To Upgrade or Not To Upgrade Application

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TO UPGRADE OR NOT TO UPGRADE

ABSTRACT

New Technology consists of new hardware devices, computational workflows, digital advances, and information systems. As technology continues to evolve over the years, this never-ending cycle of new devices and experiences will always be present amongst consumers. Traditionally, new hardware devices are intriguing because they are designed to improve our access to information, media, and a connection to the digital world, but does this mean our previous-gen devices are no longer valuable?

This project involves creating a prototype application designed for both computer and mobile interfaces to help improve the accessibility to information and the overall user experience with an older device. The “To Upgrade or Not To Upgrade” app will inform end-users of their older technological device specifications and suggest hardware/software methods to unlock their full potential.

The goal of this paper is to shed some light on consumers that upgrading to the following gen devices is not always necessary to receive the best human-to-computer interactions. It is likely the computer or mobile device that one owns now, with some slight modifications, is all that is needed to provide a pleasant experience.

Keywords: New Technology, New Hardware, Old Hardware, Mobile Devices, Computers, Hardware, Electronic Waste, Upgradability, and Hardware Apps

Artifact Presentation:

https://drive.google.com/drive/folders/1xUtKnMb2yNfro-amhy2Y50cmeup-SJ5Y?usp=sharing
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INTRODUCTION

Technology is evolving at a rate that can feel challenging for humans to keep up. Recent discoveries by engineers, scientists, and developers can be replaced in minutes, or realistically, within a few months to a year by New Technology. The majority of New Technology consists of new hardware devices, computational workflows, digital advances, and information systems.

New Technology helps our world grow, become more efficient with manufacturing goods, and evolves our social systems. One of the biggest booms of "New Technology" in American history was during the Industrial Revolution. "Mantoux and subsequent historians analyzed the first industrial revolution as more than a one-time change in technology or as resulting inexorably from innovations in steam power. Instead, they argued that the industrial revolution involved the emergence of a completely new approach to production, work, and consumption, a process that took over a century to fully unfold in England" (Daemmrich, 2017, pg. 259).

From this period forward, society’s expectations of technological advances to have dramatically changed. This idea of inventing new ways to improve society's efficiency has been at the forefront of the latest tech, but what about the tech, specifically hardware devices, released the year before? Consumers inherently are enticed by and tend to gravitate towards the latest technological advances. However, older devices should not be made obsolete once a more contemporary product is released.

Depending on the device's age, older hardware can usually support new software implementations from tech companies. The device is often labeled as outdated by the company but that is not always the case. In most cases, the hardware is still usable and upgraded to increase the device's overall performance. A few reputable third-party hardware component
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companies have already developed an app to advise consumers about viable upgrade options on their devices. The majority of them are diverse but lack some key elements that can benefit the consumer.

Listed below are the questions that have driven the thought process of creating a more informative application for consumers to become aware of their older hardware's potentiality.

- Is it worth investigating upgrading old hardware compared to purchasing new hardware?
- What can a consumer do to increase the performance of their devices?
- What hardware upgrade applications are already available to consumers?
- How are old devices treated?

LITERATURE REVIEW

New Hardware

New hardware from major tech companies is released almost every second or fourth quarter of the year. These companies equip themselves with the latest technology innovations from new computers, laptops, televisions, and smart appliances and assure consumers why they must have this new tech. The general rule of thumb is that consumers update their devices between two to three years; tech companies implement new models of their devices within the three-year mark compared to their yearly revisions.

According to Haselton, technology companies and phone carriers like to drill this idea of upgrading each year to consumers, touting improvements in speed and efficiency. This push for the “latest and greatest” also applies to computers and laptops. "This strategy, like the biennial
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one, has helped to create the idea in our heads that we need to upgrade our smartphones often. The truth is, you really don't need the fancy new hardware" (Haselton, 2017).

New software and operating system implementations is the only reason for upgrading a potentially outdated device. Even so, the majority of previous generations' devices can still withstand the latest software updates with hardware upgrades. "They may slow down a hair as more advanced features are added to Apple's new software. Your display may crack after a few drops, or you may start to experience a decrease in battery life, but Apple Care+ can help you take care of those relatively small problems" (Haselton, 2017).

