"Seven Stitches Later": A Technologically Interdependent Travel Experience From The Perspective Of A Visually Impaired Individual

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Abstract

Travel is an integral aspect of our lives, and this rings true for blind and visually impaired individuals alike. This activity can be enhanced with technology to facilitate a safer and more efficient experience, however with the abundance of options available it becomes difficult to establish a decision on which tools to use. In this autoethnography, I propose a technologically interdependent travel framework comprised of five pillars, orientation, communication, evaluation, navigation, and transportation. Based on over ten years of technology-supported travel experiences I have encountered first-hand as a visually impaired traveler, this experience report serves as a demonstration of what tools I have chosen and why, as well as how I utilize them throughout a naturalistic travel experience while associating each tool to a pillar from the proposed framework. I conclude this report with a recognition of existing limitations and opportunities for future research based on my observations and experiences.

CCS Concepts

• **Human-centered computing** → **Accessibility design and evaluation methods**; **Accessibility technologies**; **Accessibility systems and tools**; **Empirical studies in accessibility**.

Keywords

Orientation, Mobility, Travel, Transportation, Navigation, Technology, Interdependent

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1 Narrative of Inquiry

At the age of six, like most children, I had a need to disburse energy by way of physical activity. In an effort to satisfy this need, I chose to run, and I would inadvertently sprint directly into a door that was left ajar. This event would resulted in a visit to the hospital where I would be the recepiant of seven stitches. The next day, I showed up to my school with a prominent change to my appearance, a clear and surprising addition to my forehead. This would immediately prompt my orientation and mobility (O&M) instructor to issue me my first white mobility cane which would define the commencement of my independent travel which I continue to enjoy and appreciate today. In addition to this gift, I carry the scar above my right eye which reminds me where it all started, and the importance of a systematic, safe, and efficient approach to independent travel.

I have employed my O&M skills in over eight countries and 15 U.S. states, with most experiences having been independent travel in unfamiliar environments. Since the age of 16, technology has been the foundation of my travels, only to be superseded by my white cane or guide dog, Maximus, who has since retired after eight years of service. While each travel experience comes with its own unique challenges, I have found that every one has adhered to five foundational pillars essential for the success of each scenario.

2 Background

Travel is a foundational aspect of our daily lives from the day we are born to the day we are laid to rest. Whether that is travel for school, work, shopping, medical, leisure, or simple movement from one point to another within a given space (e.g., children learning how to crawl or adults walking around the neighborhood), it is difficult not to appreciate the significance of travel and movement on our physical health [31, 46, 56], mental health [19, 20, 29], and our economy [7, 8, 18]. This essential activity can create a friction for untrained and unfamiliar blind and visually impaired (BVI) individuals who wish to exercise this core aspect of life. To do so, BVI individuals may need to rely on assistance from a non-visually impaired (NVI) spouse, relative, friend, or stranger who is able to provide guidance based on their visual perception of the surrounding environment. Alternatively, they could seek assistance from a fellow BVI individual who is familiar with the environment, or has the necessary skills to traverse unfamiliar ones. Those who may lack the training or familiarity with safe, efficient, and independent travel may satisfy this deficiency with O&M training from a Certified Orientation and Mobility Specialist (COMS) [11], or an individual who holds the National Orientation and Mobility Certification (NOMC) [36] here in the United States of America. While many technological tools exist to assist BVI individuals in their travel efforts, these are a compliment to required foundational O&M skills [22, 55]. As an example, individuals driving a *Tesla* vehicles outfitted with *Autopilot* are expected to be attentive to the road ahead, able to take over control when necessary, not to fully entrust *Autopilot* with the task of driving, and are expected to use it as a tool in efforts

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of enhancing the quality of the drive experience as opposed to a primary means of operation [48].

