

Thesis Portfolio

**Designing an Updated System for Time Lapse Microscopy to Study *Toxoplasma gondii*
Invasion in Intestinal Epithelial Cells**

(Technical Report)

**The Grocery Gap in America:
How segregation policies of the past live on through the inequality of food accessibility**

(STS Research Paper)

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Sociotechnical Synthesis

The global crises of food insecurity and foodborne illness need to be addressed not only in the United States but across the globe. Combining moderate and severe food insecurity, roughly 26.4 percent of the world's population are either moderately or severely food insecure and there are around 600 million cases of foodborne illness each year (*Estimating the Burden of Foodborne Diseases*, n.d.; *SOFI 2019 - The State of Food Security and Nutrition in the World*, n.d.). These topics, backed by statistics, are what connect the technical thesis and the sociotechnical paper.

One example of foodborne illness that affects a large percentage of the world's population (roughly 33 percent) is toxoplasmosis (Robert-Gangneux & Dardé, 2012). This infection is caused by the parasite *Toxoplasma gondii*, which is typically harmless, but can cause severe complications in immunocompromised people and pregnant women. Under the guidance of Dr. Brian P. Helmke in the University of Virginia Department of Biomedical Engineering, the technical research team spent the last two semesters researching *T. gondii* and its relationship to diseased cells. People with inflammatory bowel disease (IBD) are a subgroup of immunocompromised individuals, and their intestinal epithelial cells are characterized by diseased morphology that has a relationship to increased susceptibility to *T. gondii* invasion. In addition to performing extensive research into the methods of motility, invasion and egress of *T. gondii*, the team designed, laser cut and 3D printed an environmental chamber to study the interactions between this parasite and intestinal epithelial cells. The original plan was to stretch these cells in the chamber to mimic the healthy and diseased human intestinal wall tissue, such as those without and with IBD, respectively. Then, experiments were to be done inside the chamber

such that *T. gondii* could invade epithelial cells and various mechanisms could be determined due to the constant physiological conditions.

However, due to the COVID-19 pandemic, the team had to make several alterations. Human foreskin fibroblasts (HFF-2s) were cultured instead of intestinal epithelial cells, because they grow faster. Additionally, no *T. gondii* experimentation was done, and instead the HFF-2s were stretched using a stretch device and a plexiglass chamber originally in the lab. The designed chamber was unable to be manufactured until the end of the year due to only being in the lab for a month, but the plexiglass chamber sufficed for the experimentation. While the initial aims to observe *T. gondii* invasion were not possible, the research team was able to show morphological differences in HFF-2s when stretched. The designed environmental chamber was also successfully laser cut and 3D printed and placed on the microscope. Future work may include improving on the design of the chamber and testing its efficacy. Furthermore, important lab protocols were standardized so that future teams can easily conduct all the necessary experiments. This will further the research contributing to a potential therapeutic for those with IBD, pregnant women and other immunocompromised people, suffering from the harmful effects of *Toxoplasma gondii*.

A similar problem in need of attention is the issue of food insecurity in America. Roughly 10.5% of households in America are food insecure, meaning they do not have consistent access to healthy and fresh foods (*USDA ERS - Food Security and Nutrition Assistance*, 2020). When people do not have access to this type of food, they are more likely to get foodborne illnesses, such as toxoplasmosis, from rotten, ill-prepared foods. The aim of the sociotechnical paper is to explain how American historical policies of segregation have lived on through a disparity of food access across the country. This disparity is also known as the grocery gap, which is characterized

by a lack of grocery stores and supermarkets selling healthy and fresh foods, and instead, fast food chains and convenience stores. This phenomenon affects African Americans and Latinos at much higher rates than whites, which is no coincidence when looking to the racist policies of the past (*The Food Trust | The Grocery Gap*, n.d.). Through the political technologies theory, policies such as the New Deal in 1933 and the federal housing laws that followed are analyzed as vehicles that promote segregation, put people of color in inferior positions to the U.S. government and white Americans, and caused lasting inequalities. The results of this research and analysis indicate a system where racism is perpetuated through food accessibility and the overlap between redlined districts and areas today that either are food deserts or are made up of many food insecure households is strong. Solutions at the local and federal level must be implemented, which starts with acknowledging the continued racism that exists in America.