The Detriment to the United States' Electronic Waste Management Infrastructure Due to National Disposability and Consumerist Culture

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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

The average U.S. household in 2022 had 22 connected devices between their smartphones, home surveillance, and entertainment systems, a quantity largely necessary because of the prevalence of virtual experiences (Weinschenk, 2023). Electronic devices have made their way into almost every avenue of life: personal, business, academia, and health, and only seem to become further integrated as people continue incorporating devices and further technological advances are made. Yet, even with electronics' vitality and high prices, they are seen as expendable, with repairs sometimes costing more than an entirely new device. There is largely no alternative for most, as the inner workings of electronics are commonly unknown due to a lack of interest, information, parts, or tools (Klosowski, 2021). The culture of the United States has bred values of disposability and upkeep with materialistic trends, as further explained by examining the Apple ecosystem and its representation of larger trends. Coupling this barrier of inaccessible electronic repair with the cultural prioritization of consumerism leads a device to meet its disposal much sooner than anticipated. Once someone cannot continue to finance repairs, they begin to seek out new devices, ultimately sending their old gadget closer to the end of its life.

The end of the life cycle of an electronic device most commonly includes electronic waste and recycling, which differs by institution, state, or country, however no solution can truly capture all waste thoroughly and sustainably. My research will analyze how the University of Virginia (UVA) handles electronic waste through its ReUSE Store, which accepts donations from academic departments with the intent to resell large items back to students, faculty, and staff for personal or academic use. My analysis will include comparing the quantity of UVA's collections to state and national value and interviewing employees involved with the University's infrastructure. This will provide a metric for what a “successful” amount of electronic waste management might entail and offer insight into how the administration views the University’s processing of electronic waste. This thesis explores the inadequacy of the current electronic waste infrastructure within the United States, an attribute exacerbated by disposability culture and an inability to account for increased innovation and technology developments.

STS Topic

One consequence of US corporations’ technological developments is their impact on the electronic waste industry, a problem that integrating new technologies such as AI will exacerbate. Companies are making use of technologies and trending away from physical records, relying on digital repositories to track and process information. This unrestricted increase in electronic usage should pose a concern, as the environmental impacts are not adequately understood or funded. With only 25 of the 50 states within the US currently having e-waste regulations (US EPA, 2022), companies’ value for technological advancement may be environmentally unsustainable. Accompanied by a lack of environmental sustainability are concerning health risks, which often go unaddressed. Metal exposure as a result of electronic recycling can pose a risk to workers’ health and safety (Nukpezah et al., 2014). Even with practices to supposedly prevent such risks, including wearing N95s and frequent handwashing, observations show that these practices are not properly enforced (Gravel et al., 2023). In a study concerned with inappropriate e-waste practices, researchers found that only 25% of e-waste is properly disposed of with adequate worker protection (Perkins et al., 2014). This can result in cuts, metals leaching into groundwater, fume inhalation, chemicals released from burning, or acid contact with skin and eyes for workers (Pinto, 2008). The long-term effects of these risks are not adequately understood and the neglect of understanding such violates the ethical call for social responsibility, protecting health, equality, and justice.

To understand the interaction between the current system of electronic disposal and society, American sociologist Susan Leigh Star presents properties of infrastructure (1999). She coins the term *visible when broken* to describe when a system is not operating as intended and thus brings attention to said system. Once an attribute is not performing as intended, it draws users' attention and causes frustration. The Waste Electrical and Electronic Equipment (WEEE) Forum sheds light on e-waste's invisibility, citing that small electronics are often hoarded and are not recognized for their potential to be recycled, thus ending up in landfills and avoiding proper disposal (WEEE Forum, 2023). Those who acknowledge the importance of improving recycling, such as the WEEE Forum, recognize issues with the infrastructure and seek to draw attention to the subject. The infrastructure behind e-waste allows for much to go unnoticed and can enable a false sense of security.