As stipulated in my *Individualized Educational Program* (IEP) I received O&M instruction throughout my school years and up intil my graduation from high school. I was fortunate enough to leveraged the power of technology in my O&M instruction, and have been employing such tools in my day-to-day travels for over 10 years. During this time, I have witnessed the impressive evolution of how technology has introduced innovation and advancements into the field of O&M. Yet, little has been discussed at the ASSETS community about how various O&M technologies are being used together and how they are situated in the daily lives of BVI individuals. This paper aims to fill this gap by presenting a comprehensive review of the current state of technology-supported O&M practices and discussing the potential of future research in this area. Based on my autoethnographic and experiential reflection, I share the five pillars of O&M practices that are essential for the success of each travel scenario. I also discuss how technology ties into each pillar based on my own travel experiences. Finally, I outline opportunities where improvements can be made and lay the groundwork for my future work in this domain based on my observations.

3 Technologically Interdependent Travel

Orientation and mobility (O&M) is generally defined as the act of safe, efficient, and *independent* travel of a BVI individual, however in the context of this report, *independence* is taken in the literal sense, *depending on nothing and nobody*. Instead, the concept which serves as the foundation for this work will be *interdependence*, the idea that a given task is achieved with the help of other people or tools while embracing the fact that we are not alone, and that dependence is not inherently a sign of defeat, a source of hindrance, or an indicator of reduced autonomy [17].

3.1 The Big Picture

Before diving into each pillar that define my technologically interdependent travel framework, I will first present a real-world event which demonstrates how they are applied in a naturalistic setting. The pillars, in no particular order are *orientation*, *communication*, *evaluation*, *navigation*, and *transportation*. These pillars stem from my years of formal O&M instruction and over a decade of practical travel experience that followed.

The example I will use is a route I commonly took when I lived in Champaign during my first year at the University of Illinois. The route starts at my former apartment and ends at 614 E Daniel Street in Champaign which is the School of Information Sciences (iSchool) where my office is. The example will be a reconstruction of my first experience planning and executing the route (i.e., before I committed it to memory).

For me, every travel experience starts with the *orientation* pillar. This consisted of me using Google Maps [26] to review the route from my apartment to the iSchool. I would always check if walking was an option, however my apartment was four miles away, so this was not viable. I knew before I signed my lease that there was a bus stop less than 400-feet away from my apartment, and another one less than half a mile away. The closer stop was for an express line that only ran in the early morning and again in the late afternoon, so based on the *Depart At* time I had specified in Google Maps, I was directed to use the further stop. I would go on to familiarize myself with the route from my apartment to the further bus stop by memorizing the steps of the route as well as the streets and intersections along the way.

Having identified the stop I need to get to, I downloaded My Bus Helper MTD [53], a bus tracker for the bus system in Champaign-Urbana. I would use this application to easily see when a bus will be arriving at a given station near my location. Of course, this information is also provided in the route overview on Google Maps, however I liked to have this app in situations where I no longer need to refer to Google Maps for directions.

With the trip planned completed, and now having been oriented conceptually with aspects of the upcoming travel experience, we pivot to the *navigation* pillar, which commences with the act of mentally loading the trip plans in my mind and launching BlindSquare [34], an application on my phone which allows me to track my destination and receive real-time location-based information including cardinal heading, nearest address, points of interest, streets, intersections, and most importantly, feedback about my progress to the destination I had set (e.g., destination 0.2 miles at 11 O'Clock).

While navigating, I am expected to incorporate the *evaluation* pillar when encountering situations that require me to stop and evaluate before acting (e.g., crossing an intersection). This route consisted of two traffic-light controlled intersections, so when I came across those crossings, I would use Oko [15], an application designed to help me detect the current state of pedestrian walk signals and communicate that state by means of spoken prompts, audible beeps, and haptic feedback.

