A Web of Responsibility

On the Promotion of Personal Agency for the Visually Impaired Community

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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

In 2020, the International Agency for the Prevention of Blindness (IAPB) reported that "[g]lobally, 1.1 billion people were living with vision loss" (IAPB, n.d.). And in 2017, the Centers for Disease Control and Prevention (CDC) reported that "over 7 million Americans had vision loss or blindness" (CDC, 2022). Though not all cases of vision loss are serious, these figures remain staggering, yet most people are surprised to learn of their magnitude. The general public's lack of awareness can be partially attributed to one reason: visually impaired individuals tend to be excluded from society. This social rift is often unintentional, but it unfortunately plagues many in the visually impaired community, especially those with more severe vision loss (Garcia et al., 2017; Tobias et al., 2017; Carabellese et al., 1993). Numerous studies have investigated the daily experiences of visually impaired individuals, and the results are heart-wrenching: anxiety and depression, stemming from the personal and social doors that their disability has closed to them (Scott et al., 2001; Klauke, 2023; Heppe et al., 2020). This last point, of lessened opportunities, is actionable; if the personal agency of visually impaired individuals is improved, then they can begin to reclaim their voice and presence in society. Personal agency, as used in this context, refers to the ability for a person to direct their life while feeling empowered in their capability to do so. Personal agency will be used interchangeably with the concept of independence. This paper also examines physical agency and educational agency. I define physical agency as the ability to navigate physical spaces independently and comfortably, and I define educational agency as the ability to direct one's own academic studies. In this paper, I present an analysis of the responsibility for furthering personal agency for the visually impaired community. I perform document analysis and employ the Actor-Network Theory (ANT) framework to structure my argument (Law, 1992). First, I examine the physical agency of visually impaired individuals and discuss the technology industry's role in its improvement. I then proceed with educational agency alongside the government's role. Lastly, I critique ANT through the lens of this issue of personal agency and responsibility.

I. Physical Agency and the Technology Industry

A combination of software applications and a stronger usability mindset in the technology industry can increase the physical agency of visually impaired individuals. An example of the relationship between physical independence and the technology industry is the proliferation of global positioning systems (GPS). Though initially developed for military use, GPS has experienced widespread adoption in the civilian population. Especially in recent years, large swathes of the population have become dependent on GPS for wayfinding. What started as special devices that inhabited automobiles have now become integral components to all modern personal technology, from luxury cars to web applications to smart devices. One of the most popular satellite navigation systems, Google Maps, has even become a component of the contemporary vernacular, with the expectation of the answer to "where is it?" to be something like "let me check Google Maps". In 2019, Google added a feature to Google Maps called Voice Guidance, which provides spoken information about a user's route and surroundings (Sugiyama, 2019). Wakana Sugiyama, a legally blind woman living in Tokyo, recounts her experience with Voice Guidance on a Google blog:

> "As I take my journey, Google Maps proactively lets me know that I'm on the correct route, the distance until my next turn and the direction I'm walking in. As I approach large intersections, I get a heads-up to cross with added caution. And if I accidentally leave my

> route, I'll get a spoken notification that I'm being re-routed. Frequent updates…give [people who are blind or have low vision] more confidence and reassurance when we travel alone…detailed voice guidance in Google Maps…can help us explore new and unfamiliar places." (Sugiyama, 2019).

Sugiyama said it best: spoken directions and alerts from a GPS app on a smartphone can dramatically alter a visually impaired person's physical agency. Sugiyama was an adviser and tester of Google Maps' Voice Guidance feature, and her incorporation in the project surely contributed to its success. However, the inclusion of the end user in product development – in this case, a blind adviser to a feature designed for blind and low vision users – is unfortunately not a common occurrence in the world of tech. This absence of critical perspectives during the design stage leads to systematic biases in products and, in the worst case, blatant exclusion of sectors of the population. There is currently no regulation in the technology industry that requires such user experience research, even when designing technologies specifically created to increase accessibility. In addition, people with serious visual impairments are historically underrepresented in engineering (National Science Foundation, 2023). Without user research or engineers with personal experience with these issues, the visually impaired community does not have a voice in the accessibility features designed for them.

