Board Buddies: A Physical Board Game with Wireless Communication Capabilities

(Technical Report)

Illuminating the Effects of Blue Light Emitted by Electronic Devices

(STS Research Paper)

A Thesis Prospectus
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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

Most people hear the term “blue light” and think of some black magic that allows their phone or computer to light up. Rarely do they dig any deeper than that. This paper will introduce a research project with the goal of revealing the truth around blue light, detailing what exactly blue light is and its impact on those that interact with it. Specifically, the question I plan to answer is as follows: is a lack of public information regarding the effects of blue light exposure putting consumers at risk?

To answer this question, I plan to do a deep dive into the effects of blue light exposure on several aspects of one’s health. If the research deems there are in fact some serious health risks that are not being fully covered, I will recommend the structure for an informative campaign discussing the effects of blue light and blue-light-emitting devices. I will also recommend the institution of certain regulations on companies that sell blue-light-emitting devices to force said companies to reveal some of the risks that might come with using their products.

Going off the theme of digital devices, four fellow computer engineers and I decided to create a physical board game system that can be played remotely by individuals located in different parts of the world. The Technical Report will focus on this project. We feel as though this system can be particularly impactful after the lockdown period caused by COVID-19. During the rise of COVID-19, communication and entertainment became almost entirely digital, and we feel as though it would be desirable to provide an alternative form of entertainment that doesn’t require the constant use of computers or cell phones.

Essentially, we sought to create a unique gaming experience in which users can still get the homey feel of a board game even if they can’t be in the same place to play it.

This prospectus will first look over the details of the research project: how it will be structured, the relevant social groups involved, the science, technology, and society (STS) methods/frameworks to be used, and the timeline. After this, the details of the technical project will be talked through in more depth. Finally, I will wrap up by discussing a few of the key sources I found to aid in the execution of my research.

STS Project

Background

The world is largely powered off electromagnetic energy, which flows around, and even through, us in the form of waves. These waves fall into different categories based on the energy they transmit. The shorter the length of these waves, the more energy they transmit. Radio waves have the longest wavelength in the electromagnetic spectrum, in the order of miles, whereas gamma waves have the shortest wavelength, with waves more than a billion times smaller than a millimeter.

Most waves are invisible to the human eye, but in the middle of the spectrum there is a category of waves we can in fact see. This category is aptly named "visible light". These waves constitute all the colors we can see, with red light on the low energy side of the category and blue light on the high energy side.

The category that lies right next to blue light on the electromagnetic spectrum is called "ultraviolet rays" (more commonly referred to as "UV rays"), with wavelengths slightly shorter than those in the blue light category. One of the primary reasons we wear sunscreen is to protect us from the energy that comes from UV rays. Too much exposure can have many adverse effects such as skin cancer, cataracts, and premature aging.

Fortunately, we have instituted measures, like sunscreen, to protect us from UV rays. However, even though it is of very similar energy to UV rays, companies currently do not feel we need to do the same with blue light. Blue light is also produced by the sun but has more recently become a topic of conversation due to its involvement in light-emitting diode (LED) technology, which is used in screens for computer, cell phones, tablets, etc.

According to a study conducted by the United States Census Bureau, in 2018 92% of households had at least one computer, and smartphones were present in 84% of households (Martin, 2021). These are pretty staggering numbers, and, keep in mind, this study took place before the COVID-19 pandemic, which only increased the use of blue-light emitting devices. These numbers may begin to decrease slightly as we emerge from lockdown conditions, but the general reliance on digital devices is here to stay.

Most professions nowadays involve use of a computer to varying extents, and most education systems, in the United States at least, are gravitating in a direction of being entirely reliant on devices that emit blue light.

As such, I feel is though it is important to develop a concrete answer as to whether we should be concerned about blue light as soon as possible.

Execution

My research will include the use of several studies discussing the known and unknown effects of blue light exposure. These sources will help demonstrate whether the information currently published/readily available for consumers regarding blue light is sufficient, answering the overarching research question. I will also employ the use of several more general STS sources, which will aid in determining how to get blue light research to the larger society in a more effective way.