**Matured Hardware**

Early generation hardware is typically considered "old" when a new device is released to the market. This is technically true amongst most tech companies, consumers, and retailers, but is that a creditable assumption? The use of the latest hardware allows for new technology implementations to evolve and support future releases. Simultaneously, new hardware is not always 100 percent stable when compared to matured hardware.

Marques Brownlee, a well-known tech YouTuber, describes how early adopters are beta testers when tech companies introduce a new product to market. Recently, in 2020, Apple started to integrate its CPU silicon again onto their entry-level 2020 M1 MacBook Pro. Brownlee states, "I would also recommend not getting an M1 MacBook Pro specifically for work; the second its available. You don't want to feel like you're beta testing, and then you find out that this one little niche app that you need for your workflow doesn't work on the Apple Silicon Mac, and you don't have a timeline for when they're going to update" (Marques Brownlee, 2020).
For many consumers, this is the commonly known issue with new devices compared to matured hardware. With mature hardware, specifically, a generation's worth or two has the time to be developed by the tech companies and hopefully reaches complete stability. This is why you may hear from end-users that they rather wait until the recent electronic matures or would instead hold on to their current device and upgrade its usability performance.

Linus Tech Tips is another well-known tech YouTube channel based in Canada. The company, Linus Media Group, focuses on creating content on computers, smart devices, and other technological advances. Anthony Young, an employee at LMG, explains how older hardware is still usable, and it is not necessary to make the jump when a new piece of tech is launched every yearly quarter. "While saving between $370 and $500 off of the cost of a new machine, the money can then be turned into an upgrade for those parts later on down the line. Better yet, that's a case, motherboard, and power supply, and a CPU that won't end up in a landfill for at least another couple of years. But for everyday gamers and desktop users, well, a little upgrade goes a long way" (Linus Tech Tips, 2020).

Upgradability

A typical upgrade for many consumers would be to purchase the latest device introduced by a reputable tech company. Companies like Apple, Samsung, Dell, and Microsoft are the familiar tech companies that consumers gravitate when either a new computer, laptop, or a new smart device has been released to the market. Depending on the consumer's situation, choosing to purchase the new device tends to overrule potentially upgrading their previous generation hardware.
"As consumers, we are often faced with the opportunity to purchase a new, enhanced product—such as an upgraded cell phone—even though the device we currently own is still fully functional. To justify the purchase to ourselves, we behave in rather strange ways" (Gino, 2015). Consumers tend to opt for the latest tech because of the device's appeal or new functionalities. It’s in our nature to desire new functionalities in order to perform our day-to-day tasks efficiently. "Consumers' buying intentions can be key determinants of whether they will upgrade to a newer model product. Consumers may measure their own use of a product based on their perception of the services they are offered, which directly influences their plans to upgrade" (Tseng, F. & Lo, H., 2011, pg. 75).

The user will need to consider the upgrade cost if they are considering upgrading to a new device entirely or simply the components of their current, more mature device. More importantly, if the user decided to upgrade their matured hardware, they will need to consider the components' availability. "If your current computer is more than eight years old, or if when you use the Crucial® Advisor™ tool or System Scanner tool you get very few compatible parts, you might think about buying a new system. Another indication of needing to buy a new computer is that if the price of the components you need to replace is approaching the cost of a new computer, you might as well start over with a new computer" (Crucial, 2021).

The components that are typically upgraded on a device are the Random Access Memory (RAM) Modules and the hard drive. The hard drives are mechanical, which tend to fail over time. Consumers are usually advised to upgrade to Solid State Drives (SSD) because they are more reliable and increase their system's overall performance. "Unlike the conventional Hard Disk Drives (HDDs), SSDs have many benefits including high access speed, high durability, and low-power consumption. Nowadays, the SSD cost, which is the main disadvantage of SSDs in
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comparison with HDDs, is steadily being lowered because the NAND flash density has been increasing" (Kang, M., Lee, W., & Kim, S., 2018, pg. 1492).