Star cities *built on an installed base* as another infrastructure property, or that infrastructure must exist within a larger, established system, inheriting the strengths and weaknesses of such. It expands on previously established resources, systems, and infrastructure (1999). The entire national recycling infrastructure is supported by multiple legislative levels, not exclusive to e-waste recycling. Federal recycling started as an effort to conserve and reuse material during World War II. Since then, recycling has leveraged exiting trash collection networks to establish its own program, taking advantage of existing sorting facilities and transportation between business or personal residences and collection facilities (Virginia Recycling Association, 2024). Joining onto an imperfect system, recycling's successes and failures are intertwined with the infrastructure which they reside in.

Case Context

The current electronic waste infrastructure in the United States begins with collection, a process that is highly personal and variable based on social expectations, pressures, and access to resources, with cultural ties influencing the current industry. The 20th century within the United States has shaped "[...] the ordinary person into a consumer with an unquenchable thirst for its 'wonderful stuff'" (Higgs, 2021). The desire for Americans to own the best applies to electronics as well, with one prevalent instance manifesting in smartphones. Apple Inc.'s launch of the first iPhone in 2007 changed the United State's mobile phone industry. Within the first 30 months following its release, Apple sold 42 million models (Laugesen & Yuan, 2010) and reached a quarterly 15.7% market share of global smartphone shipments, a number which has grown to 24.7% of shipments in Q4 of 2023 (Laricchia, 2024). Apple's national success can be attributed to its efforts to target consumers and prioritizing a simplistic, aesthetic interface. By targeting young customers, Apple influenced culture and was able to sustain its brand by upholding an illusion of simplicity while simultaneously restricting accessible repair.

In the years soon following the iPhone's launch, Apple found its target demographic to be young adult, college-educated men. Apple continues to sustain high usage by young adults, as 58% of 18-34 year smartphone users in the US owned an iPhone in 2021, while Apple was only owned by 47% of 35-54 year olds (Statista Research Department, 2023). Apple continued to develop its entire "ecosystem", with the addition of headphones, specialized cords, fitness trackers, and iPhone-exclusive apps. In regards to the iPhone's primary messaging service iMessage, Tim Higgins explains that it has built "[...] into one of the world's most widely used social networks and helped to cement the iPhone's dominance among young smartphone users in the U.S." (2022). This social pressure among young consumers to own an iPhone and thus be compatible with the Apple ecosystem exemplifies the United States' materialistic, consumerist values, instilling these standards in young individuals.

Apple pushes values of simplistic aesthetics, offering a distinct appearance that is discernible from their competitors. Jean Burgess, commenting on Apple's choices to balance security and usability, explains that "the iPhone's touchscreen, gestural interface and icon-based operating system couldn't be more closely aligned with this notion of radical transparency, and the underlying architecture of Apple's iOS couldn't be more carefully hidden from us as users" (Burgess, 2012). The iPhone accomplishes a balance of feigning inclusion to the user through its interface and customization while simultaneously restricting knowledge of the iPhone's inner workings to a select crowd. One tactic Apple is known to employ is restricting access to software updates and replacement parts for older devices, eventually encouraging users to seek a newer, more expensive iPhone model (Adefioye, 2023). Critics accuse Apple of planned obsolescence, or an intentional effort to create a short lifespan of its own devices to encourage expensive repairs or upgrades.

The cultural development of Apple epitomizes the broader American sense of materialism and disposability, extending beyond only mobile phones. Expanding the scope to other electronic devices such as laptops, hard drives, televisions, printers, and small appliances, the quantity of electronic waste is likely to increase far beyond the United States capabilities, exacerbating existing problems with e-waste and overwhelming the industry.

Research Question

This leads to my research question: how is the current United States' electronic recycling management infrastructure and how does disposability and over-consumerism American culture exacerbate these issues?

Methods

To begin to answer how the United States handles electronic waste management, I sought to capture a comprehensive overview of the varying degrees of electronic waste management by comparing one example of a local initiative, a thorough state program, and federal legislation. This prompted my comparison of the University of Virginia's ReUSE Store, a quantitative analysis of electronic waste recycled per capita in California, and a case study on federal regulations, or lack thereof, concerning electronics' generation and disposal. Through this, I compared quantitative volumes of waste recycled locally and statewide versus non-recycled as well as national policies.