The process of finding this bus stop was difficult since it was in a residential neighborhood with no sidewalks, half-way down the block, and was marked only by a sign post (i.e., no prominent bus shelter at a defined intersection corner). Having experience with similar bus stop setups, I looked for the sign with my cane, found it, and confirmed it was indeed the sign for the bus stop with Seeing AI [44], an application that is able to perform real-time optical character recognition (OCR) and speak the detected text.

When the bus arrives, this is when the *communication* pillar comes in. As a hypothetical, if the driver did not speak English or Arabic, then a translation application like Google Translate [27] or Apple Translate [13] would be required for me to communicate with the driver and ask them what route this was, what direction it was heading, and to provide me an indication when we are arriving at my intended stop.

As I embark the bus and it departs the station, the *transportation* pillar is in effect. As part of this process, I am actively monitoring the route by keeping track of real-time cardinal heading, current street, nearest address, intersections being crossed, points of interest going by, and our distance from the intended stop with the help of BlindSquare [34]. This is not exclusive to public transportation like buses and trains, but also when I am in a ride share or riding along with a friend or family member in a private vehicle.

Given this was only a portion of a trip I regularly embarked on while living in Champaign, it demonstrates how all five pillars co-exist, intersect, and at times overlap in the name of making a travel experience possible. In the following sections, I will go into more detail about each pillar.

3.2 Orientation

Every trip, regardless of destination and complexity, would start with the orientation pillar. This is the planning phase of the travel where I review the trip steps, details, and any associated components before leaving my house. This consists of a cursory review of the overall route on Google Maps [26]. Upon becoming familiar with the overall trajectory of the route, I would pivot to an in-depth review of the step-by-step directions required to execute the route on my computer. Relevant details of the trip like steps to follow, public transportation details, phone numbers, addresses, landmark descriptions, destination surroundings, emergency contacts, and any other pertinent information related to the route/destination are gathered from various sources across the web and organized into a concise text file which is subsequently sent to my phone. This is done to account for situations where internet connectivity is sporadic or non-existent (e.g., remote locations and international destinations).

In situations where I wish to gain more context and familiarity about the route and surrounding area (e.g., points of interest, intersections, landmarks), I leverage the simulation functionality built into apps like BlindSquare [34], GoodMaps Outdoors [25], and Lazarillo [23]. These apps allow me to interact with the environment virtually without leaving my residence.

If a route calls for multiple modes of transportation, Rome2Rio [42] is a great way to get a high-level overview of what modes of transportation one could use to get from point A to point B, including buses, trains, and planes. While Google Maps does offer this functionality, Rome2Rio presents this information more concisely, though it is still my responsibility to conduct the search and reservation of the transportation on the respective public transportation websites.

Over the past year, I have been utilizing generative artificial intelligence (gen AI) in my planning. For example, tools like OpenAI's ChatGPT [39] and Google's Gemini [28] are great for creating a trip itinerary that includes flight and hotel costs and options, places to visit, and activities to do. At this time, my reliance on these tools is for informational purposes only. Instead, I will refer to the respective websites of the hotels and airlines, or sites like Expedia [2].

The orientation phase of the travel process is instrumental to the success of the trip to follow. While subsequent phases are significantly important, proper planning ensures I am prepared and confident to carry out what is needed of me to reach my final destination.

3.3 Communication

Communication is the core of how our society interacts with one another. The mode of this interaction is language, and while English is recognized as the lingua franca of the world, I have encountered situations where a language barrier is present. When I was in Spain for an academic workshop, I interacted with airport staff who did not speak any English. I was prepared, and as part of my orientation and planning process, I had downloaded both Google Translate and Apple Translate on my phone, ensuring that Spanish was downloaded for offline use on my mobile device in both apps [13, 27].

