How Have Transportation Infrastructure Designs Discriminated Against Low-Income and Diverse Communities in the United States?

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By

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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

Pedestrians and bicyclists are put at risk every day due to insufficient transportation infrastructure. In 2017 alone, a total of 6,760 pedestrians and bicyclists were killed in the United States by motor vehicles (Pedestrian and Bicycle Information Center, 2019). The U.S. Department of Transportation (DOT) describes a livable community as one where all forms of transportation in that community are safe and accessible for all residents (Federal Highway Administration, 2018). However, according to the DOT, the number of pedestrian and bicyclist deaths and injuries are increasing annually. In order to provide livable communities for all, the condition of pedestrian and bicycle infrastructure in the United States needs to be addressed. Unfortunately, with concern to transportation infrastructure in general, some communities are at a greater disadvantage than others.

Across the United States, infrastructure serves as a constant barrier to residents attempting to travel from one location to another (Schindler, 2015). More specifically, transportation infrastructure has been designed to exclude minorities by increasing their difficulty and length of travel to particular destinations. Premeditated at times, and unintentional at others, engineers and designers have created infrastructure that discriminates by race and socio-economic status. For example, in many low-income and diverse communities, sidewalks and bike paths are almost nonexistent, which restricts the connectivity between neighborhoods and forces residents to walk on or along the shoulder of high-volume roads (Schindler, 2015).

This research paper addresses this issue on how particular transportation infrastructure designs have discriminated against low-income and diverse communities in the United States. On the other hand, my Capstone project aims to improve the safety of pedestrians and bicyclists along the Water Street corridor in downtown Charlottesville. Water Street was identified by the

Virginia Department of Transportation (VDOT) as an area of focus due to a high rate of pedestrian crashes between 2012 and 2016 (Virginia Department of Transportation, 2018). Additionally, Water Street tends to have high bicycle traffic. Therefore, the objective of this Capstone project is to redesign this corridor to incorporate a variety of safety features for pedestrians and bicyclists. In order to integrate my Capstone project into my STS research paper, I investigated the Water Street corridor and the Downtown Mall, which is adjacent to the Water Street corridor, for any discriminatory features and have included the results as a case study. These results are compared to another case study involving two segregated communities in Baltimore in order to come to a conclusion on the full discriminatory effects of transportation infrastructure. In the United States, low-income and diverse communities are discriminated against by transportation infrastructure, thus adding to the many adversities these individuals face on a daily basis.

Case Context

Transportation infrastructure shapes the world around us, affecting the way people get to and from different locations. It directly authorizes or inhibits individuals from being able to access particular locations. This has allowed transportation infrastructure to serve as "physical barriers [that] divide urban space in ways that reinforce or exacerbate segregation" (Roberto & Hwang, 2016, p.1). At first glance, transportation systems may not appear to discriminate against low-income and diverse communities. However, after careful analysis, it becomes apparent that transportation infrastructure can discriminate. These discriminatory systems create difficult and sometimes dangerous situations for their users. For example, Robert Bullard (2003) describes a case where a seventeen-year-old, African-American girl named Cynthia Wiggins was

killed by a dump truck while crossing a seven-lane highway in order to get to the nearest bus stop. Cynthia was working at the Walden Galleria Mall, where the mall's owners refused to have a bus stop on its property (Schindler, 2015). Therefore, she was forced to jaywalk across a seven-lane highway to reach the nearest bus stop. During the trial of her death, it was "revealed that this transit-siting decision was motivated at least in part by race or class bias" and that the mall's owners wanted to discourage people who rely on public transportation from accessing the mall (Schindler, 2015, p. 1964). Unlike this situation, the majority of discriminatory infrastructure designs are never brought up in court. To everyday users, the built environment appears normal, therefore never questioning whether it has discriminatory effects.

