ROMULUS I: 16-Bit Computer

Negative Effects of Child and Adolescent Use of the Internet and Mobile Devices

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 Electrical Engineering

By
Wolfgang Ploch

November 8, 2024

Technical Team Members: William Rimicci, August Bresnaider, Austin Chappell

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.

Prof. Pedro Augusto P. Francisco, Department of Engineering and Society

Prof. Todd Delong, Department of Electrical Engineering

Introduction

The problem that me and my team are addressing in our Capstone project is that of the education and learning method of basic computers and programming. We are designing a fully-functional and independent 16-bit CPU out of common 74XX series chips, flash memory chips, and SRAM chips. Students are often taught about machine code and computers with a virtual simulation that puts a divide between the hardware they learn about and programming and operation of a compter. We want to bridge that gap by creating this custom, discrete CPU that students can program but also see and understand the circuitry behind it.

The sociotechinal problem that I am addressing for my STS research is that of young children spending large amounts of time behind screens and large amounts of time on the internet, unsupervised by parental figures. The interest in this area of research come from the fact that this is a relatively new phenomenon, meaning the long term affects of this are unclear and up for prediction. The real effects of this issue will be seen when the children spending time of screens and the internet grow up and become adults. The research primarily focus on the negative effects of this phenomenon. There are positive benefits in some aspects but it seems that the negatives are more profound and important to investigate.

This is not a direct link between the technical Capstone project that me and my group are completing and the sociotechinal research I am completing. This is not to say that the STS reach does not pertain to my area of study. Computers (in the form of smart phones, Ipads, etc) are only becoming more and more ubiquitious. Carrying a smart phone with you everywhere you go has become the accepted norm in today's society. Despite this, the public's knowledge of how a computer works seems to be stagnant. It is a dangerous president for people to use and rely on a device everyday and not have a create (if rudimentary) idea of how it functions. This opens the

door for tempering and manipulation. This links to our Capstone problem as this is the sociotechinal problem that we are aiming to solve with our device. This links partially to the STS research too because children today have never know anything else that always having a screen. They are the ones that would benefit the most from knowledge of how a computer works.

Romulus I – 16-Bit Custom Designed CPU Intended for Education

Electrical engineering students and computer engineering students in college will likely encounter a clase like Computer Systems and Organiztion 1, the course that is offered at the University of Virginia. This course starts by introducing logic gates and registers briefly and then to machine language on a simple ISA (Instruction Set Architecture) and then to more complex C programming. These classes do a good job of broadly covering all the marks but they tend to fall short in that they take a big leap from logic gates and registers to an ISA. The ISA is usually a simulation run on a laptop. They separates it from the components that make it up. Students understand that these components somehow make this computer but the simulation is just this magix thing that runs on a laptop, out of the view of a person. The simulator and computers in general seem like magic boxes that do what they are supposed to. Nothing should seem like magic to an engineering tasked with working with and designing these devices. Our device solves this problem. Once students take classes like computer architecture, digital logic design, and electronics, they will be able to fully understand the operation of our computer on a circuit level. We feel that this will effectively bridge the gap. The device consists of 5 boards housing different parts of the computer that will all be mounted on a wood board. Every board will be visible including the power supply. In addition, all of the registers, signals of interest, and the

data bus have LED indicators on them so the program can be seen when it is running. The computer has multiple speed options. Full speed will likely be around 1 MHz, this will be reserved for large, complex programs. Other speeds available are 400 Hz and 8 Hz. AT 8 Hz, all the instructions are reasonably able to to be seen with a vigilant eye. There are options for stepping through sub instructions and full instructions with a pushbutton. This allows a user to step through their program and visually debug it. The computer also features 4 IO ports with 16 inputs and 16 outputs each. The computer has a separate stack, data, and instruction RAM. Each of these RAM banks can store 64k 16-bit values. That means that the programs uploaded to this computer can be decently complex. The separate stack RAM is not something that is standardized but it ensures that the user cannot store data over it by accident. That would cause a stack overflow and ruin the program. These allow uses to install peripherals on the device to read in out output information from and to the computer. These IO ports are also equipped with an interrupt, allowing more complex communication between the peripheral device and the computer. A secondary goal of this device is to inspire future computer and electrical engineers. If a student is more easily able to understand a concept, they are more likely to investigate that topic further. We also feel that visually, a large device with lots of wires and LEDs is more visually appealing than a boring simulator on a computer screen.

The Effects of Prolonged Screen-Time in Young Children and the Effects of Unregulated Internet Access

The question that my research aims to answer is how prolonged screen time and internet use will affect young children in the future. This is an important topic that needs to be

investigated. Children, on average, spend more time in front of laptops and Ipad devices than watching television [1]. This trend of heavy device use was only accelerated by the Covid-19 pandemic [3]. Children have the freedom to change the program and view more things on these devices than television. While attention span is difficult to accurately measure [7], it is generally agreed that Ipad and tablet use has a negative effect on attention span [2]. The importance of this is that children have not used technology like this at a rate seen today for a significant period of time. This means that the long term effects of this behavior are yet to be seen. It is important and explore this and predict the effects because this generation will be adults and in charge of the world one day. If their social skills will be limited by constant use of technology, that would have a detrimental effect on the world as a whole. Social media has already been seen to have an addictive tendency and tends to negatively affect that mental health of adolescents [5]. The addiction specifically affects and adolescents ability to have meaningful social interactions in the real world and affects relationships with family [9]. It can also affect their ability to pay attention and complete tasks and make them more irritiable and affect their anger management [6]. It is clear that this topic has been on researchers minds since the beginning of the internet. The IAT (Internet Addiction Test) was developed in 1998 to characterize an individual's addiction to the internet with a series of questions [8].