I have yet to experience the recent implementations of hands-free translation by means of worn headphones, and that is due to my heavy reliance on auditory cues which excludes me from wearing headphones to prevent obstruction to my sense of hearing. While modern headphones do offer transparency modes that allow me to perceive sound from my environment, there is a significant and perceivable negative impact to the quality of the audio thereby compromising my ability to fully utilize auditory cues. I do own bone conduction headphones from Shokz [45], however, the model I have is, at times, uncomfortable. Shokz have recently released the OpenFit and OpenFit Air which promise a more comfortable open-ear experience. I do still prefer these over in-ear headphones and will use them when I need auditory information from my phone while in an environment where I require full auditory spacial awareness.

One of the most prominent communication challenges I encounter is coordinating with ride share drivers like Uber [50]. This interaction consists of communicating my location to the driver so they know who they are picking up and from where. This is trivial in residential and low-traffic environments, however when I am at an airport, train station, or a busy metropolitan area like downtown Chicago, this tasks can prove to be significantly difficult, especially when the driver is rstricted by street ordinance from meeting me where I am. If I am in a location where I know meeting with my driver will be relatively difficult, I will send a message to the driver notifying them of my visual impairment, nearby landmark, and appearance (e.g., I'm blind, I am next to a pole, I am holding a white cane, and wearing a blue cap). If I know the task of meeting with my driver is going to be extremely difficult, I will give them a call when they are a couple minutes out to coordinate. I have also found that Uber's Spotlight feature [49], which fills the screen of the phone with one of six colors and automatically sends a message to the driver letting them know what color they should be on the lookout for, has been extremely helpful in my efforts of communicating my location to the driver when they pull up.

In another example of where communication meets technology in the realm of ride shares, I had requested an Uber to pick me up from the airport. When the Uber arrived, and the application notified me of such, I tried calling my driver, but I was unable. I sent the driver a message letting them know that I was blind. Moments later, I received a response from the driver who was letting me know that they were deaf. I then directed them to find me, walk up, and tap me on my left shoulder twice. This non-verbal exchange, agreed upon by means of a technological channel, made it possible for us to successfully meet and embark on the journey even though our primary biological means of communication were incompatible.

Even though communication challenges will continue to persist in my efforts of traveling as a visually impaired person, technology has facilitated a means of eliminating what once was near impossible to accomplish, thereby unlocking hundreds of perspective locations I can freely visit and explore.

3.4 Evaluation

The *evaluation* pillar is integral to the safety and efficiency of any travel experience, with a need to take into account considerations like weather, traffic conditions, and any ongoing local events that

may impact the travel plans. For example, I will typically refer to the Apple Weather app on my iPhone, Siri on my HomePod Mini or iPhone, and Google Assistant on my Nest Audio for weather and traffic related information [1, 3–6]. At times, I need a more in-depth and interactive look at the weather conditions for the day broken down by hour, and for that I use *Weather Gods*, an application on iOS that allows me to perceive hour-by-hour weather conditions through an auditory experience which represents forcasted conditions with appropriate sound effects for each individual hour [52].

One task which is considerably trivial for NVI individuals though can be non-trivial and potentially dangerous for BVI travelers like myself is crossing streets. Low-traffic, stop-sign controlled, and familiar intersections are simple and straightforward, posing no additional consideration on my part, however more complex, traffic-light controlled, busy, and unfamiliar intersections require attention, patience, and discretion as conditioned by countless hours of O&M instruction. One mistake can result in significant injury or loss of life, so it is paramount that prior to attempting a crossing, an intersection is to be carefully evaluated as many times as deemed necessary to establish full and irrefutable confidence. Some, but not all intersections are fitted with Accessible Pedestrian Signals (APS) devices which allow a BVI or deaf-blind individual to perceive the state of the pedestrian walk sign by means of spoken prompts, auditory beeps, and haptic feedback [16, 43]. Oko [15] takes the features of an APS and places them into an iPhone app for use at intersections where a walk signal is present, however no APS has been installed. When switched to the pedestrian signal detection mode, Oko is able to detect a pedestrian signal and recognize its current state with the rear-camera. Once it has identified a pedestrian signal, it will communicate its real-time state to me through the same modalities as the APS, spoken prompts, audible and distinct beeps, and haptic feedback, with the added benefit of customization for the available modalities.