The overpasses designed by Robert Moses in Long Island, New York are an example of discrimination that has never been brought up in court. Moses purposefully built approximately 200 overpasses with a vertical height as low as nine feet in order to prevent twelve-foot buses from using the expressways underneath (Winner, 1980). Therefore, these underpasses discriminate against those who rely on public transportation, which are mainly low-income groups and minorities, and favor the white automobile owners of the upper- and middle- classes (Winner, 1980). Figure 1 shows an example of one of Moses' nine-foot overpasses.

Figure 1. An example of Robert Moses' nine-foot overpasses. (Garutti, 2014)

Other than simply preventing these individuals from using his expressways, he also wanted to restrict their access to his highly admired public park, Jones Beach (Winner, 1980). This intentional outcome is supported by the fact that Moses vetoed "a proposed extension of the Long Island Railroad to Jones Beach" (Winner, 1980, p.124). During his career, Moses was known as a "Master Builder" as he took part in a variety of infrastructure projects in New York and was involved with $27 billion worth of work (Schindler, 2015; Aurbach, 1976). Of this $27 billion, "Moses provided almost no service for the poor, minorities, and underprivileged … [and his] projects were generally at the expense of these groups" (Aurbach, 1976, p.410). With respect to the overpasses he designed and other projects he was involved with, Moses was able to "make it physically difficult for certain individuals to reach places" without having to gain the public support needed to legally exclude them from these areas (Schindler, 2015, p.1954).

While the Cynthia Wiggins and Robert Moses examples illustrate outcomes of intentional discrimination, there are a great number of cases where the discriminatory infrastructure was unintentional. For example, residents of the inner city of Detroit cannot access jobs and other suburban areas because of the lack of coordination of their public transportation systems (Schindler, 2015). Therefore, this causes an increased separation of the majority white suburbs and the more diverse inner city. Other cases of discriminatory infrastructure include street grid designs, one-way streets, highways, transit locations, parking permits, highway exits, pedestrian infrastructure, walls/barriers, and gated communities (Schindler, 2015). The theories reviewed in the next section -- *technological politics*, *actor network*, and *discriminatory technologie*s -- can be useful to reveal forms of discrimination.

STS Topic

In 1980, Langdon Winner introduced the theory of technological politics in his publication *Do Artifacts Have Politics?*. This theory attempts to explain how technological devices are embedded with political properties. Winner identifies two instances where this takes place and provides case studies to back his theory. The first instance occurs when technologies are utilized as a form of order in communities. Winner provides the example of Robert Moses purposefully designing the overpasses in Long Island to discriminate against those who rely on public transportation. Using this example, Winner (1980) demonstrates "how technologies can be used in ways that enhance the power, authority, and privilege of some over others". He also mentions how technologies are able to unintentionally have political consequences. Winner (1980) states "consciously or not, deliberately or inadvertently, societies choose structures for technologies that influence how people are going to work, communicate, travel, consume, and so

forth". The second instance of this theory deals with inherently political technologies. This is "the belief that some technologies are by their very nature political in a specific way [and that] … the adoption of a given technical system unavoidably brings with it human relationships" (Winner, 1980, p.128). This differs from the first instance in that there is no flexibility in whether the technology will have political properties if adopted. Winner provides two different cases for inherently political technologies. In the first, the technology requires the adaptation of certain social conditions while in the second, the technology is strongly compatible with a set of particular social conditions. Along with the theory of technological politics, actor network theory was also utilized to examine transportation infrastructure.

Actor network theory was developed by Bruno Latour in 1992 in his article *''Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts''*. This theory attempts to explain how human and nonhuman actors have an equal part in developing how society is today. Latour (1992) notes how "we have been able to delegate to nonhumans not only force as we have known it for centuries but also values, duties, and ethics". The primary example discussed throughout the article deals with the human and nonhuman aspects of a door. As new technologies were developed for the door, human actions adapted consequentially. In order to understand how a new technology affects human actions, Latour (1992) suggests to "simply imagine what other humans or other nonhumans would have to do were this character not present". To disregard the impacts of technology on society, as most sociologists do, would be the same as looking at only half the picture. Latour describes technologies as being anthropomorphic. Anthropomorphism is the projection "of a human behavior onto a nonhuman" (Latour, 1992, p.160). Therefore, he is perpetuating that technologies reflect human thoughts and values. Thus, technological artifacts can be created to "replace human action and constrain

and shape the actions of other humans" based upon the values of the creator (Latour, 1992, p. 151). It is important to consider both the human and nonhuman actors when analyzing the discriminatory factors of transportation systems. While the theories of technological politics and actor-network were used to examine transportation infrastructure as STS frameworks, the theory of discriminatory technologies was used as an evaluative framework.

