at the headings and figures prior to reading the article in depth. The abstract, headings, and figures typically provided enough information on the aims of the article to allow me to make a more informed decision on its value to my research. Furthermore, as I neared completion of my report, this strategy increased my efficiency in finding the remaining information.

My experience using library tools for my project taught me the importance of establishing a research strategy that includes methods for tracking sources when collecting information. A difficult lesson I learned was to begin saving applicable sources early with notable findings from each source, which could be narrowed down later when I started writing the report. I also became more familiar with the criteria needed to evaluate the validity and value of sources. Most importantly, this research experience gave me transferrable skills I know I will apply in my future work as an NSF Graduate Research Fellow.