

# **The Role of Sociocultural Values in Parking Lot Design and Administration**

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## **Abstract**

This work uses the mediation theory of technology to investigate the sociocultural and ethical implications of parking design and management. Several case studies are analyzed and implications for effective and ethical parking lot design are discussed.

# **The Role of Sociocultural Values in Parking Lot Design and Administration**

## **Introduction**

The automobile is one of the greatest technological feats of the modern era and has exerted an unparalleled influence on the development of commerce, culture, and lifestyle. The automobile has cemented itself in the modern American culture as a status symbol and a national pastime. Despite the significance of driving, any given car spends about 95% of its lifetime parked (Nourinejad et al., 2018). Parking is a very profitable and important industry in the United States, comprising up to 1% of the US GDP according to a report from the National Parking Association (2020). With \$131B in revenue per year, the parking industry has a total economic output of \$262B per annum and supports 1.3M jobs nationwide (NPA, 2020). Prior works have demonstrated parking lots are critical to the American way of life as they support the 240 million passenger vehicles owned in the United States; as such they take up 0.7% of the landmass of the continental US (Chester et al., 2011).

Parking lots can serve as more than a mere utility however, they also serve as social confluence points where people with similar interests meet, exchange ideas, and develop a culture (Neely & Marone, 2016). This can be seen in the parking lot subcultures found at sporting tailgates and outside of the concerts of jam bands such as Phish, The Grateful Dead, and Widespread Panic. What the current literature fails to address, however, is the significant interactions that occur between humans and technology in parking lots.

In this thesis, I seek to analyze several case studies of parking design and administration using a sociotechnical framework of technological-human interaction in order to identify how parking lots and associated technologies mediate relationships between the users and the world.

These findings can inform decisions concerning parking design and allow those who make these decisions to better meet the needs of their users and society.

## **Literature Review**

The existing literature addresses several topics regarding parking lots. Chief among these are environmental effects, economic effects, and social effects. A majority of the scholarly work is comprised of observational case studies, likely due to the prohibitive cost and scale of constructing experimental parking lots as well as the need to observe natural user behavior. Kent Robertson (2007) approaches the issue of user experience of downtown parking from the perspective of psychology but he does not examine the ethical ramifications of these relationships. Besides this, authors typically fail to discuss on how a parking designer's choices affect users' experience and relationship with the world from an ethical perspective.

There is no dearth of research concerning the environmental effects of paved parking lots and roads. Asaeda et al. performed a study on the impact of asphalt parking lots on the urban environment and finds that the replacement of soil with asphalt reduces the permeability of the area and traps heat due to the asphalt's higher thermal mass (Asaeda, Ca, & Wake, 1996). Davis et al. reach a similar conclusion in their quantitative analysis of parking lot ground cover (Davis, Pijanowski, Robinson, & Engel, 2010). McPherson discusses how practical San Francisco's tree shading ordinance was in reducing local atmospheric heating (McPherson, 2001). Rushton elaborates on good design principles for environmentally conscious parking lots and shows the effectiveness of these applications by reporting on a Florida case study (Rushton, 2001).

From a social perspective, user-parking lot interaction consists of everyday encounters with the decisions that designers and administrators make for their parking lots. Douissembekov

et al. investigate the difficulties that the elderly face when using parking lots (Douissebekov, Gabaude, Rogé, Navarro, & Michael, 2014). Lu et al. (2014) describe the reform of a handicapped-only permit parking system in Japan and survey users on their experiences with the new system. The reform expanded eligibility and allowed pregnant mothers and temporarily injured people to use the permit-only parking spaces. While the change did reduce unoccupancy of handicapped parking spaces, wheelchair-bound and permanently disabled users reported that they were often unable to find available handicapped spaces (Lu, Vandebona, & Kiyota, 2014). There are major differences between the cultures of Japan and America, so Lu's findings may not translate to an American context. Snider seeks to illuminate how perceptions of public parking among users affect beach visitation and draws management principles from their findings (Snider, Luo, Hill, & Herstine, 2015). Likewise, Sultana uses interview results with college students to draw conclusions on incentives regarding parking permits (Sultana, 2015). Interview-based studies are vulnerable to selection bias, so their results may not be representative of the whole population if the interviews were voluntary. Furthermore, the only demographic studied is North Carolina college students and they do not address the fact that any takeaways can not necessarily be generalized nationally. Snider's research suffers from the same limitations: it is a demographic study of North Carolina beach goers and may not be applicable to the general public.