Dylan Wittkower provides this evaluative framework for analyzing discriminatory technologies in his article *Technology and Discrimination*. In this article, Wittkower (2018) argues "how technologies embody, transmit, and produce ontologies of normativity which result in privilege and discrimination". He utilizes the theoretical structures of Heidegger, Latour, and Ihde in his theory of discriminatory technologies. Heidegger contributes the idea of the "One" to Wittkower's theory. The One is defined as the perfect image of normativity and averageness. Wittkower emphasizes how the One directly excludes anyone who does not fall into its image. Privilege is defined as "the invisibility of our attributes caused by their fallenness into the One" (Wittkower, 2018, p.6). Latour's work contributes to Wittkower's theory by what Wittkower refers to as a Latourian delegation, a Latourian delegation being "social values [that] are enforced through material implication, surviving through replication of design long after their designers unthinkingly built their discriminatory values" (Wittkower, 2018, p. 7). The theoretical structure of Ihde contributes to Wittkower's theory by providing four different categories of human technics: embodiment technics, hermeneutic technics, alterity relations, and background relations. Each of these categories describes a different way of how technology interacts with users and/or the world that produces a discriminatory outcome. This theory of discriminatory technologies was used as a research method for evaluating different transportation infrastructure systems.

As for the STS frameworks, the theory of technological politics was utilized in conjunction with the actor network theory. Winner's theory is applicable to discriminatory transportation infrastructure as its design has political consequences for sections of the community whereas Latour's theory is applicable to discriminatory transportation infrastructure as it is a nonhuman actor reflecting the human values of its designer. This STS paper is of particular concern because of the limited amount of research completed involving the impact of infrastructure design on communities (Coutard & Guy, 2007). Furthermore, it is important to identify and acknowledge transportation systems that are discriminatory in order to progress society in regards to race and socio-economic status.

Research Question and Methods

My research question is: How have transportation infrastructure designs discriminated against low-income and diverse communities in the United States? It evaluates transportation systems in respect to having equal opportunities for all and the effect of this technology when it does not meet these standards. This research question examines transportation systems only in the United States in order to narrow down the subject area, and specific case studies serve to constrain the focus even further. The methods that are utilized to analyze this research question include a case comparison of two case studies and Wittkower's framework.

Information on the first case study, found through current literature, involves two communities in Baltimore that are separated by Greenmount Avenue (Greenspan, 2012). These communities are clearly divided by economic class and race, which is a result of historic legislation and current infrastructure. Data for this case study has been collected from Lilian Knorr's *Divided Landscape: The Visual Culture of Urban Segregation*, Sarah Schindler's

Architectural Exclusion: Discrimination and Segregation Through Physical Design of the Built Environment, Elizabeth Roberto and Jackelyn Hwang's *Barriers to Integration: Physical boundaries and the Spatial Structure of Residential Segregation*, and Sam Greenspan's podcast on *The Arsenal of Exclusion*.

As for the second case study, I examined the Water Street corridor from my Capstone project and the Downtown Mall for discriminatory properties. This was completed by conducting a personal investigation of the transportation infrastructure in the area and determining its social impacts. This area was selected as a case study due to my familiarity of the location from my Capstone project and its direct impact on the community in which I reside as a University of Virginia student. The first set of data collected involves determining any correlation between the quantity of bus stops in a particular zone and its associated demographics within the Charlottesville Area Transit (CAT) system. These demographics include race (specifically white and black), median household income, median house/condo value, unemployment percentage, and the percentage of people below the poverty line. Eleven of the twelve bus routes serve the Downtown Mall, therefore allowing the CAT system to be an ideal measure for determining the accessibility of that area. This investigation was limited strictly to Charlottesville, as some of the bus routes go outside of its boundaries. Also, the twelfth bus route that does not serve the Downtown Mall was not included when counting the number of bus stops in each zone, see Figure 2 for bus routes.