Whether it's crossing the street, checking the weather, or understanding current traffic conditions, the evaluation pillar focuses on the process of reviewing available information, comparing with other sources and/or senses where possible, and making a decision based on the observations ensuring travel plans are carried out, modified, or postponed to ensure safety and efficiency are the highest priority.

3.5 Navigation

Any form of travel will essentially boil down to the act of navigation. Whether I am moving from my bedroom to my office within my house, or from my residence to a location nine-thousand miles away, I am expected to navigate (i.e., identify and execute a set of steps in sequence) from my current location to the final destination. Travel will not always have a clearly defined final destination, a prime example being the Voyager 1 spacecraft launched in 1977 [35], however there is always a direction of heading, intentional or otherwise. That being said, the two most important aspects of navigation for me are cardinality and my current location.

While it is the simplest form of navigation, and could even be classified in the orientation bucket, cardinality is the most basic form of directionality, knowing my position and heading as it pertains to the four cardinal directions, north, east, south, and west. To best accomplish this, I leverage the built-in Compass app on my iPhone [14], as well as BlindSquare [34], GoodMaps Outdoors [25], and Lazarillo [23]. Apps like SARA Nav [40], VISCompass [21], and the Backtrack functionality built into the Compass app on Apple Watch [9] all prove to be excellent tools for outdoor activities like kayaking, sailing, and hiking.

We typically represent current location with an address which consists of, at minimum, a number, street name, city, state, and postal code here in the United States. This information, while helpful, may lack context about nearby points of interest, streets, and intersections. This is where I use apps like BlindSquare [34], GoodMaps Outdoors [25], Lazarillo [23], VoiceVista [57], Apple Maps [12], and Google Maps [26] to know where I am, build an image of my surroundings, and navigate to a desired destination while receiving relevant information throughout the route. Oko [15] has recently introduced navigation functionality in their app which previously only provided the ability to detect pedestrian signals, and as this functionality improves, this app may become my primary application for most travel tasks as the functionality spans multiple pillars.

At times, an accurate representation of my current location is all that's needed, however there are situations where an address is not sufficient in communicating my precise position (e.g., forest, park, open water, airport, mall, etc). For those times, and when I am sending my location to someone who uses this specific system, I use *What3words*, a mapping and navigation system that has broken up the surface area of this Earth into approximately 57 trillion squares measuring 10 feet by 10 feet (3 by 3 meters), and assigned each square a unique three-word address [54]. While *What3words* is a powerful and simple approach to communicating my exact location, it does come with the limitation that it is not as widely adopted as the traditional address system. Furthermore, relying on the app to tell me what my location is automatically may be hindered by the GPS signal accuracy as it is recommended to enable the satellite view in the app and manually choose a square that is closest to where I am. This can be prohibitive from a visual standpoint as I am expected to visually perceive the top-down satellite view of my location, compare with where I stand, and then based on my observation, pick the square on the map that is closest to me.

An alternative option that exists in the market is the StellarTrek hand-held GPS from Humanware [30] which serves as a standalone GPS device. It features turn-by-turn directions, point-of-interest exploration, intersection announcements, optical character recognition (OCR), and street crossing assistance, all without an internet connection. While this tool does include most of what one would ask of a navigation tool, it comes at a cost of $1,595, which would require a perspective buyer like myself to justify such a high cost when all those functions are available to me on my phone, with the only exception being offline functionality in some of the apps I mentioned.

When it comes to indoor navigation, my only experience with offerings designed to help BVI people navigate this type of environment was GoodMaps Explorer at the 39th annual CSUN Assistive Technology Conference in Anaheim, California [24]. While I was able to successfully use it to find a few rooms throughout the venue,

I could not provide a comprehensive and in-depth assessment as I did run into issues with the apps accuracy and functionality based on surrounding factors like crowds.