An important component of this problem is that most of the time the use of the technology is not supervised by the parent. This opens the door for children to stumble upon potentially harmful content on the internet and develop bad habits with screen time. When children are properly supervised on technology and use educational programs they tend to get bored [10]. If children are not becoming bored on this technology by themselves, they are probably watching over-stimulating content that is harming their attention span.

Steps have been taken in places to curve and monitor the trend of heavy internet use in adolescents. For example, policies have been put in place in South Africa to monitor and protect children from harmful content [4]. It is acknowledged though that update regulators are needed to keep up with the changing nature of the internet.

The problem will be analyzed by comparing metrics between children today with children in the past to see how the heavy use of devices has affected things. Changes in childrens dily routines and social environments will be analyzed and links to the use of social media and the internet will be investigated. Children's performance in school will also be taken into account, their eagerness to learn, and their ability to retain information. No links will be assumed to be 100% connected as there are many factors that affect the metrics described in children and it cannot be definitely proven that they arise from the use of devices and the internet.

Conclusion

The Capstone project aims to deliver a discrete logic gate computer than can be programmed in machine code and used to educate students on how a computer works. Larger than that though, it aims to bridge the gap between compute scientists and electrical engineers by creating a device they both can use and and understand. Electrical engineers will benefit from the programming and computer scientists will benefit from the increased circuit knowledge.

The sociotechnical research aims to determine what negative impacts will come from the level of screen use and internet use seen in children and adolescents today. Mainly it will aim to charactize the effect on their physical and mental health social relationships, and their intellegnce and ability to learn. There is not a direct link between the Capstone project and the STS reasarch. This is not to say that the Capstone project will not have a positive effect. It will increase the

knowledge of the computers that people use on a daily basis and allow people to make more informed decisions on how to use them. This will be its main effect. The effect of the STS research will be the increased awareness of the dangers that heavy screen and internet use will have on children in the future.

References:

[1] Chang, H. Y., Park, E.-J., Yoo, H.-J., Lee, J. W., & Shin, Y. (2018). Electronic Media Exposure and Use among Toddlers. *Psychiatry Investigation*, *15*(6), 568–573. https://doi.org/10.30773/pi.2017.11.30.2

[2] Espiritu, M. (2016). *Early Childhood iPad Use and Effects on Visual Spatial Attention Span* (dissertation). Claremont Colleges, Clarement, CA.

[3] Kroshus, E., Tandon, P. S., Zhou, C., Johnson, A. M., Steiner, M. K., & Cristakis, D. A. (2022). Problematic Child Media Use During the COVID-19 Pandemic. *American Academy of Pediatrics* , *150*(3). https://doi.org/https://doi.org/10.1542/peds.2021-055190

[4] Mthethwa, G. (2014). *INTERNET REGULATION OF HARMFUL CONTENT AFFECTING CHILDREN* (dissertation). University of Witwatersrand, Johannesburg, South Africa.

[5] O'Keefe, G. S., & Clark-Pearson, K. (2011). Clinical ReportThe Impact of Social Media on Children, Adolescents, and Families. *American Academy of Pediatrics* , 800–804. https://doi.org/10.1542/peds.2011-0054

[6] Shukla, A., & Kirmani, M. N. (n.d.). Effect of Internet Addiction on Aggression and Attention Span In Adolescents: Empirical Investigation. *International Journal of Humanities & Social Science Studies*, *9*(5), 154–163. https://doi.org/10.29032/ijhsss.v9.i5.2023.154-163

[7] Silverman, I. W., & Gaines, M. (1996). Using standard situations to measure attention span and persistence in toddler-aged children: Some cautions. *The Journal of Genetic Psychology*, *157*(4), 397–403.

[8] Young, K. S. (2017). Internet Addition Test (IAT). Wood Dale, Il; Steolting.

[9] Yusuf, A., Rachmawati, P. D., & Rachmawati, D. (2020). The correlation of Internet addiction towards adolescents' social interaction. *International Journal of Adolescent Medicine and Health* , *34*(5), 351–355.

[10] Zhukova, M. A., Kilani, H., Garcia, J. L., Tan, M., Parell, P. D., Hein, S., & Grigorenko, E. L. (2020). How Does a Toddler Experience Digital Media? A Case Study of a 28-Month Old Child Learning to Use the iPad. *Modelling and Data Analysis*, *10*(3), 5–23. https://doi.org/https://doi.org/10.17759/mda.2020100301