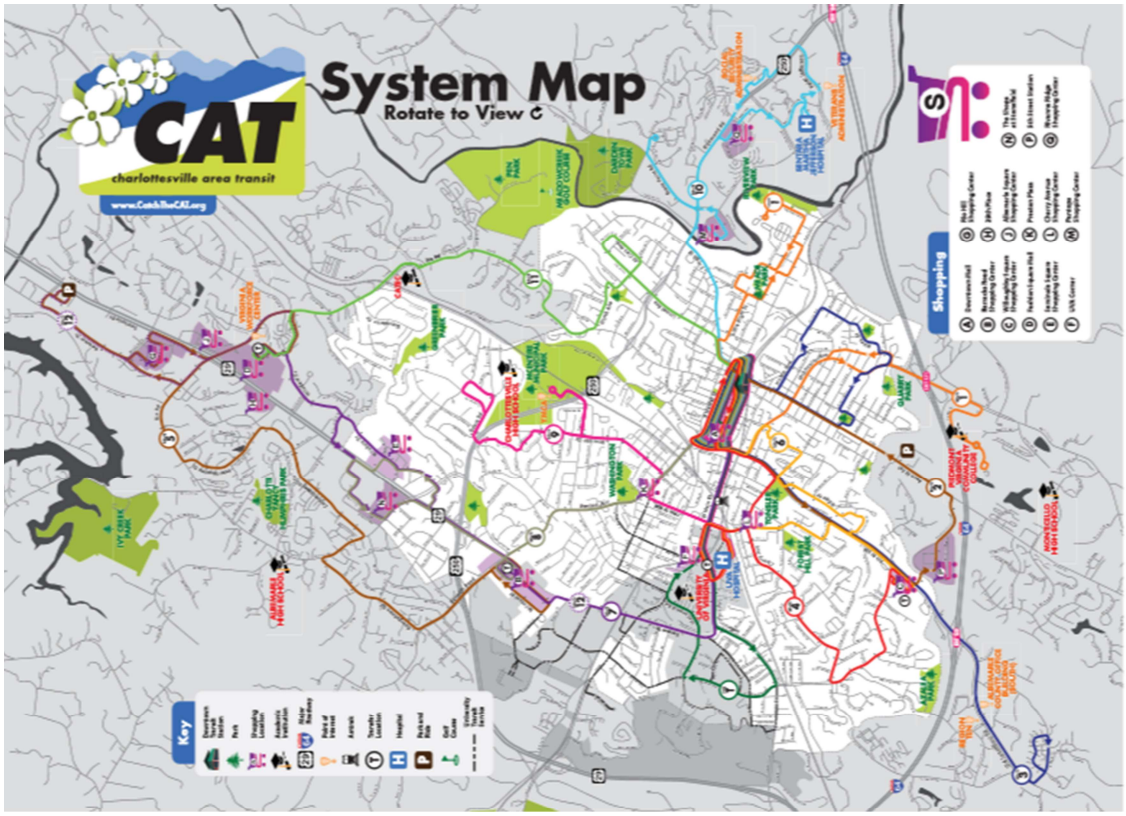

Figure 2. Map of the bus routes in the CAT system. (City of Charlottesville Virginia, 2020d)

Each zone was determined based upon the data available for each zone's demographics on *City-Data.com*. Zones where the average age was under 28 were not included in this analysis because the data was more likely to be influenced by having a high number of college residents. Other data that was collected for this case study involves the cost of using the CAT system, the price of parking, the type of restaurants and stores on the Downtown Mall, and the design of the roadway system. This information was collected from the *City of Charlottesville Virginia* website and *Google Maps*. A survey was also conducted on University of Virginia students in order to gain an understanding of their perceptions of the Downtown Mall.

