

Right to Repair: The Struggle Between Product Ownership, Protection, and Profit

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Abstract—The average timeframe that a consumer owns an electronic device is diminishing due to socio-economic reasons as well as technical issues. Companies release newer versions of products and pressure the users to “upgrade their devices”. Even if the consumer does not upgrade, they may still run into the issue of technical failure, forcing them to replace it. This costs the consumer heavily as the new electronics keep escalating in price. Right to repair focuses on breaking the monopolies companies’ have placed on the repair of products such as smartphones. This restrictive behavior prevents simple repairs on mostly-functioning devices, which can increase costs to consumers, reduce device use time, hinder the economy centered around repairs, and also increase e-waste. Right to repair can also be analyzed from a company’s point of view, including the costs associated with providing repair parts, as well as the ownership of the intellectual property of those products.

In this report, we examine the current operating model for most major technology manufacturers. Reviewing this monopolistic model, we discuss major manufacturers’ arguments against the right to repair. Finding how assets and profits can be protected while allowing consumers to repair devices freely and economically allows us to address the positive impact on social and environmental concerns. Using the Triple Bottom Line methodology, discussed later in the report, we find weaknesses in the industry’s current operating model. Using these weaknesses, we form our analysis and solution. The results from our research indicate that right to repair legislation is necessary to protect consumers and our planet. By allowing customers to choose how, where, when, and the cost of repair results in longer use of the device by the primary or secondary consumer. This allows recycled use of the device as well. Without the need to create more devices to solve repair problems, we can limit economical strain on consumers and e-waste to protect our planet.

Index Terms—Consumer, device ownership, legislation, obsolescence, repairability,

I. INTRODUCTION: WHAT IS RIGHT TO REPAIR?

Right to repair is an ongoing movement to protect consumers from planned obsolescence through law. Obsolescence is defined as a process where electronic devices or products fall into disuse which tends to result from material deterioration or lost or outdated functions. Planned obsolescence is the idea that companies design products to fail quicker over time, forcing the customer to buy the product again. Devices that fail early, with no option for repair, will only increase the number of devices purchased and disposed of, which costs more for consumers and produces more e-waste. Planned obsolescence

is terrible for consumers and the planet, but great for corporate profit [1].

Due to a lack of infrastructure, parts, and high repair costs, consumers are currently unable to repair their damaged products [2]. Some manufacturers design their products to be irreparable to achieve planned obsolescence. Other companies profit by offering repair services through high-cost warranties while preventing the public from accessing the necessary parts, tools, and technical documents required to complete repairs themselves. Right to Repair legislation is geared to eliminate planned obsolescence as much as possible from technology manufactures. This legislation is complicated because of the complexity of the product. It is straightforward to understand who owns the technology design, but who can manufacture parts? What are the costs for licensing the design? Is it economical to make more parts? For planned obsolescence to be minimized consumers must have access to economical repair and service. These problems are the focus of our research.

II. TECHNICAL BACKGROUND: SOME STATISTICS ABOUT REPAIR

Before the Industrial Revolution, repairing one’s instruments/tools was common without any awareness of any form of “rights” [3]. This contrasts greatly with modern repairs of today’s electronic tools/devices. Unlike maintenance, repairs are performed in response to malfunctions. The act of repairing can be divided into three main categories. Below is a list of the most common and most fatal failures that occur to smartphones.

- 1) Assembly repair: You do not need any skills or knowledge to perform this repair. This type of repair simply involves putting product parts together, gluing, or fastening them [4].
- 2) Medium level repair: This repair type requires a certain level of skill and technical knowledge to complete, such as soldering and a basic understanding of the components of the device [4].
- 3) Advanced level repair: This repair type requires advanced skills and knowledge, such as diagnosing what exactly is wrong with a device with complex tools such as oscilloscopes. A deep understanding of the device is also needed to troubleshoot issues. Some advanced repairs

involve changing the screen of a laptop or smartphone, motherboard repair, or even software support [4].