Though outdoor navigation systems can facilitate great physical agency to individuals with visual impairments, indoor navigation systems share the same potential while also supporting the reestablishment of social habits. "Think about how much of daily life depends on sight…like going to the movies with friends" said Sarah Humphreys, Assistant Director of the UVA Student Disability Access Center (2023). Indeed, shopping at a mall or visiting a museum, activities that provide positive social interaction with friends or family, could be difficult to navigate with limited or no sight. Fortunately, indoor wayfinding technology is a growing frontier in development. In 2019, the Association of Computer Machinery published a paper proposing a smartphone app called CityGuide that aims to provide a "seamless indoor-outdoor wayfinding" experience (Cheraghi et al., 2019, p. 1). The app uses a combination of Bluetooth and satellite technology to complete a smooth handoff between interior and exterior environments (Cheraghi et al., 2019). Cheraghi's team tested CityGuide by sending visually impaired participants on a novel route across a college campus (Cheraghi et al., 2019). Despite the complexity of navigating both indoor and outdoor environments, the study showed promising results in increasing the efficiency with which visually impaired individuals navigated unfamiliar areas (Cheraghi et al., 2019). Though this technology is not commercially deployed, it has the potential to drastically improve how people with visual impairments navigate their milieus. For example, blind or low vision individuals could use similar indoor wayfinding technology to navigate to an agreed-upon meeting place in a shopping mall, or they could use this technology to find a bathroom without requiring an escort. These small improvements to physical agency could make a noticeable difference in the social interactions of visually impaired individuals.

The responsibility for the improvement of physical agency is due, in part, to the technology industry. Cheraghi et al.'s paper provides an excellent vehicle with which to view this relationship. CityGuide is implemented with a back-end Google product to aid in its outdoor navigation component (Cheraghi et al., 2019). The inclusion of a Google technology as a cornerstone of this project highlights the prevalence of Google wayfinding in both the technology industry and civilian

sphere, as in Sugiyama's experience. Such market dominance is not exclusive to Google; the companies that comprise Big Tech, a collection of massive global technology corporations, have incredible influence over consumers and the rest of the technology industry. These companies have the funding to invest in, build, and widely deploy advanced technologies. Big Tech is best resourced to develop products that meet the technological needs of the visually impaired community.

Thus, Big Tech companies have an ethical obligation to lay the path toward better accessibility, not only for the visually impaired, but for all accessibility groups. Big Tech has monopolized the social and economic infrastructure of billions of people worldwide (Klinge et al., 2023). In their quest for profit, these conglomerates have inadvertently put themselves in a position of great moral responsibility. Since it wildly outcompetes the rest of the industry, Big Tech holds the duty to not only create accessible products, but to create excellent ones. Such a challenge can only be made manifest by a genuine effort to meet the needs of users across all ability levels. This effort must, at the very least, incorporate end users in the design process. Such an onus is undue, some may say: "These businesses have no responsibility to ameliorate the day-to-day interactions of such a small portion of their customer base. It is societal attitudes, or even the government, that are excluding people with disabilities. Big Tech is part of the private sector, and it is a hallmark of capitalism that they can act with more-or-less economic freedom, unburdened by the cares due to the social contract of government." However, the digital age has tied business and community in unprecedented ways. In January 2024, 5.35 billion people worldwide used the internet (Petrosyan, 2024). The number of people broadly affected by digital technology is impossible to track, but it is most assuredly significantly higher. Never before have people been connected to big business in the manner in which they are now: from the moment they wake up to the moment they go to sleep, billions of people across every continent are engaging a few companies' services. Inadvertent as it may be, the degree of digital permeation has placed Big Tech in this locus of ethical responsibility to drive the movement for accessibility.

II. Educational Agency and the Government

In addition to improving the physical agency of visually impaired individuals, technology can make education more accessible, which can increase the career independence of visually impaired individuals later in life. Since "90% of blind and low vision high school students" attend public high schools, the following discussion will center on public school systems (Mobility International USA, n.d.). As students pass through grade levels, the responsibility for learning increasingly shifts from the instructor to the students, but self-study (the learning method by which students direct their own studying) can be difficult without access to adequate learning aids. This is especially true for students with visual impairments. These students often use screen reading software, which reads selected text aloud and can customize the interaction flows of the host device to the user's unique needs. The digitalization of education has made screen reader usage easier, but non-text-based content remains largely inaccessible. The print or 3D models needed to represent non-text-based information require training and expensive machines to create. The resulting heavy reliance on caregivers poses a significant barrier to the educational proactivity of visually impaired students.

Newer technology, such as digital tablets, provide novel avenues for allowing visually impaired students to explore academic content. Dr. Jenna Gorlewicz is the dean of research and