Wittkower's theory of discriminatory technologies has been utilized to evaluate these transportation systems to determine who is seen as the "One", what social values are being

imposed by each design, and what category of human technics each design falls into. After the analysis of each individual case study, the two case studies are compared in order to come to a conclusion of the overall effects of transportation infrastructure on low-income and diverse communities.

Results

In the United States, transportation infrastructure designs have discriminated against low-income and diverse communities by not providing them with environments and experiences comparable to those considered the "One" by Dylan Wittkower. Through the evaluation of two case studies, it is evident that these communities are not given equal opportunities due to their transportation infrastructure designs. The Baltimore case study reveals how historical legislation and current roadway infrastructure have promoted segregation by race and economic class. The Charlottesville case study displays how unintentional discriminatory outcomes have been produced from not thoughtfully designing a particular area. These two case studies provide evidence supporting the lack of equality amongst all people in regards to the transportation infrastructure designs located in the United States.

Greenmount Avenue in Baltimore

The first case study is located in Baltimore, Maryland where two communities are separated by Greenmount Avenue and are clearly divided by race and economic status. Waverly, a predominantly low-income and black community, is located on the East side of Greenmount Avenue while Guilford, a predominantly wealthy and white community, is located on the West side (Roberto & Hwang, 2016). Table 1 shows demographics for Waverly and Guilford.

	Waverly	Guilford
% African-American	80%	7%
Median Income	$40,000	$75,000
% Having a Bachelor's Degree	16%	75%

Table 1. Demographics of Waverly and Guilford. (Greenspan, 2012)

Although there is no current legislation preventing the two neighborhoods from coming together, their disconnection is most likely a result of past legislation. Beginning in 1910, black families were restricted to living in particular communities through a segregation ordinance until it became unconstitutional in 1917 (Knorr, 2016). Thereafter, segregation took the form of "redlining, racial zoning, and racially restrictive covenants" (Knorr, 2016, p.111). Restrictive covenants, which prohibited the selling of homes to black individuals, did not become illegal until 1948 (Knorr, 2016). After this time, black individuals continued to struggle to find realtors who would do business with them and often paid up to 85% more than fair market value when dealing with white sellers directly (Knorr, 2016). However, history is not the only reason these communities are still divided today. Greenmount Avenue serves as a barrier to enter Guilford from Waverly. The majority of streets that connect Guilford to Greenmount Avenue are either one-way streets exiting onto Greenmount Avenue or are blocked off by bollards (Schindler, 2015). Bollards are poles that stick out of the ground that prevent vehicles from passing through them. Therefore, it is quite inconvenient to enter Guilford when exiting Waverly. Once eventually finding your way into Guilford, the street lay out is curvy and difficult to navigate, often leading the unfamiliar driver onto a one-way street that exits them back onto Greenmount Avenue (Greenspan, 2012). The presence of one-way streets in communities "such as these are

exclusionary in that they can confuse visitors, which might discourage their continued presence in a neighborhood, or make it hard for them to find their way to or from a specific home" (Schindler, 2015, p.1970). On the other side, Waverly is easily accessible from Greenmount Avenue and its streets are in a grid type pattern, which makes the neighborhood simple to navigate (Greenspan, 2012). Figure 3 displays the street layouts of these communities. There are also only two sidewalks in a 1.25 mile stretch that connect the two neighborhoods (Greenspan, 2012). Additionally, street parking is permit only in Guilford while you are able to park freely anywhere in Waverly (Greenspan, 2012). All of the above factors contribute to the lack of connectivity between these two communities.

Elizabeth Roberto and Jackelyn Hwang (2016) conducted a study on these two communities to determine how their physical boundaries promote residential segregation. To do this, they calculated the road distance and straight-line Divergence Indexes at each intersection in these communities. A road distance Divergence Index that is higher than a straight-line Divergence Index indicates "that physical barriers play a role in increasing segregation for residents of that intersection" (Roberto & Hwang, 2016, p.13). Roberto and Hwang (2016) concluded, through a high presence of road distance Divergence Indexes being greater than the straight-line Divergence Indexes, that "the lack of road connectivity between Guilford and Waverly exacerbates segregation" (p.17). Figure 3 shows the differences in the road distance and straight-line divergence indexes.