Other hardware components inside devices like a desktop computer, laptop, and some mobile devices should be considered upgradable as well. "RAM and Storage are a good start, and Dell's made it such upgrades easy. What we really need are CPU and GPU upgrades, though. That's trickier, but imagine buying an Inspiron 15 7000 and then being able to swap out the already-dated GTX 1050 for a top-shelf part. That's the dream. Maybe one day" (Dingman, 2020).

Hardware Consultation Applications

*Crucial Memory - Advisor™ tool or System Scanner tool*

The computer memory and data storage company, Micron Technology Inc. aka Crucial Memory, was founded in October 1978. Specializing in manufacturing 64KB Dynamic Random Access Memory (DRAM), Crucial Memory was created with the belief that end-users should have the right to upgrade their computer's hardware. With that idea as their focus, they began to introduce new iterations to DRAM by the early 2000s.

By the mid-2000s, the company began to research and develop NAND Flash's future, which is the type of memory that can be found within solid-state drives (SSDs), USB thumb drives, and nonvolatile memory (NVM). Since then, the company has been known for its compatible random access memory solutions for computers and electronic devices. Currently, the company has a free scan tool entitled “Crucial System Scanner” that will scan your device's hardware and determine if there is a robust upgrade path. Here are the pros and cons of the application:
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▪ Pros

● Seeks helpful information for users about their device's hardware.

● Allows the user to choose what computer components are available to upgrade and to purchase.

● Compatible with Windows PC, Apple Macs, and Linux Machines.

● The scan tool is accessible from their website to use, or the user may select their device's model.

▪ Cons

● Only recommends their brand of computer components and does not suggest other available competitive brands.

● Random Access Memory and Storage focused.

● No Mobile compatibility.

Piriform - Speccy

Speccy is a free computer application that provides a detailed report about the consumer's device specifications. Speccy shows the following information:

- CPU Specifications.

- Hard drive Specifications.

- Random Access Memory (RAM) Specifications.

- GPU Specifications.

- Operating System information.

The app was developed and introduced to the public in April 2010 by Piriform. Piriform is famously known to the IT Community for its CCleaner application, which helps end-users clean junk files off of their systems. Here are the pros and cons of the application:
TO UPGRADE OR NOT TO UPGRADE

▪ Pros

● A free downloadable tool that shows the end-user what hardware they are running on their computers.
● Supports Windows operating systems ranging from XP to Win 10.

▪ Cons

● The app only provides the device's hardware specifications to the user but does not suggest any potential upgradability or resources.
● It does not currently support any flavor of Apple Mac operating systems or Linux.
● No Mobile Support.

CompuRAM - RAMinator

CompuRAM is another computer hardware company that specializes in manufacturing and selling random access memory. The company, based in Germany, Austria, and Switzerland, was founded in the late 90s is known for their scanning tool - RAMinator. RAMinator was developed to perform an overall computer system scan which then provides hardware upgradability options to the consumer. The company has also partnered with Samsung, Intel, and Supermicro for their various PC componentry (SSDs, CPUs, and RAM). Here are the pros and cons of the application:

▪ Pros

● The scan tool is accessible from the CompuRAM website to download onto the user's device.
● The tool can be used as a standalone product, or the individual can select their device from the website.
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- Allows the user to choose what computer components are available to upgrade and to purchase.
- Supports Windows operating systems ranging from XP to Win 10.
- Provides alternative methods to obtain user information if they are using Apple or Linux based devices.

**Cons**
- RAM and storage focused.
- No mobile support.
- No native Apple operating system support.

**CUPID - CPUZ**

CUPID is another software development company that is based out of Dunkerque, France. The company was established in 2007 but introduced its well-known CPUZ application on July 25, 2000. Like Speccy, this scan tool does a complete scan of the user's device and provides a more in-depth report of the system's hardware. Even though the app's true purpose is to monitor the device's hardware, its output of system information can be appreciated. "Provides in-depth hardware details, online validations, benchmark" (Yee, J., 2018). The software displays the following specifications:

- CPU Information
- Motherboard Information
- Random Access Memory information
- GPU Information
- Computer System information

Here are the pros and cons of the application:
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▪ Pros
  ● A free downloadable standalone tool that shows the end-user what hardware they are running on their computers and mobile devices.
  ● Supports Windows operating systems ranging from XP to Win 10.
  ● Supports Android operating systems.
  ● Conducts a series of tests to measure the device's hardware stability.