Economically, van der Waerden provides another case study on Dutch grocery stores and user preferences based on parking lot layout (van der Waerden, Borgers, & Timme, 1998). This study is a field observation, so the results are beholden to many confounding factors such as different national ethics and incentives which are not universal. Additionally, there is no control group which would provide more than a mere snapshot of usage patterns. Robertson's report

provides advice for city planners seeking to revitalize their commercial economy by prioritizing city parking and understanding what users value (Robertson, 2007). Robertson's conclusions are seemingly taken from his own observations and experience, which are possibly influenced by his own values and considerations. This does not make it useless, however, as this information and perspective is valuable.

All this literature provides helpful insight of users' values and priorities. What is lacking, however, is a synthesis of technology-human interactions which reflect how relationships with technology are affected by users' and proprietors' values.

### **STS Framework**

This work seeks to provide that synthesis by analyzing the ethics of parking lot design using the mediation theory of technology. Don Norman asserts in *The Design of Everyday Things* that nearly any technological accident which can be attributed to human error is in reality a result of inadequate design due to the designer's failure to understand how humans relate with and use technology (Norman, 2013). The goal of this work then is to help designers prevent error and accidents by investigating the anthropotechnical relationships in parking lots. Mediation theory serves as a sufficient framework through which to analyze interactions between humans and technology. It is appropriate for such ethical analysis as its scope includes any technological phenomena or relationships which affect humans and could therefore be significant in the sphere of engineering ethics.

Mediation theory portrays technology as a hybrid phenomenon rather than an extension of the user: strictly a tool, dialectic to the user and independently wielding its own oppositional force. Hybridity acknowledges the nebulous intertwined roles of the user and the technology and

offers a more nuanced approach to conceptualizing technological-human relations. Rather than giving unidirectional control or agency to humans or technologies, hybridity emphasizes the back-and-forth influence between users and machines. The human forms and designs the machine or device which then in turn informs the user's perceptions and extends his or her capabilities. In this sense, technologies mediate the interaction between humans and their actions, practices, and perceptions.

There are several interactional relationships within mediation theory: embodiment, in which the technology unites with the user to direct toward the external world, hermeneutic, where technologies unite with the world to influence or inform the user, alterity, forming the background of human-technological interactions, and background, which form a context for human life. Within these relations there are several natures of interaction between humans and technology. These are physical, cognitive, infrastructural, and cognitive-contextual. Physical interactions are self-explanatory; the technology has bodily interaction with the user. Cognitive is a more informational transaction which changes the user's interpretation. Infrastructural is a more subtle material interaction that affects experiences and actions of the user.

Motor vehicles are very dangerous due to the fallibility of their human drivers coupled with the size and power of the vehicles; therefore, unforeseen behaviors are a major liability. Engineers who desire to ethically create a parking solution must first exhaustively consider the tendencies and shortcomings of their users and environment using the framework of mediation theory.

