

The Ambiguity of Cycling and Urban Design

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1 INTRODUCTION: ALIGNING CYCLING AND URBAN DESIGN

The term “urban design” has been a source of ambiguity among researchers focusing on cycling for a few decades now. Although commonly alluded to, urban design often lacks a precise definition in relation to cycling, and when used to describe cycling, is often referred to in conjunction with other ideas, such as planning, transport, and land-use. For example, a Google Scholar search for the term “urban design cycling” lists a mix of various sources, including literature like “Environmental Correlates of Walking and Cycling: Findings from the transportation, urban design, and planning literatures” (Saelens et al., 2003), which provides an overview of transportation literature and little to none on urban design. This reflects the general state of cycling research, and Krizek et al. (2011) attests that that cycling has been viewed primarily in functional terms in relation to urban design, and that comparatively less research has been done on the aesthetic and experiential aspects of cycling. They also articulate the gap between the urban designer’s social and experiential focus on the pedestrian realm, such as sidewalks and plazas, and the traffic engineer’s operational focus of flow and speed in the motor vehicle realm of highways and intersections (Forsyth and Krizek, 2011; Hamilton-Baillie, 2004). However, this raises questions on the ambiguous role of urban design within the domain of cycling, and how urban design methods and processes can be used to address problems related to cycling and space. Furthermore, it must be understood why these problems fall specifically within the realm of the urban design discipline, as opposed to the expertise of urban planners, traffic engineers, or many of the other disciplines that also engage with cycling. In particular, this paper investigates the role and opportunity for urban design to expand the qualitative approach for framing the relationship between cycling, mobility, and space. Working on the assumption that

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the domain of cycling can benefit from a comprehensive overview of the various fields of literature it draws from, including urban planning, transport, mobilities, and public health, this paper is a critical evaluation of existing literatures and the role urban design can play here.

The first part of this paper introduces modern urban design as an interdisciplinary field, and articulates how urban design is distinct from the disciplines of urban planning and traffic engineering in how they study mobility and transport. Given the close ties of the urban design and urban planning disciplines, there is a tendency for researchers to refer to the two disciplines collectively, reflecting the ambiguous line between what is urban design and what is planning (Steino, 2004). Yet, there is value in defining each discipline separately, and Moudon (1992, p. 331) argues that the emergence of the urban discipline in the 1960s was “born out of a search for quality in urban form... focused on urban environments that have both functional and aesthetic appeal to those who inhabit them.” Hence, the urban design approach is one that prioritizes the aesthetic qualities of urban space while accommodating the functional requirements of cycling.

The second part of this paper surveys the academic literature on cycling and places the research into three frameworks: functional, social, and experiential. These frameworks have been developed from a literature review of the landscape of the literature on cycling, and these three frameworks will be used in this paper as approaches to understand cycling, mobility, and space. The importance of each approach has dominated and receded as the role of urban designers have evolved in relation to other disciplines that are also concerned with urban space and mobility, including public health (Freestone and Wheeler, 2015), traffic engineering (Dumbaugh and Rae, 2009), urban sociology (Jacobs, 1961), environmental psychology (Lynch, 1960) and mobilities studies (Sheller and Urry, 2006).

Finally, this paper concludes by outlining the relationship between urban design and the other disciplines that also study cycling. If urban planning is positioned as the more technical and quantitative of the two disciplines, then the role of urban designer may be to uncover the social, aesthetic and experiential aspects of cycling, in line with the urban designer’s particular interest of the experience of space in general. Insofar that urban design is recognized as an independent discipline and that researchers use the term “urban design” to refer to a body of ideas, it is useful to carve out space for the academic study of cycling in relation to urban design, or, alternatively, to establish the urban designers’ interdisciplinary role in facilitating the synthesis of knowledge from many disciplines.

Modern conceptions of the relationship between cycling, mobility, and space is often a combination of historical ideas, and some of these ideas have branched into their own disciplines. To understand how cycling is positioned in the context of urban design, this paper demonstrates a progression of mobility and spatial frameworks that has resulted in our current understanding of the relationship between cycling and urban design. The goal of this paper is to use these frameworks to form an interdisciplinary conceptualization of the current academic discourse on the relationship between cycling and the built environment through a literature review. By examining these ideas using the functional, social, and experiential frameworks, the contributions of various disciplines can be incorporated into urban design thinking.

