**Dataplane Software Engineer Intern Experimental Learnings**
(Technical Topic)

**An Investigation on the Merits of Keyboard and Mouse**
(STS Topic)

A Thesis Prospectus
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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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## Introduction

Current smartphones are magnitudes more powerful than the computers that sent us to the moon in 1969 and even the preeminent supercomputers of the 1980s. It is clear that computer technology has advanced in leaps and bounds over this period of time. Yet, the primary way in which we interact with computers has basically remained unchanged over the same period. Why is this the case? For my STS prospectus, I have chosen to focus on the merits behind the standardized keyboard and mouse computer input setup, as well as potential pitfalls or improvements to be made on these input devices. I seek to answer research questions consisting of: How did the keyboard and mouse become the standard for interacting with desktop and laptop computers? What (if any) improvements can be made to the keyboard and mouse? And, what other methods exist or are being developed for interacting with desktop and laptop computers? These questions are important to consider because the influence of computers on our world is only increasing, and it is important to understand how we interact with them. My prospectus will consist of an abstract on my technical topic, a description of my proposed research into my STS topic, and a section of key texts from my STS project.

My studies as a computer science student at the University of Virginia have provided me with a wealth of different experiences and opportunities. For my technical topic, I have chosen to detail my experience with one such opportunity and determine how I have offered value to the organization, which I continue to be a part of. In particular, I will describe my ongoing experience as a Dataplane Software Engineer Intern at the company Ciena. While my technical and STS topics are not explicitly related, myself and nearly every other computer scientist uses a keyboard and mouse on a daily basis to perform our work, so analyzing these tools will give insight into potential opportunities for increases in efficiency and productivity. For this technical analysis, I seek to reflect on: how my software development experience in a real-world company differed from my previous experience as a student, what value I was able to provide to the company, and how I can learn from the experience. These are important considerations, because it is valuable to reflect on and learn from past experiences in order to improve as a human being.

**Technical Project**

Over the summer of 2023 I worked in Burlington, MA for a division of the telecommunications services company Ciena. The team I worked in was formerly a separate company, Benu Networks, which was acquired by Ciena in late 2022. Benu offered a variety of software solutions for broadband access that meshed well with Ciena's existing broadband offerings. I was brought onto the team as a Dataplane Software Engineer intern.

While I had little knowledge of the field, and a very high-level understanding of my role before joining, this quickly changed within my first week. During the onboarding process, I learned about the subscriber management software that I would be working with. I also learned that my role would be to help develop an automated testing harness for this software, which would regularly test the software's ability to handle and filter large amounts of simulated subscriber data being passed through. With the guidance and help from other members of the team, I began an iterative development process in order to piece together the required features of the test suite. First, I needed to familiarize myself with the testing software, TRex. TRex is a tool developed by Cisco which is able to simulate large amounts of real-world traffic and direct that traffic to a specific address. The TRex system consists of a server component and the traffic generator; both of which must be active in order for the testing to function. After learning how to use the various aspects of the TRex, I then switched my focus over to the existing test harness that was in place for the team. It consisted of a number of different testing functionalities, however many commands and configurations needed to be run every time it was used. Another intern and I first automated all of the different configurations that needed to be run, in order streamline the setup of the suite. We then tested the existing setup with manual TRex server and traffic commands in order to verify that it was working and get a performance benchmark. We then went through the process of integrating and automating the TRex server and traffic within the test harness, so that the whole testing process could be run with a single command.

At the end of my summer internship, myself and the other interns held a demo to show the rest of the team what we had been working on. The automated testing suite was very popular with the full-time

developers on the team. They highlighted how this was a long-time want for them, but they didn't have the bandwidth to create it themselves since they were constantly working on maintaining or improving the subscriber management software. They detailed how this would save time for them and get rid of existing pain points. They also provided advice and suggestions on how to improve the testing suite, and they outlined a few desired features. Due to the success of the project, the team asked me to continue working part time in the fall of 2023 in order to further improve the testing suite. I accepted the offer, and I continue to work on the project to this day.

## Research Question

The technologies I seek to examine are those that deal with human computer interaction (HCI), consisting primarily of the mouse and keyboard. I will not extend my research outside of input devices for laptop or desktop computers. I believe that this is important in order to maintain focus, although HCI strategies for smartphones and other wearables are an intriguing topic. Primarily, my overarching research question will be: How purely effective are the mouse and keyboard as computer input devices? In order to answer this broad question, I will consider a number of other factors. These will include, but not be limited to, How did the keyboard and mouse originally get their designs and become the standard for computer input? How do people feel about the experience of learning to use a mouse and keyboard? How do people currently feel about their efficiency and function using a mouse and keyboard? And, how do users feel about potential modifications to the mouse and keyboard, or even other HCI input methods? I believe that these questions are important to answer because we have become dependent on computer use throughout our daily lives, and the influence of computers on our society will only continue to grow. I also believe it is important to understand why the mouse and keyboard have remained largely the same since they have been invented, since over the same period of time almost all other computer technology has evolved in leaps and bounds. It is important to understand why things do not follow trends, as it can help us learn about our society.