## **Data Analysis**

There are multiple ethical aspects and ramifications of parking design and administration. Since parking is so critical to our society to facilitate commuting, retail, civic participation, and one's everyday life, an ethical parking system or design is non-exclusive and non-discriminatory so as to allow all peoples and businesses to participate in civic life and systems. The parking technology will accommodate all users by interacting equitably with them and by assisting those with handicaps or disabilities through an alterity relationship with the user and their vehicle. Likewise, an ethical system or design will not have an excessively harmful impact on the environment and will facilitate sustainable and renewable technologies by accommodating efficient cars and electric vehicles. In this way, the technology will not be destructive to humans, but will produce a neutral background interaction with the environment. Finally, an ethical parking lot design will promote safety and include measures to prevent injury to its users through effective signifiers and mediation between the active parties. With respect to mediation theory, parking lots serve as a hybrid technology: neither an extension of the user, nor in opposition to him or her. Users seemingly have a background relationship with the parking lot; the parking lot facilitates use of the vehicle to allow the user to accomplish their goal of transportation.

Parking lots pose a threat to the environmental safety of the areas in which they are constructed. When a parking lot is constructed, it displaces local vegetation and soil, which prevent erosion and water runoff respectively, with a man-made structure comprised of hydrocarbon-based asphalt. Impermeability of the paved surface also inhibits evapotranspirative cooling of the surface; this results in localized heating of the adjacent air and hence the creation of microclimates. Runoff is a result of asphalt displacing natural grasses and erosion barriers (Asaeda, Ca, & Wake, 1996). There are options to mitigate these environmental harms, however. A relevant case study is The Florida Aquarium in Tampa who renovated their 11.25-acre parking



lot with several different experimental designs intended to limit the runoff of sediment and pollutants (Rushton, 2001). The lot was comprised of three different paving materials and some runoff basins with swales, sloped water-permeable areas designed to limit runoff. Wastewater samples revealed 45% less runoff and far less contamination from the portion of the parking lot with permeable paving materials and swales than from conventional paving techniques (Rushton, 2001). These water management techniques are more impactful in the climate of Florida due to the consistently high level of rainfall recorded there but the benefits conferred will be applicable anywhere there is rain. The swales as a technological artifact mediate the background experience of all users and non-users by influencing the surrounding environment. Examining the mediation between parking lots and the environment reveals a unique relationship; parking lots as a general technology exert an invisible but powerful force on all people near them who involuntarily become users of the technology. The environmental effects of runoff and localized atmospheric heating are negative effects dialectic to the users both local and global. McPherson et al. investigated the effects of a Sacramento parking ordinance that requires a certain proportion of parking lots to be shaded by trees. This was first proposed to reduce the heat-island effect in the city. He notes that the directive of the ordinance has been followed haphazardly, with little compliance due to poor planning and outcomes. Had the 50% tree shade ordinance been followed, the value saved due to reduced air conditioning costs would have been as high as \$2.5 million per year (McPherson, 2001). Another cause of noncompliance is the expense of planting and maintaining trees, a cost that the lot owners have to absorb. Their relationship with the parking technology seems to be a mediation of embodiment since the parking lot facilitates their goal of making profit from the users of the technology. Asaeda et al. have demonstrated that asphalt parking spaces cause substantial atmospheric heating compared to concrete or a

permeable surface that allows for evaporative cooling (Asaeda, Ca, & Wake, 1996). Despite this fact, damaging asphalt parking lots are still commonplace due to their ease of installation and inexpensive maintenance. Within the mediation theory framework, the parking lot designers must consider the actions that could be taken by a human (or nonhuman) user, and respond accordingly with factors which mitigate the unsafe actions users may attempt to take, allow all users to effectively use the parking lot, and consider the role of the preexisting ecosystem before the lot is constructed. An environmentally friendly parking surface technology exerts an invisible but explicit influence on the infrastructural context of the parking lot's users, and even of those who do not use the parking lot but reside nearby.