2 METHODOLOGY

This paper uses cycling and urban design literatures to identify overlaps and gaps in current research about cycling, mobility, and space. The goals of this literature review is twofold: (a) to establish the nature, methodology, and central problems of the contemporary urban design discipline and the opportunities for urban design to contribute to cycling research, and (b) to provide an overview of the research on cycling from various disciplines to arrive at an appropriate framework to perform a synthesis of cycling research into the urban design discipline.

To ascertain an overview of the state of the cycling literature, a broad search for topics relating to cycling and the built environment was conducted using Google Scholar to identify the disciplines currently studying cycling and the built environment. The most important attributes for locating sources were: year of publication, number of citations, and references to urban design literature. The literature search found that urban design often lacks a precise definition in relation to cycling. When used to describe cycling, urban design is often referred to in conjunction with other disciplines, such as planning, transport, and land-use. The focus on the functional aspects of cycling in the context of urban design has also been noticed by Forsyth and Krizek (2011) in their literature reviews.

The literature review then focused on articles that explicitly focused on non-functional aspects of cycling and models about how these non-functional aspects relate to the built environment. Through this process, fifty-one articles were reviewed and the disciplinary affiliations of its authors were identified. These articles were then tagged with keywords of their main content. The frameworks and models contained within these papers were compiled and summarized, and grouped into the disciplines of urban design, urban planning, engineering, transportation, public health, and mobility studies. These frameworks provided the basis for organizing this article. The key consideration for selecting a final framework for this article was its ability to accommodate interdisciplinary processes that are used to study cycling in urban design. To arrive at the three frameworks used for this paper, the functional aspects of cycling as most commonly studied by researchers was found to be juxtaposed against the aesthetic and experiential aspects of the environment (Forsyth and Krizek, 2011; Latham and Wood, 2015). In addition, this review also adds the social framework that seeks to capture a major area of research that is missing from the functional-experiential juxtaposition. These include the how people view cycling in the context of their social environment (Daley and Rissel, 2011) and how cycling fits in with the public health goals of society (Saelens et al., 2003). Together, the review of the cycling literature across many disciplines created the functional, social, and experiential frameworks that will be used to examine cycling in relationship to urban design.

3 INTERDISCIPLINARITY AND NORMATIVITY IN URBAN DESIGN

Since the establishment of urban design in the 1960s, urban design has drawn methods and ideas from other disciplines, and is characterized by Steino (2004) as “motley body of ideas”, or what Carmona (Carmona, 2014) regards as a “mongrel discipline”. Within its recent past urban design has inherently been an integrative discipline that draws from other fields of study. To support the core theories of urban design, Steino

argues that, “the viability of any normative theory of urban design in practice depends on its ability to relate to other rationales” (Steino, 2004). Hence, approaching cycling from the urban design perspective requires a framework for either integrating knowledge from other disciplines into the field of urban design or for creating knowledge that is specific to the field of urban design. Carmona (2014) outlines a few options for moving the urban design discipline forward. In the paper, “The Place-shaping Continuum: A Theory of Urban Design Process”, Carmona observes that the urban design discipline can be conceived in two ways:

First, as a focused amalgam of core knowledge and practice pragmatically drawn from other fields, both professional and intellectual.

Second, as a distinct and evolving field that has added to, worked over and given new meaning to this borrowed knowledge and practice through [...] fashioning it together into a singular and tolerably coherent field of knowledge [or...] the generation of new knowledge around what is unique about the subject and practices of urban design. (Carmona, 2014)

Implicit in drawing knowledge from other fields is to also integrate and make the various pockets of knowledge coherent and connected to create a whole body of knowledge that is greater than the sum of its parts. Khan et al. (2014) contrasts the relatively fragmented multi-disciplinary approach of “contracting out of services”, to the interdisciplinary and transdisciplinary integration of knowledge as envisioned by urban design:

It is in interdisciplinary work that the participants cross their ‘own’ epistemic boundaries, to co-produce new concepts and methods. [...] Alternatively,] transdisciplinarity involves the members of different scientific and practice fields working together over a long period of time, which creates the possibility of producing an overarching synthesis that goes beyond any single framework. (Khan et al., 2014, p. 399)

Currently, the urban design discipline is criticized for its absence of a positive methodology to support the normative values of the discipline. Normative theories of urban design project visions of the good city, and most urban design theories rank the importance of various aspects of the city. In contrast to the focus on aesthetics in relation to mobility, the mid-nineteenth century gave rise to a functionalist view of cities and public space. This view can be seen in the field of urban planning and transportation forecasting, starting with the four-step traffic model has been used since the 1950s and remains in use in some places today (McNally, 2008). The functionalist view of the relationship between mobility and space reduces travel as a necessary cost of moving two points in space (Sheller and Urry, 2006). However, reducing mobility to this functional problem also implicitly removes the aesthetic and social considerations that is urban designers. The effect of this functional view of mobility is to remove considerations of travel experience, and to reduce the journey to two dominant measurements: time and cost.