▪ Cons
  ● The software only displays information and does not make any recommendations of what Hardware components can be upgraded or provides resources to the user.
  ● Only runs on Windows and Android operating systems.
  ● No Apple OS or iOS support.

The majority of these applications provide valid information about the hardware that creates the device. The consumer can then take this information and consider upgrading their last-generation devices if applicable.

Consumer's Experiences

As a computer repair technician and information technology specialist, I have serviced many desktops, computers, laptops, and mobile devices over the past eleven years. Most of the time, clients feel that their matured hardware is still valid, and they are in no rush of purchasing next-gen technology. Of course, there will be the users who will want the following gen hardware simply because they want the latest tech. However, on average, the client is content
with upgrading their older devices because they feel their older device can still provide a pleasant user experience.

**Electronic Waste**

"Electronic waste or E-waste generation is considered to be one of the fastest-growing solid waste streams in the world and it contains 10 different categories (e.g., large and small household appliances, consumer equipment, lighting equipment)" (Kang, K., Kang, H., Ilankoon, I., & Chong, C., 2020, pg. 1). Even though researchers and environmentalists continue to discover new ways to eliminate the harmful contaminants in these electronic goods, the exchange between E-Waste and the latest electronics is not equivalent. As far as we know, currently, the production of new electronics will always be greater than its recycling counterpart.

Our world continues to face many current issues with the deconstruction of electronics. E-waste material are considered the most challenging amongst our other waste, like plastics, glass, metal, and paper. In actuality, replacing older but still viable devices is incredibly wasteful. Instead of adding more fuel to the E-Waste fire, consumers can upgrade their older devices, prolong the device’s life span, and help diminish the negative environmental impact that E-waste incurs for years to come.

Donating old computers and mobile devices to nonprofit organizations is another alternative consumers can use to reduce E-waste. In the last decade, nonprofits that focus on recycling and repurposing old electronics have grown exponentially. Their mission is to fight the war on E-waste and help social communities in need of technological equipment. Not all old technological devices are unusable or "out-of-date." Free Geek, a nonprofit located in Portland, Oregon, whose mission is to "sustainably reuse technology, enable digital access, and provide
education to create a community that empowers people to realize their potential." (Free Geek, 2021).

The push for new technology influences an individual to upgrade from their old devices to new generation implementations. However, new hardware can feel incomplete when released compared to matured hardware. Matured hardware can still serve a purpose by upgrading its vital componentry, which boosts the device's optimization. Existing applications were designed to inform the consumer about their device's hardware and provide available upgrade options.

While reviewing applications like Crucial Advisor Tool and RAMinator, the overall user experience was robust regarding accessibility and upgradability information. The interface explains what end-users need to do to get started with device scans. Once the device is scanned, the app identifies the installed hardware componentry and shows compatible upgrades. It will then be up to the user to decide whether or not to upgrade their current device's hardware or onto the next-gen iteration. The overall usability is relatively straightforward, which is always the ultimate goal for app developers, to pursue a seamless user experience.

UX Design (user experience design) is the process of increasing the overall application's experience with the individual. There are many factors to consider from a user's perspective when designing an app's usability. The application needs to be simple but effective with human-to-computer interaction. The specific area where UX designers focus on is the application UI or User's Interface. However, there are other approaches that can help improve the user's experience with their device. Most of these hardware consulting apps only focus on upgrading specific hardware, such as RAM and Storage, and are not fully compatible with all types of devices and operating systems. Also, not all devices can be upgraded, but software optimization techniques can restore a pleasant user experience on these non-upgradable devices.
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The artifact that I will be demonstrating will be using the concept of UX Design but concentrate on enhancing/restoring the user's experience from the device's hardware and software perspective. My application will provide consumers a more substantial look at upgradability options for their older devices and software optimization suggestions. The app's overall purpose will be to provide awareness that older technological devices can still deliver a pleasant experience without needing to upgrade to next-gen implementations.