Figure 3. Street layout and differences in the road distance and straight-line Divergence Indexes. The darker the circle at each intersection, the higher the road distance Divergence Index is than the straight-line Divergence Index. (Roberto & Hwang, 2016)

In regards to Wittkower's theory of discriminatory technologies, the "One" for this case study includes the white, upper- and middle- class residents of Guilford. Only these residents would be familiar with how to navigate the area and are also not affected by the discriminatory effects of historical legislation. The social values being imposed in this case study include the racist intentions left over after decades of prejudice. The discriminatory characteristics that the area currently holds are most likely unintentional, however, the intentional legislation during the 1900's has caused Greenmount Avenue to act as a barrier of race and economic class. This case study falls into the background relations category of human technics. Background relations is when "the technology forms an environment to other interactions but disappears entirely from the user experience" (Wittkower, 2018, p.13). This case study falls into this category due to the

fact that residents and other users of these two communities are unaware of the background discrimination that they unavoidably interact with.

Water Street in Charlottesville

The second case study is located in Charlottesville, Virginia where I have done a personal investigation of the Water Street corridor and the Downtown Mall. The first set of evidence collected involves analyzing the bus routes of the Charlottesville Area Transit (CAT) system. This has been done by determining if there is any correlation between the demographics of a zone and the quantity of bus stops within that zone. For comparison, the average demographics for the zones were calculated in increments of five bus stops to determine whether any discrimination was present. Table 2 displays these average demographics.

		Number of Bus Stops Per Zone			
		< 5	**≥ 5 and < 10**	**≥ 10 and < 15**	**≥ 15**
Demographics	**% White**	85.05%	76.61%	63.85%	48.08%
	% Black	3.13%	15.01%	25.18%	33.45%
	Median Household Income	$ 94,589	$ 61,356	$ 54,917	$ 40,035
	Median House/Condo Value	$ 307,275	$ 246,633	$ 241,350	$ 243,650
	Unemployment %	3.15%	3.65%	4.11%	3.11%
	% Below Poverty Line	9.22%	11.32%	15.67%	27.00%

Table 2. Average Demographics of the Zones in Increments of Five Bus Stops. (City-Data.com, 2020; City of Charlottesville Virginia, 2020d)

From Table 2 and this part of the investigation, it can be concluded that there is no discrimination present in the CAT system. As the number of bus stops per zone increases, the percentage of black residents increases, the median household income decreases, the median

house/condo value mainly decreases, the unemployment percentage mainly increases, and the percentage of residents that are below the poverty line increases. This demonstrates that the CAT system provides more accessibility to public transportation to minorities and those who are of lower income. However, the cost to use the CAT system varies depending on who you are. The system is free for UVA students and employees, children (under the age of 18), and City of Charlottesville employees (City of Charlottesville Virginia, 2020c). The fare is reduced to half-price for seniors (ages 65 and up), people with disabilities, Albemarle County employees, and people with Medicare cards (City of Charlottesville Virginia, 2020c). Otherwise, it costs $0.75 for a single ride and $1.50 for a twenty-four-hour pass (City of Charlottesville Virginia, 2020a). Although the fare seems low, this price could discourage low-income individuals from using the CAT system regularly and potentially limit these individuals to traveling on the CAT system for necessity (trips to the grocery store, doctor, etc.) rather than for pleasure (trips to the Downtown Mall). As for parking on the Downtown Mall, there are a very limited amount of free parking spots on the street. Otherwise, you must pay for parking at either the parking garage on Water Street, the surface lot on Water Street, or the parking garage on Market Street. The parking garages allow you to park there for an hour for free and then pay $1.00 per half hour thereafter, up to a daily maximum of $12.00 (City of Charlottesville Virginia, 2020b). The surface lot charges $1.00 per hour and does not give you the first hour free (City of Charlottesville Virginia, 2020b). Once again, these prices could discourage low-income individuals from visiting the Downtown Mall. Additionally, although the Downtown Mall does not have an entry fee, many of the restaurants and stores located there are expensive. In a survey of 75 participants, 64% believe that the restaurants on the Downtown Mall are high-end and 81.3% believe the

Downtown Mall is more suited for people with more money. Furthermore, 68% of participants perceive the Downtown Mall to be inaccessible to people of lower income.