To counter this functional view of transport literature in general, and cycling in particular, the most important value of urban design as a discipline is its normative arguments in defining what a good city is. One

insight from urban designers is to balance the needs mobility to serve the good city, rather than designing cities around the needs of transport modes (Bertolini, 2012). Urban design in particular has a rich history of normative theories that have influenced cities of the past century. Steino remarks,

Normative theories of urban design generally take a critical stance towards the status quo. Thus, the societal theories of urban design are critical towards the existing society, envisaging new concepts for society and its organization in space. (Steino, 2004)

One role of urban designers could be to prescribe the normative values and visions of cycling and mobility in cities but to leave the technical expertise of construction with the engineers. This division of labour is a viable arrangement, as long as the normative-positive division holds true. However, as the technical disciplines have dominated the academic study of cycling, the functional approach have also encroached into the normative aspects of cycling, and dominated the study of transport and mobility in general (Spinney, 2009). The distinction between the positive and normative aspects of cycling is important in itself because the idealistic visions for cycling's role in the good city not cannot be established merely through positive methodology alone, but rather, it must be developed from a normative stance. If, for example, cycling is portrayed as a value-free domain of transport engineers, then the connection between cycling and the good city can be lost, giving way to a mechanistic focus on speed, movement, and transport efficiency.

After locating the core knowledge relating to cycling in urban design, the goal of urban design could be the creation of interdisciplinary and transdisciplinary integration of the diverse range of knowledge on cycling that exists today. This process provides new scaffolding for normative theories of urban design to be supported by positive methods from other disciplines. Hence, the lack of core knowledge and the ambiguity of the word "urban design" is an opportunity for integrative research. In relation to cycling, the task is two-fold. First, to catalogue areas of cycling knowledge that can be properly classified as within the urban design domain. The overview of various disciplines later in this paper is an attempt at constructing the "amalgam of core knowledge" (Carmona, 2014). Second, to coherently tie together bodies of multi-disciplinary cycling knowledge and to facilitate the collaboration of various disciplines.

4 THREE FRAMEWORKS FOR UNDERSTANDING CYCLING, MOBILITY, AND SPACE

Moving towards defining urban design as an interdisciplinary and normative field of cycling research requires a framework that brings together knowledge from other disciplines. So far, researchers have developed models for integrating various factors contributing to people's decision to cycle (Saelens et al., 2003; Wang et al., 2016). However, existing models do not bring diverse disciplines and their respective methodologies together to support normative arguments about how cycling can be a field of integrative and interdisciplinary work. For example, while technical studies may be innovative in inventing safer intersections layouts and smoother bicycle paths, these individual improvements should be positioned in relation to research on social issues of culture, health, and social norms. Yet, it may be in an entirely different framework under which these

two seemingly disparate fields of study may be connected. One example is to use the experiential framework to demonstrate that factors such as physical fitness and the skill level of the cyclist may affect both individual social perception of cycling (social) as well as their ability to comfortably use certain types of physical infrastructure (functional). This section identifies the functional, social, and experiential approaches of analysing cycling to provide frameworks under which various disciplines may interact.

These conceptualizations range from: 1) the engineering and planning perspectives associated with the functional framework, in measuring the speed, direction, and flow of traffic and understanding the relationship between land use, mobility, and accessibility (Botma and Papendrecht, 1991; Heinen et al., 2010); 2) the public health and urban sociology perspective associated with the social framework, in considering mobility and urban form in relation to social connection, physical exercise and active healthy lifestyles (Wang et al., 2016); and 3) the mobilities and environmental psychology perspective associated with the experiential framework, in studying the sensation and legibility of the environment from the perspective of the cyclist (Jones, 2012). Using the perspectives provided by various disciplines, this section will review the main ideas associated with the functional, social, and experiential frameworks as they relate to cycling.