I chose to examine UVA as an instance of a local community because of its close geographical proximity and its thorough data recording. Data was sourced from the ReUSE Store's locally collected statistics as well as a personal interview with the manager Glenn Shifflett (G. Shifflett, personal communication, February 2, 2024). Using Star's analysis of infrastructure (Star, 1999), I drafted interview questions (Table 1. Interview Questions and Property of Infrastructure Addressed) to adequately understand UVA's current system for electronic waste collection and processing.

Table 1. Interview Questions and Property of Infrastructure Addressed

Interview Question	Star's Property of Infrastructure Addressed
How does UVA currently handle electronic waste? How do departments/faculty/students opt into this system? Does this differ based on personal or academic use?	Built on an installed base
What pushed UVA to start the ReUSE Store and how were electronics handled before?	Built on an installed base & visible when broken
How do you advertise to the UVA population and what are the struggles with advertising?	Built on an installed base
What are goals for the ReUSE Store in the future?	Visible when broken

I selected the State of California as a representative of state-level electronic waste management since it became the first state to pass legislation with a comprehensive electronic waste recycling program–the Electronic Waste Recycling Act of 2003 (Bergner, 2004). Not only was it beneficial to analyze a state with extensive historical records of electronic waste, but a relatively exemplary instance of electronic waste infrastructure within the United States underscores how deep disposability and overconsumption culture manifests. Data was sourced from the State of California's Covered Electronic Waste Recycling Statistics report (Department of Resources Recycling and Recovery (CalRecycle), 2020).

I contextualized collection data from both UVA and California by comparing the numeric value of electronics recycled against The Global E-Waste Statistics Partnership's estimate of yearly electronic waste generated, UVA's Employees and Enrollment population data (The University of Virginia, 2022a & 2022b), and The United States Census Bureau (United States Census Bureau, 2022) population information to create pounds of electronics recycled versus non-recycled per year per capita. Data analysis was performed in Microsoft Excel.

While some state reporting requirements exist, the United States lacks a comprehensive federal mandate to record such information. As a result, to capture the national state of e-waste management, I conducted a case study examining three notable smaller-scale federal initiatives and regulations over the past 20 years. This includes the Environmental Protection Agency's (EPA) amendment to cathode ray tube (CRT) regulations in 2006 (US EPA, 2023), the E-Waste Research and Development Act of 2009 (*Electronic Waste: Investing In Research and Innovation to Reuse, Reduce, and Recycle*, 2009), as passed by Congress in authorizing research and development activities related to e-waste management, and an additional amendment to CRT regulation in 2014 (US EPA, 2023). In tandem, these three scales of jurisdiction–local, state, and federal–are indicative of the national environment.

Results

The University of Virginia's Facilities Management (FM) manages the University's construction, sustainability, upkeep, and houses the University's ReUSE Store. The store accepts electronic surplus, office furniture, and general large equipment that is "[...] University owned property, including purchased, donated, and unclaimed, lost or abandoned property, regardless of age and condition" (University of Virginia, 2024) in an effort to create a circular economy for large equipment.

