**Amazon Grocery: Automating the Retrieval Process**

**The Technology Industry and the Adoption of Remote Work**

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Computer Science

By
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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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COVID-19 is an infectious disease caused by the SARS-CoV-2 virus. COVID-19 was first reported in December 2019, and the World Health Organization (WHO) declared COVID-19 a pandemic in March 2020. As of May 2020, the disease has infected 4,806,299 people, has caused 318,599 deaths (Ciotti et al., 2020, p. 367). With a large portion of carriers being asymptomatic, it is difficult to track the spread of the disease. In response to the pandemic, many companies moved their workers to remote work, also known as work-from-home (WFH), with about half of pre-COVID-19 workers working remotely (Brynjolfsson et al., 2020, p.1). COVID-19 continues to infect populations around the world today, and even two years later, many companies persist in maintaining WFH for their workers, with many companies instead opting for what is called "hybrid" work and workers commuting to the office some days of the week and working remotely others (Yang et al, 2021, p.1).

The technical and computer-science related portion of the project will view my experience interning at Amazon in the summer of 2022. The technical portion will delve into my experience working with the Amazon Robotics organization as part of the Amazon Grocery division. The technical portion will discuss my project, as well as how the transition from in-person work to hybrid and remote work affected the company culture while I was an intern. In addition, I will discuss the various technologies and programming languages I learned, as well as areas for potential improvement within the project. The STS portion of the thesis will examine how the COVID-19 pandemic and the transition from in-person work to remote work affects workers mental health, as well as company productivity. These two topics are tightly coupled, especially because Amazon was one of the largest companies affected by the COVID-19 pandemic, and as a result has pushed for workers to work from home. Research will be conducted throughout the year, during the Fall 2022 and Spring 2023 semesters.

## AMAZON GROCERY: AUTOMATING THE RETRIEVAL PROCESS

Amazon is innovating within the grocery space, through the acquisition of companies such as Whole Foods, and rolling out grocery delivery services such as Amazon Fresh. Amazon's Grocery Automated Storage and Retrieval System (GRASRS) is commonly called Grocery ASRS. The Amazon Grocery Retrieval Team is currently working on Amazon Fresh and is developing a more efficient way to retrieve groceries from orders by using robots to automate the picking and stowing processes. They have run into many issues with debugging and system failures. As mentioned before, the GRASRS team is working on optimizing the ASRS for Amazon Fresh warehouses.

## OPTIMIZING THE ASRS

An ASRS (automated storage and retrieval system) is a system used for the storage and retrieval of products in a distribution environment (Roodbergen et al, 2009, p.344). Amazon uses ASRS's for most of their warehouses. The advantages of using an ASRS over manual labor are twofold. In the long term, money will be saved due to labor costs- robots do not have labor costs. The second advanatage is that robots are less prone to making mistakes compared to manual labor (Roodbergen et al, 2009, p.345). Currently, Amazon does not have an ASRS for their grocery sector. This is because, unlike most of Amazon's inventory, many groceries, such as fresh vegetables and meat, are perishable, and must be stored in optimal conditions so as to not spoil. Because ASRS's are manned by robots, the robots must be coded to deal with perishabele items such as these. Moreover, Amazon Fresh is a grocery delivery service, meaning the whole process, from processing a placed order to retrieving the groceries to packaging it, must be automated.

## AMAZON'S GRASRS TEAM

As stated before, GRASRS is focused on developing an ASRS for the grocery space. More specifically, GRASRS specializes in the Internet of Things (IoT). IoT describes a network of physical objects and devices and the technology that allows them to communicate (Li et al , 2014, p. 244). GRASRS is responsible for using IoT technology to communicate order information between Amazon servers and the robots that compose the ASRS. The problem that the technical report will deal with, is that GRASRS is a relatively new team, only being formed less than a year ago. As such, their codebase and systems are in very early stages of development, and are prone to system failures and severe bugs that can cause outages. There is currently no way to efficiently debug these errors, since there isn't much debugging infrastructure in place for the GRASRS team. With the GRASRS team having a beta test site in Atlanta that is actively serving consumers, it is important that system outages are dealt with in a fast and efficient manner. The problem that the technical portion of the thesis will deal with, is the problem of developing a full-stack website (frontend and backend) that allows members of the GRASRS team, as well teams collaborating with GRASRS, to view all error logs within a common source, without having to extensively search for the relevant error logs, which detracts valuable time from debugging issues at hand.