4.1 THE FUNCTIONAL FRAMEWORK

From the modern urban planning perspective, a functional line of thought can be drawn between cycling and the built environment through quantitative land use and activity variables (Bertolini, 2012). The functional framework pursues the positive aspects of logistics in terms of movement, speed, and flow while seeking to minimize the negative impacts of congestion, collisions, and delays. To identify functional relationships, studies have been conducted to assess the correlation between built environment variables, such as trip distance, bike lanes, crash risk and bike parking, and people's willingness to cycle (Heinen et al., 2010; Wang et al., 2016; Winters et al., 2011). The genesis of the functional framework can be traced back to the works of Le Corbusier, Robert Moses and the post-war idea of master planning. In this era, the goal of town planning went beyond establishing the physical location, form, and layout of land uses and buildings, and extended to the ideals of detailed master design of entire communities (N. Taylor, 1998). Although this functional conception of the city over the last decades has been ceded to engineers and urban planners through the division of public space into the traffic and design realms, the hybrid nature of cycling has challenged urban designers to integrate the needs of mobility with those of place-making (Hamilton-Baillie, 2004).

The traffic engineering discipline is most usually associated with the functional study of the bicycle in relationship to the built environment, viewing the bicycle as a physical element of traffic. Taylor and Davis (1999) summarizes the functional aspects of infrastructure design undertaken by their paper "Review of Basic Research Bicycle Traffic Science, Traffic Operations, and Facility Design". As reviewed by this article, basic research in engineering relates to factors such as intersection control, pavement surfacing, acceleration characteristics, and cyclist reaction time, to name a few. The dominant methods for this line of research are naturalistic observational methods using traffic counts, computer simulation, and mechanical measurements such as size, speed and energy. In relation to urban design, these studies make explicit the physical parameters

of the bicycle, and that the human-bicycle system has have limited capabilities. For urban designers, these limits serve to define the minimum necessary, but not sufficient, conditions for designing cycling-oriented spaces.

Travel demand is a topic that concerns both engineers and urban planners. In a mechanistic paradigm, people are assumed to travel in order to go to a destination. The total distance that people travel depend on the frequency of the trips and the destination of those trips. Relative cost and travel time are the usual measurements of behaviour in this model, but incorporating the idea of generalized travel cost without identifying its components results in a highly simplified idea of why people travel (Wee et al., 2013). The financial costs are conceived as the costs of gasoline, bus fares, road tolls and parking meters. Time costs are conceived as the missed opportunity of doing the next best thing as each minute of travel is reduced. This way of thinking implicitly values shorter time and greater speed. However, conventional models of travel demand do not explicitly consider the quality of the journey itself, even though an attractive urban environment is especially important to enticing active modes such as walking and cycling (Spinney, 2009).

A related component to travel demand is the mode choice of how people choose to travel. In order for people to choose to travel by bicycle, the bicycle must, on the whole, be advantageous compared to other methods of travel. Mode choice is related to travel demand as a percentage of total travel by bicycle. Mode choice can be influenced by trip characteristics such as trip distance (a function of land use), travel costs, cycling facilities, and other variables that are listed in detail by Hunt and Abraham (2007). However, choosing the bicycle for travel is also largely dependent of many factors are unrelated to trip characteristics, such as attitudes towards cycling and socio-demographic characteristics (Fernández-Heredia et al., 2014).

Land use factors such as density and use is recognized to have as having a large influence on cycling. However, land use is different from travel demand (when and if to travel) and mode choice (how to travel) in that the resulting land use patterns in cities is not the result of individual choice. On a trip by trip basis, a person may choose to travel down the street or to another city, or a person may choose to travel by car or by bicycle. However, living location and land use is constant over a longer period of time compared to choosing the method of travel (Wee et al., 2013). Therefore, land use is seen in combination with social measurements such as income and age as an overall factor in affecting people's travel demand and mode choice decisions.

The functional framework ties together engineering research on the physical characteristics of cycling and the infrastructural needs of the cyclist with urban planning research on the relationship between travel choice, and land-use variables. For urban designers, the functional framework provides a wealth of quantitative studies that demonstrate a variety of ways in which cycling is related to the built environment, both as a physical object in the environment and as a transport alternative to other modes of travel such as automobiles, transit, and walking.