METHODOLOGY

UX Design Theory

UX design is when designers create products that provide meaningful and relevant experiences to users based upon human-to-computer interactions. This involves acquiring and integrating the product, including aspects of usability, adaptability, branding, design, and function. Generally, when it comes to UX design, the overall focal point is how the designer will enhance the product's UI (user interface), where it can accommodate various user personas, learning characteristics, and physical limitations.

UX designers come from various technical backgrounds such as visual design, programming, psychology, accessibility, and interaction design. These designers base their improvements on different design principles like:

Color Theory - This is the concept of understanding how to communicate with your target audience effectively by using different color schemes on a visual interface. (e.g. dynamic color choices on a desktop and mobile application.)

Consistency – This is the concept of understanding how to maintain a focus with aesthetics,
functional, internal, and external elements that can efficiently transmit information to the user. In this case, when a designer tackles an app, they want to be consistent with branding, colors, font typefaces, graphics, and any visual elements that help represent the application's purpose.

**Minimalist Design** – This is the concept of providing a user application, containing rich and valuable information, but keeping the overall design to a minimum. Do not clutter the app with unnecessary elements that are not valued to the end-users. Building an easy app to understand without any intricacy will be more effective in usage.

**Symmetry Theory** – This is the concept of understanding how to provide a concise visual appearance to your users. In this case, aligning the optical elements will create a more attractive and inviting desktop and mobile application.

These design principles and many others are the building blocks on what motivates a designer to create or innovate an application.

**UXD Through Device Optimization**

Typically, UXD relates to the overall "versatility and adaptability, Intuitive navigation, Personalization, Animation, Harmonious colors and Human writing" (Helmy, W. & Lashin, M., 2021, pg. 482) of a product, specifically, a digital application. Instead of focusing on improving the user's experience through UI design, how about taking another approach and having users focus on optimizing their devices' hardware and software to deliver a better user experience?

Optimizing the hardware and software inside a computer, laptop, or mobile device can enhance the overall user experience. These devices with restored or better processing power can
effectively compute the human inputs with the medium, increase the user's day-to-day workflow, restore the seamless connection to information and the user's Uses and Gratifications. With this approach, consumers can preserve their old technological devices and improve their user experience simultaneously.

The hardware consultation apps that are already on the market are pretty rich with device upgradability but lack some fundamental elements to improve a device's performance. My artifact, The “To Upgrade or Not To Upgrade (TU or NTU)” application, will not only improve the consumer’s device, but provide other means of improving the overall performance of the device.

Compatibility and Availability

The majority of the reviewed apps in the literature review were not compatible between desktop and mobile devices. This lack of compatibility can hinder a consumer from finding if they can upgrade their device's hardware components or not. My application will be compatible with all primary desktop and mobile operating systems, such as Windows, Apple, and Android. In terms of availability, the To Upgrade or Not To Upgrade application will be available to download from the app's main website, Google's, and Apple's respective app stores.

Hardware Optimization Methods

These reputable computer hardware applications advise consumers to improve their device's performance by offering RAM and storage upgrades. According to various IT and computer engineer community sources, these components are considered "the best bang for your buck." "With more RAM, more of the program instructions can be loaded, and there is less need to keep swapping data in and out to the swap file on the hard disk drive. The constant swapping
of data slows down the speed at which applications can run, so increasing RAM will increase the speed of operation of the computer" (Pdf4pro, 2018, pg. 3).

When it comes to storage upgrades, users are advised to replace their old hard disk drives with solid state drives because the mechanics of their old HDDs tend to fail over time. Now solid state drives are used in a wide range of computer systems and devices. This flash-based memory boosts the device's response time when loading programs and provides a snappier experience for the end-user. When SSD's first came to market, they were costly, but this component has become more affordable from consumer and manufacturing perspectives.