The mediatory agency of the parking lot technology is in large part determined by the city policymakers who seek to benefit their constituency, both civil and corporate, through visible forceful interaction through cognitive contextual contact. Third parties such as governments or regulating bodies participate in an embodiment relation with the technology where their objective is to serve the interests and safety of the public. Government regulation of parking is essential to constructing inclusive, well-lit, environmentally-friendly, safe parking areas (Code of Ordinances of the City of Richmond, Virginia, 2020). Local ordinances effectively consider user behavior and use specifications such as maximum lot capacity as a function of occupancy of the building, lighting regulations, and water drainage capacity and configuration to mediate the user's interaction with their surroundings and with other cars. Widespread lighting mediates vision for pedestrians and for drivers in a hermeneutic relationship: the lights allow the driver or pedestrian to obtain previously obfuscated information and to perceive where other drivers, pedestrians, obstacles, or road markings are. Signage and markings serve as a more subtle suggestive instrument of mediation while more concrete

technologies such as barriers, curbs, poles, and gates mediate the user interaction more forcefully. This is the correct approach: the significance of user safety demands forceful influence and sometimes an even dialectic approach. The aforementioned Florida parking lot case is a great example of this, they reinforce their visible suggestive parking space markings with the forceful mediation of a parking curb which makes it physically difficult to drive off of the edge (Rushton, 2001). This demonstrates careful consideration of human behavior and acknowledgement of the fallibility of people.

Enthusiasm for electric vehicle (EV) adoption has been tempered by range anxiety: a phenomenon caused by the lack of availability of electric vehicle charging locations. Some businesses have tried to attract wealthy electric-vehicle drivers as customers by offering charging stations for electric vehicles in their parking lots, but frequently these charging stations are placed in corners, limiting the usability of the stations. Additional issues include traditional combustion vehicles parking in these EV-only spots, or users returning to their car to find it unplugged by another user (Bonges & Lusk, 2016). Bonges (2016) suggests placing these chargers in less valuable spots to disincentivize occupation of these spots by traditional vehicles. This is a perfect example of an invisible suggestive influence affecting EV users in an infrastructural context. Implicitly, the presence of these charging stations encourages use of electric vehicle technologies by removing barriers to adoption. On the other hand, a measure preventing combustion engine vehicles from parking in EV spots is a powerful visible force, explicitly but non-corporeally preventing this behavior. If these principles are followed, then adoption of EV's might become more widespread which would benefit the environment significantly by reducing societal reliance of non-renewable and dirty fossil fuels. In this way,

the EV charging technologies serve as a background mediating force between the environment and the modern human population.

Parking lot designers are looking ahead to the future of autonomous vehicles in order to make parking systems more efficient and effective. Nourinejad et al. introduce an automatic parking scheme for self-driving vehicles that minimizes space consumed while maximizing how quickly and efficiently a vehicle can be retrieved (Nourinejad, Bahrami, & Roorda, 2018). When cars can drive themselves, parking lots are no longer limited to a two-column format. With human drivers, cars cannot block other cars when they park because then one user would be parked in and stuck until the other driver returns and leaves. But if cars can drive themselves, then they can more densely pack and rearrange themselves as needed. This technology would fundamentally change how humans interact with parking lots. Their car would, along with other's cars nearby, form an extension of the parking lot technology; humans would suddenly have a passive relationship with the car and parking lot, and our relationships with one another would change as well. Gone will be the days when parking lots serve as points of sociocultural confluence (Neely & Marone, 2016). The competitive aspect of parking will disappear as well, however, and we will see the limitation of available parking cease to be a mediating factor between customers and businesses. Kent Robertson's report titled "The Psychology of Downtown Parking" demonstrates that companies' main considerations when developing parking include appeal to users, based either on convenience or aesthetics, efficient land use to reduce the amount of expensive urban real estate needed, cost-effectiveness through the installation of durable and low maintenance parking lots, and layouts which maximize the number of establishments a user may see (Robertson, 2007). Over-construction of parking lots, which serves as a burden on the economy, is due to drivers' false perceptions of parking as

scarce (Chester, Horvath, & Madanat, 2011) (Snider, Luo, Hill, & Herstine, 2015). In an average Midwestern city, parking lots take up 6.5% of urban space and there are 2.2 spaces for each registered vehicle in the county (Davis, Pijanowski, Robinson, & Engel, 2010). Such inefficient usage of space is a challenge that requires unique solutions. Tysons Corner Center is a major retail mall and outlet located in Tysons Corner, Virginia. The parking garage has a clever system which uses sensors for each space and lights hanging above each space to signal whether it is available for parking. This is a visible hermeneutic relationship which informs users and allows them to find parking spaces without frustrating guesswork, and it allows users to use space more efficiently.