In my estimation, the most important discussion regarding blue light is whether it has adverse effects when people are exposed to it for long periods of time. Prolonged blue light exposure has been reported to have potentially adverse effects on many aspects of one's health. Due to this, I feel as though it is important to highlight each of these potentially affected areas, detailing the changes that occur as a result of the exposure. In addressing each of these aspects, I feel as though I can best determine the overall effect blue light exposure has on an individual and whether there is serious cause for concern. As a sidenote, reserach indicates that blue light has similar effects on those of different races and sex, and, as such, I do not feel as though breaking the research into these categories will alter the overall results by a statistically significant amount.

In pursuing my research, I plan to utilize the public policy framework, a framework that depends on the identification of a set of valued conditions a society is trying to achieve and a set of policy instruments that can be used to achieve the desired effects. The valued condition regarding this project is more information regarding blue light and the policy instruments to achieve the desired effect are an informative campaign regarding blue light as well as certain regulations on the companies selling blue-light-emitting devices.

The purpose of the informative campaign would be to give users who want to know more about blue light better access to information, and the regulations would force companies that sell blue-light-emitting devices to clearly present certain details about the potential harmful effects of overusing their products (similar to how commercials regarding medical drugs have to put side effect warnings at the end).

I plan to organize the timeline for my research as follows:

Initial research will involve general research on blue light. This will include any studies detailing exactly what blue light is and how it wholistically interacts with the human body. I will then break down the research into studies focused on the aforementioned health areas. After I have everything I need to present a clear case on the potential dangers of blue light, I will focus on research that analyzes historically successful informative campaigns and regulatory practices. This research will, in turn, structure how I recommend the informative campaign be run as well as what specific regulations to instill.

Technical Project

My technical project allows two individuals to play a physical board game while in different parts of the world. The system is comprised of two game boards (one for each player) that can communicate wirelessly through a central server. When one player makes a move on their board, that move is sent wirelessly to the other board, and both boards are reconfigured appropriately. During the game, players interact with an 8x8 tile display interlaid with pushbuttons and light-emitting diodes (LEDs). When a player wants to make a move, they will push down on a tile on their board and the color of the appropriate tiles will change in accordance with the gameplay instructions. Said gameplay instructions follow the rules of the common household game Othello. The system will moderate the players' choices and not allow an illegal move or allow one player to go twice in a row. This is an internet of things (IoT) product, pairing software with hardware to push the boundaries of what a board game can be.

This system will provide an entertainment option for those who may be isolated and will foster more long-distance communication amongst friends and family. We also believe our system will open a new sector in an otherwise stagnant board game industry: a physical board game with modern wireless capabilities.

Key Texts

One source that I am leaning on to convey some of the general effects of blue light is a research paper published by the National Library of Medicine called *Effects of Blue Light on the Circadian System and Eye Physiology*. This piece was written by researchers Gianluca Tosini, Ian Ferguson, and Kazuo Tsubota. As the title suggests, the paper summarizes how blue light exposure for long periods of time might affect sleep patterns and dives into whether it might endanger ocular health. The primary purpose of the piece is to summarize current knowledge of these topics and determine their relative levels of risk rather than present new evidence.

Another piece, published by Wiley Online Library, called *Age-related Maculopathy and the Impact of Blue Light Hazard* discusses a more eyesight-specific issue and the impact of blue light on said issue. The piece was written by Peep V. Algvere, John Marshall, and Stefan Seregard, and it discusses whether blue light exposure increases macular degeneration.

As touched upon previously, a source I found to be particularly useful in communicating the extent that society relies on blue-light emitting devices, hence why this project is particularly important, is a study conducted by the United States Department of Commerce called *Computer and Internet Use in the United States: 2018*. This text is primarily informative and provides a series of statistics revealing the usage of computers and smart phones in the United States as of 2018.

Finally, regarding the more general STS sources incorporated into the project, the piece *Understanding Regulation* by Andrei Shleifer discusses the efficacy of government regulation worldwide and provides some intriguing points discussing what makes certain regulations successful and others not. Similarly, a piece entitled *Effectiveness of Information Campaigns* by E.W. Breitbart, R. Greinart, and B. Volkmer takes a wholistic view of information campaigns. The article details a series of past informative campaigns, both successes and failures, and points out what made them work/not work. Both sources are very useful for organizing the plan of attack for getting more blue light information to the public.

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