4.2 THE SOCIAL FRAMEWORK

The social framework is one of the earliest frameworks employed by urban designers with strong historical roots. Shaped by thinkers and designers, such as Jane Jacobs and Jan Gehl for example, the recognition of social dimensions of cycling has pushed urban planners and designers to extend their studies to the social factors that affect cycling. Gender, age, and cultural background have all been shown to affect

people's willingness to cycle (Harms et al., 2014; Pucher and Buehler, 2008). The idea that mobility is shaped by society is revealed in the history of cycling itself, having initially been viewed as a leisure activity of the wealthy and upper class with the introduction of the penny farthing. Only at the turn of the twentieth century, with the invention of the safety bicycle that was affordable to the masses, did cycling become a common transport tool (Shove, 2012). This social concern with cycling extends to the present line of research, where cycling can be viewed as a highly politicised practice, with its own culture and subcultures (Spinney, 2009). Recently, there has been a notable increase in studies of the relationship between active mobility, physical exercise, and healthy neighbourhoods from the public health perspective (Dill, 2017).

Active modes of travel, such as walking and cycling has been the attention of public health professionals as a routine way to integrate more physical activity into everyday life. In recent decades, the academic study of public health and active transport has borrowed heavily from the methods used by traffic engineers and urban planners in creating quantitative analysis of the relationship between bicycle use and the built environment. (Saelens et al., 2003). The implications is that if land use can be demonstrated to affect cycling, then land-use policies should be able to affect public health through more travel-related physical activity. Public health studies have explicitly emphasized this relationship between policy and rates of bicycle use, both in terms of reducing death and injury from collisions and the positive health effects of increased physical activity due to cycling (Pucher and Dijkstra, 2003).

Social perceptions about the image of cyclists and peer groups associated with cycling also affect people's willingness to cycle. Is cycling a sport or a transport activity? Are cyclists viewed as law breaking? Daley and Rissel (2011) examine these questions and conclude that improving the social perception of cycling and cyclists has a large role to play in promoting cycling as a mainstream activity. Hence, the decision to cycle is not only influenced by the built environment, but also by the images of what cycling represents (Daley and Rissel, 2011). For example, in a survey of adults in a Flanders, a Dutch speaking part of Belgium, researchers found that social support played a more important role than environmental variables to encourage cycling. The results seem to suggest that given adequate cycling infrastructure, it is important for people to have friends and family who also support cycling (de Geus et al., 2008). Similar findings supporting the importance of social support in cycling was also found in study of a Portuguese population (De Bourdeaudhuij et al., 2005).

Measuring the social costs and benefits, as opposed to the individual costs and benefits of cycling, includes how users benefit from cycling as well as how cycling affects others in society. Two main approaches have been taken by researchers to understand the decision to cycle. One method analyzes the social, economic, and spatial data and relate those data points to the method of travel (Saelens et al., 2003). Another method is the use of surveys that ask people about their personal motivator and barriers to cycling (Winters et al., 2011). Some social benefits include the reduction of pollution, the creation of a more lively urban environment, an increase in general healthiness through exercise, and more equitable transportation access (McClintock, 2002). On the individual level, people choose to ride their bicycle because it is pleasurable, fun, fast, healthy, or to obtain a greener identity. However, the person choosing to travel by bicycle may not necessarily consider that their neighbours may breathe easier because of reduced air pollution, nor do people travel by bicycle consider that others may spend less time on a highway traffic jam.

The social framework ties together research on the physical activity benefits of cycling, social perceptions of cycling, and the various aspects of calculating the costs and benefits of cycling. For urban designers, the social framework brings awareness that the factors such as the image of cycling is also an aspect that can be influenced by the design language of the built environment. In addition, public health research shows that the benefits of physical activity from cycling for transportation yields health benefits in addition to improving accessibility through better transport options.

4.3 THE EXPERIENTIAL FRAMEWORK

The experiential framework focuses on the aesthetic experience in urban design. The experiences of movement has been studied by urban designers from the perspective of the person walking and through the windshield of a car, yet there the experience of movement from the perspective of the cyclist has not been extensively studied (Forsyth and Krizek, 2011). From the walking perspective, Bosselmann (2007) writes about perceptions of time through different urban environments by representing journeys through cities around the world using pictorial sequences. From a faster perspective, “A View from the Road” analyses the highway landscapes through the perspective of the driver (Appleyard et al., 1964). Only much more recently has extensive research been conducted from the cycling perspective. Stefansdottir (2014) positions the experience of cycling in relation to a recreational and commuting purposes, drawing from theories of phenomenology of sensory perception and experience, urban design theory, and theory of environmental aesthetics. The field of mobilities studies have used mobile methods to analyse the experience of cycling, with Jones (2012) making explicit the sensory demands placed on the cyclist, and Latham and Wood (2015) viewing cycling in relation to the infrastructure that surrounds cycling.