This technology of self-managing parking lots will also serve to mediate more equitable experiences for the elderly and disabled, who find difficulty in parking and walking through parking lots (Douissembekov, Gabaude, Rogé, Navarro, & Michael, 2014). When surveyed, most wheelchair users said that parking conditions became worse or stayed the same while users with mobility aids such as crutches generally felt that the system became better after the new more inclusive handicapped parking program began (Lu, Vandebona, & Kiyota, 2014). The permit system is an explicit suggestive influence with fine-based reinforcement to restrict who can park in a handicapped spot. Responsible mediation involves making parking lots more accessible so that the technology can successfully mediate a handicapped user's interaction with their vehicle and with the business at which they are parking. In this instance, those who designed the permit system failed to consider the effects of the change on those who need the handicapped parking the most. If self-parking cars become a widespread technology, the visible, infrastructural suggestive system of handicapped parking permits will cease to be, which is a good thing. No longer are the disabled and elderly subject to the whims of social norms

regarding illegally parking in handicapped spots, likewise those who are not disabled are no longer subject to the inefficiency of unused handicapped parking spaces. The self-managing parking lot will hold an invisible alterity relationship with its users.

Sultana's research sheds light on the values of college students with respect to parking. She investigated the parking habits of students at the University of North Carolina and found that most students who purchased parking passes did so to meet their mobility needs as habitual car users and because they felt unsafe walking home in the dark after class (Sultana, 2015). This explains the fact that a disproportionately higher number of women than men purchased parking permits. Convenience was a far bigger factor than cost savings for these students. This is evidenced by the strong correlation between students who had a car before college and those who purchased parking permits. Students who live on campus were more likely to have a parking permit than those who lived 5-10 miles from campus because a student who lives on campus must have a parking permit if they want to keep their car with them at college. Another study finds that the size of a parking lot correlates negatively with the likelihood of a consumer using that store (van der Waerden, Borgers, & Timme, 1998). This is because larger parking lots necessitate a further walk to and from the store. This finding clearly reflects that the consumer seeks convenience above all else when choosing where to park and shop. This is an example of implicative interaction where users are influenced by factors, in this case the cost of parking and size of the parking lot, which dictate their usage or relationship with the parking lot. The parking lot's layout plays a role in mediating the experience of the user of the business where they are driving. Proper layout mediates orderly and safe ingress and egress, with strategic placement of parking spaces to ensure that distance is not a hinderance to the user.

## **Conclusion**

Parking is an important technology in modern America, and one which strongly affects interactions between people, businesses, and technologies. Using mediation theory, this work has found that the mediations performed by parking technologies are largely hermeneutic in the background, forming a context for perception and transportation. Effective parking lot designs prioritize user safety above all else and provide redundancy through multiple levels of mediation ranging from suggestive to forceful. Effective parking lot designs seek inclusivity by considering the needs of those who are less able than the average population, and then catering to those needs to mediate with equity. Effective designers consider not only the immediate context of the mediation, but see the larger background effects of their work on the environment and on the surrounding urban area. Mediation theory will be necessary as self-driving and self-parking cars fundamentally rewrite how users interact with their cars and with parking.

Mediation theory helps designers to view parking technologies as facilitating a relationship between the user and their surroundings. This necessitates consideration of the user primarily and helps to design more effective parking lots in order to benefit society as a whole. This research helps each actor to consider the implications of their goal as well as those of other actors and therefore to make more balanced and effective decisions in the design of the parking infrastructure by analyzing parking as an intermediate hybrid technology using the framework of mediation theory.

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