The ReUSE Store is an expansion of UVA as an existing system, or *built on an installed base* (Star, 1999), which manifests in who can engage with the store as well as inherited limits from state regulations. This expansion causes the ReUSE Store to absorb the existing strengths and limitations of UVA and Virginia respectively. To participate in the ReUSE Store, one must have a connection to UVA's FM through mutual relationships, advertisement, enrollment, or employment at the University. The University's community enables a large local potential for exposure, however small, recently established programs within the University struggle to reach this large audience. Shifflett explained that when operations began in 2018, it was "[...] challenging to get [the] student population to recognize we're here and available" (Shifflett, 2024). While he did credit UVA's Office for Sustainability (OFS) for providing major assistance in drawing student customers, FM is still looking to spread further awareness of their program and tap into the large customer base of UVA. UVA also cannot freely distribute state-funded equipment as in compliance with Virginia regulations–with exceptions made for charitable organizations such as non-profits (Shifflett, 2024). Shifflett explained that the ReUSE Store sells large electronics back to the UVA population and partners with PowerHouse Recycling, to handle the recycling of unsold devices or those with a hard drive, and thus potentially sensitive information (2024). Because of the PowerHouse Recycling's extensive certifications (Powerhouse Recycling, 2024), they are state-certified contractors and can handle sensitive material, something which a smaller community like UVA does not have the certification or resources to perform themselves without additional state or external support. Shifflett shared that he would like to see this change, as the store would like "[...] to get to a point where we can wipe or remove hard drives on computers, phones and tablets ourselves so we can donate them to public schools or Social Services who provides help to people in our local community" (Shifflett, 2024).

UVA is a large-scale, highly funded institution that has the availability to cooperate with Powerhouse Recycling, however not all small-scale operations are made equal. While UVA faces challenges in engaging consumers and lacks the ability to process hard drives, other local initiatives motivated to solve e-waste face even greater barriers. Meanwhile, communities indifferent to recording and processing e-waste are met with no accountability. The larger Charlottesville community, which encompasses UVA, does not yet record and publish electronic waste statistics. And with UVA's goal to attract more students and limitations attributed to state regulations, it's evident even such a program with successful tracking and a desire for accountability struggles within the current environment.

California has extensive, proactive legislation regarding electronic waste management. California's Electronic Waste Recycling Act of 2003 began as a compromise between environmentalists wanting to challenge the industry to assume responsibility and electronics producers' intense opposition (Bergner, 2004). This Act set the groundwork for the state, with added legislation introducing accessible recycling for unwanted electronics and the anticipated inclusion of covered battery-embedded products coming in 2026 (CalRecycle, 2024a, 2024b, 2024c). California's strict electronic waste management policies exemplify *visibility when broken* (Star, 1999), as the state recognized the issues of unethical global electronic disposal and massive personal stockpiling (Bergner, 2004) and enacted policies to protect their residents and the international community, however this is not reflected in all states. Many of the 25 states without any e-waste legislation (US EPA, 2022) may ignore the impending issue by dumping waste onto other countries (Powell, 2013), thus creating a "working" system.

California and UVA represent vastly different populations, each with varying potential for outreach and engagement based on the size of each community. By analyzing the two communities within the context of the amount of average electronic waste generated per capita nationally, it is evident that no program is truly "succeeding", especially when the amount of non-recycled electronic waste far outweighs that of recycled electronic waste (Table 2. Electronics Recycled Versus Non-Recycled Per Capita). These limitations arise from the inherent feature of infrastructure being *built within an installed base*. Local and state jurisdictions inherit regulatory requirements from their respective state and nation government(s).

Table 2. Electronics Recycled Versus Non-Recycled Per Capita

	Recycled		Non-Recycled[1]	
Location	Pounds	Percentage	Pounds	Recycled
UVA[2]	6.30	15.01%	35.68	84.99%
California[3]	2.29	5.45%	39.69	94.55%

1. Baldé et al., 2017
2. Shifflett, 2024
3. Department of Resources Recycling and Recovery (CalRecycle), 2020

Under the Resource Conservation and Recovery Act, the Environmental Protection Agency (EPA) amended regulations in 2006 to encourage recycling and reuse of CRTs (US EPA, 2023). This Act was deemed to be "[...] frequently ignored and only minimally enforced" in a hearing before the United States' Committee on Science and Technology's House of Representatives in 2009 (*Electronic Waste: Investing in Research and Innovation to Reuse, Reduce, and Recycle*, 2009). The EPA began further revisions in 2014 by seeking to regulate and better track exportation of CRTs (US EPA, 2023). The success of these regulations manifests through the widespread acceptance of CRTs from a variety of recycling centers. The popular electronics retailer Staples began accepting electronic recycling and CRT monitors in 2012 and occasionally offers monetary promotions as incentive. However, even with Staples' 30+ accepted technologies, there are limitations to what the company can process. The retailer cannot accept televisions, regardless of the year of manufacture or the inclusion of CRTs (Staples, 2024). Approaching 20 years following the EPA's CRT regulations, the current national infrastructure cannot accessibly and reliably accommodate all CRT devices. The regulations fail at their desired mission, suggesting merely political legislation is not enough to solve the e-waste disaster.