It is interesting to see that these hardware apps only seem to focus on RAM and storage upgrades due to these components being the most common upgrade. However, I feel these applications can provide more information regarding upgradability options. To be fair, not all hardware components can be upgraded, especially on a mobile platform, but there are other components inside of these devices that can potentially be upgraded. Here is a table that explains how other hardware components can be upgraded:

<table>
<thead>
<tr>
<th>Component</th>
<th>Purpose and Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Processing Unit (CPU)</td>
<td>The brain of a computer system or device which executes the logic, computations, and input/output instructions of a given program or command.</td>
</tr>
<tr>
<td></td>
<td>Ideally, a CPU with a better instruction set or IPC (Instructions Per Clock) can provide a better user experience and help process programs quickly. This upgrade can potentially be applied to both computers and mobile systems.</td>
</tr>
<tr>
<td>![CPU Image](Frew, 2019)</td>
<td></td>
</tr>
<tr>
<td>Graphics Processing Unit (GPU)</td>
<td>A computing chip which is responsible for creating images and outputting a signal to a display device.</td>
</tr>
<tr>
<td></td>
<td>Ideally, a GPU that can create images faster within its frame buffer can provide a smoother display experience for the end-user. By the consumer upgrading their GPU, they can</td>
</tr>
</tbody>
</table>
improve the graphical horsepower on their device. This upgrade can potentially be applied to both computers and mobile systems.

Figure 1: Additional upgradable components

In addition to the RAM and storage component upgrades, the components listed above are part of the core items that make up computers and mobile devices.

Software Optimization Methods

Tech companies like to release next-gen products with new technologies to implement new hardware and present futuristic styles onto their latest devices. They can appear more compact and sleek and their functionalities more rich and efficient. The new hardware in these next-gen devices, like the CPU, GPU, RAM, etc are condensed to accommodate both the device's performance and overall aesthetics.

These hardware components are so condensed that the upgradability of the hardware is not physically possible. This scenario is most familiar with mobile devices like smartphones and tablets compared to full-sized computer systems. Computers systems tend to be more versatile with their hardware components because they are not as compact as mobile devices, but some computer devices simply can not be upgraded. The end-user will have a better chance of upgrading an older computer than a phone, but this does not negate other methods that can be applied to boost the older device's overall performance.
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Software is just as essential as hardware to a system. If the hardware is still functional but the software lacks, its overall user experience will not be the same. "Computations that are not suitable for best-effort execution can be handled by (i) separate hardware and software that provide the traditional "guaranteed" model of computation, (ii) a software overlay layer within the platform that ensures their correct and complete execution on the best-effort substrate, or (iii) by implementing faster,application-specific strategies to compensate for the imperfections in the computing platform" (Chakradhar, S., & Raghunathan, A., 2010, pg. 865).

Device Software Cleaners

Software cleaners are applications that will improve your system's performance by optimizing their operating system. The cleaner will clear the cache for various programs, deleting corrupted registry files and temporary files. It can help limit the processes from using RAM and CPU resources. Many cleaner programs are available to download for free to use, and others may require payment to unlock certain features. The majority of software cleaners are compatible with almost all current computer and mobile operating systems.

Operating System (OS) Refresh

If a simple cleanup of the OS will not do the trick, the consumer can opt for a fresh install of their operating system or potentially onto a new version. A fresh install of the OS, whether it is Windows, Apple, Android, can help restore the device's performance. The fresh install will help clean out any harmful system files that may have corrupted the operating system, making the device run poorly. Upgrading to a newer version of an operating system can be beneficial as well, as long as the device's hardware can support the software.
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Overall, whether the consumer decides to optimize their older devices' hardware components, software, or both will enhance and or restore the user's experience. This process of refreshing an older device will help improve the accessibility to information and connection to others without the necessity of upgrading to a next-gen device.

Creating the Concept

The “To Upgrade or Not To Upgrade” application will be a scan utility for end-users to acknowledge their device's hardware components and show what upgradability options are available to the device's full potential. If the scan utility determines the hardware components cannot be upgraded, it will suggest alternative methods to improve the user experience with their device.