In contrast to the land-use and transportation interaction that is studied closely by public health and urban planners, the field of urban design has its focus on the aesthetic qualities of urban space. However, much of this aesthetic study is done using stationary methodology, where the researcher observes space and other people’s activities from a fixed point. Using stationary methodologies, urban designers are well versed in concepts such as mental maps, activities programming, wayfinding, and contact between people. Lynch (1960) also highlights the individual’s subjective relationship to the built environment using the urban design the concept of “legibility”, and Koseoglu and Onder (2011) applies Lynch’s ideas to spatial forms and physical landmarks. Although Lynch’s ideas of scales in terms of size, time, and complexity can be studied through the perspective of the cyclist, movement through space is more commonly analysed through the perspective of the pedestrian (Ewing and Handy, 2009; White, 2007) or from that of an automobile (Appleyard et al., 1964). These urban design ideas highlight that human experience of cycling cannot be fully described by physical measurements alone.

Surveys have been used to establish the human preferences of cycling infrastructure and environments. The survey approach is important because it attempts to capture the cyclist’s perspective of their interaction with the environment. Questionnaire studies asking about the preferences of current cyclists (Hunt and Abraham, 2007; Li et al., 2012), current and potential cyclists (Winters et al., 2011), and a sample of the

population (Tilahun et al., 2007). However, the survey method usually asks cyclists to recall their experience, resulting in a reflective account of people's experiences

What is notably missing in the field of urban design are techniques to observing cyclists, who experience the environment from a moving perspective, in order to understand how the particular movement of cycling can create its own meaning in relationship to space (Spinney, 2009). The most comfortable environment as perceived through a bicycle must be designed at a scale that is in between the scale of pedestrians and the scale of automobiles (Forsyth and Krizek, 2011). This pattern of scenery may be boring for the pedestrian or distracting for the driver, but is perfectly enjoyable at cycling pace. Thus, Forsyth and Krizek (2011) writes, "cyclists' speed, height and skill diversity present challenges and opportunities for urban design in terms of scale, texture and change over time."

To capture cycling experiences on a moment by moment basis, the perspective of the cyclist has recently been studied through the application of mobile methods by mobilities researchers. The use of video and ride-along interviews has been especially informative in capturing the experience of cyclists in motion (Latham and Wood, 2015). Others have focused on how cyclists mediate their exposure to the environment through devices such as headphones (Jungnickel and Aldred, 2014). By using mobile methods, the field of mobilities advances tools for exploring the user perspective of cyclists in real-time, and reveals cyclists' strategies for interacting with unpleasant aspects of infrastructure. Law and Urry (2004) argues that "existing stationary methods have difficulty dealing with the sensory – that which is subject to vision, sound, taste, smell; with the emotional – time-space compressed outbursts of anger, pain, rage, pleasure, desire, or the spiritual." The mobilities scholarship offers urban designers the tools for understanding cycling through movement, as opposed to the static interpretation of the experiential and aesthetic aspects of a city. It is through mobile methods that the tangential user motives of cyclists can be understood (Spinney, 2011).

The experiential framework ties together research in the field of mobilities and environmental psychology about perceptions of movement through the city, the legibility of space, and the sensory experience of cycling. The experiential framework focuses on the aesthetic dimension of urban space that is at the core of the urban design discipline, and recent research applies uses innovative mobile methods to understand how various elements of urban design are perceived through the perspective of the cyclist.

5 CONCLUSION: INTEGRATION OF CYCLING INTO URBAN DESIGN

Thus far, this paper has explored the boundaries of the urban design discipline, presented the potential role of urban design in articulating a platform for interdisciplinary and transdisciplinary research on cycling, and provided a review of cycling research through various frameworks. The final part of this paper concludes with a few examples of how the integration of cycling into urban design could happen.

