

**Thesis Project Portfolio**

**Online Education to Unite U.S. Citizens**

(Technical Report)

**Exploration of How Technical Companies Measure Success**

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science  
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree  
Bachelor of Science, School of Engineering

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Spring, 2020

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## **Sociotechnical Synthesis**

Systems thinking, though seemingly complex, combines many valuable approaches to solving diverse problems in a holistic manner that can be understood by people in many different parts of the world and in many different disciplines. Systems thinking can also be useful for a myriad of real-world problems, such as exploring the effectiveness of corporate teams within the technology industry. Particularly with the events of Covid-19, which prevents students and educators from learning in traditional classroom-based scenarios, it becomes more critical than ever to find effective ways to relay lessons of systems thinking to create valuable metrics and objectives to solve problems and apply critical thinking to the real world. Therefore, the technical paper aims to explore the effectiveness of online learning by designing an online educational module that teaches the basic concepts of systems engineering to a pool of students, some who are in the engineering school and some who are in other disciplines outside of engineering. The thesis researches and considers 3 of the largest technology companies in the world—Amazon, Google, and Microsoft—and explores the differences in team makeup at each company by researching diversity, company culture, and economic strength at each corporation.

Beginning the technical capstone, a literature review and gap analysis were first done to learn more about published methods that have been found to be effective when creating assessments and administering online education. This exploration was also helpful to determine the most effective technological platform for the needs of the study. After conducting this research, Thinkific was determined to have the most scope and potential to be an interactive learning module that could be accessed and easily used by a diverse set of students. Then, after many iterations, an educational module that discussed the basic concepts of systems thinking was created and designed using human design principles to disseminate information to an even

number of students in the College of Arts and Sciences (CLAS) and in the School of Engineering and Applied Sciences (SEAS). The module includes a pre-test and post-test in which users are tested on systems thinking concepts that are gone over in the module. This module's user testing produced data that analyzes the effectiveness of the module's ability to teach concepts and how this learning may differ between groups of different disciplines. Within the STS research project, a literature review was also conducted to explore the different definitions of success within the technology world, and how these definitions changed when tailored to each of the companies discussed within the paper. Once these definitions were researched, the literature narrowed down the measure of success to three different metrics within the paper that would be used to research each technology company: economic strength, diversity, company culture. This research was done by considering a multitude of sources: scholarly papers, secondary analysis of employee reviews, and primary research in form of interviewing, in which former employees of Google and Microsoft were interviewed and asked about their experiences and their perception of diversity and company culture at their respective places of employment.

The analysis for the technical project ventured to study two hypotheses: the module has no effect on participants' knowledge and understanding of systems concepts, and the average difference in post and pre-test results is no different for study participants in the School of Engineering and Applied Science and College of Arts and Sciences. The analysis considered many statistical tests to explore these hypotheses, including the Mann Whitney and Wilcoxon Signed Rank test. The results were that the module had an effect on participants' knowledge and understanding of systems concepts; additionally, the average difference in post and pre-test results was no different for study participants in the School of Engineering and Applied Science and College of Arts and Sciences, even though students in the engineering school came in with

more knowledge pertinent to systems thinking concepts. The results hope to provide a greater understanding of how online learning can be more effective moving forward, as it becomes more critical to utilize non-traditional methods of greater scale and complexity. Regarding the STS research project, the results are more informative, showcasing how differences in diversity and company culture contributed to different employee experiences at each company. The paper describes the economic strength of the three companies as relatively comparable, with Amazon leading the other two companies in terms of revenue, and the three companies showcasing a general collective dominance in the technology world. The paper also highlights the strides that all three companies were making in improving diversity and company culture in an industry that is often behind in those topics, detailing the rates of improvement of each and some anecdotal positive experiences from former employees of Google and Microsoft.

Both projects were extremely fruitful and elicited many notable insights, shaping my understanding of online education and company team dynamics in the technology world. Regarding the technical paper, future researchers may consider further developing the online module and conducting tests on a larger sample group and eventually this tool for undergraduate systems engineering education.

In the development and execution of this technical paper, I would like to thank my advisors and client, Professor Stephanie Guerlain, Professor Michael Smith, and Arthur Rashap, without whom this project would not have been possible. And, for the STS research paper, I would like to thank my advisors, Professor Ferguson and Professor Wayland, who encouraged and supported me greatly in the development and execution of this thesis.