innovation at Saint Louis University and a storied researcher in human-machine interaction and haptics (Saint Louis University, n.d.). In 2018, she and her colleagues authored a paper summarizing the current landscape of screen reading software (Gorlewicz et al., 2018). This paper also emphasized the difficulties of making visual-based content accessible to those with impaired vision (Gorlewicz et al., 2018). Gorlewicz and her team argued that touch-screen haptics were the solution to addressing this disparity in education accessibility (Gorlewicz et al., 2018). And in 2023, Dr. Jen Tennison, a haptics researcher and coauthor on Gorlewicz's 2018 paper, led a team in expanding on the proposals from that paper (CHROME Lab, n.d.; Tennison et al., 2023). Tennison and her team built a prototype software that allowed them to study the effect of a touch-screen haptic system on learning (Tennison et al., 2023). They used two metrics: information orientation" ("ability to understand where information can be located") and information extraction" ("ability to obtain information from…figures") (Tennison et al., 2023, p. 456). The study compared the performance of students using multitouch, haptic tablets to students using standard accessible print media for a set of questions about a bar graph and a triangle geometry problem (Tennison et al., 2023). Among the 20 high-school participants, they found that students using their touchscreen prototype answered more questions correctly with statistical significance (Tennison et al., 2023). Also, and perhaps more importantly, these students were more engaged, more excited, and commented specifically that they enjoyed the variety of onscreen methods with which they could interact with the figures (Tennison et al., 2023). Providing multiple avenues of interaction is critical to personal agency; if visually impaired students can gather information on their own, they unlock the freedom to direct their understanding and investigation of the content. Tennison et al. acknowledge the limitations of their study - chiefly, the small sample size and that most participants could see the screen in some capacity - but their work highlights the improvements to education that can be achieved by modern digital technology. The rapidity with which technological advancement has progressed means that implementations such as these are generally simple and inexpensive to produce. Then, if the private technology sector were to shift its attitude and investment per the previous section's discussion, it could develop and sell similar accessibility aids at large-scale.

Some may argue that national deployment of advanced tools for vision accessibility is infeasible, despite such deployment being a necessary condition to ensure equitable access to improved education. We will examine this issue of deployment from two perspectives: investment and physical access. Regarding the first perspective, the government has not only moral and legal responsibilities, such as by the 1990 Americans with Disabilities Act (ADA), but also vested economic interest in providing accessible education in public schools. In 2022, the Biden-Harris Administration apportioned $120 billion of the American Rescue Plan (ARP) to the investment, development, and support of STEM in public K-12 schools (U.S. Department of Education, 2022). Deployment of vision accessibility aids in public schools is critical to achieving the full return on investment of this lofty initiative, particularly because there is a higher proportion of graphical content in STEM than the liberal arts (Tennison et al., 2023). As I discussed in the first section, engineers of diverse backgrounds are critical to developing excellent products, yet there is underrepresentation of many groups in STEM. Also, accessibility is a growing development target in the technology sector. Since the goal of the ARP is to build a larger STEM workforce and there will be a clear need for engineers with unique perspectives on accessibility, it would be a waste of potential to exclude visually impaired students by not improving accessibility aids in public

schools. Given the relatively low cost of deployment of these technologies, the return on investment of improving accessibility in public schools is worth the effort.

As to the second perspective, physical deployment of these accessibility applications onto students' devices would not be onerous. Tennison and her team briefly mentioned the increased prevalence of digital devices in schools, citing Presley & D'Andrea's 2008 research (Tennison et al., 2023). Fourteen years later in 2022, this shift is confirmed by the Institute of Education Sciences (IES), the "evaluation arm of the U.S. Department of Education" (IES, n.d.). The IES surveyed 1200 public schools nationwide, and they found that 94% of those schools "provide digital devices to students who need them" (IES, 2023). Even broken down by region, school location/size/level, minority, or poverty, no group dropped below 90% in its capacity to provide digital devices to students with demonstrated need (IES, 2023). This statistic highlights the feasibility of incorporating new vision-accessible software and hardware into the public education system. Assuming the accessibility aids are similarly small as Tennison et al.'s prototype, students can install the software on their existing school-provided devices without much difficulty.

It is not my stance that the government is not supporting students with vision disabilities; rather, I argue that the government is not doing enough to support these students. Special education programs have been instituted in public schools for decades, and they provide alternative instruction designed to meet the needs of students with varied disabilities. Each state defines their own special education requirements, though certain standards are enforced by federal law. According to an excerpt from the Code of Virginia,

> "Special education for visually impaired children provided by a school division shall be established, maintained and operated jointly by the school board and the Virginia Department for the Blind and Vision Impaired subject to the regulations of the Board of Education. Braille instruction shall be included in the student's Individualized Education Plan (IEP)…[unless] other special education services are more appropriate to the student's educational needs." (Va. Code Ann. §§ 22.1-217 (1998)).

Indeed, the government is attempting to provide for these students, as evidenced by the above law code, but it is operating under outdated regulations and assumptions. For instance, a 2022 study found that disabled students who spent "80% more time in inclusive classrooms did better in reading and writing than peers spending more time in special education classrooms" (Cole et al., 2022, p. 13). Though this statistic covers all disabilities, it is not irrational to assume that visually impaired students would benefit from inclusive instruction in similar proportions. Personalized accessibility aids would facilitate integration of visually impaired students into standard classrooms, allowing them to reap the academic and social benefits of learning in an inclusive setting.

