

Library Research Award Reflective Essay – Connor Geiman

My research project, which was the final result of my Mechanical Engineering Mechatronics capstone of Spring 2020, focused on improving the functionality of life support systems involving algae for space travel. I developed the idea for the project after working with a friend on a biological life support system project earlier in undergrad. Biological life support, in contrast to the more popular non-living chemical life support used on all current and previous manned space missions, uses living organisms to recycle air or other resources in space. I spoke with Dr. Joseph Garbini, the professor who oversees the Mechatronics capstone, and he believed the project would make an excellent capstone but would require thorough research to successfully complete. Under Dr. Garbini's guidance, I worked with a team of four other students during the quarter, but wrote a paper based on the results from the capstone on my own (due to the coronavirus pandemic), which was accepted for presentation at the International Conference on Environmental Systems. I was primarily responsible for setting the research direction, searching the literature, and leading experimentation, while other team members designed hardware, identified and ordered electronic components, and created a feedback controller for the system. Dr. Garbini gave guidance on the design of the controller and kept us on track to fulfill capstone requirements but allowed us free rein to take the project where we chose.

My literature search began by accessing the UW Libraries article database and Google Scholar for papers related to the control of algae life support systems. I started with simple terms: “bioreactor control” or “life support system efficiency.” After reviewing the literature available under those broad terms, I then got more specific, including terms such as “*Chlorella vulgaris*” or “PID control.” Later, I began paying attention to the journals and conferences where the most helpful articles were published and searched directly for articles from those specific sources. I found the International Conference on Environmental Systems particularly helpful, which is the conference where I later submitted my finished research paper.

At an early point during the literature search process, I ran into trouble finding papers that discussed research on artificial algae ecosystems. I turned to Dr. Frieda Taub, a professor emerita in the School of Aquatic and Fisheries Sciences who researches algae ecosystems. She pointed me toward a book, “Man-Made Closed Ecological Systems,” which she stated was her go-to resource for space algae systems. I found the book through Interlibrary Loan and was able to check it out for the duration of the project. The book turned out to be an indispensable resource that helped me figure out the direction for the project, and I cited the book in my paper. I later checked out another book on algae, *Slime*, through Interlibrary Loan as well.

As the project progressed, while I continued using the UW Libraries database and Google Scholar to search for literature, I began to learn the power of using the bibliographies of papers I had read to discover papers I had not. Many of the papers I ultimately cited were found in the bibliographies of other papers. This strategy seems particularly powerful for a small field like biological life support. The search terms I used got me started, but cited work deepened my understanding of the field. In addition, the strategy that most rapidly increased my knowledge of the field was talking to a researcher directly. I reached out to the author of several papers on algae life support systems, Dr. Emily Matula, who gave me a clearer understanding of the state of research on the topic and later helped me interpret the experimental results from my algae system. I am still in touch with her more than a year later.

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I evaluated the relevance of sources using several factors, including scope, recency, and quality. There are few if any papers published on my exact scope, controlling an algae system for life support, so I had to incorporate research from other areas to support my project. Most papers I cited covered a subset of the topic, such as control of an algae system, using algae for life support, or simply the properties of my species of algae, *Chlorella vulgaris*. The recency of publication played a small role, since most papers on algae from the beginning of space travel 60 years ago are still relevant today because of how little research has been done on the topic of algae life support. Most of all, speaking with domain experts helped me determine the most appropriate sources for my project. I was able to evaluate the quality of information I found by speaking with Dr. Taub and Dr. Garbini, and I developed more discernment as the project progressed. The ability to turn to their differing perspectives as a biologist and a mechanical engineer strengthened the paper significantly.

Looking back, when I began this project, I was very new to the research process. My default was to turn to Google Scholar. However, I soon realized that often copies of articles were easier to find on the UW Libraries article database so I included UW Libraries in my searches. Later I started paying more attention to the bibliographies of papers I was reading, and dove into the referenced literature. I also realized the value of connecting with conferences, journals, and individuals for domain knowledge. I went from knowing very little about how research is done to having a full set of tools for doing effective research, including UW Library Search, Interlibrary Loan, and relationships with professors at UW and beyond. Effective research strategy is one of the most valuable skills I have learned as a college student. I worked in research labs throughout undergrad but to actually orchestrate a project, search for literature, and write a research paper developed me far more as a student and a researcher.