List of Main Failures:

- Display screen: cracked glass, LCD failure, touchscreen failure
- Casing: scratches, cracks
- Battery: shorter life, overheating, not charging
- Operating system: malfunctions, performance issues, security issues
- Circuits: part failure, short-circuiting

The repair of these failures is necessary for the extended use of an electronic device. Without these, e-waste will continue to grow and the consumers will be forced to continue the unending cost of owning a device. Without repair, the average lifetime of a smartphone is 2.7 years [5]. Statistically in the first two years of use, 47% of failures were reported, while 39% of failures occurred between the second and third years. The average replacement cycle is coincidentally close to the average length of a smartphone service contract. Out of the main reasons for a consumer to decide to replace a smartphone, nearly 40% are because of the previous phone failing [5]. The lack of repair options and planned obsolescence are the main causes of this.

III. TODAY'S INDUSTRY: THE CONFLICT OF SAFETY, OWNERSHIP, AND SERVICE

A consumer's decision to upgrade or repair a device is heavily affected by the original manufacture, standard warranties, and purchased protection plans [5]. The aspects of reparability and longevity of a device help a consumer decide on the device they want to purchase, with one aspect having greater importance. There are two major factors when a consumer decides to repair a device: the limiting state of the device and the cost of reparability. A limiting state is defined by the current devices broken or lacking features. The cost of reparability is the overall cost and work needed to fix the broken or lacking features. For a consumer to decide to repair a device the cost of repair must be less than the perceived loss from the limiting state of the device. The repair cost is usually set by the original manufacturer. To give a device a long life a manufacturer will use high-quality, expensive, parts. This can affect reparability cost negatively and resulting waste from broken devices not being repaired.

A balancing alternative to expensive components leading to expensive repair costs is to allow a consumer to decide what replacement part to use. For example: in most modern desktop computers, if the ram goes bad you can purchase a new ram module from nearly any manufacturer because they use a standard. However, this is not typical for laptops and phones. Right to Repair legislation argues for diagrams provided by the manufacturer to explain how the components work as shown in [6], Fig 1. Most companies limit the repair of mobile devices by not selling parts or explaining the repair process. Companies will often use proprietary parts to limit who can access components and service their device. For

example, Microsoft touted the reparability of their Surface Laptop 3, yet you must break the feet and use a custom screwdriver that is not standard in most mobile device repair kits. This forces you to pay the cost the manufacturer sets for the repair [7]. Microsoft is not the only one guilty of this practice.

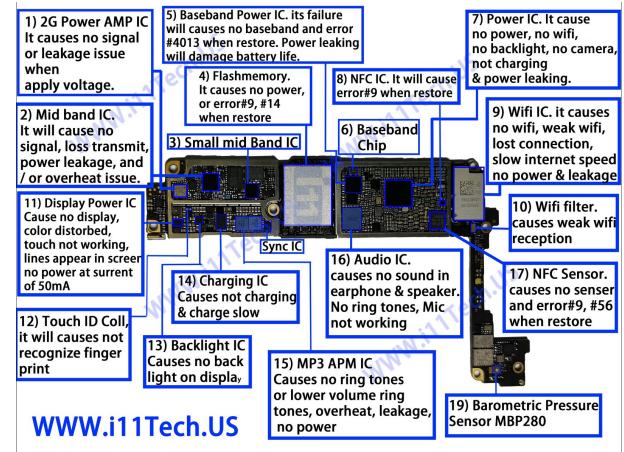


Fig. 1. Example a good schematic the original manufacturing company should produce. Includes part number, what the part is used for, as well as limiting state.

Many major companies would argue that Microsoft's requirement for proprietary tools and equipment ensure that the repair is done correctly. These companies actively try to prevent upgrades arguing that they are protecting the consumer. They claim allowing anyone to upgrade/change a device is a quality of life, security, and safety concern. These manufacturers often give an example of a battery. If the battery is non-genuine, and not built in-spec, it could easily explode [2]. This incident would be bad for both the consumer and the company. The company could be unaware of the swap in battery and believe they need to re-evaluate all their batteries.

While a bad battery can cause a problem, the chances are small. While any incorrect repair to a phone has an extremely small chance of causing a safety concern, an incorrect repair to a car, such as a Tesla and its Autopilot system, has a much higher safety risk. The car industry has been trending away from the ability to work on your own vehicle for a while now, with Tesla leading this movement. It's nearly impossible to modify/repair a Tesla yourself. Tesla argues that only allowing Tesla approved mechanics is required to maintain the safety of the car. They believe their car is built so differently that only people who are trained on the software and hardware can repair them; Anyone else repairing increases the safety risk substantially.