Application's Contents

Here are the specifications that the application's scan tool will pinpoint:

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make, Model, and Year of Production</td>
<td>To determine viable upgrades, compatibilities, and overall lifespan</td>
</tr>
<tr>
<td>CPU, CPU Socket, and CPU Layout</td>
<td>To determine possible CPU upgradability</td>
</tr>
<tr>
<td>GPU and GPU Layout</td>
<td>To determine possible GPU upgradability</td>
</tr>
<tr>
<td>RAM Type, Capacity, and Compatible RAM Speeds</td>
<td>To determine possible RAM upgradability</td>
</tr>
<tr>
<td>Motherboard and BIOS Version</td>
<td>To determine the Motherboard and BIOS information</td>
</tr>
<tr>
<td>Storage Size, Interface type, and Disk Health</td>
<td>To determine possible Storage upgradability and maintenance</td>
</tr>
<tr>
<td>Operating System version</td>
<td>To determine what operating system the device is running</td>
</tr>
</tbody>
</table>

*Figure 2: To Upgrade or Not To Upgrade scan specifications*
TO UPGRADE OR NOT TO UPGRADE

Once the application acquires the consumers' device's hardware information, it will connect to a rich database containing all the possible upgrades for the end-users computer or mobile device. Also, the app will connect to reputable e-commerce and retailers' websites that focus on computer and mobile hardware components. Now that the consumer will know what potential upgrades can be done on their device, TU or NTU will also recommend locations to purchase these hardware components. The table below shows some of today's well-known e-commerce and retailers:

<table>
<thead>
<tr>
<th>Internet Commerce Websites</th>
<th>Reason of Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microcenter</strong></td>
<td>A technology and electronics company with an online store and active brick and mortar locations. The company supplies a wide range of computer hardware to facilitate upgrades.</td>
</tr>
<tr>
<td><a href="https://www.microcenter.com/">https://www.microcenter.com/</a></td>
<td></td>
</tr>
<tr>
<td><strong>Newegg</strong></td>
<td>A reputable technology, electronics, and other various goods e-commerce. Currently, Newegg is only online-based and provides consumers competitive pricing on their computer hardware and electronic goods.</td>
</tr>
<tr>
<td><a href="https://www.newegg.com/">https://www.newegg.com/</a></td>
<td></td>
</tr>
<tr>
<td><strong>Amazon</strong></td>
<td>The highest-rated and well-known e-retailer out of them all. The company provides a tremendous range of consumer goods. They also provide an excellent selection of computer hardware and some mobile integrations.</td>
</tr>
<tr>
<td><a href="https://www.amazon.com/">https://www.amazon.com/</a></td>
<td></td>
</tr>
<tr>
<td><strong>eBay</strong></td>
<td>A well-known e-commerce corporation that deals with the selling of goods between consumers. eBay would be a great resource because the application will find new and used hardware components for the Make and Model of the user's computer or mobile device.</td>
</tr>
<tr>
<td><a href="https://www.ebay.com/">https://www.ebay.com/</a></td>
<td></td>
</tr>
<tr>
<td><strong>Craiglist</strong></td>
<td>Craiglist is a well-known advertisement website where consumers can purchase</td>
</tr>
</tbody>
</table>
TO UPGRADE OR NOT TO UPGRADE

https://www.craigslist.org/about/sites

craigslist

Figure 3: E-commerce and retailers recommendations

The application's last function will suggest to the end-user how they boost their experience through software optimization techniques. Whether through a software cleanup or operating system refresh, these methods will help revitalize the useability of the device. Below are some of the recommended software cleaners that are used today:

<table>
<thead>
<tr>
<th>Software Cleaners</th>
<th>Description</th>
</tr>
</thead>
</table>
| CCleaner  
https://www.ccleaner.com/    | CCleaner is one of the most popular free software cleaners developed by Piriform. This utility is compatible with PC, Apple, and Android devices. |
| Eusing Free Registry Cleaner  
https://www.eusing.com/index.html  | Eusing Registry Cleaner is another free utility that can help resolve a registry software issue on a device. Registry entries are the building blocks to a Windows operating system. Even though this app is not compatible with Apple or Andriod, it can help optimize a user's Windows-based system. |
| CleanMyMac X  
https://macpaw.com/cleanmymac | CleanMyMac X is another free utility by MacPaw that was designed to help optimize Apple devices, specifically. Since this app was built for Apple systems, it is not compatible with any Windows or Android-based system. |