## APPROACHES AND OUTCOMES

In the technical portion of the thesis, I will be documenting my approach to creating the full-stack testing website that GRASRS will use for streamlining the debugging process. I will describe the architectures of the frontend and backend of the website I created for the GRASRS team. I will describe all design choices I made, such as creating the backend architecture in Figure 1.

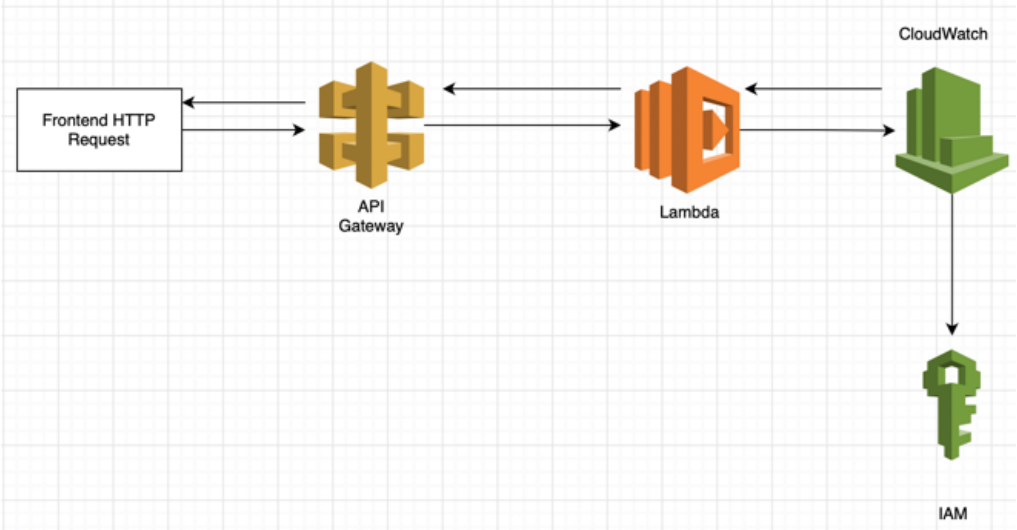


**Figure 1**: Cloud Architecture of GRASRS Operational Website Backend (Tran, 2022)

With regards to outcomes, the result of the technical thesis will be a documentational report about the project I developed as an intern on the GRASRS team as well as the technologies and languages I learned in my internship.

## THE TECHNOLOGY INDUSTRY AND THE ADOPTION OF REMOTE WORK

The STS thesis topic is loosely coupled with the technical topic. The technical topic goes in depth on the development process in creating the full-stack website for the GRASRS team, as well as personal experiences interning at Amazon this past summer. This includes personal experiences with Amazon's policy with remote work. In the summer of 2022, the GRASRS team worked mostly remotely, with the team being split between Seattle and Boston. This is representative of the problem the STS thesis topic proposes: how technology companies such as Amazon are adapting and adopting remote work, with the COVID-19 pandemic bringing the problem to light. This transition to remote work is not just exclusive to Amazon. The expected growth rate of full-time remote work over the next five years has doubled, growing from 30% to 65% (Ozimek, 2020). This change would be much more rapid, were it not for lack of

infrastructure and technology to facilitate the transition to remote work for workers. Although preliminary, this change seems to be permanent, with many workers continuing to work remotely, establishing the transition for good, as shown in figure 2. With companies increasingly and permanently transitioning to a work-from-home or hybrid culture, it is important to analyze how this transition affects company productivity, workers, and the causes of this transition to work-from-home.

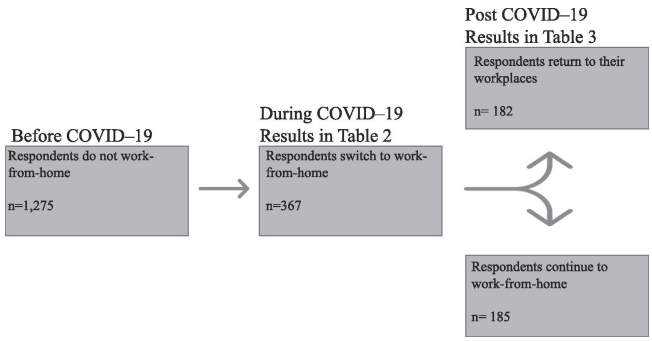


**Figure 2**: Flowchart displaying the number of workers who transitioned to remote work before and after the COVID-19 pandemic. From "A statistical assessment of work-from-home participation during different stages of the COVID-19 pandemic" by Barbour et al, 2021.