More recently, I have begun exploring no-cost and low-effort navigation solutions like NaviLens [38], ann app that allows an individual to navigate using printed codes placed throughout an environment. Clew [10], an app that allows someone to record a route using their camera, then share it with others who can then follow the route in an accessible experience including sound and visual breadcrumbs superimposed on the real-world by means of augmented reality (AR). In the case of Clew Maps [32], the route can be stored in the cloud, and initiated using a special start code and near field communication (NFC) tag which makes it possible to record a route once, and share broadly while providing a more simple experience for initiating and following the route as opposed to the traditional Clew app approach.

From current location, cardinal bearing, to the steps necessary for the execution of a given route from departure to destination, navigation is at the core of any travel experience.

3.6 Transportation

Transportation, the use of a vehicle to move from one point to another by means of ground, water, or air serves as the fifth and final pillar for my technologically interdependent travel framework. I have found it necessary to distinguish between the act of navigation and transportation which can be interpreted as a single concept. While transportation requires me to navigate from one point to another, I regularly navigate without the use of transportation modalities. However, in this section, I will outline how I employ technology in efforts of navigating with the help of transportation modalities.

One of the most significant technological innovations that has positively impacted my ability to travel more freely and flexibly is the widespread adoption of ride share services like Uber [50] and Lyft [33]. As someone who is legally blind, the option of obtaining a driver's license and operating a motor vehicle on the roadways is not possible for me, which makes ride share services my preferred form of private transportation. Of course, autonomous vehicles are actively being developed, tested, and deployed in real-world applications [51], however at this moment, this is not an available option in my region. The viability and preference of ride share services for me is emphasized greater, specifically when I am in the Chicagoland area given the recent introduction of the Rideshare Access Program (RAP) [41], a program which subsidizes a portion of my ride share cost so long as the pick-up and drop-off locations are within three-quarters of a mile from a fixed-bus route.

In situations where ride share services are not appropriate (e.g., my 130+ mile commute between Chicago and Champaign), I take an Amtrak train [37]. As for destinations where Amtrak is not the most efficient option, I opt to fly, specifically with Southwest Airlines [47], or any other airline that flyes out of Chicago's Midway International Airport. If I find that I will save more than $150 by flying out of Chicago's O'Hare International Airport, then I opt for an airline flying out of there. This threshold takes into consideration the ofset in ride share cost, and the point where saving money out-weighs the convenience factor alloted by Midway.

When I take into account transportation options as part of my travel experience, I consider not only the efficiency, viability, and cost-effectiveness of the options, I review the accessibility of the technology used, the accommodations provided, and how the option ties in with other pillars in my travel experience.

4 Future Opportunities

While there is an abundance of tools available to BVI travelers, there is always room for new innovations to enhance the technologically interdependent travel experience. In this section, I outline one challenge I am working on addressing in future works.

Many locations offer maps to help familiarize current and perspective visitors to the layout and location of different areas (e.g., universities, airports, hotels, conference venues, and malls), however these maps are typically in an inaccessible format. The goal is to take the inaccessible version of the map, typically an image, and feed it to an application which is capable of outputting an interactive experience which is multi-modal and accessible for BVI individuals, and the community at large. This can be achieved with recent advancements in multimodal AI models and can be served to the user in a simple web interface either on a phone or on a laptop or desktop computer.

5 Conclusion

In this paper, I presented five pillars which define the foundation of any given travel experience based on my autoethnography as a visually impaired traveler. While *orientation*, *communication*, *evaluation*, *navigation*, and *transportation* may be perceived as five independent components, in reality, they co-exist in parallel, and at times intersect and overlap to create the harmony of a technologically interdependent travel experience. While frictions exist to impede the seamless nature of this experience, opportunities have been presented to begin the process of tackling such limitations for our future generation of BVI travelers.

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