Figure 4: Recommend software optimizers
Lastly, if the consumer decides that it is not worth upgrading their current device and moves on to the next-gen product, the To Upgrade or Not to Upgrade app will provide information on how they can dispose of their old device properly. The app will provide information on E-waste recycling locations around the user's area. Here are some examples:

<table>
<thead>
<tr>
<th>Electronic Waste Center</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Geek&lt;br&gt;&lt;br&gt;<a href="https://www.freegeek.org/">https://www.freegeek.org/</a></td>
<td>A nonprofit organization that believes in closing the gap on the digital divide. The organization recycles old computers, electronics, and technology. These recycled items give back to the community by refurbishing functional devices and selling them at an affordable price. Free Geek is also a big advocate on discarding Electronic Waste or E-Waste properly and donates the earnings to charities.</td>
</tr>
<tr>
<td>Alliance for Technology Refurbishing and Reuse&lt;br&gt;&lt;br&gt;<a href="https://www.aftrr.org/">https://www.aftrr.org/</a></td>
<td>Alliance for Technology Refurbishing and Reuse is another nonprofit organization that focuses on recycling old computer technology. They are not as robust as Free Geek, but they can be a valuable resource for the application to recommend to users.</td>
</tr>
</tbody>
</table>

*Figure 5: E-waste recycling resources table*

*Application's Preview*
TO UPGRADE OR NOT TO UPGRADE

Figure 9: To Upgrade or Not To Upgrade
Software Tune

Figure 10: To Upgrade or Not To Upgrade
E-Waste Drop
The To Upgrade or Not To Upgrade (TU or NTU) application concept was created using Appypie appmakr. Appypie is an online no code application development platform. Instead of focusing on hard coding an application for either Apple, Android, or Microsoft devices, Appypie
appmakr allows the user to design their app using a robust graphical interface. The reason I chose this app builder because the overall experience was seamless and relatively simple to learn.

The overall design of To Upgrade or Not To Upgrade is concise through the different pages and gets to the point once the users open the application. The app delivers a simplistic but effective design with technology-inspired colors. The font layout is standard to provide an easy read about the different items to the user. The To Upgrade or Not To Upgrade (TU or NTU) application would be available on all Microsoft, Apple, and Android devices to utilize.

**CONCLUSION AND FUTURE OUTLOOK**

There will always be a never-ending cycle of new devices with continued technological evolution. Whether the consumer decides to optimize their older device's hardware/software or onto a newer implementation, the choice will depend on the consumer's use case.

The foundation of this project was User Experience Design. Instead of focusing on the typical UXD concepts, the artifact focused on another approach on how an individual can boost and restore their UXD on older generation devices. Upgrading to next-gen equipment is not always necessary to obtain a pleasant experience or to meet the consumer's uses and gratifications. All of these ideas are what fueled the main research question for the artifact's concept:

- **Is it worth investigating upgrading old hardware compared to purchasing new hardware?**
TO UPGRADE OR NOT TO UPGRADE

- What can a consumer do to increase the performance of their devices?
- What hardware upgrade applications are already available to consumers?
- How are old devices treated?

The goal of the To Upgrade or Not to Upgrade (TU or NTU) application is to provide a detailed orientation of the end user's device and inform them what strategies are available to help them optimize their experience. Unlike the current apps that we reviewed, the “To Upgrade or Not to Upgrade” application will provide further hardware upgradability and software resources, regardless of the device's eligibility to upgrade its hardware components. In addition, the application UI will be user-friendly and compatible amongst all device platforms.

However, the development of this application is still in the early stages. Apps need alpha, beta, and gamma testing before an official copy is released. Feedback from the testers who will review the application from both desktop and mobile perspectives would be constructive. They may have some insight into any additions or changes to improve the application's functionalities and its usability.

Technology is an entity that will continue to aid and improve society's access to information. Hopefully, by introducing this new app to the world, it can help consumers take advantage of their day-to-day devices' full potential.
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