## APPROACHES AND OUTCOMES

Academic journals, specific company case studies, and news articles will be used as primary sources in researching the causes and effects of the transition from in-person work to remote work and WFH. In addition, additional research will be conducted to evaluate the longevity of remote work, and what implications it holds for companies and workers. Because this issue is relatively complex, with multiple entities and actions causing this transition, actor-Network theory (ANT) will be used to examine the STS topic. Actor-network theory attempts to define causalities as the result of relationships or connections between humans and objects, such

as ideas and technologies (Dolwick, 2009, p. 22). The system of influences between people and objects is called an actor-network (Desai et al, 2017, p.135).

Actor-Network theory will be used to analyze the transition to remote work for two reasons. The first reason is that, arguably, many non-human factors contributed to the transition to remote work, such as the COVID-19 pandemic, and other social forces. In addition, non-human forces, such as the technology needed to communicate between coworkers (video communication software), have a direct influence on this transition, and directly affect workers. This relationship is shown in figure 3.

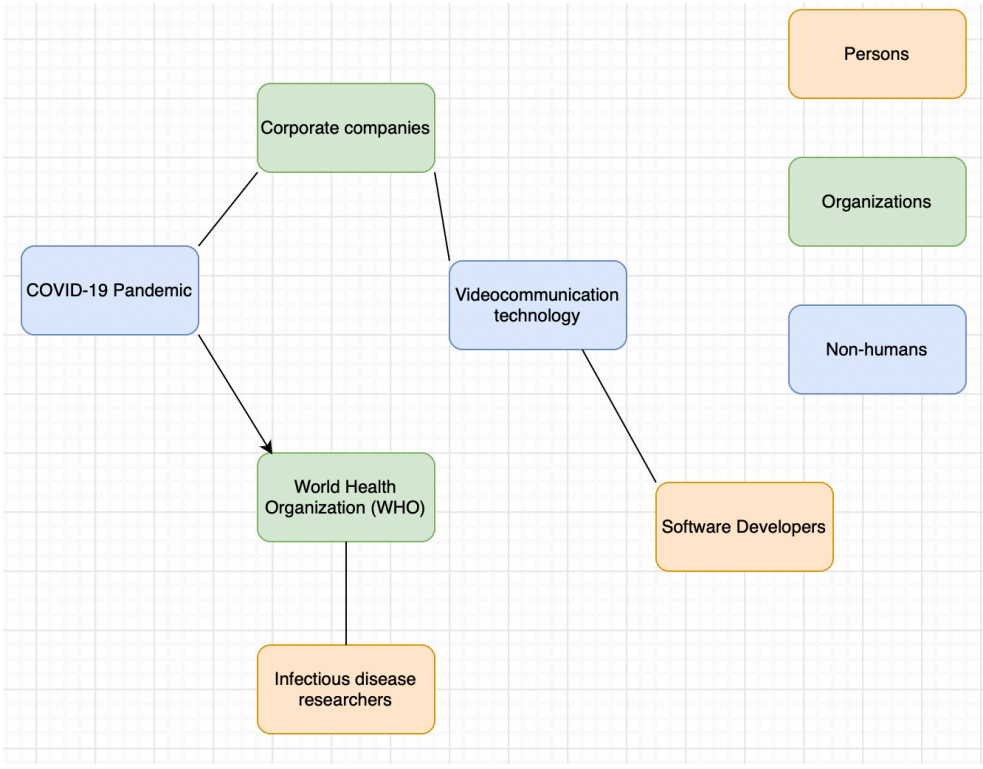


**Figure 3**: Actor-Network Theory diagram featuring actors to the transition to remote work within the technology industry (Tran, 2022)

## MOVING FORWARD

The technical and STS topics presented in this prospectus are moderately coupled, especially because my team at Amazon worked mostly remotely, visiting the office once or twice a week. With this in mind, an article will be produced delving into the causes and effects of my STS topic through the lense of Actor-Network theory, and then compare it to the technical topic. Research will be conducted throughout the year, ending in May 2022, and culminating in a research article.

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