III. Actor-Network Theory and Responsibility

Actor-network theory (ANT) is a framework by which sociotechnical issues can be examined as entities within a web whose relationships define social forces (Law, 1992). I will use ANT to examine the issue of distribution of responsibility for improving personal agency for the visually impaired community. Following this analysis, I will explain why ANT is insufficient as a model for networks in which actors have unequal relationships.

From the perspective of ANT, the issue of social responsibility and personal agency for the visually impaired possesses the following actors: visually impaired persons; caregivers, family, and friends of the visually impaired; public schools; government; Big Tech; and the remainder of the technology sector. Visually impaired persons include any individuals with a vision-related disability. Caregivers, family, and friends include people who provide visually impaired individuals with any level of aid in their daily activities. The government actor includes any sectors of the government that relate to technology adoption, education, welfare, or disability/accessibility. Big Tech is distinguished from the rest of the technology industry because of its disproportionate effect on the other actors as compared to smaller companies within the industry. These actors' interactions form a network that defines the flow of information, technology, and care experienced by the visually impaired. Visually impaired people depend on the services and products provided by the other actors to accomplish tasks within their daily lives. As outlined in the previous sections, public schools and the government are responsible for providing accessible education opportunities, but they are themselves dependent on the technology industry to produce accessible products. While Big Tech and smaller companies in the industry all create new accessible technologies, Big Tech is better equipped to put such innovations into the hands of the visually impaired, either by selling their own products or buying the rights to those of smaller companies. Big Tech is further distinguished from other businesses in the industry by its superior financial and distribution power and corresponding greater ethical responsibility. The visually impaired depend on their caregivers for any aid not received from the other actors.

An ANT perspective on this sociotechnical issue implies that the dependencies between actors are equal in weight, but this is not a true representation of the situation. People with visual impairments rely far more on the other entities than these entities rely on the visually impaired. Let us consider a hypothetical child, Jimmy, and walk through his typical day to see how he interacts with other actors in the network. Jimmy is legally blind and attends 9th grade at a public school in a low-income area. Jimmy walks down the street to his new high school bus stop, and he uses his cane to feel for the truncated concrete that marks the entrance of the sidewalk into the road. This tactile surface is required under the ADA, a relationship with the government actor (Americans with Disabilities Act of 1990, 42 U.S.C § 4.7.7 (1990)). Once he arrives at school, Jimmy heads to his special education classroom, where they begin with English class. The school has provided him with a tablet and headphones to allow him to follow along with the reading, a dependence on the public school actor. At lunch, Jimmy pulls out his iPhone, and uses the Spoken Content accessibility feature to navigate the device, demonstrating his relationship with the Big Tech actor. These other entities – the public school system, the government, and Big Tech – see Jimmy as one in a sea of many. Even with the most altruistic intentions by members of these organizations, Jimmy is simply not as important to these actors as they are to Jimmy. Their services and products determine how Jimmy interacts with his world, but Jimmy does not conversely dictate the public-school curriculum, pass legislation, or approve long-term business strategy. The ANT framework ignores this uneven power balance in the relationships between actors, effectively erasing the crux of the issue with improving personal agency for the visually impaired community: responsibility. The question of how to improve the independence of people with visual impairments cannot hope to be effectively answered without first determining who, and to what degree, is responsible. ANT helps to answer the question of "who" by identifying stakeholders, but its 2D representation of the problem sorely ignores the "to what degree" component. I do not have a solution to this distribution

of responsibility, but I am convinced that an effective plan can only come about through a cross-disciplinary effort by the government, the technology industry, and, most importantly, the visually impaired community.

Conclusion

Personal agency for the visually impaired is a demonstrably complex issue, but it is not impossible to address. In this paper, I identified key stakeholders in the question of responsibility for improvement of conditions for the visually impaired and exposed a limitation in applying a common approach, ANT, to visualizing sociotechnical issues. I maintain that the distribution of responsibility for the improvement of personal agency for the visually impaired is not straightforward, and I advocate for a broad effort to address this problem on multiple fronts. Such an improvement depends on the technology industry, the government and all its extensions, and the people directly affected by visual impairments, whether themselves or through their loved ones. However, it is not just these stakeholders who bear this ethical duty to push for change. It is the responsibility of everyone to demand equity, to make it clear that empathy has a place in the face of relentless technological progress. I claimed previously that a network created by an ANT perspective does not put appropriate weights on the relationships between actors. I extend that claim now: it is the general public's responsibility to be the weights in these relationships. Investment and legislation swing with popular opinion, so it falls on the populace to champion the issue of personal agency for the visually impaired. It is the moral onus of every person to care about the plight of the visually impaired community and to demand better from the organizations who have the power to make it so. Only then can society finally coordinate a sweeping initiative to support the personal agency of the visually impaired.

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