The challenge of Right to Repair vs companies at the core is ownership of the device. If a consumer truly owns their device, they should be able to repair it where, when, and how they want it. The argument from Right to Repair is to either make service more affordable or allow the use of third-party parts. However, if the consumer truly owns the device, who is responsible for the safety and security of the

device? Companies cannot be tasked with balancing all third-party parts, so the consumer must take on the liability. Is there a point where liability becomes too big of a factor? The argument from manufacturers is that it takes a non-technical consumer to overestimate their ability to create a major safety risk. Right to Repair legislation currently exists in a battle of safety, ownership, and service.

IV. CASE STUDY: IS APPLE STARTING TO BITE INTO THE RIGHT TO REPAIR MOVEMENT?

Apple historically has been seen as strictly against the consumer right to repair legislation. In 2017 users began to realize that older iPhones were running slower than they were previously. Apple confirmed they were slowing arbitrarily throttling customer devices on the argument of protecting the battery [8]. This became widely publicised as “Battery Gate”. After Battery Gate, Apple decreased the cost of battery repair from \$129 to \$29. They also implemented a feature in iOS to allow consumers to use the full performance of their device at the cost of less battery life. Despite these changes, Apple still settled in 2020 for \$113 Million after being sued by 30 states for planned obsolescence of the device [9].

In the midst of Battery Gate in 2017, Apple announced the iPhone X. This came in at a new \$1000 price bracket over their previous standard of \$700. However, this new phone also brought with it a new controversy; a repair cost of up to \$549 [10]. The repair cost was over half the cost of the phone. Apple had already participated in other seemingly anti-consumer practices at the time. They had already introduced proprietary tools, and soldering of unnecessary components to the motherboard, making it difficult to change components in their computer lineup.

In 2017, Apple’s business philosophy almost directly opposes that of Right to Repair legislation. Apple continued to add protections to prevent non-genuine repair through their T2 chip. This allowed Apple to check all the parts of the machine through both software and hardware. This made it nearly impossible to get a device repaired through someone other than certified Apple technicians. Because of public opinion, Right to Repair legislation started becoming more and more well known. Leaders of the movement included Louis Rossmann and iFixit. Both these entities have a direct benefit from Right to Repair legislation.

Today, Apple has seemingly started to back away from their prior anti-consumer trends. Apple’s current flagship, the iPhone 13 Pro Max starts at \$1100. The most expensive replacement part, the screen, is only \$330. If the phone is completely broken, an out of warranty replacement is \$549 for a refurbished phone. These prices are proportionally lower than they were in 2017 by about \$50. They have also maintained the battery replacement cost of \$29. While lower repair costs are not the primary goal of Right to Repair, this does show a trend in pro consumer policies.

Recently, on November 17th 2021, Apple continued their pro-consumer trend by announcing a new self repair service [11]. Apple is allowing those who are comfortable to purchase

their own genuine repair tools and parts. Despite the fact that Apple has not introduced pricing or start date yet, Apple is typically a trend setter. This is seemingly a huge win for the right to repair. While immediate pessimistic reactions stated that Apple is trying to make accessories out of parts, that is one of the primary goals of Right to Repair. As long as the repair cost of self service is less than taking the device to Apple, allowing consumers to repair their own device is beneficial no matter what. It appears that Apple is beginning to understand the benefits of allowing consumers to repair their device; hopefully other companies follow Apple’s trend and begin to implement more Right to Repair policies.

V. METHODOLOGY

To analyze the implications of the enforcing right to repair, we propose to look through the lens of the Triple Bottom Line. By exposing the social, economic, and financial consequences that right to repair legislation would bring, we are able to understand how it affects companies and people.

A. Company cost and profit

To understand what is feasible for repair, we must understand the implications of disclosing repair processes and the cost of manufacturing spare parts. What is the cost to the company to produce spare parts, repair tools, and documentation on the repair process? Can repairs be completed safely by end-users, or do they need specialized labor? Answering these questions can give us insight into a realistic expectation of what the maintainability and longevity of a product are. This can also help us address if the right to repair should apply everywhere or only to specific products.