Since Moudon (1992) and later Carmona (2014) articulated the core literature of urban design as the body of theoretical literature related to Lynch, Whyte, and Appleyard, the strength of urban design can be argued to lie within the experiential domain, with an awareness of the social issues associated with space. However, the contribution of urban designers have been largely limited to what Forsyth and Krizek (2011) expressed as the functional understanding of the requirements of cycling. Perhaps part of this problem is that

other disciplines fail to see how the more qualitative aspects of urban design knowledge can be integrated into the largely quantitative methodology of urban planning and traffic engineering, exacerbated by the siloed nature of cycling research. In addition, there is a failure to recognize how the normative theories of urban design can play a role in the design of future cities to complement the positive methods used by other disciplines to understand cities (Moudon, 1992).

From the traffic counts of transport engineers, to video ride-alongs of mobilities researchers, to the surveys about social attitudes, the largest contribution of other disciplines to urban design is in the realm of methodologies. It seems that on balance, the use of qualitative methods applied to the study of cycling is more a more recent venture, and remains less explored than the use of quantitative methods. This focus on quantitative data is evident within the functional framework derived from traffic engineering, and planning, as well as in the social framework that uses demographic and physical activity data to study cycling. On the street level, a striking contrast between the qualitative realm of urban designers and the quantitative realm of traffic engineers is given by the following example:

The immediate, close-up environment of almost all our cities is determined by curbs, asphalt, road markings, bollards, traffic signals, barriers, and signs. We will negotiate our journey into and through the city amidst a landscape fashioned by traffic engineering. The rules that govern this landscape have little in common with the special cultural history and values that will have shaped the architecture and the unique signature of place. (Hamilton-Baillie, 2004)

Here, a distinction is made between the foreground and the background of the city. In one domain, the functional control of the traffic engineers dominate. In the other domain, the aesthetic, social, and experiential priority of urban designers can be seen. The social perspective on cycling also contains both quantitative and qualitative approaches. On the one hand, there is the traditional quantitative methods of using demographic and physical activity data in correlation to quantitative measures of the urban environment such as street layout, residential density (Saelens et al., 2003). On the other hand, social researchers have also studied the qualitative image of cycling, as well as the role of social support and peer groups in people's decision to cycle (Daley and Rissel, 2011; de Geus et al., 2008) While research within the context of the functional and social frameworks employ positive methodologies, the normative values of what is measured, and implicitly promoted, is often unarticulated and uncriticised.

These new methods give urban designers the necessary tools for going beyond the utilities model of transportation planning used dominantly by transportation engineers and economists referred to as the "black box" conception of mobility referred to by Sheller and Urry (2006). In a study on cyclists' perceptions, Fernández-Heredia et al (2014) articulates:

The fact that the classic factors which determine transport user behaviour – such as cost and time – are not as influential regarding bicycles use as for other modes may indicate that these other kinds of factors of

a psycho-social type gain importance in the correct characterization of cyclist behaviour.

This reflects the mobilities critique of assigning value solely to stationary places and the utilitarian method of conceptualizing of travel as simply a matter of derived demand, used as a means to get to from origin to destination. Sheller and Urry (2006) argue that “[t]ransport researchers [...] take the ‘demand’ for transport as largely given, as a black box not needing much further investigation, or as derived from the level of a society’s income. They tend to examine simple categories of travel, such as commuting, leisure, or business as if these were separate and self-contained.” By examining the experiential and qualitative aspects of cycling using mobile methods, urban designers can look inside this black box of travel to better understand the experience of travel, and to design the built environment to improve the cycling journey.

If urban designers know more about the social and experiential aspects of cycling, then is there framework to also integrate the technical expertise of engineers into the urban design process? This comes back to the question of the normative-positive divide and the position of urban design as an interdisciplinary or transdisciplinary field of study. For urban designers to set the normative agenda to move away from engineering concepts such as efficiency, speed, and traffic density, then these functional aspects of cycling must be adequately articulated in the context of greater social goals such as accessibility, aesthetics, and diversity. The functional aspects of cycling, from lane widths to intersection design to paving materials and traffic capacity serve as the building elements of enabling the physical operation of bicycles. These functional factors alone, however, only serve as necessary, but not sufficient factors of the good and pleasant cycling experience. Other elements, such as *imageability*, *enclosure*, *human scale* (Ewing and Handy, 2009), and *perception*, *aesthetics*, *morphology* (Forsyth and Krizek, 2011) are qualitative criteria, each consisting of numerous variables, yet it is precisely because these elements are not subject to direct numerical measurement that urban designers have the opportunity to apply qualitative methods of research and design. This provides the opportunity for urban design to integrate the functional, social, and experiential frameworks of cycling with research methodologies from multiple disciplines into a more complete understanding of cycling, mobility, and space.

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