My relevant social groups that I have identified are users of modern laptop and desktop computers. These are the groups that will have used mouse and keyboard technologies the most, and this group will have the most input on the topic. Potentially relevant groups that I am omitting from this research are current users of older laptop or desktop computers (say pre 2010) and those who primarily use tablets. Users of older computers, while they almost definitely also use mouse and keyboard, may not use their computers for the same functionalities that users of modern computers do. Additionally, this group will be less accessible to me. In terms of those who use primarily tablets, they potentially could have attached keyboards or use the touchscreen keyboards that their tablets display. However, I believe that these options provide a potentially different user experience. Similar to users of older computers,

tablet users may also use their devices for slightly different purposes. It is important to consider which social groups are relevant because having focused data that is pertinent to the investigation at hand will lead to better conclusions.

The frameworks and methods I will primarily use are social construction of technology, technological momentum, and surveying. I believe it is important to use a variety of tools to analyze this topic, because understanding the original designs and influences on the development of the keyboard and mouse will help contextualize the data on how current users feel about their user experience, decades after the fact. These methods will allow me to understand common problems that people encounter with mouse and keyboard use and analyze pain points of these devices from a user perspective. In terms of my survey, I will ask a range of participants different questions regarding how they felt about experiences they have had with the mouse and keyboard. This will include things like their learning experience and current feelings on the two devices. I also may acquire another input device, such as a trackball, and have the participants use it and provide feedback as compared to the mouse and keyboard.

In terms of timeline, I plan on finishing my list of survey questions and survey design by late November or early December. This will allow me plenty of time to conduct preliminary surveys over the holiday break and hone my questioning, before conducting more surveying in January and February of 2024. I will then have ample time to sort through my results and draw any relevant conclusions from them before the project is due later in the spring.

**STS Prospectus: Key Texts**

Throughout my review of the existing literature on both the history and future of computer input devices, I found a number of key texts that furthered my understanding of the field and offered valuable insight. One of the first sources I came across sought to answer one of the questions that initially drew my attention to this topic: “How and why did [the computer mouse] become the single most accepted interface technology?” (Atkinson 2007). This source described how the rise to prominence of the computer mouse can be attributed to a number of factors, including both ease of use and socio-political agendas that are not often discussed. This source piqued my interest into potential pitfalls of different

computer input devices, since their adaptation is seemingly not purely influenced by practicality and merit.

The next source I found sought to pit the computer mouse and keyboard against each other. The research study was designed to put users under pressure through time constraints and make them use both input devices (one at a time) to make fast selections of prompted colors. According to the study, the participants responded faster and made more correct selections with the keyboard, yet they also had significantly more incorrect responses. In terms of the experiences of the users, the study found that "11 out of 12 subjects preferred the keyboard over the mouse", primarily due to the fact that those users could "develop a working strategy" (Jorgensen 2002).

Is the keyboard then a nearly flawless input method? According to another source I found, it is far from it. This source recognizes the strain that the keyboard's design puts on specific parts of the forearm and fingers, which can lead to user discomfort. This is, in part, due to the layout of the keys on the keyboard. The layout of the qwerty keyboard was originally invented for use with the typewriter, and it has not really changed since. The source seeks to redesign the keyboard layout using a computer algorithm, and it discovered that an alternate layout resulted in "the distances traveled abstained by the proposed keyboard layout [being] less than those for the QWERTY keyboard in all texts" that they tested with, except for one (Onsorodi, Korhan 2020). The proposed keyboard not only changed which letters appear in which positions, but it also changed the entire layout of the keys.

The final source I found discussed an entirely alternate system for humans to interact with computers, which used tracking of eye, eyebrow, and head movements. This HCI method was designed for use by those who have limited motor capabilities and may have difficulty using traditional input methods such as the keyboard and mouse. When the researchers tested their Difference Between Eye and Eyebrow (DEEB) system, they found that "the system operates successfully at distances between 40-to-80 cm and all movements are detected with 100% accuracy". The researchers also were pleased to discover that, regarding speed, "there is no big difference between using a mouse and using the head movements" (Tas 2022).

**References**

Atkinson, P. (2007). The Best Laid Plans of Mice and Men: The Computer Mouse in the History of Computing. *Design Issues, 23*(3), 46-61.

Chou, J. R. (2016). An Empirical Study of User Experience on Touch Mice. *Eurasia Journal of Mathematics, Science and Technology Education, 12*(11), 2875-2885.

Grover, A. (2021). The Significance of the Application of HCI Concepts and Methods in Analysis, Design and Evaluation of Interactive Technologies. *Turkish Online Journal of Qualitative Inquiry, 12*(7), 11989-12006.

Onsorodi AHH, Korhan O. (2020). Application of a genetic algorithm to the keyboard layout problem. *PloS One, 15*(1), 1-11.

Jorgensen, A. H. (2002). Using mouse and keyboard under time pressure: preference, strategies and learning. *Behaviour & Information Technology, 21*(5), 317-319.

Tas, M. O. et al. (2022). A human-computer interaction system based on eye, eyebrow and head movements. *Mühendislik Bilimleri Dergisi (Online), 28*(5), 632-642.

Weinert, J. (2017). KEYING IN ON KEYBOARDS: Past, Present, and Future: This brief of history of the keyboard also delves into how they may soon change and ways you can improve your typing ability. *Machine Design, 89*(10), 65-67.