B. Social and economic implications

Once we understand the feasibility of repairs, we can then address both positive and negative social implications including longer device lifetime, more device uses, eliminating e-waste, the overall cost to the consumer, the safety of performing repairs, and jobs created through both manufacturing and third-party repair companies. These questions help us understand both the social and manufacturing pros and cons of the right to repair legislation. This pros and cons list will help us compare and implement an answer to our third subtopic.

C. Ownership vs profit

Who owns the device after it is sold? More specifically, who owns what part of the device? How do the expectations of the consumer differ from that of the manufacturer? Assuming ownership one way or the other, does that ownership change at the end of a device’s lifetime? Pairing these questions with our pros and cons list from subtopics one and two allows us to get a solution on what realistic expectations are for consumers and manufacturers on right to repair legislation. This solution will maximize the benefits to people, profit, and the planet while discussing shortcomings to each category of the triple bottom line.

VI. ANALYSIS

With the triple bottom line applied specifically to the idea of right to repair, we are able to expand on the consequences that would come with it. Namely, the costs associated with providing repairs by both companies and consumers, the principle of a circular economy, and what ownership means for a consumer.

A. Who foots the bill?

Under right to repair, many implications regarding part availability including the cost to the company, the repair processes and the required labor or training, and the maintainability of providing these services arise. Should this cost be placed on the consumer, or do these requirements even incur a substantial cost? Providing repair parts includes the purchasing, warehousing, selling, and delivery of parts, and it may seem that companies will lose profit by maintaining these activities, but for many companies, this may be one of the most profitable functions of the corporation [12]. By providing repair parts, a company will have to consider not only the required manufacturing costs third-party but also storage costs. A successful model will include adequate service levels with minimal inventory or operating costs. Analyzing the business model required to generate such profit is beyond the scope of this research, however previous research shows that manufacturing and selling spare parts can be profitable when implemented [12]. Companies may, however, also abuse how they provide spare parts. Many third party repair shops are forced to purchase any repair parts from the original equipment manufacturer (OEM), which allows the OEM to raise the price substantially [7]. Right to repair is directed to remove this monopolistic practice.

Providing spare parts is not the only thing right to repair aims to remedy, it also includes providing knowledge or schematics that may be required to repair devices by third party entities. There is an interesting line between infringing on the intellectual property (IP) of a company and requiring them to provide necessary documents, information, and knowledge used to repair a product. Historically, IP laws have been vague, arguable, and not very extensive [7] so this line is not immediately clear. If companies are not required to provide information to independent repairers, the repair shops will not have as much time or knowledge to train staff and carry out repairs, creating a monopoly on the repair of devices [7]. However, how much information is enough to provide service? Should a company have to provide detailed processes of the internal workings of a device? If, for example, a user had issues with a part on a motherboard, a simple schematic showing resistor or capacitor placements may be helpful, while also not giving away large amounts of knowledge on the inner workings of the device. This would satisfy both the need for repair shops to have some knowledge about the device while also protecting the IP of a company.

B. What does a circular economy mean?

Determining if the right to repair legislation is a worthwhile pursuit requires looking at the proposed social and ecological benefits that it would bring as well as the potential costs of doing so. One model to look at is the concept of the circular economy.

A circular economy attempts to mitigate the environmental cost of devices by reducing, reusing, and recycling [13]. It is important because making efficient usage of resources is ever-pressing with the threat of climate change. This requires designing for sustainability, designing for repair, and designing for recyclability. As mentioned earlier, repairers and refurbishers will be an essential part of making sure existing devices can continue to be used within and beyond their expected lifetimes. By extending the life of existing devices through refurbishment or repair, theoretically reduces the need for raw materials and reduces the amount of e-waste that ends up in landfills [13]. Keeping devices out of landfills allows their materials to be recycled for other purposes. Figure 2 below shows a device's lifecycle through this proposed circular economy. Devices that can be repaired or recycled increase the flow through the entire economy, preventing excess e-waste and unneeded manufacturing.