In regards to the design of the roadway system, there are three one-way roads directly connected to the Water Street corridor as well as an additional eleven one-way roads in close proximity to the Downtown Mall. Two of these one-way roads go directly through the Downtown Mall and there are also six locations where bollards prevent traffic from traveling through this area. Figure 4 shows the locations of the one-way roads and bollards. As in the Baltimore case study, these one-way roads and bollards can confuse newcomers and discourage them from coming back.

Figure 4. Locations of one-way roads (arrows) and bollards (circles) in the Downtown Mall and Water Street corridor area. (Created by Dobson, 2020)

In regards to Wittkower's theory of discriminatory technologies, the "One" for this case study includes the upper- and middle- class users of the Downtown Mall that are familiar with

the area. These frequent users would be able to easily navigate the Water Street Corridor and other one-way roads in its proximity. They are also able to afford any transportation costs associated with traveling to the Downtown Mall along with being able to comfortably eat and shop at the restaurants and stores located there. The social values being imposed in this case study include the favoritism of individuals who are able to afford nonessential experiences. Although unintentional, the Downtown Mall is designed to be more suited for people who can easily afford the transportation, restaurants, stores, and other costs. This case study falls into the embodiment technics category of human technics. Embodiment technics is when the user accesses "the world by withdrawing into the user's experience of self" (Wittkower, 2018, p.8). This case study falls into this category due to the fact that the users will most likely assign blame to themselves for not being able to afford the luxury of using the Downtown Mall rather than finding fault with the way the area has been developed.

Case Comparison

Both of the above cases deal with discriminatory designs as not everyone falls into the category of the "One". For the Baltimore study, the "One" includes white, upper- and middle-class individuals. As for the Charlottesville case study, it was found that the "One" only includes upper- and middle- class individuals with no evidence of discrimination on any particular race. However, it cannot be concluded from these results that there is no discrimination against minorities in this area. The discrimination in the Charlottesville case study is completely unintentional as none of the transportation costs, restaurants, stores, one-way roads, and bollards were developed purposefully to discourage low-income individuals from using the Downtown Mall. As for the Baltimore case study, it has a mix of intentional and unintentional

discrimination in that the two communities are affected by historical legislation and the current roadway infrastructure. Additionally, the Baltimore case study falls into the background relations category of human technics while the Charlottesville case study falls into the embodiment technics category. This is mainly due to the fact that users in the first case study interact with the design unaware of its background discrimination while users of the Charlottesville case study design most likely assign blame to themselves for not being able to afford the Downtown Mall rather than finding blame with the design itself.

Discussion

In connection to Winner's theory of technological politics, transportation infrastructure undoubtedly has political consequences. As shown through the two case studies, transportation infrastructure is utilized as a form of order in communities. In Baltimore, historical legislation has been replaced by technologies that influences how the two communities travel and interact. Although the past legislation was inherently political, the current design of one-way streets and bollards act as a form of order by continuing to limit the integration of the two communities. In Charlottesville, the structure of the Downtown Mall and surrounding roads influence who spends their free time in the area. This design inadvertently acts as a form of order by discouraging those of lower income from visiting the Downtown Mall. The political consequences revealed by these two case studies are characteristic of other transportation infrastructure designs that exist across the country.

In connection to Latour's actor network theory, nonhuman transportation infrastructure reflects the human values of its designer. Humans and their technologies both equally play a role in how communities interact. In Baltimore, the clear distinction between Waverly and Guildford

is due to past human created legislation and a current infrastructure system that reflects the social values of those prior times. In Charlottesville, the designers of the Downtown area have unconsciously developed a nonhuman space that perpetuates their biased values against low-income communities. Across the United States, transportation infrastructure designs convey the human values of their designers, impacting the everyday interactions of underprivileged communities.