The aforementioned hearing supported the Electronic Waste Research and Development Act, meant to address the hurdles to costly nationwide electronic recycling. The Act also sought to reduce the carbon footprint of production and development by promoting the reuse of electronics, hence beginning to acknowledge the difficulties convincing consumers to recycle. Though this implementation would be difficult with slowing down electronic manufacturing, it was vital to inform consumers on the importance of e-waste recycling and intentional purchasing, which would require market research and public investment (*Electronic Waste: Investing in Research and Innovation to Reuse, Reduce, and Recycle*, 2009). Part of the solution to change electronic waste infrastructure is changing the culture and attitude behind it.

Even with local, state, and federal efforts from the US to process electronic waste, national demand for electronic waste processing far outweighs the capacity to accept such electronics. US residents still massively overproduce electronic waste in comparison to surrounding countries, generating 60% more electronic waste per capita than the American continent and 30% more than Europe (Baldé et al., 2017). Understanding the United States' cultural tendency to dispose quickly of material items and the tendency to seek technological advancements, ultimately requiring more computing power and further electronic developments, contextualizes the urgency for sustainable action for electronic waste Despite the combined efforts of local communities, states dedicated to electronic waste regulations, and national policy, programs cannot adequately handle the mass amount of waste generated within the United States due to national consumerist culture hindering realistic adherence to legislation and encouraging of overconsumption.

Discussion

This calls into question who bears responsibility for perpetrating overconsumption and disposability culture within the United States? Fault could fall to corporations like Apple, accused of planned obsolescence and social ostracization. The government may bear blame for a lack of standardized federal legislation, despite over 20 years of known state efforts. Or does the fault fall to the consumer for not changing their attitude? Two things are evident: electronic waste management infrastructure existing *within an installed base* will always succumb to American culture and the United States' ability to hide *visibility* of a *broken* system prolongs the existence of such issues.

In reality, though a large majority of Americans support recycling and 74% say it should be a top priority (World Economic Forum, 2021), its actual effectiveness can be called into question. Richard Gertman, a Los Angeles resident on the board for nonprofit Californians Against Waste, believes that the option to recycle makes people more wasteful, believing that we can internally justify purchasing single-use plastics since it can be recycled. Gertman suggests this has made Americans less conscious of reusing materials (Morrison, 2020). The same can be said for electronics.

I largely excluded many aspects of electronic waste management within my research due to the extensive scope of the problem and the vast quantity of stakeholders involved. These aspects include but are not limited to the social effects of demographic information such as but not limited to race, socioeconomic status, or geographic location. I also did not acknowledge any of the actual environmental benefits and burdens associated with proper electronic waste such as the mass-energy usage required to process such devices. Had I been able to expand on my thesis report, I would have incorporated these topics to demonstrate a variety of concerns related to the current electronic waste infrastructure and its trending path.

Conclusion

Electronic waste management is an extremely difficult and overwhelming topic, yet it's more important than ever. As technology continues to develop and people begin to incorporate electronics further into their lives, the need for a sustainable solution is necessary. The existing problem is largely unaddressed, especially within the United States, on both a personal and legislative level. Even with local and state initiatives to tackle the daunting issue of environmental waste, the current infrastructure is failing. Mass infrastructure changes are needed coming from all avenues, including personal lifestyle and cultural changes, local initiatives, additional state legislation, and national involvement. Only once these all work in tangent may we see the beginnings of a sustainable electronic future.

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