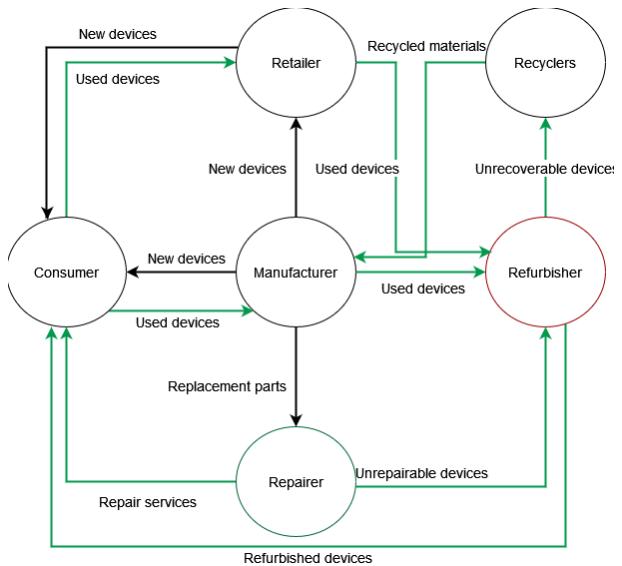


Fig. 2. Showing what the life cycle is of device through a circular economy

From a customer perspective, a developed repair and maintenance infrastructure will save money by eliminating or delaying the purchase of a new product. In the agricultural sector, farmers have been fighting legal battles with John Deere as it began installing software on farming equipment that prevents farmers from running equipment that has had some issue until it's been fixed by their authorized service technicians [11]. This means even for trivial repair jobs, farmers cannot fix their own equipment, and often have to wait several days for a technician to be available to assist them as farmers are in remote areas. For farmers, this is a disruption

to their livelihood, while on a societal scale, it threatens food production.

Increasing the availability of repair parts and tools creates entirely new jobs around repairs and the manufacture of spare parts. Third-party repairers are often small local businesses that provide an important local part of a circular economy. It is far more economical in terms of financial and environmental costs to have the repair done locally as opposed to having to send it to an authorized repairer or the company itself [14]. However, these benefits from a circular economy are not without potential costs and difficulties to overcome if implemented. Currently, a major issue exists regarding consumer habits that would hamper any circular economy implementation. In the domain of smartphones particularly, individual consumers are often driven by a desire to have the ‘latest and greatest’ when it comes to technology or functionality [2]. This often leads to early replacement of devices when their functionality was nominal or could be repaired. For consumers who might repair their devices, often the infrastructure to do so is non-existent or perceived inconvenient. Repairing a device requires taking time out of the day to take it to the repairer and waiting for them to service it, while the option to simply buy a replacement exists at all times with a few clicks at any online store. Even in cases where repair is possible, it can be more expensive than a new product because manufacturers do not facilitate the repair or even impede it [13].

Companies themselves will understandably fight to protect what they see as their interests, both in protecting their IP and their financial bottom line. Returning to the case of John Deere, the company financially benefits from its near repair monopoly on their products. Right to repair legislation directly threatens their ability to control their products in design and in how they are used. Incentivizing repair infrastructure while considering the needs of businesses is important to any right-to-repair legislation that will determine how a circular economy would function.

One specific challenge is in determining to what extent the manufacturer is obligated to support the software that makes hardware run. What is a reasonable timeframe for which companies can be expected to provide feature updates, bug fixes, and security patches to devices running on older hardware? The next section covers how this problem can be framed from the position of who owns the software and data on the device.

C. Who is the true owner of an electronic device?

The growth of the right-to-repair movement has largely been driven by consumer tech companies, primarily those that make hardware like smartphones and PCs. When a consumer purchases an electronic device, they believe that they are the owner of the device, but the manufacturer of the device can do whatever they want with the device. Consumer electronic products and devices often contain software that facilitates their operation or provides automation, Wi-Fi connectivity, and smartphone control, among others. The consumer purchases these “software-enabled” products from retailers, acquiring

ownership of the physical hardware, but may only be able to use the embedded software with a limited license, that the company that developed the software can do whatever they want with. When the product fails due to a technical issue, the company doesn’t claim responsibility for the issue or offer to fix it unless the consumer bought a warranty. The companies also chose to not sell parts and tools to repair personnel who do not work for the company or its retail partners and will void consumers’ warranties if they try to repair their own broken devices.