One limitation of this research is that both case studies that were analyzed in order to come to a conclusion on the transportation infrastructure of the United States are located on the East Coast. It was assumed that these case studies are representative of the entire country and that reasonable conclusions could be made. In regards to the Charlottesville case study, my personal investigation includes a few limitations. The first, and largest limitation, is the validity of the information on *City-Data.com*. This information was extremely useful in the evaluation of the CAT system, but the information received from the site has the possibility of being inaccurate. Additionally, the zones that were used from *City-Data.com* are slightly varied in area, creating a higher probability that a zone with a greater area will have more bus stops. However, it was found that the layout of the bus routes in the CAT system are nondiscriminatory and therefore the limitations of this website do not greatly impact the results of this research. Another limitation of the Charlottesville case study includes the survey conducted on the Downtown Mall. All participants of the survey are current students of the University of Virginia. Therefore, the results of the survey are representative of the perceptions of UVA students and is not inclusive of the perspectives of the Charlottesville locals.

There are a number of ways this research could be improved upon if done differently in the future. As mentioned above, both case studies analyzed are located on the East Coast. In

order to gain a better representation of the United States, transportation infrastructure designs from different parts of the country could be selected instead. In-person interviews could be conducted with local residents of each case study as well. These interviews would provide valuable insight to the perspectives of the people who are affected by these designs on a daily basis. Additionally, each specific case study contains sections that could be improved upon. For the Baltimore case study, other communities in Baltimore could also be explored for the same discriminatory characteristics present in Waverly and Guilford. The presence of these attributes at other locations in Baltimore would strengthen the evidence found in this case study about its historical legislation and current roadway designs. For the Charlottesville case study, additional data could be collected on the race demographics of the Downtown Mall. These could be useful in analyzing whether the Downtown Mall contains discriminatory characteristics toward specific races. In regards to the CAT system, the travel time from particular zones and the bus schedule could be examined as well for discriminatory features. Furthermore, the survey that was conducted could be expanded to include all residents of Charlottesville in order to gain a better understanding on their perspectives of the Downtown Mall.

This research will advance my engineering practice by enabling me to make a conscious effort to design fair and unprejudiced infrastructure post-graduation. The knowledge I have gained through this experience will directly impact how I think about future projects and how I attempt to come up with solutions. I have learned that it is greatly important to keep in consideration the consequences of my future designs as they can directly impact how others interact with the world. It is also my hope that with this newfound knowledge I can inspire others to design with the same amount of awareness.

Conclusion

In regards to the research done in this paper on transportation infrastructure, the next actions include further analysis, increased awareness, and the redesign of the built environment. Further analysis should be done on other case studies across the United States along with the additional examination of transportation infrastructure systems in other developed countries. Through the investigation of other countries, we can potentially learn ways of improving our system and preventing future discrimination. Increased public awareness on this topic would assist in creating unprejudiced designs and advancing society towards equality. The redesign of the built environment would include the demolition and replacement of discriminatory infrastructure.

The inequality amongst all people in transportation infrastructure designs is a single aspect of a much larger societal issue. Low-income and diverse communities face discrimination in almost all aspects of their everyday lives. This lack of fairness and justice within the United States causes these communities to lack equal opportunities, thus putting them at a severe disadvantage. The public must become aware of these discriminatory issues if there is any hope of stripping them from our society. Without awareness, the societal gap between privileged and unprivileged will continue to widen. For example, without the acknowledgement of transportation infrastructure being capable of having discriminatory characteristics, the unconscious designer will continue to create disadvantages for these communities. However, awareness is insufficient without action. Action is how we rid ourselves of the generations of prejudice infrastructure and values that exist in our society. The next political actions required to create equality between transportation infrastructure designs might not ever be complete in the

United States. However, it is the progression towards this goal that is essential for the continuous progression towards absolute societal equality.

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