VII. RECOMMENDATIONS

Through our research, it is clear that it is important for the consumer to “own” their device. This means the consumer is free to modify the device as they see fit but if a modification is not approved by the original manufacturer, the manufacturer is no longer liable for damages. While there are safety and security risks associated with allowing customers the freedom to modify their device with third-party parts or by themselves, we believe these risks to be small. With current technologies, for parts to communicate to each other effectively they must match a protocol or standard. Parts that do not follow this protocol will not work and therefore not be viable as replacement parts. The exception to the third-party part rule would be critical hardware that safety of people can be directly influenced by. For example, Tesla components used for their Autopilot software could be software locked. This is because Autopilot is directly related to human safety, as a malfunction could have severe consequences to human health.

Past legislation has been proposed to enforce right to repair, namely to require manufacturers to provide spare parts to consumers and repairers. In 2021, most states in the US proposed a right to repair bill, however only 1, Massachusetts, made it law [15]. This law was successful, however it applied more in the automotive industry by aiming to require vehicle manufacturers to provide diagnostic and repair information. In July of 2021, President Biden signed an executive order on promoting competition in the American economy, which reinforced antitrust laws and promotes competition within the economy, aimed at stopping monopolistic practices and corporations. These policies are to be enforced by the Fair Trade Committee (FTC), however many of the policies have been unenforced [16]. Because of this, additional legislation and requirements must be made.

Our recommendation implies two major pieces of legislation and oversight: better access to parts and nothing prohibiting third-party parts through software. We believe that a limiting factor must be placed on repair costs for all companies. The cost for a repair is dictated by the cost of the part as well as the cost of the service itself [14]. The part cost should not exceed the cost of manufacturing plus research and development by more than ten percent. Parts should be available to anyone to purchase, creating an equalized market cost of service from third or first-party companies. Finally, the original manufacturer cannot charge more than 10% of the current industry standard for repair service. We trust these

3 rules will bring the cost of reparability below the limiting device state resulting in a longer device life.

We propose two strategies to keep companies honest. Our first recommendation is to create competition by allowing third-party parts to be used in all non-human grade devices. Some manufacturers rely on firmware that blocks “non-genuine” parts, effectively killing any third-party devices. This practice needs to become illegal, allowing the market to influence the cost of parts. Our other solution is auditing companies. A specific entity would make sure that the prices of repair parts and services generate less than 10% profit. Penalties for not accurately representing part cost or charging more than a 10% markup would result in fines. These fines would fund the auditing entity. These two strategies for maintaining companies are important for our planet and people. Jobs are created through third-party manufactures and the auditing entity, while also creating reparability and longevity of the device.

VIII. CONCLUSION

We conclude that right to repair is an important step that needs to be taken to protect consumers while also keeping monopolistic practices from forming. Due to the increasing production and use of devices around the globe, this issue is becoming more prevalent than ever. Planned obsolescence and repairs that are made difficult and expensive both stand as deterrents for consumers to repair their devices, which leads to increased e-waste, higher expenses for consumers, and monopolies formed. These problems, along with others discussed in this report, can be remedied by right to repair legislation. Many considerations must be taken into account such as protecting a companies’ intellectual property, however the benefits of a truly circular economy far outweigh this.

Past legislation has been directed to remedy the problems right to repair causes, however they have been infrequent and ineffective. Our proposed recommendations to allow better access to parts and limiting and boundaries third-party parts may face will inhibit monopolistic practices corporations currently employ and help create a more circular, healthy economy. Without intervention by legislation, tech giants will continue to dominate not only the economy, but how and when people use their wallets.

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Alex Hudson is a Computer Engineering student at the University of Utah. He has a passion for embedded systems, and this shows through his personal and competitive projects, including his first-place finish in Utah Ignite's active transportation programming competition. Alex has a history of sharing his passion with others by speaking at schools and working with at-risk youth to prepare and take the AP programming test. He has a diverse skill set including customer service, technical problem solving, and hardware sales. Currently, he is continuing development on his winning bike sensor, android app, and several other personal projects.



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Tyler Liddell creates hardware and software systems using the fundamentals of digital design, computer architecture, and software optimization. While earning his BS in computer engineering at the University of Utah, he has worked with hardware and software at a low level, and created projects that show a deep understanding of these concepts. Tyler is currently working as a software engineering QA intern at Microfocus, where he can apply the skills acquired from his time in school. Tyler has recently been accepted into the University of Utah's Master of Computer Science program to further his knowledge of computer technologies.